Ann. Acad. Med. Siles. (online) 2016; 70: 256–264
eISSN 1734-025X
DOI:10.18794/aams/66867

PRACA ORYGINALNA
ORIGINAL PAPER

Physical activity in pregnancy and its impact on duration of labor and postpartum period

Aktywność fizyczna w okresie ciąży i jej wpływ na czas trwania porodu oraz połogu

Anna Brzęk[1], Beata Naworska[2], Kamila Plasun[1], Anna Famuła[1], Weronika Gallert-Kopyto[3], Violetta Skrzypulec-Plinta[4], Michał Michalski[1], Zbigniew Sprada[5], Ryszard Plinta[5]

[1] Department of Kinesiology Chair of Physiotherapy, School of Health Sciences in Katowice, Medical University of Silesia in Katowice, Poland

[2] Department of Gynaecology and Obstetrics, School of Health Sciences in Katowice, Medical University of Silesia in Katowice, Poland

[3] Department of Physiotherapy Chair of Physiotherapy, School of Health Sciences in Katowice, Medical University of Silesia in Katowice, Poland

[4] Department of Women's Disease Control and Prevention, School of Health Sciences in Katowice, Medical University of Silesia in Katowice, Poland

[5] Department of Adapted Physical Activity and Sport Chair of Physiotherapy, School of Health Sciences in Katowice, Medical University of Silesia in Katowice, Poland

ABSTRACT

OBJECTIVES: The aim of the work was to assess the level of physical activity of women before and during pregnancy and to determine whether physical exercise influences the course and duration of labor and the postpartum period.
MATERIAL AND METHODS: The study encompassed 63 pregnant women aged 19–36, with a mean pregnancy weight gain of 7–27 kg, no contraindication to physical activity, and term birth. Physical activity was assessed at three stages: before and during pregnancy, and during the postpartum period, with the use of the seven-day international IPAQ questionnaire. The respondents' physical condition in the postpartum period was assessed with an original 26-item questionnaire.
RESULTS: The self-assessed level of physical activity before pregnancy was moderate in most respondents (60.3%); only 12.7% of the respondents declared a low level of physical activity. During pregnancy the level of physical activity decreased in 25.4% of the respondents and significantly reduced in 11%. Women who were inactive before pregnancy remained inactive during pregnancy. The mean duration of the second stage of labor in women with moderate and high levels of physical activity was 43.61 min. The length of the entire postpartum period was the shortest (four weeks) in active women.
CONCLUSIONS: Physical activity before and during pregnancy has an impact on the duration of labor and the postpartum period.

KEY WORDS
physical activity, exercise, pregnancy, labor, postpartum, antenatal classes

Received: 14.10.2016 **Revised:** 14.10.2016 **Accepted:** 09.11.2016 **Published online:** 12.12.2016

Address for correspondence: Anna Brzęk, PhD, PT, Department of Kinesiology Chair of Physiotherapy, School of Health Sciences in Katowice, Medical University of Silesia in Katowice, Poland, ul. Medyków 12, 40-754 Katowice, tel. +48 32 208 87 21, e-mail: aniabrzek@interia.pl

STRESZCZENIE

CEL PRACY: Celem pracy była ocena poziomu aktywności fizycznej kobiet przed i w trakcie ciąży oraz ustalenie, czy aktywność fizyczna wpływa na trwanie porodu i okres połogu.
MATERIAŁ I METODY: Badania przeprowadzono na 63 kobietach w ciąży w wieku 19–36 lat bez przeciwwskazań do aktywności fizycznej, u których odnotowano przyrost ciężaru ciała pomiędzy 7–27 kg. Poziom aktywności fizycznej mierzono trzykrotnie: przed i w trakcie ciąży oraz podczas połogu. W tym celu użyto kwestionariusza IPAQ – wersji siedmiodniowej oraz dodatkowo autorskiego kwestionariusza ankiety składającego się z 26 pytań.
WYNIKI: Poziom aktywności fizycznej przed ciążą był u większości badanych kobiet umiarkowany (60,3%), tylko 12,7% kobiet deklarowało niski poziom aktywności fizycznej. W trakcie trwania ciąży poziom tej aktywności obniżył się w 25,4% przypadków i istotnie zmniejszył w 11%. Kobiety, które były nieaktywne przed ciążą, pozostały nieaktywne również w okresie jej trwania. Średni czas II etapu porodu u kobiet o średnim i wysokim poziomie aktywności fizycznej wynosił 43,61 min. Długość okresu połogu była krótsza u kobiet aktywnych i twała średnio 4 tygodnie.
WNIOSKI: Aktywność fizyczna przed ciażą i w trakcie jej trwania ma wpływ na fazy porodu oraz długość okresu połogu.

