

EFFECTS OF PHYSICAL ACTIVITY DURING PREGNANCY AND GESTATIONAL WEIGHT GAIN ON THE NUTRITIONAL STATUS OF NEWBORNS IN WARMIŃSKO-MAZURSKIE VOIVODESHIP

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ABSTRACT

Background. Epidemiological research has identified a relationship between maternal physical activity, early nutrition and infant birth weight with likelihood of developing future diseases. The aim of the study was to determine a relationship between gestational weight gain and physical activity during pregnancy to the nutritional status of newborns.

Material and methods. The presented study was conducted in the period from February 2010 until November 2012 in the gynecological and obstetric clinics in Warmińsko-Mazurskie voivodeship with various levels of reference. The research subjects included 510 women in the puerperal period aged 18-36. The scope of the research included an assessment of the selected anthropometric parameters of both pregnant women (body mass, height, BMI, gestational weight gain) and newborns (infant birth weight, infant length, Ponderal Index), as well as an analysis of the connections between the gestational weight gain, physical activity during pregnancy and anthropometric parameters of newborns.

Results and conclusions. In the study group there was a significant percentage of women characterised by an inactive lifestyle and excessive gestational weight gain. There were significantly higher neonatal birth anthropometric parameters in women with abnormal excessive gestational weight gain than in women with normal and inappropriate – low gestational weight gain. The highest percentage of women with appropriate weight gain was observed in the group of women who are physically active, although this requires confirmation in larger population. Our studies have not shown statistically significant differences between the gestational weight gain and nutritional status of newborns in relation to the level of physical activity of pregnant women.

Key words: pregnancy, physical activity, weight gain, fetal development, birth weight

INTRODUCTION

Epidemiological research has identified a relationship between infant birth weight, maternal physical activity and nutrition with likelihood of developing

future diseases such as hypertension, diabetes, obesity, infectious, allergic, and autoimmune diseases, as well as death resulting from ischemic heart disease, relating

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all of these factors to functioning in adulthood [Ferraro et al. 2012]. Appropriate regular physical activity is a critical mediator of weight gain and weight maintenance at all ages and has been specifically identified as a predictor of excessive gestational weight gain. Maternal obesity and excessive gestational weight gain have become increasingly common and contribute to poor obstetrical outcomes for the mother and baby. Regular participation in physical activity may improve risk profiles in pregnant women [Ferraro et al. 2012].

Pregnancy is a critical period of body weight regulation. Gestational weight gain (GWG) often exceeds clinical recommendations, a situation that poses an elevated health risk to mother and fetus [Institute of Medicine 2009, Lowell and Miller 2010]. Recent findings suggest that the downstream effects of maternal physical activity may trigger beneficial adaptations to environmental stressors, which may lead to child health benefits later in life [Hopkins et al. 2010, May et al. 2010, Mottola 2009, Oken 2009]. The intrauterine environment plays a critical role in downstream child health and as such, there is a need for strategies aimed at reverting childhood adiposity by managing maternal weight gain during pregnancy.

Birth weight is an important predictor of survival and health. Infants with a low birth weight have increased risk of perinatal morbidity and mortality, as well as adulthood hypertension and type 2 diabetes [Hegaard et al. 2007, Ong 2006]. However, delivering an infant with a birth weight >4000 g increases the risk of other complications, such as shoulder dystocia, operative delivery, and birth canal lacerations [Heiskanen et al. 2006]. Furthermore, it has been associated with increased risks of certain types of diseases in adulthood, e.g. type 2 diabetes and breast cancer in women [McCormack et al. 2005].

Pregnant women are generally highly motivated to follow advice to improve the outcome of pregnancy. As such, pregnancy should be an ideal time in life to focus on a healthy lifestyle [Ferraro et al. 2012, Hegaard et al. 2007]. Not exceeding the recommended amount of weight during pregnancy minimizes the incidence of adverse outcomes, including gestational hypertension, caesarean delivery, and birth weight, independent of pre-pregnancy BMI [May et al. 2010, Oken 2009, McCormack et al. 2005]. Engaging in healthy active behaviours during pregnancy may turn

out useful to attenuating excessive weight gain, improving obstetrical outcomes, and promoting optimal fetal growth trajectories [Tremblay et al. 2010].

