

## Special Article - Obesity in Pregnancy

# Maternal Obesity Increases the Risk of Primary as Well as Secondary Caesarean Section

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Maternal obesity is not only associated with pregnancy outcome but also with the mode of delivery. In the present study the impact of maternal prepregnancy weight status on the mode of delivery, in particular on caesarean section rate was tested. The data of 3451 live births taking place at the Viennese University Hospital were analyzed. Maternal somatometrics (height, weight, weight gain) and newborn somatic characteristics (birth weight, birth length, head dimensions, APGAR scores) were documented. Prepregnancy weight status was classified using Body Mass Index (BMI) categories published by the WHO. The caesarean section rate was 15.6%. (6.8% primary CS, 8.8% secondary CS). 24.2% of the mothers were overweight, 9.6% obese and 0.8% morbidly obese before pregnancy. Maternal prepregnancy BMI was significantly associated with newborn size. The relative risk to give birth to a macrosome newborn was significantly increased among overweight (OR 1.46 CI 1.24-1.72), obese (OR 1.76 CI 1.40-2.19) and morbidly obese mothers (OR 1.51 CI 0.57-3.99). The relative risk of caesarean section increased significantly with increasing prepregnancy weight status ( $p < 0.04$ ). Morbidly obese women showed the significantly highest rate of caesarean section (33.4%; primary CS 16.7%, secondary CS 16.7%). The relative risk of experiencing caesarean section was significantly higher among morbidly obese women than among underweight (OR 3.57 CI 1.85-6.86), normal weight (OR 2.89 CI 1.25-6.69), overweight (OR 2.27 CI 0.99-5.22) and even obese women (OR 2.11 CI 0.94-4.72). Prepregnancy obesity is clearly a significant risk factor of newborn macrosomia and primary as well as secondary caesarean section.

**Keywords:** Pre-pregnancy obesity; Newborn size; Mode of delivery; Caesarean section**Introduction**

The prevalence of overweight and obesity as a worldwide epidemic has increased dramatically since the beginning of the 21st century [1-3]. In 2008 for the first time in the long history of Homo sapiens, the number of obese people on earth exceeded the number of people who suffer from starvation and malnutrition [4]. Currently more than 1.9 billion adults, 18 years and older, were overweight. Of these over 600 million correspond to the definition of obesity [5]. From the viewpoint of public health this high prevalence of overweight and obesity is a major concern because overweight and especially obesity increase rates of metabolic diseases such as diabetes type II, cardiovascular diseases such as heart disease, stroke, hypertension, but also pancreatitis, osteoarthritis and cancer [6]. Obesity however, is also related to reproductive problems, such as increased infertility rates in women as well as in men [7,8]. A special problem represents obesity among women of reproductive age. In the United States more than 50% of women ageing between 20 and 39 years are overweight or obese [6,9,10]. Europe seems to follow a similar pattern, albeit with some delay. Currently one in five pregnant women can be classified as obese in Europe [5,11]. This high rate of obesity among women of childbearing age represents an enormous public health problem because obesity during pregnancy has been associated with both short- and long-term health effects for women

and their offspring [9,12-16]. In general, maternal obesity before and during pregnancy increases the risk for morbidity and mortality of mother and child. Furthermore maternal obesity is associated with an increased risk of miscarriage [17,18], hypertensive disorders such as pre-eclampsia, hypertension and thromboembolic complications [11,19] but also and increased risk of Gestational Diabetes (GDM) and pre-eclampsia [20,21]. On the other hand maternal obesity bears also technical problems: ultrasonography in morbidly obese patients can be challenging because fat tissue attenuates the ultrasound signal by absorption of associated energy [19]. Obesity related problems occur also during parturition. Obese women are more likely to face induction of labor, caesarean section, anesthetic problems, wound infections and postpartum hemorrhage [11,22-24]. Especially caesarean section rates are extremely high among obese women. Several studies have shown an excess risk of caesarean section among overweight, obese and morbidly obese women [25-31]. Caesarean delivery risk is increased by 50% in overweight women and is more than double for obese women in comparison to normal weight women [32]. Consequently prepregnancy obesity is mentioned as a major risk factor for caesarean sections. The aim of the present study was to analyze the impact of maternal prepregnancy weight status, gestational weight, body height but also newborn somatometrics on the mode of delivery.

**Table 1:** Sample description Maternal and newborn characteristics, (descriptive statistics mean, sd, range, absolute and relative frequencies).