SŁOWA KLUCZOWE
aktywność fizyczna, ćwiczenia, ciąża, poród, połóg, szkoła rodzenia

INTRODUCTION

Pregnancy triggers extensive adaptive changes in the woman's body. Correct adjustment of all the affected systems, i.e. circulatory, digestive, respiratory, secretory, genitourinary and the central nervous systems, is a condition for a healthy pregnancy [1].
As the pregnancy progresses, the relatively rapid weight gain, combined with endocrine changes and mood fluctuations, cause the woman to limit her daily physical activity [2,3]. This may sometimes lead to total akinesia [4], the consequences of which have been proven to have a more negative effect in pregnant than in non-pregnant women [5].
Physical activity improves cardiovascular and respiratory functions and enhances metabolic mechanisms. It increases exertion tolerance and the predisposition to high-intensity effort [6,7,8,9]. Physical performance is usually measured in terms of maximal oxygen consumption (VO2 max), with the typical value for healthy young people being 45–55 ml/kg/min. The higher the VO2 max value, the longer the body is able to sustain considerable physical effort without homeostatic imbalance. Physical activity that is too strenuous or too long may lead to excess VO2 max. The resulting anaerobic condition can be dangerous with respect to the effort required during childbirth and leads to a reduced pH of the system [10]. Early involvement of the anaerobic metabolism of stress causes less efficient use of oxygen delivered to the working muscles.
From the biophysical point of view, delivery is associated with intense muscle work: the smooth muscles contract to dilate the cervix and the skeletal muscles intensify the intrauterine pressure. Childbirth can thus be considered a specific category of physical exertion, requiring considerable effort and associated with extensive physiological changes [11].
Pregnant women should maintain a functional balance through physical exercise with aerobic metabolism [12]. This can prevent excessive fluctuations of homeostasis and protect against the development of metabolic acidosis. The VO2 max of pregnant women is affected by physical training [9,13,14,15,16].

PURPOSE OF THE STUDY

The aim of the work was to assess the level of physical activity of women before and during pregnancy as well as to determine whether physical exercise influences the course and duration of labor and the postpartum period.

MATERIALS AND METHODS

The study encompassed 63 pregnant women aged 19––36 ($X = 25.51 \pm 3.38$), with a mean pregnancy weight gain of 7–27 kg ($X = 16.28$ kg ± 4.48 kg), no contraindication to physical activity, and term birth. The respondents' level of education was tertiary (48%) and secondary (52%). Half of the participants were professionally active.
The respondents' physical activity was assessed at three stages: before pregnancy (Study I), during pregnancy (Study II), and during the postpartum period (Study III). Physical activity was assessed using the seven-day international IPAQ questionnaire involving

work-related professional activity, backyard and domestic activities, transportation activities and leisure time activities. The respondents' physical condition in the postpartum period was assessed with an original 26-item questionnaire [17]. The study exclusion criteria were: pregnancy pathology restricting or preventing physical activity, multiparous pregnancy and caesarean section. The study was approved by the Bioethics Committee of the Institutional Review Board of the University where this study took place. All the participating women provided written informed consent prior to the study, including enrollment and data collection. The respondents' average daily and weekly energy expenditure was calculated in METs and divided into one of three categories: LOW, MODERATE, or HIGH. Data regarding the type of sports discipline/physical activity, how the activity changed, and the women's self-reported assessment of their activity were used for comparative analysis between stage I (before pregnancy) and stage II (during pregnancy). The data were compiled in one database and then analyzed using Excel spreadsheet and Statistica StatSoft v. 10.

The respondents' profile of physical activity was determined. The changes in parameters obtained from analysis of the IPAQ questionnaire before and during pregnancy were analyzed. The impact of those changes on the duration of phase I and phase II of labor and on the duration of confinement was also studied. Descriptive statistics were used for data analysis. The t-test for dependent samples was used to compare the mean values. The relationship between the nonparametric variables was assessed with the χ^2 test and the Spearman Rang test. The level of significance for all the analyses was $p < 0.05$ [18].

RESULTS

Study I – before pregnancy

The self-assessed level of physical activity of the majority (60.3%) of the respondents was moderate (exercise at least three times a week with high intensity physical activity of at least 20 min, total energy expenditure of at least 600 MET min/week). A high level of activity was declared by 27% of the respondents (exercise three times a week with a total of 1,500 MET min/week or 7 times a week with a total of 3,000 MET min/week. Only 12.7% of the respondents declared a low level of physical activity.

