Issue Rehabil. Orthop. Neurophysiol. Sport Promot. 2021; 35: 31–39. ISSN 2300-0767
DOI: 10.19271/IRONS-000135-2021-35

ORIGINAL ARTICLE

ASSOCIATION OF PRE-PREGNANCY AND PREGNANCY BODY MASS INDEX WITH LABOR DURATION

ZWIĄZEK MIĘDZY WSKAŹNIKIEM MASY CIAŁA PRZED I PODCZAS CIĄŻY A CZASEM TRWANIA PORODU

Angelika Szemraj[1], Agnieszka Opala-Berdzik[2]
[1]Department of Physical Therapy in Internal Diseases, Jerzy Kukuczka Academy of Physical Education, Poland
[2]Department of Physiotherapy in Internal Diseases, Jerzy Kukuczka Academy of Physical Education, Poland

ABSTRACT

Introduction
Excessive body mass index may have adverse effects on the health of women in their perinatal period. Regular physical activity contributes to body mass control.

Aim
To determine the association of pre-pregnancy and pregnancy BMIs with labor duration in primi- and multiparas. Also, to determine the proportions of pre-pregnancy BMI > 25 in women after cesarean sections and vaginal deliveries.

Material and methods
Data of 54 women on a postpartum day 3 to 5 (29 primiparas: 17 after vaginal and 12 after cesarean deliveries; 25 multiparas: 15 after vaginal and 10 after cesarean deliveries). Demographic data collected from the patient's history included body height, pre-pregnancy and pre-labor body mass, mode of delivery, duration of labor and its second stage, number of deliveries. Pre-pregnancy and pre-labor BMIs were calculated.

Results
In primiparas, there was a moderate positive correlation between pre-pregnancy and pre-labor BMIs and the labor duration ($r = 0.56$, $p = 0.02$; $r = 0.65$, $p = 0.005$, respectively). Multiparas did not exhibit a significant correlation between the BMIs and the labor duration ($p > 0.05$). Neither of the subgroups showed a significant correlation between pre-pregnancy and pre-labor BMIs and the duration of the second stage of labor ($p > 0.05$). Among women after vaginal deliveries, 15.6% had pre-pregnancy BMI > 25; the respective proportion was 22.7% in women after cesarean sections.

Conclusions
Primiparas with greater pre-pregnancy and pre-labor BMIs were more likely to have a longer labor. The proportion of pre-pregnancy BMI > 25 was higher for cesarean compared to vaginal deliveries. Physical activity should be promoted in women planning pregnancy to help control BMI.

Author responsible for correspondence:
Agnieszka Opala-Berdzik
Department of Physiotherapy in Internal Diseases
Jerzy Kukuczka Academy of Physical Education
Mikołowska 72
40-065 Katowice, Poland
email: a.opala-berdzik@awf.katowice.pl
https://orcid.org/0000-0002-2051-0185

Authors reported no source of funding
Authors declared no conflict of interest

Date received: 27th February 2021
Date accepted: 24th March 2021

Keywords: mirror foot, resection of foot radius, deformation classification

STRESZCZENIE

Wstęp

Podwyższony wskaźnik masy ciała może mieć niekorzystny wpływ na zdrowie kobiety w okresie okołoporodowym. Systematyczna aktywność fizyczna sprzyja kontroli masy ciała.

Cel

Zbadanie zależności pomiędzy BMI przed i podczas ciąży a czasem trwania porodu pierworódek i wieloródek. Ustalenie odsetka podwyższonego BMI przed ciążą u kobiet po cesarskich cięciach i po porodach waginalnych.

Materiał i metody

Dane dotyczyły 54 kobiet będących między 3 a 5 dobą po porodzie (29 pierworódek: 17 po porodach waginalnych i 12 po cesarskich cięciach; 25 wieloródek: 15 po porodach waginalnych i 10 po cesarskich cięciach). Dane demograficzne zebrane z wywiadu dotyczyły wzrostu, masy ciała przed ciążą i porodem, rodzaju porodu, długości porodu oraz II okresu porodu, liczby porodów. Obliczono przedciążowy i ciążowy (przedporodowy) BMI.