OBJECTIVES

The aim of the study was to determine a relationship between gestational weight gain, physical activity of the women and the nutritional status of newborns.

MATERIAL AND METHODS

The presented study was conducted during the period from February 2010 until November 2012 in the gynecological and obstetric clinics in Olsztyn voivodeship and Warmińsko-Mazurskie with various levels of reference. The research subjects included 607 women in the puerperal period aged 18-36. 510 women satisfying the requirements were accepted into the study. The scope of the research included an assessment of the selected anthropometric parameters of both pregnant women (body mass, height, BMI, gestational weight gain) and newborns (infant birth weight, infant length, Ponderal Index), as well as an analysis of the connections between the gestational weight gain in relation to physical activity.

The data on the patients' characteristics, their health status before pregnancy, gestational weight gain and pregnancy course were collected using a survey questionnaire. The data on pregnancy duration and type of delivery, as well as newborns' data, was collected from the hospital documentation.

The analysis of the results included:

- women without any known gynecological diseases or chronic metabolic disorders
- appropriate course of weight gain
- pregnancy carried out for a normal full-term (>37 weeks)
- only successful live births were accepted
- women who were non-smoking.

Informed consent of women participating in the study and agreement to participate in continuing testing

Excluded from the study were women:

- who had multiple pregnancies
- with premature delivery
- who had suffered from diabetes before pregnancy

- with hypertension diagnosed before pregnancy
- with anemia before pregnancy.

Pre-pregnancy body weights of women and gestational weight gains were determined according to American criteria, elaborated by the Institute of Medicine of the National Academy of Sciences (Table 1) [Institute... 2009]. The gestational weight gain during pregnancy represented the difference between the body weight of a woman before the pregnancy (body weight reported by the women) and the body weight measured during the last medical consultation, which was adopted as the body weight around birth.

Table 1. Recommendations of the Institute of Medicine of the National Academy of Sciences (USA) concerning gestational weight gain

Pre-pregnancy BMI kg/m ²	Recommended gestational weight gain, kg
Underweight (< 18.5)	12.5-18.0
Correct body weight (18.5-24.9)	11.5-16.0
Overweight (25.0-29.9)	7.0-11.5
Obese (≥ 30.0)	5.0-9.0

Physical activity was assessed on the basis of a questionnaire on subjective assessment as a way of lifestyle – participation in leisure activity during pregnancy, for women without contraindications to exercise. Leisure activity was assessed by asking the following question: During the past month, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise? (yes or no). If the participant answered yes, they were asked the type, frequency, and duration of the most common leisure activities performed in the past month [Evenson et al. 2004].

1. Sedentary: no voluntary physical activity, sedentary lifestyle, lack of activity
2. Light activity: physical activity 1 time per week for 30 min
3. Moderately active: physical activity 2 to 3 times per week for at least 30 min each time
4. Active: daily physical activity for at least 30 min each day.

The statistical analysis of the results was carried out using the Anova test. The results recognised as statistically significant were those with $p < 0.05$. The study project was approved by the Ethics Committee of the University of Warmia and Mazury in Olsztyn (20/2010).

RESULTS

The average age of the population was 28.1, with a large percentage of women reported to have completed some form of higher education (45.1%; Table 2). The women resided in various cities, towns and provinces. They ranged widely in their economic status with a majority of the mothers (79.2%) reporting their status as middle-class. The majority of the tested women characterised themselves to be within the appropriate body mass range before pregnancy (70.9%). 10.6% of the women were reported underweight, while 18.5% were reported to be overweight (Table 2). The majority of the births suffered no complications (55%), yet it is important to note the significant amount of births via caesarean section (45%). 87.1% of the women were giving birth for the first time, with 12.9% having previously given birth (Table 2).

The average increase in body mass during pregnancy was 15.4 kg \pm 5.8 kg of which 36% of women achieved the appropriate increase, 16.6% achieved an inappropriately low increase, and 47.4% an inappropriately high increase as compared to recommendations listed by the Institute of Medicine (IOM; Table 3). In the analysed group of women significant differences in the values of pre-pregnancy BMI, body mass, depending on the evaluation of gestational weight gain were reported. Women with abnormal higher gestational weight gain had a higher values of the analysed parameters (Table 3).