Women with tertiary education presented a more informed approach to issues relating to physical activity and this relationship was statistically significant ($X2 = 7.62$, $p < 0.022$, $df = 2$). The respondents' level of physical activity was not related to age ($R = 0.004$, $p > 0.94$) or body weight ($R = 0.15$, $p > 0.21$). The daily energy expenditure ranged from 284.78 to 5,626.28 ($x = 1,960.8 \pm 1,436.3$) and was significantly different between the two extreme groups of LOW and HIGH categories ($t = 6.08$, $p < 0.00003$). The weekly expenditure was 1,993.5–9,798.0 MET min/ /week in the LOW category, 4,116.43–39,384 in the MODERATE category and 9,798.0–39,384 MET min/week in the HIGH category (Tab. I).

The most common forms of activities were: outdoor walking (34.92%), stationary cycling and organized fitness classes (36.5%). Only 3.2% of the respondents indicated swimming. During weekdays, the respondents spent from 75 to 720 min. per day in the sedentary position ($x = 311.21 \pm 143.68$); during weekends the time was between 329.71 and 177.57 min.

Study II – during pregnancy

The level of physical activity during pregnancy decreased in 25.4% of the respondents and was significantly reduced in 11%. Women who were inactive before pregnancy also remained inactive during pregnancy. The limitations in activity were slight and their distribution among the respondents unspecific. None of the respondents significantly increased her level of physical activity. In the third trimester of pregnancy, the intensity of physical activity decreased significantly but the variety of forms of activity increased. The most popular were yoga, Pilates, and prenatal fitness classes (42.85%). A shift from the High category to the Low category was observed in two respondents only. The distribution of respondents before and in the 3rd trimester of pregnancy is shown in Figure 1. The change in activity level was not related to body weight gain in the third trimester (Spearman $R = 0.04$, $p > 0.71$).

The decline in physical activity in the third trimester ranged from 100 min to 18,262 min ($x = 6,056.94 \pm 4,442.39$). A downward trend was observed in each category. Physical activity decreased by 50.19% in the LOW category and by 45.13% in the MODERATE category. In more than half of the respondents, the mean time spent in the sedentary position increased by 90% on weekdays and decreased significantly at weekends (by 73%) compared to the pre-pregnancy data.

Labor

Based on the results of the IPAQ questionnaire, the longest duration of the first stage of labor was observed in the physically inactive women. In the largest group of respondents, i.e. with a moderate level of activity, the first stage of labor lasted between 90 and 720 min ($x = 272.76 \pm 196$) and was not significantly different from the very active group ($t = 0.001$,

p > 0.94) or the inactive group (t = 0.12, p > 0.89). The duration of the first stage of labor was not related to the decrease in physical activity in MET in the third trimester compared to the period before pregnancy (R = 0.15, p > 0.23). Physical activity (MET min/week) in the third trimester was related to the level of pre-pregnancy activity (Fig. 2).

The mean duration of the second stage of labor in women with moderate and high levels of physical activity was 43.61 min. In some women with low activity, the duration was even 88.89% longer; however, the difference was not statistically significant (Tab. II).

Surprisingly, the majority of the respondents, including 42% of the active women, did not attend antenatal classes. Participation in antenatal classes was related to the level of physical activity during pregnancy (Spearman R 0.25, p < 0.04).

Table I. Minimum values (Min), maximum values (max), arithmetic means (X) and standard deviations (SD) of energy expenditure in women in each category before pregnancy and during pregnancy
Tabela I. Wartości minimalne (min), maksymalne (max), średnia (X) i odchylenie standardowe (SD) wydatku energetycznego MET w grupie kobiet przed i w okresie ciaży z uwzględnieniem poziomu aktywności fizycznej wg IPAQ

Physical activity	IPAQ Category											
	LOW				MODERATE				HIGH			
	min	max	mean	SD	min	max	mean	SD	min	max	mean	SD
W_1 (3.5 MET) Walking Intensity	1122	7128	2844.2	1948.6	693	17424	4732.9	3774.9	3069	17424	9718.5	5349.1
W_2 (3.5 MET) Walking Intensity	495	5940	2178	1681.1	396	8514	3139.5	2334.2	330	8415	4814.8	2274.1
t	t = 1.51				**t = 3.3[b]**				**t = 3.65[b]**			
M_1 (4.0 MET) Moderate Intensity	360	5640	1666.3	1734.4	660	16200	4600.3	3385.1	4470	16200	10482.2	4429.9
M_2 (4.0 MET) Moderate Intensity	60	3360	1080	1148.6	340	10050	2291.9	2034.8	210	11880	3652.2	3418.1
t	t = 2.11				**t = 4.34[c]**				**t = 5.05[c]**			
V_1 (8.0 MET) Vigorus Intensity	–	–	–	–	480	8640	3040	2251.4	640	9120	4705	2790.4
V_2 (8.0 MET) Vigorus Intensity	–	–	–	–	960	4000	1960	1378.7	640	2700	1440	914.5
t	–				t = 1.0				t = 2.4			
Daily energy expenditure$_1$	284.78	1399.7	644.34	425.6	588	5626.3	1516.7	1013.4	1399	5626.3	3483.3	1274.6
Daily energy expenditure$_2$	122.14	1050	465.4	293.9	185.3	2262	805.4	549.6	77.14	2608.9	1263.9	714.4
t	t = 2.1				**t = 5.05[c]**				**T = 6.21[c]**			
Weekly energy expenditure$_1$	1993	9798	4510.4	2057.5	4116	39384	10617.4	7093.7	9798	39384	24382.9	8922.6
Weekly energy expenditure$_2$	855	7350	3258	2979.1	1297	15834	5638.1	3846.9	540	18262	8847.1	5000.8
t	t = 2.1				**t = 5.05[c]**				**t = 6.21[c]**			