Wyniki

U pierworódek stwierdzono umiarkowaną dodatnią zależność pomiędzy BMI przed ciążą i porodem a czasem trwania porodu (kolejno: $r = 0,56$, $p = 0,02$; $r = 0,65$, $p = 0,005$). U wieloródek stwierdzono brak istotnej zależności pomiędzy BMI przed ciążą i porodem a długością porodu ($p > 0,05$). W obu podgrupach analiza wykazała brak istotnej zależności pomiędzy BMI przed ciążą i porodem a długością II okresu porodu ($p > 0,05$). Wśród kobiet po porodach waginalnych 15,6% miało BMI przed ciążą > 25. Spośród kobiet po cesarskich cięciach 22,7% miało BMI przed ciążą > 25.

Wnioski

Kobiety z wyższym BMI przed i pod koniec pierwszej ciąży były bardziej narażone na dłuższy poród waginalny. Kobiety rodzące przez cesarskie cięcie miały wyższy odsetek BMI przed ciążą > 25 w stosunku do kobiet, które miały poród waginalny. Aktywność fizyczna powinna być promowana u kobiet planujących ciążę w celu kontroli BMI.

Słowa kluczowe: wskaźnik masy ciała, ciąża, poród, cesarskie cięcie

Introduction

Obesity, which has been included in the group of civilization diseases of our time, is defined as a pathological increase in the amount of adipose tissue leading to impaired body function and increased morbidity and mortality rates. In obesity, there is an impaired energy balance resulting from excessive food intake and insufficient physical activity. A Body Mass Index (BMI) of 30 and above indicates obesity (Apovian, 2016). The elevated BMI may lead to infertility. It may also adversely affect both the pregnant woman and the fetus and may have a negative impact on labor and delivery. Pregnancies of obese women are at higher risk of complications, including gestational diabetes, pregnancy-induced hypertension, miscarriage, premature labor or stillbirth. Their babies present a higher risk of fetal macrosomia and congenital anomalies of the cardiovascular or nervous systems.

Cesarean delivery rates are higher for obese women (Denison *et al.*, 2008; Torloni *et al.*, 2009; Bodnar *et al.*, 2010; Medard, 2010; Li *et al.* 2013; Declercq *et al.*, 2016; Huras *et al.*, 2014; Shaukat and Nur, 2019). Also, a greater proportion of postpartum depression was found among women with increased BMI (LaCoursiere *et al.*, 2010). In the result of maternal obesity, the macrosomic fetus may develop overweight or obesity in childhood (Streuling *et al.*,2011, Thangaratinam and Jolly, 2010; Mueller *et al.*, 2017).

Research outcomes indicate the importance and effectiveness of regular physical activity during pregnancy to prevent excessive gestational weight gain (Streuling *et al.*, 2011; Zavorsky and Longo, 2011). However, the guidelines on regular aerobic exercise for overweight or obese expectant mothers differ from those for women with normal BMI and physically active before pregnancy. It has also been found that regular physical activity before and during pregnancy reduces the risk of gestational diabetes mellitus. Pregnant women diagnosed with gestational diabetes should adhere to regular aerobic exercise supervised by a physiotherapist and consulted by an attending obstetrician (Bebelska *et al.*, 2011, Streuling *et al.* 2011, Thangaratinam and Jolly, 2010; Zavorsky and Longo, 2011).

Physiological labor starts with regular uterine contractions, which gradually increase in intensity resulting in cervical shortening and dilation. This first stage of labor takes 9 to 15 hours in primiparas and about 7 to 9 hours in multiparas; it lasts until cervical dilation to approximately 10 cm. The second stage starts with full cervical dilation; expulsive involuntary uterine contractions are helped by voluntary pushing efforts made by the woman in labor. The duration of this stage is about 1 to 2 hours in primiparas and 0.5 to 1 hour in multiparas; it ends with the delivery of the child (Pisarski, 1993).

Women with a high BMI are likely to deliver post-term and tend to need oxytocin labor induction (Denison *et al.*, 2008; Adams *et al.*, 2020). Increased BMI may also have negative effects on the course of labor, its duration (Carlhäll *et al.*, 2013). In turn, prolonged labor may result in maternal and offspring health-threatening complications (Altman and Lydon-Rochelle, 2006; Simic *et al.*, 2017).

