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Case Report

The Impact of BMI in Pregnant Women on the Perinatal Outcome, Laboratory Parameters, Length of Breastfeeding and Weight Gain during the First Year of Life

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Abstract

Aim: The aim of this study is to establish whether a women's BMI during pregnancy affects perinatal outcome, length of hospitalization, metabolic disorders (hypoglycaemia, hypocalcaemia) and the decision on the length and duration of breastfeeding in region. This study will show whether a difference exists in the birth mass and weight gain the first year of life.

Methods: The subject research is a prospective cohort study on 128 pregnant women and their newborn according to the body mass index of the pregnant women before delivery. The control group, 65 (BMI > 25.0 kg/m^2) and the study group, 63 (BMI > 25.0 kg/m^2) women and in their newborns.

Results: No statistically significant difference was found either in the prenatal outcome or the biochemical parameter with respect to the pregnant women's BMI. Statistically significant difference was found neither in the prenatal outcome, biochemical parameters considering the pregnant women's BMI. The newborn study group was hospitalized for a longer period (t = -3,104; p = 0,002). There was no statistically significant difference in breastfeeding between the groups.

Conclusion: This study is that elevated BMI in pregnancy does not increase the frequency of the tested biochemical disorders in the newborn or excessive weight gain in the first year of life. At 18 months, the presented results show that the percentage of mothers who breastfed is approximately the same in both groups (7.9% vs. 4.6%) and that there was no statistically significant difference in the beginning, length and intensity between the groups of women according to their BMI.

Keywords: *BMI; Pregnancy; Breastfeeding; Weight Gain*

Introduction

For many women, achieving and maintaining normal body weight is a long and painstaking process, and pregnancy of its own account is the time when women are more motivated to change their lifestyles. Nevertheless, since we live in a time and age where food is readily accessible, future mothers have much higher chances of becoming overweight pregnant and parturient women. Studies in Western countries indicate that excessive weight and obesity are twice as frequent in pregnant women. An increasing number of studies have shown that being overweight during pregnancy significantly affects the health of the newborn and its health in later stages of life. Obesity in preg-

nancy has a significant impact on the type of delivery, perinatal complications, metabolic changes, on the nutrition of the newborn and on body weight during early childhood [1-3]. A chronic mild inflammation in pregnancy is accompanied by elevated values of circulating inflammatory markers TNF-alpha and leptin, which play an important role in the fetal programming of birth mass of the newborn, metabolic disorders and obesity in children, and thereby, according to Sen., *et al*. overweight pregnant women breastfeed for a shorter period of time in comparison to pregnant women with normal BMI [4,5]. Studies in recent years have shown that the occurrence of preeclampsia, bleeding, and Cesarean sections is more frequent in overweight pregnant women, and that the chances for a longer period of hospitalization and tretment of their newborn are higer than in pregnanat women with normal BMI in pregnancy [4-7]. Furthermore, research conducted in the USA shows that the newborn of pregnant women with elevated BMI have a higher occurrence of complications such as hypoglycemia, hypocalcaemia, a poorer Apgar score and remain longer in the maternity ward in comparison to the pregnant women who had gained the recommended amount of weight [8].

Another study suggests that pregnant women with elevated BMI, due to long and stressful delivery, the consequences of Cesarean section and a longer sojourn in the maternity ward, decide against beginning breastfeeding more easily [9]. The growth and weight gain in early infanthood and correct nutrition in early childhood have permanent consequences on health in adulthood. The World Health Organization (WHO) and the American Academy of Pediatrics recommend breastfeeding solely during the first six months of life in order to achieve optimum growth and development and to prevent adverse consequences on health in later childhood [10]. As early childhood is the critical period in development, breastfeeding acts as a protective factor, particularly against the occurrence of obesity and cardiovascular diseases in adulthood [11]. In spite of all the recommendations in favor of breastfeeding, overweight mothers give up breastfeeding and decide to terminate breastfeeding much earlier because of unrealistic expectations and prejudices about its negative impact on post-delivery weight loss [12]. Although obesity is detrimental to one's health, there is, nevertheless, a lack of guidelines for clinical practice and public health interventions to prevent obesity in pregnancy and its possible impact on future generations.