The newborns were delivered in a general state of good health (average of 9.3 \pm 1.4 points in accordance with the Apgar scale). The average birth weight, infant length and PI (Ponderal Index) indicator reported to be 3370.2 \pm 647.6 g, 54.7 \pm 3.5 cm, 20.9 \pm 2.3 kg/m³ respectively (Table 4).

Analysing gestational weight gain in comparison to average birth weight, the length of the newborn and PI score had a significant impact on all measures of the newborn (Table 4). Average birth weight of

Table 2. Characteristics of population – mothers

Characteristics	N	Percentage
Categories BMI		
Underweight	52	10.6
Correct body mass	365	70.9
Overweight	93	18.5
Education		
Elementary and career specific	95	36.3
Middle and technical	185	18.6
Higher (university degree)	230	45.1
Residence		
Suburbs	140	27.5
Small town < 50 thousand residents	138	27.1
Small city 50-100 thousand residents	68	13.3
Large city > 100 thousand residents	164	32.1
Lifestyle		
Active: daily physical activity	43	8.4
Moderately active: physical activity – 3 times per week	128	25.1
Light activity: physical activity 1 time per week	154	30.2
Sedentary: no voluntary physical activity	185	36.3
Economic status		
Below average	20	3.9
Average	404	79.2
Above average	86	16.9
First birth		
Yes	311	87.1
No	61	12.9
Method of delivery		
Physiological birth	257	55.0
Caesarean section	210	45.0

the newborn (3666.4 ±482.1 g) was clearly higher in women with improperly high body mass when compared to the newborns of women with body mass within, as well as below the recommended values (3666.4 g compared to 2750.8 & 3666.4 g compared to 3477.5 g, respectively; Table 4). Testing average length of newborns the largest differences in length were distinguishable between mothers above, as well as within, the recommended range and women below the range (55.5 ±2.7 cm compared to 52.7 ±4.2 cm & 55.5 ±2.9 cm compared to 52.7 ±4.2 cm; Table 4). Similar results were seen in PI score. Newborns of mothers with particularly low gestational weight gain had significantly lower values of PI score (19.9 ±1.9 kg/m³) than mothers within the recommended range of gestational weight gain (20.6 ±1.9 kg/m³) and significantly excessive (21.7 ±2.3 kg/m³; Table 4).

Analysing physical activity in women leading an active lifestyle, it was determined that women within the appropriate gestational weight gain made up the highest percentage (50%) of this group (Table 5). A large percentage was also from women with an inappropriate low gestational weight gain (26.7%). The smallest percentage found in this group was from women with an excessive gestational weight gain (23.3%). In the moderately active group the women with excessive weight gain made up the largest percentage (55.4%). A similar percentage (55.1%) of women with excessive weight gain made up the majority in the low activity group (Table 5). In the sedentary group, it was determined that women with excessive gestational weight gain made up 42.6%, and women with inappropriate low made up 19.1%. In general, 36.3% of the entire led a sedentary lifestyle and 30.2% a low activity lifestyle, while only 25% of women declared a moderately active and an even smaller percentage of 8.4% an active lifestyle (Table 2 and 5).

Testing the parameters of mothers and newborns as it relates to physical activity, it was determined that physically active women displayed the lowest maternal BMI and gestational weight gain. Also, the newborns of physically active women displayed the lowest mass, though there was no significant difference post analysis (Table 6).