[a] $p < 0.05$; [b] $p < 0.01$; [c] $p < 0.0001$

[1] study I (before pregnancy); [2] study II in 3rd trimester of pregnancy

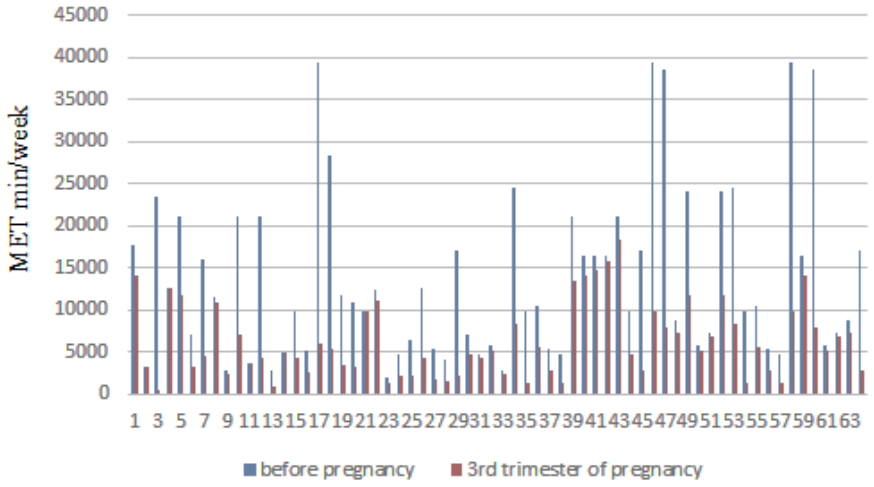

Fig. 1. Distribution of respondents before and in 3rd trimester of pregnancy including MET.
Ryc. 1. Rozkład badanego materiału pod względem wartości MET przed okresem ciąży oraz w trzecim trymestrze ciąży.

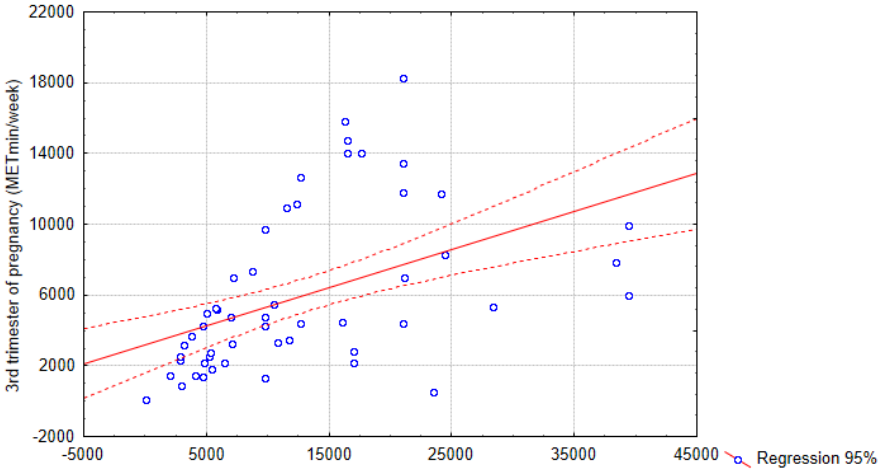

Fig. 2. Relationship between weekly energy expenditure in MET min/week in 3rd trimester of pregnancy to pre-pregnancy period.
Ryc. 2. Korelacja pomiędzy tygodniowym wydatkiem energetycznym w MET min/tydzień w 3 trymestrze ciąży a okresem przed ciążą.