Aim of the Study

The aim of this study is to establish whether BMI during pregnancy affects the perinatal outcome, metabolic disorders (hypoglycaemia, hypocalcaemia) and the decision on the duration of breastfeeding in our region. Current studies have shown that the type of dairy nutrition during the first 4 - 6 months of life has a serious role in the rate of weight gain during the first year of life and in later childhood. Therefore, this study will show whether a difference exists between the birth mass and weight gain in the first year of life with respect to the BMI of the pregnant women included in this study. The results of this study shall also contribute to a better connection between gynecologists and neonatologists due to the available information on the negative impact of obesity on the health of pregnant women and their newborn and its possible consequences in adulthood.

Objective of the Study

1. To determine the level of glucose and calcium in the two examined groups of newborn according to the BMI of the pregnant women.
2. To test parameters (age, Apgar score, gestational age, birth mass and duration of hospitalization in the maternity ward) in the two examined groups according to the BMI of the pregnant women.
3. To establish the weight of the newborn at three points in time (birth weight, weight at 6 months and weight at 12 months), as well as weight gain according to the BMI of the pregnant women
4. To test the length and duration of breastfeeding according to the BMI of the pregnant women.

Materials and Methods

Methods and examinees

The subject research is a prospective cohort study on 128 pregnant women and their newborn with respect to the body mass index of the pregnant women prior to delivery. The study was conducted at the Clinic for Gynecology and Obstetrics at the University Clinical Hospital (UHC) Mostar. This study was approved by the Ethics Committee in Mostar 15.7.2013, report number 01.1005.2013. Valid documentation exists for this matter. The authors received informed consent from the participants. The study included healthy pregnant women hospitalized at the Department of Perinatology, Unit for Parturient Women of the Department for Gynecology and Obstetrics at the University Clinical Hospital (UCH) Mostar, for the purposes of delivery, i.e. 24 to 48 hours prior to delivery. To classify the pregnant women into their corresponding group, the criteria of The Institute of Medicine (IOM) were used, which provides recommendations for the recommended weight gain during the course of pregnancy. The study included pregnant women who had an increased BMI before the term of delivery, but without any pathological clinical or laboratory test results. The study excluded all pregnant women who had metabolic syndromes, active inflammations or preeclampsia. The study also excluded all prematurely born children, i.e. those born before the 37^{th} week of gestation or if they had any diagnoses that required medical treatment at the Intensive Care Unit for Newborn.

The control group, 65 of them (50.8%) consisted of pregnant women with normal body mass index prior to delivery (BMI from 18.5 to 24.9 kg/m^2). The study group, 63 women (49.2%) consisted of pregnant women who were overweight (BMI from 25.0 to 29.9 kg/m^2) or obese (BMI equals or is higher than 30 kg/m^2).

The parameters monitored in the pregnant women were as follows: the number of previous deliveries, the course of pregnancy, medications taken, type of delivery and body mass index (BMI). The parameters monitored in the newborn were as follows: gender, gestational age, body weight at three points in time (birth weight, weight at 6 months and weight at 12 months), vitality according to Apgar score, length of hospitalization, blood sugar level from capillary blood, calcium from serum, duration of exclusive breastfeeding according to group.

Blood glucose level testing was conducted on each newborn 30 minutes upon birth from capillary blood by a measuring device (glucometer) and was recorded in the protocol for each child. Normal concentrations are over > 2.5 mmol/L in a healthy full-term newborn. A vein blood sample was taken from the newborn included in the study, in a glass test tube, to determine the calcium concentration during a routine blood test during their stay in the maternity ward, and the blood was analyzed at the Institute for Laboratory Diagnostics at the UCH Mostar. The total calcium result was determined by a photometric coloring test on the Beckman Couter AU 680 device. For full-term children, the referent values of calcium are from 2.00 to 2.78 mmol/L.

The data on weight gain and the type of dairy nutrition were collected through insight into medical documents from the corresponding health centers or through telephone contact with the child's mother. In competent pediatrics institutions, percentile curves published by the American Academy of Pediatrics are used to measure weight gain during the first year of life, and they are acknowledged in our region.