Cesarean section is a surgical intervention aimed at delivering a child through incisions in the abdomen and uterus. When deemed the best delivery option, it might be scheduled as an elective procedure before labor begins but may also be performed as an emergency when vaginal birth becomes complicated. According to National Institute for Health and Clinical Excellence (NICE), increased BMI is one of the indications for planned cesarean section (Skrypnik *et al.*, 2015).

Aim

The aim of this study was to determine whether a relationship existed between pre-pregnancy and pregnancy BMIs and labor duration in primi- and multiparas. We also attempted to determine if obese women were more likely to have a cesarean section. It was hypothesized that increased BMI might be associated with longer labor and that obese women were more prone to have a cesarean section.

Material and methods

The study comprised anonymous data from 54 postpartum women in good overall health. The data were collected during routine physiotherapy procedures as part of a clinical physiotherapy course at the Obstetrics/Gynecology Department of Jaworzno Multispecialty Hospital. The data used for this study were obtained between the 3rd and 5th postpartum days from March 2014 through December 2015. The inclusion criterion was singleton pregnancy. Data were collected from the patient's history, which included age, body height, pre-pregnancy and late pregnancy (about one-week pre-labor) body mass, number of deliveries and the type of the most recent delivery. With permission of women who delivered vaginally, data on the

duration of their labor and its second stage were obtained from Health Record Books of their children. Based on body height and pre-pregnancy and pregnancy (pre-labor) body mass, the respective BMIs were calculated [body mass (kg)/body height (m)^2]. Gestational weight gain was calculated by subtracting pre-pregnancy from pregnancy (pre-labor) body mass.

The patients included in the analysis were 19 to 39 years old with a mean of 28 ± 4.6 years. There were 29 primiparas (17 after vaginal and 12 after cesarean deliveries) and 25 multiparas (15 after vaginal and 10 after cesarean deliveries). The lowest and highest pre-pregnancy BMIs in the whole group (n = 54) were 16.7 and 36.4, respectively. The mean pre-pregnancy BMI was 23.1 (SD ± 3.8). The lowest pre-labor BMI was 22.3, and the highest 44.6. The mean pre-labor BMI was 29.4 (SD ± 4.7). Since the first labor lasts longer than that in a multipara, two subgroups of vaginal deliveries (17 primiparas and 15 multiparas) were formed based on the collected data. Table 1 shows the characteristics of primiparas and multiparas, who delivered vaginally.

Statistical analysis was performed using a Statistica software package and Excel spreadsheets. The data of primi- and multiparas after vaginal deliveries were compared with the Mann-Whitney U test. The Spearman's Rank Correlation Coefficient was used to test whether BMIs before and at the end of pregnancy were correlated with the duration of labor and its second stage in primi- and multiparas. A conventional approach to interpreting the absolute magnitude of the correlation coefficient was used: 0.00 – 0.10 negligible; 0.10 – 0.39 weak; 0.40 – 0.69 moderate; 0.70 – 0.89 strong; and 0.90 – 1.00 very strong correlation (Schober *et al.*, 2018). The level of significance was set at $\alpha = 0.05$.

The investigation did not require the consent of the Bioethics Committee because only anonymous patient data from routine physiotherapeutic procedures at the obstetric unit were used. All data were kept anonymous, the data of the patients were made confidential, statistical worksheet included a particular patient as the number only.

Results

In the subgroup of 17 primiparas, the Spearman's rank test revealed a moderate positive correlation between pre-pregnancy and late pregnancy (pre-labor) BMIs and total labor duration ($r = 0.56$, $p = 0.02$ and $r = 0.65$, $p = 0.005$ respectively; Figures 1 and 2). In this subgroup, no significant correlation was found between pre-pregnancy and pre-labor BMIs and duration of the second stage of labor ($p > 0.05$).

Table 1. Characteristics of primiparas and multiparas after vaginal deliveries*.