Table 3. Gestational weight gain and the anthropometric parameters of women ($X \pm SD$)

Characteristics	Population average	Gestational weight gain (IOM)			<i>p</i>
		inappropriate low <i>N</i> = 85	appropriate <i>N</i> = 184	excessive <i>N</i> = 241	
Pre-pregnancy body mass, kg	62.2 ±12.1	57.1 ±6.7	60.6 ±14.5	65.3 ±10.7	s
Height, cm	166.6 ±5.7	165.4 ±5.9	167.5 ±6.1	166.3 ±5.2	ns
Pre-pregnancy BMI, kg/m ²	22.4 ±3.9	20.9 ±2.2	21.5 ±4.2	23.6 ±3.8	s
Body mass before birth, kg	78.2 ±13.1	67.0 ±7.4	73.9 ±12.9	85.4 ±10.5	s
Gestational weight gain, kg	15.4 ±5.8	9.9 ±3.1	13.7 ±3.0	20.1 ±4.6	s

X – mean, *SD* – standard deviation.

Table 4. Gestational weight gain and the anthropometric parameters of the newborn ($X \pm SD$)

Characteristics	Population average	Gestational weight gain (IOM)			<i>p</i>
		inappropriate low <i>N</i> = 85	appropriate <i>N</i> = 184	excessive <i>N</i> = 241	
Infant birth weight, g	3 445.7 ±657.8	2 750.8 ±788.6	3 477.5 ±574.6	3 666.4 ±482.1	s
Infant length, cm	55.1 ±3.2	52.7 ±4.2	55.5 ±2.7	55.5 ±2.9	s
Ponderal index, kg/m ³	20.9 ±2.2	19.9 ±1.9	20.6 ±1.9	21.7 ±2.3	s
Apgar scale	9.4 ±1.4	8.4 ±2.3	9.7 ±0.8	9.4 ±1.2	s

X – mean, *SD* – standard deviation.

Table 5. Physical activity and gestational weight gain

Gestational weight gain	Physical activity							
	active		moderately active		light activity		sedentary	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Inappropriate low	22	26.7	16	12.1	18	11.1	31	19.1
Appropriate range	41	50.0	44	32.5	40	30.8	64	38.3
Excessive	18	23.3	74	55.4	71	55.1	71	42.6

Table 6. Anthropometric parameters of mothers and newborns in relation to physical activity during pregnancy

Characteristics	Physical activity				<i>p</i>
	active	moderately active	light activity	sedentary	
	<i>X</i> ± <i>SD</i>	<i>X</i> ± <i>SD</i>	<i>X</i> ± <i>SD</i>	<i>X</i> ± <i>SD</i>	
BMI, kg/m ²	20.6 ±2.0	22.1 ±4.2	22.6 ±3.7	22.51 ±3.7	ns
Gestational weight gain, kg	14.5 ±4.6	15.7 ±6.1	15.9 ±6.2	15.3 ±4.9	ns
Apgar scale	8.9 ±1.9	9.3 ±1.6	9.2 ±1.4	9.4 ±1.2	ns
Infant length, cm	54.5 ±3.3	55.1 ±4.1	54.5 ±3.6	54.6 ±2.9	ns
Infant birth weight, g	3 284.0 ±703.5	3 423.9 ±695.6	3 377.2 ±634.2	3 347.8 ±612.7	ns
Body mass before childbirth, kg	71.9 ±8.7	78.9 ±15.8	77.2 ±12.1	77.4 ±12.1	ns
Ponderal index, m/kg ³	21.2 ±1.9	20.8 ±2.8	21.1 ±2.2	20.9 ±1.9	ns
Pre-pregnancy body mass, kg	58.2 ±6.9	62.7 ±14.3	62.1 ±10.9	61.8 ±10.3	ns
Height, cm	167.0 ±4.9	167.9 ±5.3	165.3 ±5.5	166.0 ±5.8	ns

X – average, *SD* – standard deviation.

DISCUSSION

Apart from the rising problem concerning more women of reproductive age being over-weight and obese, there is also a cause for rising concern from the fact that body mass increases during pregnancy, as well as the widespread low levels of physical activity. The high percentage of healthy women leading a low activity or sedentary lifestyle in the study is alarming, especially since existing evidence showing regular maternal aerobic exercise in healthy, low-risk pregnancies seems to positively influence the development of fetal cardiac autonomic control. This evidence, together with the developmental origins hypothesis, which states that the fetus makes adaptations in response to the in-utero environment, suggests that maternal exercise may induce an adaptive response in-utero that yields cardiovascular health benefits later in life [Misra et al. 1998]. The analysis also showed that within the group of overweight women all birth parameters of the newborn were higher when compared to underweight women and women with normal body mass. Kaim et al. [2009] showed similar results. As such, it seems logical to encourage women to partake in physical activity with intentions to minimize health risks for both the mother and infant. Engagement in physical activity