Maternal parameters	x (SD)	range	n(%)
Maternal age (yrs)	28.5 (4.4)	19-42	
Stature height (cm)	168.4 (6.5)	144-193	
Prepregnancy weight (kg)	68.9 (13.1)	37 -142	
End of pregnancy weight (kg)	81.2 (13.3)	48-146	
Gestational weight gain (kg)	12.3 (4.8)	2.0 -29.0	
Gestational weight gain < 7kg			500 (14.5%)
Gestational weight gain 7-15kg			1898 (55.0%)
Gestational weight gain >15kg			1053 (30.5%)
Prepregnancy body mass index (kg/m <sup>2</sup> )	24.82 (4.29)	15.1-50.3	
Prepregnancy weight status			
underweight BMI < 18.50			98 (2.8%)
normal weight BMI 18.50-24.99			2158 (62.5%)
overweight BMI 25.00-29.99			836 (24.2%)
obese BMI 30.00-39.99			333 (9.6%)
Morbidly obese BMI >40.00			26 (0.8%)
<b>Newborn parameters</b>			
Sex			
female			1733 (50.2%)
male			1718 (49.8%)
Birth weight (g)	3451.7 (484.8)	1650-5110	
Birth length (cm)	50.9 (2.5)	32-59	
Head circumference (cm)	35.2 (1.4)	29-39	
Newborn weight status			
very low birth weight < 1500g			0 (0.0%)
low birth weight 1500-2499g			50 (1.4%)
normal birth weight 2500-4000g			2807 (81.3%)
macrosome >4000g			594 (17.2%)
Apgar 1	8.7 (0.9)	0-10	
Apgar 5	9.7 (0.8)	10-Jan	

## Materials and Methods

### Data set

This retrospective study is based on a data set of 3451 singleton births which took place at the University Clinic of Gynecology and Obstetrics in Vienna, Austria between 1995 and 2000. Although a total of 7138 births were collected, only 3451 met the strict inclusion and exclusion criteria. The present analyses included exclusively births which took place between the 38<sup>th</sup> and 41<sup>st</sup> gestational week, because term birth of comparable gestational length was a strict inclusion criterion. Furthermore exclusively nulliparous women ageing between 19 and 42 years whose first prenatal check took place during the eighth week of gestation were enrolled in the present study. Additionally the following inclusion criteria were used: all prenatal check-ups of the Austrian mother-child passport completed, the delivery of a single infant without congenital malformations, no registered maternal diseases before and during pregnancy, no hypertension (BP < 150/90 mmHg), no proteinuria, no glucosuria, no pregnancy related

immunization. On the other hand caesarean delivery on maternal request, coincident medical diseases such as gestational diabetes or preeclampsia, drug or alcohol abuse, twin birth or IVF were strict exclusion criteria. Therefore only 3451 births were considered for final analyses. Gestational age was calculated in terms of the number of weeks from the beginning of the last menstrual bleeding to the date of delivery (=duration of amenorrhoea). All subjects originated from Austrian or central Europe.

### Maternal parameters

All women enrolled in the present study aged between 19 and 42 years ( $x=28.5 \pm 4.4$ ). Furthermore the following maternal somatometric parameters were determined at the first prenatal visit: Stature height was measured to the nearest 0.5cm. Body weight was measured to the nearest 0.1kg on a balance beam scale. Additionally maternal weight at the End of Pregnancy (EPW) was measured before birth. The weight gain during pregnancy (PWG) was calculated by subtraction of pre-pregnancy weight from body weight at the end of pregnancy. A gestational weight gain below 7kg was classified as low gestational weight gain, while a gestational weight gain above 15kg was defined as high gestational weight gain.

Maternal pre-pregnancy weight status was determined by the body mass index (BMI) kg/m<sup>2</sup> using stature height and pre-pregnancy weight. To classify maternal weight status the cut-offs published by the WHO [33] were used.

Underweight = BMI < 18.50kg/m<sup>2</sup>

Normal weight = BMI 18.50 to 24.99 kg/m<sup>2</sup>

Overweight = BMI 25.00 to 29.99 kg/m<sup>2</sup>

Obesity = BMI 30.00 to 39.99 kg/m<sup>2</sup>

Morbid Obesity = BMI > 40,00kg/m<sup>2</sup>

### Newborn parameters

Birth weight, birth length and head circumference were taken directly from newborn immediately after birth. Newborn weight status was defined as follows: very low < 1500g, low 1500-2500 g, normal 2500-4000 g and high (macrosomia) >4000g. Furthermore the one- and the five minute APGAR scores for the evaluation of the newborn were determined.