	Primiparas (n = 17)	**Multiparas (n = 15)**	*p***
Age (years)	26.2 ± 3.7	30.3 ± 3.7	0.005
Pre-pregnancy BMI	21.4 ± 3.2	23.9 ± 2.7	0.01
Pregnancy (pre-labor) BMI	26.8 ± 3.0	30.1 ± 3.3	0.003
Gestational weight gain (kg)	14.6 ± 4.9	17.1 ± 3.8	> 0.05
Duration of labor (min)	366.5 ± 223.2	189 ± 75.6	0.002
Duration of second stage of labor (min)	47.6 ± 34.7	23.3 ± 14.4	0.01

*Mean ± standard deviation
**Mann-Whitney U test

The subgroup of 15 multiparas exhibited no significant correlation between pre-pregnancy and pre-labor BMIs and total labor duration ($p > 0.05$). In the multiparas, no significant correlation was also revealed between pre-pregnancy and pre-labor BMIs and duration of the second stage of labor ($p > 0.05$).

Ten out of 54 study participants (18.5%) had pre-pregnancy BMI > 25.

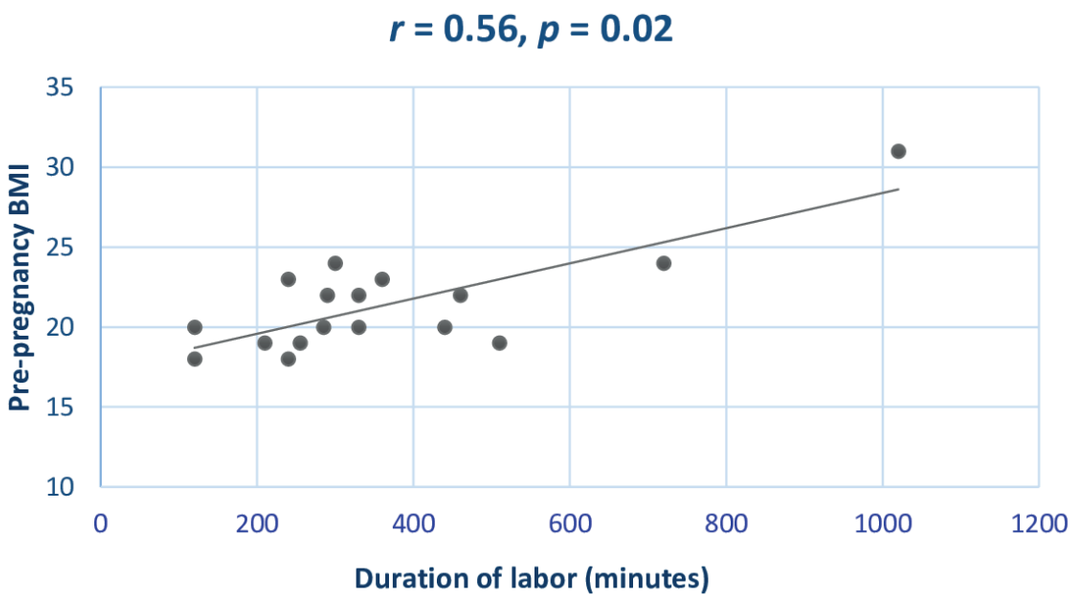

Figure 1. Correlation between pre-pregnancy BMI and duration of labor in 17 primiparas.