before and during pregnancy was associated with a reduced incidence of GDM, with pronounced benefits especially in those with an increased pre pregnancy (BMI: >25) [Institute of Medicine 2009]. Overweight and obese women are at increased risk of several pregnancy complications, such as gestational hypertension, preeclampsia, GDM, fetal growth abnormalities, such as macrosomia and intrauterine growth restriction, stillbirth, congenital malformations and operative delivery [Davies et al. 2010, Ferraro et al. 2012, Jensen et al. 2003, Kanadys et al. 2012].

Upon analysing the data, it was recorded that 18.5% of women had a pre-pregnancy BMI indicating an overweight body mass. Many studies have shown that women performing physical activity during and/or before pregnancy had a better or unchanged outcome in relation to GDM, pre-eclampsia, preterm delivery and birth weight [Hegaard et al. 2007, Hopkins et al. 2010, Lowell and Miller 2010]. Importantly, physical activity may prove most advantageous for overweight or obese pregnant women as a way to reduce their risk of delivering an LGA infant [Ferraro et al. 2012, May et al. 2010]. Observational data from a large birth cohort demonstrated that routine engagement in exercise during pregnancy protects the developing infant from birth weight extremes (i.e., SGA or LGA) [Juhl et al.

2010]. It is unsettling that within the majority of the analysed group of healthy women of appropriate range pre-pregnancy BMI, a large number achieved a high gestational weight gain. The achieved results are supported by Wierzejska et al. [2011] studies. These study showed that most women (48%) achieved gestational weight gain above the recommended values; 37.8% of them reached the recommended weight gain during pregnancy, and gestational weight gain below recommendations occurred among 14.2% women [Wierzejska et al. 2011]. Regular physical activity may help women meet gestational weight gain targets and thus positively influence maternal fetal outcomes [Institute... 2009, Lowell and Miller 2010, May et al. 2010]. Many women with excessive gestational weight gain will not come back to their pre-pregnancy weight after pregnancy, and physical activity during pregnancy might help preventing weight retention after pregnancy and has been linked to improvements in physical fitness, emotional wellbeing and reduction in stress and anxiety [Villamor and Cnattingius 2006, Wierzejska et al. 2011]. Modern epidemiological studies estimate the prevalence of depression during pregnancy at between 4-20% [Makara-Studzińska et al. 2013]. In overweight women symptoms of anxiety in the first trimester of pregnancy were experienced by 27.4% of the respondents, in the second trimester by 23.9%, and 29.9% in the third [Makara-Studzińska et al. 2013].

Our studies have not shown statistically significant differences between the gestational weight gain, neonatal outcomes and physical activity during pregnancy, which could have been caused by the fact that the majority of the women tested led either a low activity or sedentary lifestyle, and only a small insignificant percentage of women led an active or moderately active lifestyle. The achieved results were similar to another study in which the effects of physical activity during pregnancy on parameters of the newborn were tested. These studies also have not shown a significant detrimental effect on birth weight with moderate amounts of exercise, suggesting that regular physical activity is safe and does not compromise fetal growth [Ferraro et al. 2012, Juhl et al. 2010, Wojtyła et al. 2012]. Currently, there is a dearth of evidence from well designed, appropriately powered randomized controlled trials to address the effects of maternal physical activity on fetal growth outcomes [Bergier et al. 2012, Ferraro et al.

2012, Wojtyła et al. 2012]. The inconsistency of results from studies examining the effect of activity on infant birth weight likely arises from differences in the type, frequency, timing, and duration of the activity program imposed [Melzer et al. 2010].