Table II. Minimum values (min), maximum values (max), arithmetic means (X) and standard deviations (SD) in duration of particular phases of labor and postpartum period in each category
Tabela II. Wartości minimalne (min), maksymalne (max), średnia (X) oraz odchylenie standardowe (SD) w poszczególnych fazach porodu oraz okresie połogu z uwzględnieniem poziomu aktywności fizycznej

Phase of labor low	Category LOW				Category MODERATE				*P*
	min	max	X	SD	min	max	X	SD	
I (min)	120	720	316.33	184.88	90	720	257.29	172.67	0.19
II (min)	5	120	44.5	31.63	5	180	43.08	41.77	0.88
Duration of puerperium (weeks)	5	9	6.63	1.32	4	8	5.58	1.07	0.0009[b]

[a] $p < 0.05$; [b] $p < 0.01$; [c] $p < 0.0001$

Study III – postpartum period

The length of the entire postpartum period was the shortest (four weeks) in active women (Tab. II). It was related to the intensity of physical activity before pregnancy ($R = -0.31$, $p < 0.012$) and activity in the third trimester of pregnancy ($R = -0.33$, $p < 0.007$). It was not related to age ($R = -0.07$, $p > 0.58$) or weight loss during the postpartum period ($R = -0.05$, $p > 0.65$). Women with the lowest level of physical activity had the smallest weight loss ($t = 2.01$, $p < 0.049$); this was probably due to the high pregnancy weight gain, which was 32% higher than in active women.

DISCUSSION

The modern concept of health is not just the absence of disease but rather a state of general well-being [18]. Half of the factors determining health status are associated with an appropriate lifestyle, including physical activity [19]. Although pregnancy is not a disease, it temporarily affects the woman's physiological system and has an impact on health-related fitness [20]. A rapid weight gain may adversely affect physical activity. In the presented study, the weight gain was 7–27 kg, regardless of the type of physical activity. The course of pregnancy and childbirth have a huge impact on the newborn's health status. Many abnormalities that prevent a spontaneous delivery can be determined only during the actual birth; this increases the risk of perinatal injuries to both the mother and the baby [5,20,21].

Mother-related perinatal traumas include uterine atony, difficulty in separation and expulsion of the placenta, as well as uterine, cervical, vaginal and perineal rupture. Perinatal asphyxia is one of the most common causes of neonatal death [22] and the leading cause of neurological disorders in later life. Perinatal asphyxia is a collection of symptoms resulting from disorders associated with tissue oxygenation in the first and second stage of labor. Mechanical traumas of childbirth [23] include injuries to the newborn resulting from force (a physical factor, usually pressure) from childbirth. According to many authors, the risk factors include: a large fetus (macrosomia) [24], prematurity, obstetric procedures, abnormal fetal position, the structure of the reproductive organs, prolonged labor, emergency delivery [9,10]. Extracranial injuries include: hemorrhagic edema of the soft tissues of the periosteum as a result of compression of blood vessels, subperiosteal hematoma which is formed by the accumulation of blood in the intracranial space following the continuity of blood vessels, damage to the skin and subcutaneous tissue of various sizes and depths (scratches, bruises, wounds with breaking of subcutaneous tissue), cranial injuries – fractures – as a consequence of surgical births, coexisting with other injuries, mostly in the area of the parietal bone [13,14, 25,26].

In view of the above, substantial effort has been put into shortening the duration of labor as an important factor in reducing perinatal risks to both the mother and her baby. However, research indicates that the need to shorten the second stage of labor is a stereotype and rarely occurs [15,16,27,29]. Baranowska, a midwife at the Childbirth with Dignity Foundation [16], reports that the mean duration of the second stage of labor with directed pushing was 46 minutes whilst in women following their own spontaneous urge, the duration was 59 minutes. The longer duration of labor [29] in the second group had no adverse effect on the health of the mother or the baby. By contrast, the directed thrust (the Valsalva maneuver) [30] has been shown to cause perineal injury, acid-base disorders and short-term fetal hypoxia [31].

In some cases, however, there is a justified need to shorten the second stage of labor [32]. Many of the factors affecting the duration of labor are beyond our control, such as intra-individual characteristics, pelvic parameters, or fetal size. Surgical or obstetric interventions, such as episiotomy, caesarean section, or the Kristeller maneuver are often necessary to shorten the delivery time. At the same time, if performed without medical grounds, the risks of these interventions outweigh the benefits [33,34]. In our study, episiotomy was performed in 66.6% of the women; the mean duration of the second stage of labor in that group was 42.3 minutes and was not statistically different from the group without episiotomy. According to the data of the Childbirth with Dignity Foundation, one in two gravidae in Poland, including almost all primigravidae, undergo episiotomy. In total, the procedure is performed in 80% of Polish women. By contrast, the percentages of births with episiotomy in other countries are much lower: 33% in the U.S., 12% in the UK, 11% in New Zealand, and less than 10% in Sweden.

Less invasive and safer solutions for shortening the second stage of labor have been sought. Research shows that in some women it is possible to reduce the delivery time by introducing regular physical activity [21,35,36]. Properly trained pelvic floor muscles are more flexible and more resistant to damage, whilst systematically trained skeletal muscles are able to generate more power. In physiological conditions, this method is safe, non-invasive and preventive in nature. In the absence of contraindications, pregnant women can continue practicing various forms of physical activity, professionally adapted to their stage of pregnancy [37,38,39].