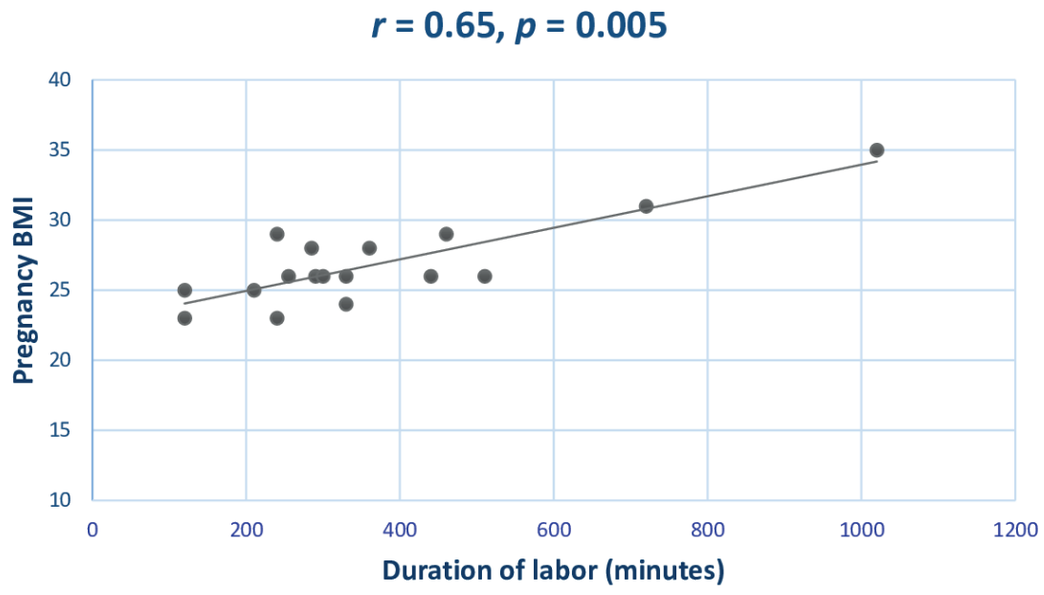

Figure 2. Correlation between late pregnancy (pre-labor) BMI and duration of labor in 17 primiparas.

Five out of 22 women after cesarean delivery (22.7) had pre-pregnancy BMI > 25, including four (33.3%) out of 12 primiparas and one (10%) out of 10 multiparas (Figure 3).

Among 32 women who delivered vaginally, five (15.6%) had pre-pregnancy BMI > 25, including one (5.9%) out of 17 primiparas and four (26.7%) out of 15 multiparas (Figure 4).

Discussion

The primary objective of this study was to analyze whether there was an association of pre-pregnancy and pre-labor BMIs with the duration of vaginal labor and its second stage. Physiologically, primiparas take longer to deliver than multiparas; therefore, correlation analysis was performed separately for these two subgroups.

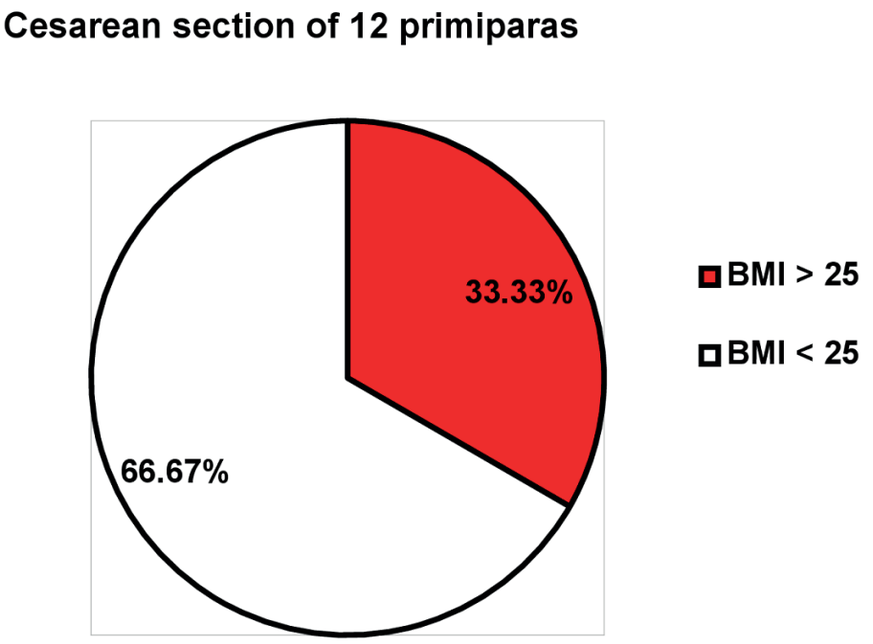

Figure 3. Percentage of pre-pregnancy BMI > 25 in 12 primiparas and 10 multiparas who had a cesarean section.