Statistical methods

The results are indicated by the following measures: absolute and relative frequency, mean (M) and standard deviation (SD). The following tests were used to test the significance of differences between groups: chi-square (χ^2) test, Fisher's exact test (in the absence of the expected frequency) and the Student's t test for independent samples. The limit of significance was set at $p = 0.05$ and p values that could not be expressed to three decimal places are reported as $p < 0.001$.

Results and Discussion

The study included 128 pregnant women and their newborn. The control group (G1) with normal BMI (18.5 to 24.9 kg/m^2) in pregnancy consisted of 65 pregnant women. Of the 128 pregnant women, 63 were placed in the study group (G2), meaning that they were either overweight, i.e. had a BMI from 25.0 to 29.9 kg/m^2, or were obese (BMI equals or is higher than 30 kg/m^2). The average age of the pregnant women with increased BMI is 29.59 years, and of pregnant women with normal BMI is 30.77 years. The difference in the number of deliveries in the control and study groups is not statistically significant (p = 0.661). There were 29 primiparae in the group of pregnant women with normal BMI (G1), i.e. 44.6%, while the group of pregnant women with increased BMI (G2) contained 34 primiparae, i.e. 54.0% (χ^2 = 1.120; p = 0.290). The groups were not significantly different in the manner of birth either (p = 0.179). In both groups, natural birth was more common. 50 (76.9%) pregnant women with normal BMI and 42 (66.7%) pregnant women with elevated BMI gave birth naturally. Complications during pregnancy were noticed in only one pregnant woman with elevated BMI. Medicines during pregnancy were taken by 5 (7.7%) women with normal BMI and by 2 (3.2%) pregnant women with elevated BMI (χ^2 = 1.040; p = 0.492; Fisher's Exact Test). The pregnant women with normal BMI gave birth to 28 (43.1%) boys and 37 (56.9%) girls, while the pregnant women with elevated BMI had 27 (42.9%) boys and 36 (57.1%) girls (χ^2 = 0.001; p = 0.980).

		Groups - Number (%) pregnant women		
		G1 (n = 65)	**G2 (n = 63)**	**p**
The perinatal outcome				
Gestational age	37	2 (3.1)	2 (3.2)	
	38	18 (27.7)	24 (38.1)	
	39	20 (30.8)	18 (28.6)	0.737[A]
	40	23 (35.4)	18 (28.6)	
	41	2 (3.1)	1 (1.6)	
	M ± SD	39.077 ± 0.941	38.873 ± 0.924	
APGAR score	8	0	1 (1.6)	0.807[A]
	9	2 (3.1)	2 (3.2)	
	10	63 (96.9)	60 (95.2)	
biochemical parameters (M ± SD)				
Glucose (30 minutes after birth)		4.505 ± 0.705	4.452 ± 0.804	0.696[B]
Calcium (3rd day of life)		2.086 ± 0.133	2.095 ± 0.110	0.680[B]
Day of discharge (C [IQ])		3 [2]	4 [3]	0.001[C]
G1: Pregnant women with normal BMI; G2: Pregnant women with increased BMI; A: Fisher's exact test; B: Student's' t test for independent samples; C: Mann-Whitney U				

Table 1: *Distribution of individual tested parameters (Apgar score, gestational age, level of glucose from capillary blood, calcium concentration, day of release from maternity ward) in the newborn according to the BMI of pregnant women.*

No statistically significant difference between both groups of newborn was found either in the perinatal outcome (Apgar score, gestational age) or in the tested biochemical parameters (glucose level and calcium concentration) according to the pregnant women's BMI. A statistically significant difference was found in the day of release from the maternity ward according to the pregnant women's BMI. The newborn of the pregnant women from the study group (G2) were hospitalized for a longer period. The observed difference in the duration of hospitalization is statistically significant (t = -3.104; p = 0.002).