The increasingly accessible antenatal classes are another option. A comprehensive program of antenatal

classes includes issues regarding physical activity during pregnancy, the theory and practice of Kegel exercise, and the role of breathing exercises [40]. Additionally, antenatal schools prepare future parents for changes relating to the postpartum period, teach self-care during this period and offer physical exercises designed for each of the three periods of confinement to aid faster recovery and return to the pre-pregnancy shape [16,34,41]. One of the basic premises of antenatal classes is to prepare parents to actively participate in childbirth, which is seen as harmonized work of both the mother and the father. Indeed, increasingly more emphasis is being put on the man's role and it is increasingly common for both expectant parents to attend classes. Before the 1990s, only 5% of Polish women attended antenatal classes. In 2010, nearly 25% of all expectant parents participated in classes organized by one of nearly 400 antenatal schools in Poland [34]. In our study, only 42% of the women (mainly women with a high or medium level of activity before pregnancy) participated in antenatal classes. Women who have attended antenatal classes are able to manage labor better and cooperate with the medical staff more effectively [16,34,41]. Women increasingly more frequently decide to maintain an active lifestyle throughout pregnancy. Many fitness clubs offer a range of trimester-specific prenatal classes. However, although pregnancy is not a disease, some precautions should be taken, especially when doing Pilates [42], yoga [43] or ball exercises [44]. The most appropriate form of activity should be chosen individually for each woman in consultation with her doctor who, guided by his/her knowledge and experience, will propose a safe form of exercise taking into account the relative contraindications.

Women can begin physical activity already in the first days after childbirth [45]. The program contains exercises adequate for each phase of confinement and is taught during antenatal classes. The purpose of these exercises is to improve the condition of the weakened and stretched muscles, to improve tension within the abdominal and pelvic floor muscles and to improve sphincter function.

According to Fijałkowski [16,34,46], a woman will not be able to maintain correct posture and will no longer be able to achieve proper tension within the muscular system involving abdominal organs unless she starts appropriate exercises within 6–12 weeks after delivery. Excessive stretching of the soft structures of the musculoskeletal system, which occurs during pregnancy, may result in future pelvic organ prolapse and stress urinary incontinence. Systematic exercise prevents such complications and has a positive effect on the woman's well-being.

There is a paucity of data regarding the impact of physical activity on the duration of labor. Further research in this area is warranted.

CONCLUSIONS

The level of physical activity in the third trimester of pregnancy decreased.

The level of physical activity before pregnancy affected the intensity of physical activity during pregnancy.

The duration of each stage of labor varied slightly between physically active and inactive women.

Women with a high intensity of physical activity participated in antenatal classes.

The intensity of physical activity before and during pregnancy had an impact on the duration of the postpartum period.

Implications for Practice

Women increasingly more frequently decide to maintain an active lifestyle also in pregnancy. The choice of suitable exercises should be made with the help of a physiotherapist. Physical activity before and during pregnancy has an impact on the duration of labor and the postpartum period.

Conflict of Interest

The authors report no conflicts of interest**.** This research did not receive any specific grant from funding agencies in public, commercial, or non-profit sectors.

Ethical Approval

The study was approved by the Bioethics Committee of the Medical University of Silesia (Resolution No. KNW/0022/KB1/144/10 on 07/12/2010). All the participating women provided written informed consent prior to the study, including enrollment and data collection.

Author's contribution

Study design – A. Brzęk, K. Plasun, R. Plinta
Data collection – A. Brzęk, K. Plasun, M. Michalski, R. Plinta
Data interpretation – A. Brzęk, K. Plasun, V. Skrzypulec-Plinta
Statistical analysis – A. Brzęk, A. Famuła, B. Naworska, V. Skrzypulec-Plinta
Manuscript preparation – A. Brzęk, K. Plasun, R. Plinta, Z. Sprada, W. Gallert-Kopyto
Literature research – A. Brzęk, W. Gallert-Kopyto, A. Famuła, Z. Sprada

REFERENCES

1. Shloim N., Hetherington M.M., Rudolf M., Feltbower RG. Relationship between body mass index and women's body image, self-esteem and eating behaviours in pregnancy: a cross-cultural study. J. Health Psychol. 2015; 20: 413–426.

2. Hegaard H.K., Damm P., Hedegaard M., Henriksen T.B., Ottesen B., Dykes A.K., Kjaergaard H. Sports and leisure time physical activity during pregnancy in nulliparous women. Matern. Child. Health. J. 2011; 15(6): 806––813.