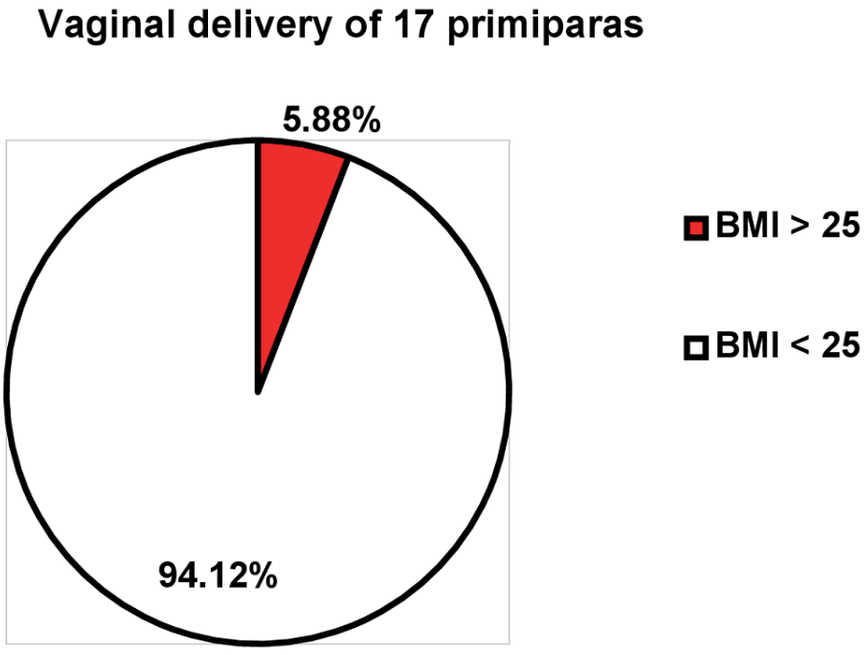

Figure 4. Percentage of pre-pregnancy BMI > 25 in 17 primiparas and 15 multiparas who delivered vaginally.

The results confirmed the study hypothesis, i.e., pre-pregnancy and pre-labor BMIs of primiparas were positively correlated with total labor duration. Interestingly enough, such a correlation was not found in multiparas. Neither of the subgroups exhibited a significant correlation between pre-pregnancy and pre-labor BMIs and duration of the second stage of labor.

The present results indicate that higher pre-pregnancy and pre-labor BMIs of primigravidas were related to longer vaginal labor.

Overweight and obese women most frequently give birth to larger children (Bodnar *et al.*, 2010; Abdel Moety *et al.*, 2013; Li *et al.* 2013); therefore, their natural labor and delivery can be longer and more difficult. Women with increased BMI are also characterized by lower endurance which may be another factor leading to longer and more exhausting labor. Natural childbirth requires enormous physical effort, and it has been suggested that a higher level of physical fitness is related to easier and shorter labor (Zavorsky and Longo, 2011). In multiparas of this study, however, increased pre-pregnancy and pre-labor BMIs turned out to have no significant impact on labor duration. It might be that overweight or obesity do not affect the generally shorter and easier labor of multiparas. The duration of pre-pregnancy overweight/obesity might also be of importance, but no such data were available in our study.

Our results regarding primiparas are consistent with those of other authors who concluded that excess body weight was associated with longer labor (Bebelska *et al.*, 2011; Carlhäll *et al.*, 2013). Similar to Carlhäll *et al.* (2013), our study suggests that the duration of the first stage of labor increased with greater maternal BMI. Nevertheless, Carlhäll *et al.* (2013) noted that the second stage of labor was shorter in obese than in normal-weight women.

In this study, we also attempted to verify whether the percentage of increased pre-pregnancy BMI was higher in women who had a cesarean delivery. Our hypothesis was confirmed, i.e., the proportion of women with pre-pregnancy BMI above 25 was higher in the group with cesarean compared to vaginal deliveries (23% and 16%, respectively). The same observation was made in the subgroup of primiparas, where the proportions were 33% and 6%, respectively. On the contrary, only 10% of multiparas who delivered by a cesarean section had a pre-pregnancy BMI of over 25, while 27% of multiparas with vaginal deliveries were overweight or obese before pregnancy.

Our results indicate that overweight/obesity might have been among the causes of cesarean section, and especially in primiparas. Increased risk of emergency cesarean section in overweight and obese women (Pettersen-Dahl *et al.*, 2018), among others, might be related to reduced tolerance of longer physical effort associated with first labor and delivery. A planned cesarean section might, in turn, be related to pregnancy-induced hypertension and gestational diabetes mellitus, more commonly found in pregnancies of overweight and obese women (Denison *et al.*, 2008; Torloni *et al.*, 2009; Li *et al.* 2013; Shaukat and Nur, 2019). Fetal macrosomia related to maternal BMI can be another indication for cesarean delivery (Thangaratinam *et al.*, 2010).