### Obstetrical characteristics

Four categories of birth mode were distinguished:

Spontaneous vaginal birth

Assisted vaginal birth i.e. vacuum extraction or forceps

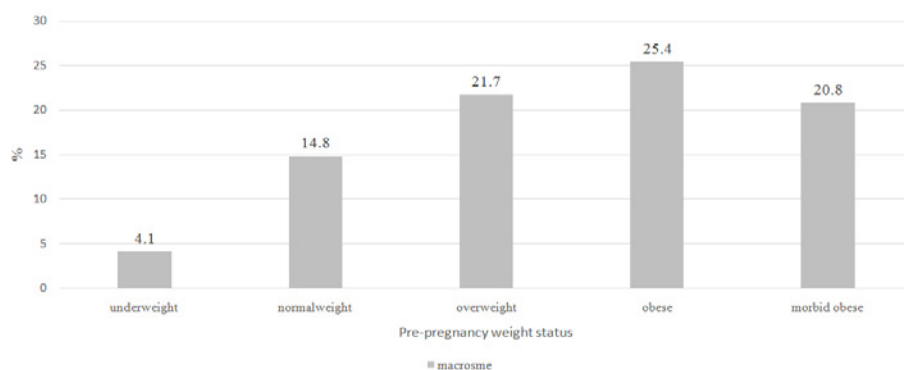
Primary caesarean section

Secondary caesarean section

Caesarean sections requested by the mother without any medical indication were not carried out at this hospital.

### Statistical analyses

Statistical analyses were performed by means of SPSS for Windows program Version 22.0. After calculating descriptive statistics (means, SDs), group differences were tested regarding their statistical significance using Duncan analyze and Student t-tests.



**Figure 1:** Pre-pregnancy weight status and prevalence of macrosomia ( $p < 0.01$ ).

Furthermore  $\chi^2$  analyses and odds ratios were computed. Multiple regression analyses were performed to test the impact of maternal prepregnancy BMI, stature height, gestational weight gain, birth weight, birth length and newborn head circumference on the mode of delivery. Additionally binary logistic regressions were computed in order to test the association of maternal stature, prepregnancy body mass index as well as newborn anthropometrics and caesarean section. Vaginal delivery was coded as 1; a caesarean section was coded as 2.

## Results

### Mode of delivery

The majority of women (74.3%) experienced a spontaneous vaginal birth. 10.2% of the women needed forceps or vacuum extraction. Primary caesarean section was performed among 6.8% of the women, while 8.8% experienced a secondary or emergency caesarean section.

### Maternal and newborn anthropometrics

Maternal and newborn anthropometrics characteristics are presented in Table 1. As to be seen, only less than 3% of the women corresponded to the definitions of underweight ( $BMI < 18.5 \text{ kg/m}^2$ ), 62.5% of the women corresponded to the definitions of normal weight ( $BMI 18.5\text{-}24.99 \text{ kg/m}^2$ ). 24.2% of the women were overweight during prepregnancy phase, whereas obesity during prepregnancy phase was found among 9.6%. 0.8% of the women were classified as morbidly obese i.e. the BMI was higher than  $40.00 \text{ kg/m}^2$ . 55% of the women experienced a weight gain between 7 and 15kg, 14.5% experienced a weight gain of less than 7kg and 30.5% experienced a weight gain higher than 15kg. Since only term births were included in the present analyses, none of the newborns was lighter than 1500g and only 1.5% of the newborn were lighter than 2500g. The majority of newborns (82.3%) corresponded to the definitions of normal weight (2500-4000g), 17.2% newborns however were classified as macrosome ( $>4000\text{g}$ ). Macrosomia was significantly more often found among overweight and obese mothers compared to normal weight or underweight women (Figure 1). In comparison to normal weight mothers the relative risk to give birth to a macrosome newborn was significantly ( $p < 0.001$ ) increased among overweight (OR 1.46 CI 1.24-1.72), obese (OR 1.76 CI 1.40-2.19) as well as morbidly obese mothers (OR 1.51 CI 0.57-3.99).