	Groups- M ± SD		
	G1 (n = 65)	G2 (n = 63)	P*
Weight infants			
T1: At birth	3.248 ± 0.301	3.238 ± 0.342	0.856
T2: 6 months after birth	5.669 ± 0.554	5.587 ± 0.550	0.403
T3: 12 months after birth	10.262 ± 1.364	10.183 ± 1.179	0.727
Weight gain during the 12 months			
T2-T1	2.421 ± 0.676	2.350 ± 0.653	0.544
T3-T1	7.014 ± 1.430	6.945 ± 1.217	0.771
T3-T2	4.592 ± 1.027	4.595 ± 0.847	0.986
G1: Pregnant women with normal BMI; G2: Pregnant women with increased BMI; *Student's' t test for independent samples			

Table 2: *Distribution of infants' weight at three points in time (Birth weight, weight at 6 months and weight at 12 months), and weight gain by the end of the first year of life according to the pregnant women's BMI.*

No statistically significant difference in the infants' weight at three points in time (birth weight, weight at 6 months and weight at 12 months) according to the pregnant women's BMI was found. No significant difference in the children's weight gain according to the BMI of the pregnant women was found at any of the three measured points.

The figure shows that mothers from both groups began breastfeeding upon delivery, i.e. in the first days of their child's life. Six months after delivery 46% of the pregnant women from the study group breastfed exclusively, which is similar in the control group of mothers, 42% of which breastfed exclusively up to the sixth month of the child's life. Both groups of mothers gradually introduced the recommended supplementary food, i.e. solid food along with breastfeeding, after sixth months. At 18 months, the presented results show that the percentage of mothers who breastfed is approximately the same in both groups (7.9% vs. 4.6%) and that there was no statistically significant difference in the beginning, length and intensity between the groups of pregnant women according to their BMI.

The prevalence of obesity worldwide has reached the proportions of an epidemic [13]. What is significantly more alarming is the dramatic increase of obesity in early childhood in recent decades [14]. Women in industrialized society walk less and less during pregnancy and lead a sedentary lifestyle. Nevertheless, pregnancy provides the opportunity to change life habits and eating habits which affect the intrauterine environment, thereby contributing to the health of the future generation, as concluded by a study conducted in Denmark in 2014 [15]. Obesity in pregnancy has long been recognized as a risk factor leading to complications during pregnancy and later [16]. A study conducted in Japan shows that the frequency of complications in pregnancy, such as bleeding, hypertension, use of medications and

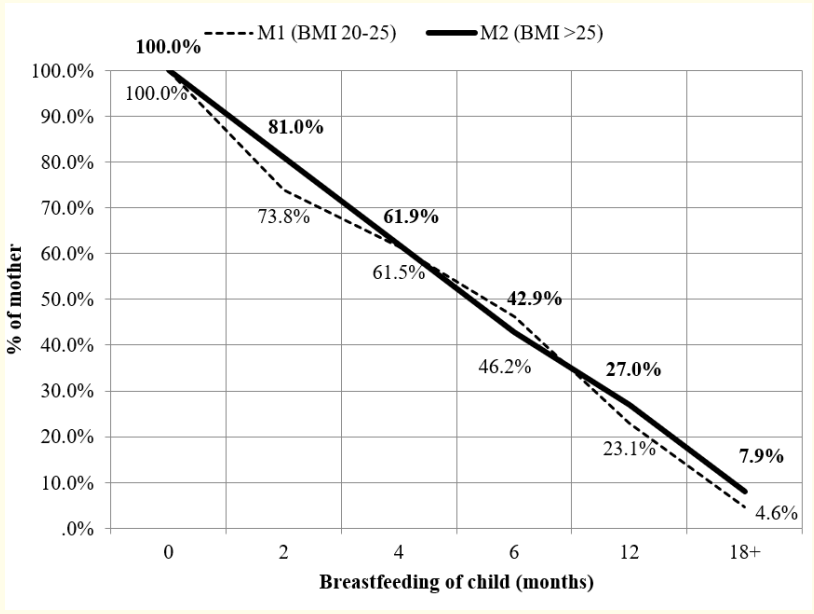

Figure 1: *Distribution of breastfeeding of infants expressed in months i.e. months of infants' life according to the pregnant women's BMI.*