3. Ning Y., Williams M.A., Dempsey J.C., Sorensen T.K., Frederick I.O., Luthy D.A. Correlates of recreational physical activity in early pregnancy. J. Matern. Fetal Neonatal Med. 2003; 13(6): 385–393.

4. Lindqvist M., Lindkvist M., Eurenius E., Persson M., Ivarsson A., Mogren I. Leisure time physical activity among pregnant women and its associations with maternal characteristics and pregnancy outcomes. Sex. Reprod. Healthc. 2016; 9: 14–20.

5. Gavard J.A., Artal R. Effect of exercise on pregnancy outcome. Clin. Obstet. Gynecol. 2008; 51(2): 467–480.

6. Domenjoz I., Kayser B., Boulvain M. Effect of physical activity during pregnancy on mode of delivery. Am. J. Obstet. Gynecol. 2014; 211(4): 401, e1–11.

7. Morgan K.L., Rahman M.A., Hill R.A., Zhou S.M., Bijlsma G., Khanom A., Lyons R.A., Brophy S.T. Physical activity and excess weight in pregnancy have independent and unique effects on delivery and perinatal outcomes. PLoS One 2014; 9(4): e94532.

8. Myers J. Exercise and Cardiovascular Health. Circulation 2003; 7: 1–4.

9. Czarkowska-Pączek B., Przybylski J. Zarys fizjologii wysiłku fizycznego [Physiology otline of physical exercises]. Elsevier Urban & Partner. Wrocław 2006.

10. Traczyk W., Trzebski A. Fizjologia człowieka z elementami fizjologii klinicznej [Human Physiology with applied physiology and clinical elements]. Wydawnictwo Lekarskie PZWL. Warszawa 2003.

11. Barakat R., Perales M. Pregnancy, Physical Activity, Functional Capacity and Adaptations to Exercise. Current Women's Health Reviews 2015; 11(1): 13–18.

12. Szumilewicz A., Wojtyła A., Zarębska A., Drobnik-Kozakiewicz I., Sawczyn M., Kwitniewska A. Influence of prenatal physical activity on the course of labour and delivery according to the new Polish standard for care. Ann. Agric. Environ. Med. 2013; 20(1): 380–389.

13. Dudzik I. Antenatal classes under special supervision. Infor. Warszawa 2010.

14. Bartelmus E. Kinezyterapia pozycyjna, oddechowa, techniki sprężystego odkształcania tkanek stosowane podczas pierwszej fazy porodu [Kinezytherapy positional and respiratory and techniques of elastic deformation of tissues used during I Phase of birth]. Rehabilitation in Practice 2010; 4: 24–27.

15. Baston Hall J. Podstawy położnictwa. Przed Porodem [Basics of obstetrics. Before birth]. Elsevier Urban & Partner. Wrocław 2011.

16. Ćwiek D., Augustyniak K., Branecka-Woźniak D. Szkoły Rodzenia [Antenatal classes]. Wydawnictwo Lekarskie PZWL. Warszawa 2010.

17. Pate R.R., Pratt M., Blair S.N., Haskell W.L., Macera C.A., Bouchard C. et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. Journal of American Medical Association 1995; 273(5): 402–407.

18. Leischik R., Dworrak B., Strauss M., Przybylek B., Dworrak T., Schöne D., Horlitz M., Mügge A. Plasticity of Health. German Journal of Medicine 2016; 1: 11–17.

19. Danielsen K.K., Svendsen M., Mæhlum S., Sundgot-Borgen J. Changes in body composition, cardiovascular disease risk factors, and eating behavior after an intensive lifestyle intervention with high volume of physical activity in severely obese subjects: a prospective clinical controlled trial. Hindawi Publishing Corporation J. Obes. 2013; 325464.

20. Wojtyla A., Kapka-Skrzypczak L., Paprzycki P., Skrzypczak M. Epidemiological studies in Poland on effect of physical activity of pregnant women on the health of offspring and future generations – adaptation of the hypothesis development origin of health and diseases. Ann. Agric. Environ. Med. 2012; 19(2): 315–326.

21. Royal College of Obstetricians and Gynecologists. Exerc. Pregnancy 2006; 4: 1–7.

22. Azzopardi D., Strohm B., Marlow N., Brocklehurst P., Deierl A., Eddama O., Goodwin J., Halliday H.L., Juszczak E., Kapellou O., Levene M., Linsell L., Omar O., Thoresen M., Tusor N., Whitelaw A., Edwards A.D. Effects of Hypothermia for Perinatal Asphyxia on Childhood Outcomes. N. Engl. J. Med. 2014; 371: 140–149.

23. Reed R.C. Mechanical traumas of childbirth include injuries to the newborn resulting from force. Semin. Perinatol. 2015; 39(1): 64–69.