**Table 2:** Differences in maternal and newborn characteristics according to mode of delivery. Vaginal delivery (VD) vs caesarean section (CS). (Student t-tests).

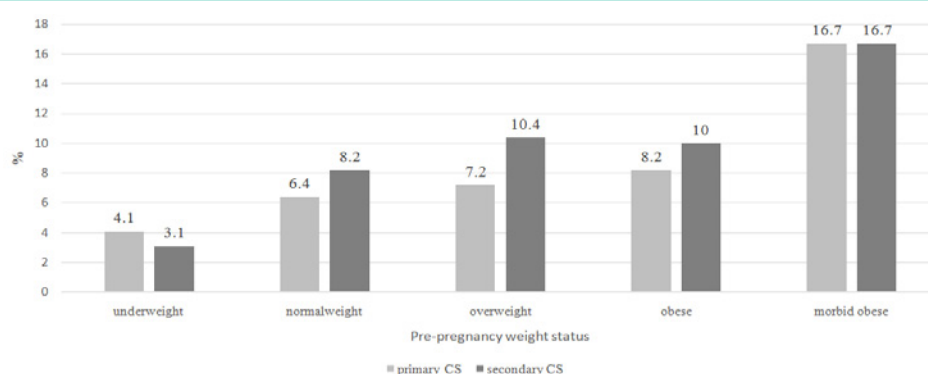
	VD (n=2914)	CS (n=536)	Sig.
	x (SD)	x (SD)	p-value
Maternal age (yrs)	28.4 (4.4)	28.8 (4.3)	0.047
Maternal stature height (cm)	168.6 (6.4)	166.9 (7.0)	0.001
Prepregnancy weight (kg)	68.9 (12.9)	69.1 (13.4)	0.643
End of pregnancy weight	80.9 (13.2)	82.6 (13.5)	0.011
Gestational weight gain (kg)	12.1 (4.7)	13.4 (4.8)	0.001
Prepregnancy weight status (BMI) ( $\text{kg/m}^2$ )	24.19 (4.23)	24.81 (4.63)	0.003
Birth weight (g)	3566.3 (468.2)	3472.2 (560.7)	0.001
Birth length (cm)	53.0 (2.5)	52.4 (2.8)	0.001
Head circumference (cm)	35.3 (1.4)	35.4 (1.6)	0.058
Apgar 1min	8.7 (0.9)	8.6 (1.0)	0.001
Apgar 5min.	9.7 (0.7)	9.6 (0.8)	0.016

VD: Vaginal Delivery; CS: Caesarean Section.

### Maternal and newborn characteristics according to the mode of delivery

Comparing vaginal delivery (spontaneous + VE + forceps) and caesarean section (primary CS + secondary CS) it turned out that women experiencing caesarean section were significantly older, shorter but heavier before and at the end of pregnancy. Furthermore the caesarean section group experienced a significantly higher gestational weight gain and exhibited a significantly higher prepregnancy body mass index. Newborns of the caesarean section group were significantly lighter and shorter. Furthermore their Apgar scores one and five minutes after birth were significantly lower than that among newborns that experienced a vaginal delivery (Table 2). Comparing all four modes of delivery it could be shown that women experiencing secondary caesarean section were significantly shorter than women experiencing primary caesarean section or vaginal delivery. In contrast, women experiencing primary or secondary caesarean section exhibited a significantly higher prepregnancy body mass index than women who experienced vaginal deliveries. The significantly highest gestational weight gain was found among the secondary caesarean section group (Table 3).