Our results showing that maternal overweight/obesity might have increased the likelihood of cesarean section confirm previous reports on a higher risk of cesarean delivery in women with excessive BMI (Denison *et al.*, 2008; Medard, 2010; Bebelska, 2011; Li *et al.* 2013; Pettersen-Dahl *et al.*, 2018; Ratnasiri *et al.*, 2019; Shaukat and Nur, 2019).

Our findings indicate a need for educating women about the importance of healthy pre-pregnancy and pregnancy body weight. In women with normal BMI, gestational weight gain should be between 11.5 and 16 kg. For overweight (BMI 25–29.9) and obesity (BMI ≥ 30), the recommended weight gain is 7–11.5 kg and 5–9 kg, respectively (Institute of Medicine Guidelines, 2009). Regular physical activity helps maintain healthy pre-pregnancy and pregnancy bodyweight (Zavorsky and Longo, 2011) and should therefore be promoted among women who are planning pregnancy. In the absence of contraindications, exercises should be of moderate intensity. Regular physical activity increases endurance and physical fitness leading to better adaptation to pregnancy and labor tolerance (Zavorsky and Longo, 2011).

Before and during pregnancy in obese women, any comorbidities should be controlled, especially arterial hypertension and diabetes melitus (Denison *et al.*, 2008; Torloni *et al.*, 2009;

Medard, 2010; Li *et al.* 2013; Shaukat and Nur, 2019). It should be emphasized that physical activity not only helps stabilize blood pressure at lower levels but also prevent hypertension; it also reduces blood glucose to normal range (Streuling, 2011; Kicel *et al.*, 2014).

Conclusions

In primiparas, greater pre-pregnancy and pre-labor BMIs were associated with longer labor. The duration of second stage of labor was not related to the BMIs. The proportion of women with pre-pregnancy BMI above 25 was higher in the group with cesarean compared to vaginal deliveries. Maternal overweight/obesity might have increased the likelihood of a cesarean section. Regular physical activity should be promoted among women who are planning pregnancy to enhance BMI control.

REFERENCES

Abdel Moety, G.A., Gaafar, H.M., Ahmed, A.H. (2013) *'Maternal prepregnancy BMI and gestational weight gain: which correlates more with neonatal birth weight?'* J Evidence-Based Women's Health Journal Society, 3 (3), pp. 122–126.

Adams, A.D., Coviello, E.M., Drassinower, D. (2020) *'The Effect of Maternal Obesity on Oxytocin Requirements to Achieve Vaginal Delivery'*. Am J Perinatol., 37 (4), pp. 349–356.

Altman, M.R., Lydon-Rochelle, M.T. (2006) *'Prolonged second stage of labor and risk of adverse maternal and perinatal outcomes: a systematic review'*. Birth. 33 (4), pp. 315–322.

Apovian, C.M. (2016) *'Obesity: definition, comorbidities, causes, and burden'*. Am J Manag Care, 22 (7 Suppl), pp. 176–185.

Bebelska, K.P., Ehmke vel Emczyńska, E., Gmoch-Gajzlerska, E. (2011) *'Obesity as a factor disturbing reproductive processes'*. (in Polish) Nowiny Lekarskie, 80 (6), pp. 499–507.

Bodnar LM, Siega-Riz AM, Simhan HN, Himes KP, Abrams B. (2010) *'Severe obesity, gestational weight gain, and adverse birth outcomes'*. Am J Clin Nutr, 91 (6), pp. 1642–1648.

Carlhäll, S., Källén, K., Blomberg, M. (2013), *'Maternal body mass index and duration of labor'*. Eur J Obstet Gynecol Reprod Biol, 171 (1), pp. 49–53.

Denison F, Price J, Graham C, Wild S, Liston W. (2008) *'Maternal obesity, length of gestation, risk of postdates pregnancy and spontaneous onset of labour at term'*. BJOG, 115, pp.720–725.

Declercq E, MacDorman M, Cabral H, Stotland N. (2016) *'Prepregnancy Body Mass Index and Infant Mortality in 38 U.S. States, 2012–2013'*. Obstet Gynecol, 127 (2), pp. 279–287.