An ideal physical activity program for pregnancy must ensure that recommendations are appropriate for the individuals' fitness level, stage of pregnancy, and degree of motivation while anticipating potential risks and identifying necessary pregnancy modifications. A recent systematic review of 14 trials involving 1014 pregnant women evaluated the effect of aerobic exercise on maternal and neonatal outcomes [Kramer and McDonald 2006]. They suggest that the available literature lacks power and consistency to allow evaluation of the potential risks or benefits of physical activity during pregnancy for the mother or infant but concluded that aerobic exercise during pregnancy can maintain or improve physical fitness, a known contributor to reduced cardiovascular morbidity and all-cause mortality [Kodama et al. 2009].

Promotion of physical activity is one such strategy that must continue to be studied during pregnancy to determine the effects that maternal physical activity has on downstream child growth and development. There is considerable evidence to suggest that lifestyle interventions during pregnancy are safe and may provide both maternal and fetal benefits [Ferraro et al. 2012]. Nonetheless, the known benefits of physical activity on maternal-fetal health obligate healthcare practitioners to provide advice to women regarding best practices for these healthy behaviours throughout pregnancy [Polish... 2012, Wojtyła et al. 2012].

CONCLUSIONS

1. In the study group there was a significant percentage of women characterised by an inactive lifestyle and excessive gestational weight gain.
2. There were significantly higher neonatal birth anthropometric parameters in women with abnormal excessive gestational weight gain than in women with normal and inappropriate – low gestational weight gain.
3. Our studies have not shown statistically significant differences between the gestational weight gain and nutritional status of newborns in relation to the level of physical activity of pregnant women.

4. The highest percentage of women with appropriate weight gain was observed in the group of women who are physically active, although this requires confirmation in larger population.

5. There is a need to raise awareness of women of the benefits of an active lifestyle during pregnancy in the light of the obesity epidemic and to provide support to women trying to overcome the challenges posed to them in our modern environment.

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WPŁYW AKTYWNOŚCI FIZYCZNEJ I PRZYROSTU MASY CIAŁA W CZASIE CIĄŻY NA STAN ODŻYWIENIA NOWORODKÓW Z REGIONU WOJEWÓDZTWA WARMIŃSKO-MAZURSKIEGO

STRESZCZENIE

Wprowadzenie i cel badań. Badania epidemiologiczne wykazały związek między aktywnością fizyczną matki, wczesnym żywieniem i masą urodzeniową noworodka a prawdopodobieństwem wystąpienia przyszłych chorób. Celem badań było określenie relacji między przyrostem masy ciała w ciąży i aktywnością fizyczną kobiet a parametrami antropometrycznymi noworodków.

Materiał i metody. Prezentowane badania przeprowadzono w okresie od lutego 2010 do listopada 2012 roku na oddziałach ginekologiczno-położniczych szpitali o różnym stopniu referencyjności z terenu województwa warmińsko-mazurskiego. Do badań włączono 510 kobiet w czasie porodu w wieku 18-36 lat. Zakres badań obejmował ocenę wybranych parametrów antropometrycznych kobiet w ciąży (masa ciała, wysokość ciała, BMI, przyrost masy ciała w czasie ciąży) i noworodków (masa, długość urodzeniowa noworodka, Ponderal index) oraz analizę powiązań pomiędzy ciążowym przyrostem masy ciała, aktywnością fizyczną matek a antropometrycznymi parametrami urodzeniowymi noworodków.

Wyniki i wnioski. W badanej grupie stwierdzono znaczny odsetek kobiet charakteryzujących się siedzącym trybem życia i nadmiernym przyrostem masy ciała w ciąży. U noworodków urodzonych przez kobiety z nieprawidłowym, nadmiernym przyrostem masy ciała w ciąży stwierdzono znacznie większe wartości parametrów antropometrycznych niż u noworodków urodzonych przez matki z prawidłowym i z małym przyrostem masy ciała. W grupie matek aktywnych fizycznie stwierdzono najwyższy odsetek kobiet z odpowiednim przyrostem masy ciała, niemniej jednak wniosek ten wymaga potwierdzenia na większej liczebnościowo populacji. W pracy nie wykazano istotnych różnic w przyroście masy ciała w ciąży i stanie odżywienia noworodków w zależności od aktywności fizycznej kobiet.

Słowa kluczowe: ciąża, aktywność fizyczna, przyrost masy ciała, rozwój płodu, masa urodzeniowa

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