Concerning newborn characteristics it turned out, that newborns



**Figure 2:** Pre-pregnancy weight status and mode of delivery (Chi-square=21.0,  $p < 0.04$ ).

**Table 3:** Maternal and newborn characteristic according to mode of delivery Duncan analyses.

	Mode of delivery								Sig.
	Spontaneous vaginal		Forceps + VE		Primary CS		Secondary CS		
Maternal parameters	x	(SD)	x	SD	x	SD	x	SD	p-value
Age (yrs)	28.5	(4.4) <sup>c</sup>	28	(4.3) <sup>c</sup>	29.3	(4.3) <sup>a,b,d</sup>	28.4	(4.3) <sup>c</sup>	0.01
Body height (cm)	168.6	(6.4) <sup>c,d</sup>	168.3	(6.2) <sup>d</sup>	167.5	(7.2) <sup>a,d</sup>	166.6	(6.8) <sup>a,b,c</sup>	0.001
Prepregnancy weight (kg)	68.9	(13)	68.1	(12.6)	69.7	(13.5)	68.7	(13.2)	0.524
End of pregnancy weight (kg)	80.9	(13.2)	81.2	(13.4)	82.2	(13.3)	82.8	(13.7)	0.075
Pregnancy weight gain (kg)	11.9	(4.7) <sup>b,d</sup>	13.1	(4.9) <sup>a,d</sup>	12.6	(4.5) <sup>d</sup>	14.1	(4.9) <sup>a,b,c</sup>	0.000
Prepregnancy BMI (kg/m <sup>2</sup> )	24.22	(4.24) <sup>c,d</sup>	24.02	(4.14) <sup>c,d</sup>	24.86	(4.86) <sup>a,b</sup>	24.76	(4.45) <sup>a,b</sup>	0.022
Newborn parameters									
Birth weight (g)	3569.2	(467.9) <sup>c</sup>	3545.1	(470.5) <sup>c</sup>	3387.7	(522.9) <sup>a,b,d</sup>	3537.2	(580.7) <sup>c</sup>	0.001
Birth length (cm)	52.9	(2.5) <sup>c</sup>	53.2	(2.6) <sup>c</sup>	51.9	(2.7) <sup>a,b,d</sup>	52.8	(2.8) <sup>c</sup>	0.001
Head circumference (cm)	35.3	(1.3) <sup>b,c</sup>	35.5	(1.5) <sup>a,d</sup>	35.5	(1.6) <sup>a,d</sup>	35.4	(1.6) <sup>b,c</sup>	0.001
Apgar 1min	8.8	(0.8) <sup>b,d</sup>	8.3	(0.9) <sup>a,c</sup>	8.8	(0.7) <sup>b,d</sup>	8.4	(1.1) <sup>a,c</sup>	0.001
Apgar 5min	9.7	(0.8) <sup>b,d</sup>	9.4	(0.9) <sup>a,c</sup>	9.7	(0.7) <sup>b,d</sup>	9.5	(0.9) <sup>a,c</sup>	0.001

VE: Vacuum Extraction; CS: Caesarean Section;

- a: significantly different from spontaneous vaginal birth;  
 b: significantly different from forceps + vacuum extraction;  
 c: significantly different from primary caesarean section;  
 d: significantly different from secondary caesarean section.

who were delivered by primary caesarean section were significantly lighter and shorter than all other newborns. On the other hand the significantly largest head circumference was found among newborns delivered by primary caesarean section as well as vacuum extraction and forceps. The Apgar scores one and five minutes after delivery were significantly lowest among newborns delivered by forceps and vacuum extraction followed by newborns experiencing secondary caesarean section.

### Prepregnancy weight status and mode of delivery

As to be seen in Figure 2, caesarean section rate increased significantly with increasing maternal prepregnancy weight status. This was true of primary as well as secondary caesarean sections. Morbidly obese women (BMI > 40.00kg/m<sup>2</sup>) showed the significantly highest rate of caesarean sections while the lowest percentage of caesarean sections was found among underweight women ( $\chi^2 = 21.04$ ;  $p < 0.04$ ). With increasing maternal prepregnancy weight status the relative risk of a caesarean section increased significantly. An especially high risk

of caesarean section was found among morbidly obese women (BMI > 40.00kg/m<sup>2</sup>), in comparison to underweight (OR 3.57; CI 1.85-6.86) and normal weight women (OR 2.89; CI 1.25-6.69). The relative risk of experiencing a caesarean section among morbidly obese women was also significantly increased in comparison to overweight (OR 2.27; CI 0.99 - 5.22) and even obese women (OR 2.11; CI 0.94-4.72). The observed significant impact of maternal prepregnancy weight status on the mode of delivery was corroborated by the results of a binary logistic regression analyses as well as the multiple regression analysis. It could be shown that maternal prepregnancy body mass index had an independent positive effect on caesarean section rate. The risk of caesarean section increased significantly with increasing maternal age prepregnancy body mass index, gestational weight gain and newborn head circumference, but also with decreasing maternal body height and newborn weight (Tables 4 & 5).

### Discussion

Worldwide the rate of caesarean delivery increases, mirroring

**Table 4:** The impact of maternal and newborn somatometry on mode of delivery. Binary logistic regression analyses (spontaneous =1, section =2).