24. Boulvain M., Senat M.V., Perrotin F. Winer N., Beucher G., Subtil D., Bretelle F., Azria E., Hejaiej D., Vendittelli F., Capelle M., Langer B., Matis R., Connan L., Gillard P., Kirkpatrick C., Ceysens G., Faron G., Irion O., Rozenberg P. Induction of labour versus expectant management for large-for-date fetuses: a randomised controlled trial. Lancet 2015; 385, 9987: 2600–2605.

25. 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: 6–12.

26. Ballard C.G., Stanley A.K., Brockington I.F. Post-traumatic stress disorder (PSTD) after childbirth. Br. J. Psychiatry 1995; 166: 525–528.

27. Physical activity and exercise during pregnancy and the postpartum period. Committee Opinion No 650. American College of Obstetricians and Gynecologists. Obstet. Gynecol. 2015; 126: e135–142.

28. Bloom S.A., Casey B.M., Schaffer J.I., McIntire D.D., Leveno K.J. Randomized trial of coached versus uncoached maternal pushing during the second stage of labor. Am. J. Obstet. Gynecol. 2006; 194(1): 10–13.

29. Harper L., Caughey A., Odibo A., Roehl K.A., Zhao Q., Cahill A.G. Normal Progress of Induced Labor**.** Obstetrics Gynecology 2012; 119(6): 1113–1118.

30. Abogamal A. Evaluating the effect of Valsalva maneuver on pain occurring during knee injection: A prospective, randomized study. Orthop. Reumatol. 2016; 5(2): 00176.

31. Pisarski T. Ginekologia i Położnictwo [Gynecology and Obstetrics]. Wydawnictwo Lekarskie PZWL. Warszawa 2002.

32. Suhitharan T., Pham T.P., Chen H., Assam P.N., Sultana R., Han N.L., Tan E.C., Sng B.L. Investigating analgesic and psychological factors associated with risk of postpartum depression development: a case–control study. Neuropsychiatr. Dis. Treat. 2016; 12: 1333–1339.

33. Merhi Z.O., Awonuga A.O. The role of uterine fundal pressure in the management of the second stage of labor: a reappraisal. Obstet. Gynecol. Surv. 2005; 60(9): 599–603.

34. Ćwiek D., Grochans E., Łuczyńska V., Szych Z. Wpływ edukacji przedporodowej na stosowanie metod zmniejszających odczuwalność bólu w czasie porodu [The influence of antenatal education on usage the reducting pain methods during the childbirth]. UMCS Sect. B 2004; 59, Supl. 14, 1: 375–380.

35. Currie S., Sinclair M., Murphy M.H. Reducing the Decline in Physical Activity during Pregnancy: A Systematic Review of Behaviour Change Interventions. PLoS One 2013; 8(6): e66385.

36. Foxcroft K.F., Rowlands I.J., Byrne N.M., McIntyre H.D., Callaway L.K. Exercise in obese pregnant women: the role of social factors, lifestyle and pregnancy symptoms. BMC Pregnancy Childbirth 2011; 11: 4.

37. Poudevigne M.S., O'Connor P.J. A review of physical activity patterns in pregnant women and their relationship to psychological health. Sports Medicine 2006; 36: 19–38.

38. Borodulin K., Evenson K.R., Wen F., Herring A.H., Benson A. Physical activity patterns during pregnancy. Med. Sci. Sports Exerc. 2008; 40(11): 1901–1908.

39. Evenson K.R., Savitz A., Huston S.L. Leisure-time physical activity among pregnant women in the US. Paediatr. Perinat. Epidemiol. 2004; 18: 400–407.

40. Dönmez Sevgul, Kavlak Oya. Effects of Prenatal Perineal Massage and Kegel Exercises on the Integrity of Postnatal Perine. Health 2015; 7(4): 495––505.

41. Lewicka M., Sulima M., Kanadys K., Stawarz B., Wiktor H. Indywidualne przygotowanie par do macierzyństwa i ojcostwa przez położne rodzinne [Individual Preparation of Couples to Maternity and Paternity]. Annals of Family Studies 2013; 5(60): 261–273.

42. Uppal E., Manley J., Schofield A. Pilates for pregnancy and beyond: a study. Pract. Midwife 2016; 19(5): 25–27.

43. Bribiescas Saleena. Yoga in Pregnancy. International Journal of Childbirth Education 2013; 28, 3: 99–102.

44. Yan C.F., Hung Y.C., Gau M.L., Lin K.C. Effects of a stability ball exercise programme on low back pain and daily life interference during pregnancy. Midwifery 2014; 30(4): 412–419.

45. Berk B. Recommending exercise during and after pregnancy: what the evidence says. International Journal of Childbirth Education 2014; 19: 18–22.

46. Fijałkowski W. Kinesiostimulation in obstetrics. [W:] Medical Rehabilitation. A. Kwolek. Urban & Partner. Wrocław 2003.