Cesarean section, is higher when, the BMI before delivery is higher [17]. The above mentioned is contrary to our result which suggests that the number of complications such as bleeding or use of medications does not increase with an elevated BMI in pregnant women. In our study, the pregnant women from both groups did not differ by the number of deliveries and approximately 54% of them were primiparae in the group with elevated BMI. In addition, the pregnant women included in the study were in their thirties, which is in accordance with the general world trend for having children. This is similar to the results obtained in California, suggesting that primiparae and middle-aged women have higher chances of becoming obese pregnant women with long-lasting retention of weight between deliveries [18]. Cesarean sections and complications in pregnancy occur more frequently among overweight primiparae than among overweight pregnant women giving birth to their second or third child, as concluded by a study carried out among 14, 875 pregnant women in Australia [19]. By analyzing the manner of completing the delivery, the results of this study suggest that natural delivery is more frequent in both groups, but that the occurrence of Cesarean section is 23% in the group with normal BMI and that it increases with an increase in the BMI of pregnant women. It is estimated that the frequency of Cesarean sections is two to three times higher in overweight pregnant women than in pregnant women with normal body weight, as indicated in a study conducted in America [20]. The results of the study suggest approximately the same occurrence of genders, a birth mass of approximately 3200 grams and full-term deliveries, which leads to the conclusion that the newborn from our study were not macrosomic nor did they have low birth weight for their gestational age. This is contrary to the conclusion that pregnant women with low BMI have a higher risk of giving birth to newborn with low birth weight for their age, while women with high BMI give birth to macrosomic newborn, particularly of the male gender, as shown in research conducted in Boston [21,22]. The study published in 2011 suggests that in spite of the implementation of guidelines recommended by the IOM, there is no difference in the frequency of pre-term deliveries and low birth weight between particular BMI categories of pregnant women, except in the reduction of the frequency of gestational diabetes and macrosomia in the newborn [23]. 98% of the newborn from our study had a normally evalu-

ated Apgar score regardless of test group, while individual studies show the occurrence of low Apgar scores with the elevation of BMI in pregnant women. 8 Other studies also suggest that the newborn of overweight pregnant women are prone to the development of hypoglycemia and hypocalcaemia, as are the newborn of pregnant women with gestational diabetes as concluded by a study conducted in France [8,24,25]. In accordance with the latter, our research observes that the newborn had > 4 mmol glucose in capillary blood 30 minutes upon delivery, which is normal for newborn at this age. Furthermore, the obtained calcium values are within the referential values in the newborn regardless of the BMI of the pregnant women. Our results show a statistical difference in the length of hospitalization depending on the BMI categories of pregnant women. However, since 33% of the newborn in the study group of pregnant women were delivered by Cesarean section, these children spent one day longer in the maternity ward on average, which is contrary to the findings of other studies which state that such children remain in hospital longer due to the development of perinatal complications [7,8]. Our study shows that the children from both groups did not differ by weight at birth, at 6 or 12 months during systematic examinations by competent doctors. In addition, the result of this study suggests that no difference exists in the time of beginning, length or intensity of breastfeeding between the two groups of pregnant women. Both groups started breastfeeding their children upon delivery, and by the sixth month of life approximately 40% of the women from both groups breastfed exclusively, so the intensity and number of mothers who breastfed after that time decreased slowly in both groups. The weight gain in both groups was equal during the first year of life, so the weight of the children was in accordance with the recommended percentile curves for age and weight during the first year of life considering that the percentage of children was fed on their mother's milk for approximately the same number of months. The obtained results are contrary to the studies carried out in the last ten years, which show that pregnant women with an elevated BMI more often decide against beginning breast feeding breastfeed for a fewer number of and introduce supplementary food earlier, and that BMI in pregnant women should be taken as an important factor which affects weight and weight gain in children in their first and second year of life [26,27]. Through a systematic overview of the published studies on the impact of elevated BMI and breastfeeding on weight in early childhood, Mahesh Viswanathan., *et al*. arrive at the conclusion that the published researches are more detrimental than beneficial to pregnant women, because there are no objective criteria for being overweight or the possible negative impact of BMI during pregnancy and delivery, in spite of IOM criteria [28].

Conclusion

The conclusion of this study is that elevated BMI during pregnancy does not affect an increase in complications during pregnancy and delivery. Furthermore, elevated BMI in pregnancy does not increase the frequency of the tested biochemical disorders in the newborn or excessive weight gain in the first year of life. What is most important, mothers with increased BMI breastfed their children for approximately the same number of months as the pregnant women with normal BMI.

Conflict of Interest

The authors declare that they have no conflict of interest.

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