Huras H., Radoń - Pokracka M., Szymik M., Jach R. (2014) *'The relationship between appearance of oxidative stress indicators, hyperlipidemia and body mass index in a pregnancy complicated with premature rupture of membranes'*. Ginekologia i położnictwo, 3, pp. 24–33.

IOM (Institute of Medicine). (2009) *'Weight Gain During Pregnancy: Reexamining the Guidelines'*. Washington, DC: The National Academies Press, http://www.nap.edu.

LaCoursiere DY, Barrett-Connor E, O'Hara MW, Hutton A, Varner MW. (2010) *'The association between prepregnancy obesity and screening positive for postpartum depression'*. BJOG: Int J Obst Gynaecol, 117 (8), pp. 1011–1018.

Li N, Liu E, Guo J, Pan L, Li B, Wang P, Liu J, Wang Y, Liu G, Baccarelli AA, Hou L, Hu G. (2013) *'Maternal Prepregnancy Body Mass Index and Gestational Weight Gain on Pregnancy Outcomes'*. PLoS ONE 8(12), e82310.

Medard, L.M. (2010) *'Otyłość a ciąża, poród i stan zdrowia w późniejszym okresie życia kobiety'*. (in Polish) Forum Zaburzeń Metabolicznych, 1 (1), pp. 37–45.

Mueller, N.T., Mao, G., Bennet, W.L., Hourigan, S.K., Dominguez-Bello, M.G., Appel, L.J., Wang, X. (2017) *'Does vaginal delivery mitigate or strengthen the intergenerational association of overweight and obesity? Findings from the Boston Birth Cohort'*. Int J Obes, 41 (4), pp. 497–501.

Pisarski T. (1993) *'Położnictwo i ginekologia'*. (in Polish) Wydawnictwo PZWL, pp. 310–312.

Pettersen-Dahl A, Murzakanova G, Sandvik L, Laine K. (2018) *'Maternal body mass index as*

a predictor for delivery method'. Acta Obstet Gynecol Scand, 97, pp. 212–218.

Ratnasiri AWG, Lee HC, Lakshminrusimha S, Parry SS, Arief VN, DeLacy IH, Yang JS, DiLibero RJ, Logan J, Basford KE. (2019) '*Trends in maternal prepregnancy body mass index (BMI) and its association with birth and maternal outcomes in California, 2007–2016: A retrospective cohort study*'. PLoS ONE 14 (9), e0222458.

Shaukat S, Nur U. (2019) '*Effect of prepregnancy maternal BMI on adverse pregnancy and neonatal outcomes: results from a retrospective cohort study of a multiethnic population in Qatar*'. BMJ Open, 9, e029757.

Schober, P., Boer, C., Schwarte, L.A. (2018) '*Correlation Coefficients: Appropriate Use and Interpretation*'. Anesth Analg, 126, pp. 1763–1768.

Simic M, Cnattingius S, Petersson G, Sandström A, Stephansson O. (2017) *'Duration of second stage of labor and instrumental delivery as risk factors for severe perineal lacerations: population-based study'*. BMC Pregnancy Childbirth, 17 (1), pp. 72.

Skrypnik D., Musialik K., Skrypnik K. (2015) '*Indications for caesarian section according to NICE*'. Ginekologia i położnictwo, 2, 36 (2), pp. 31–39.

Streuling I, Beyerlein A, Rosenfeld E, Hofmann H, Schulz T, von Kries R. (2011) '*Physical Activity and gestational weight gain: a meta - analysis of intervention trials*'. Int J Obst Gyaecol, 3, pp. 278–284.

Thangaratinam S., Jolly K. (2010) '*Obesity in pregnancy: a reviews on the effectivness of interventions*'. Int J Obst Gyaecol, 11, pp. 1309–1312.

Torloni MR, Betrán AP, Horta BL, Nakamura MU, Atallah AN, Moron AF, Valente O. (2009) '*Prepregnancy BMI and the risk of gestational diabetes: a systematic review of the literature with meta-analysis*'. Obes Rev, 10 (2), pp. 194–203.

Zavorsky G.S., Longo L.D. (2011) '*Exercise Guidelines in Pregnancy'*, Sports Med, 41 (5), pp. 345–360.