Variable	Coefficient B	SE	Significance	95% CI
Maternal age	0.03	0.01	0.002	1.01-1.06
Maternal height	-0.03	0.01	0.001	0.96-0.98
Prepregnancy BMI	0.05	0.01	0.001	1.03-1.08
Gestational weight gain	0.08	0.01	0.001	1.06-1.11
Birth weight	-0,01	0.01	0.001	0.99-0.99
Birth length	-0.07	0.03	0.010	0.88-0.98
Head circumferences	0.33	0.05	0.001	1.26-1.53

**Table 5:** The impact of maternal and newborn parameters on delivery mode. Linear regression analyses.

	R <sup>2</sup>	Coefficient	SE	Sig.	95% CI
<b>Dependent variable: Mode of delivery</b>					
Maternal age	0.2	0.01	0	0.054	0.01-0.02
Maternal stature height		-0.01	0	0.001	-0.02- -0.01
Prepregnancy BMI		0.02	0	0.001	0.01-0.03
Gestational weight gain		0.03	0	0.001	0.03-0.04
Birth weight		0.01	0	0.001	0.01-0.02
Birth length		-0.01	0.01	0.304	-0.03-0.01
Head circumference		0.11	0.02	0.001	0.08-0.15

the increase in obesity trends [32]. Currently 18.6% of all births worldwide occur by caesarean section [34], however there are marked regional differences. Caesarean section rates ranges from 6% to more than 40%. Especially high caesarean section rates are found in Latin America and the Caribbean region (40.5%), followed by Northern America (32.3%), Oceania (31.1%), Europe (25%), Asia (19.2%) and Africa (7.3%) [34]. In Europe, caesarean rates range from 14.8% in Iceland to 52.2% in Cyprus [35]. During the last 20 years caesarean delivery rates increased dramatically. Data from 121 countries indicated that between 1990 and 2014, the global average caesarean section rate increased from 6.7% to 19.1% i.e. a total increase of 12.4% with an average annual rate of increase of 4.4% [34]. There is no doubt that caesarean section is a life-saving surgical procedure when certain complications such as obstructed labor, cephalo-pelvic disproportion, placenta praevia, breech or transverse and some more occur. Consequently assuring access to caesarean delivery is an essential strategy for reducing maternal and newborn mortality [36]. Nevertheless in 1985 the World Health Organization (WHO) stated that there is no justification for any region to have caesarean section rates higher than 10-15%, because countries with the lowest perinatal mortality rates had caesarean section rates of less than 10% [37]. More recent studies however found that caesarean delivery rates of 19% are associated with lowest maternal and neonatal death rates [36]. The new recommendation of optimal caesarean section rate and the worldwide rising caesarean section rates may be a consequence of rising obesity rates among women of childbearing age during the last 20 years. The deliveries analyzed in the present study occurred during the second half of the 1990ties. The observed caesarean section rate of 15.6% (6.8% primary CS and 8.8% secondary CS) corresponded to the recommendation of CS rates between 10 to 15% of the WHO in 1985 [37]. Since that time the caesarean section rate in Austria has

increased substantially to 29.7% (primary CS 14.7%; secondary CS 15.0%) in 2015 [38].

In the present study the impact of maternal somatometrics on the mode of delivery was analyzed. It could be shown that with decreasing body height the risk of caesarean section increased. Shorter women were more likely to deliver via caesarean section. These association patterns have been documented since more than 25 years [39-45]. Maternal body height has been reported as an obstetric risk factor, because short maternal height may be associated with Cephalo-Pelvic Disproportion (CPD) resulting in obstructed labor [44,46]. Therefore short maternal stature seems to represent an important risk factor for caesarean section [47]. The main focus of this study however was the association between maternal prepregnancy obesity and the mode of delivery. It could be shown that the rates of primary as well as secondary caesarean section increased significantly with prepregnancy weight status. Highest caesarean section rates were found among morbidly obese women. 33.4% of morbidly obese women experienced primary (16.7%) or secondary (16.7%) caesarean section, while this was true of 17.6% of overweight and 18.6% of obese women only. Low caesarean section rates were found among normal weight (14.6%) and underweight women (7.2%). These results are in accordance with several previous studies [15, 26,28,32]. In general obesity is mentioned as one of the most important maternal risk factors of caesarean delivery [16,26,27,48]. This is especially true of morbid prepregnancy obesity. An Australian study demonstrated that super-obese mothers - i.e. a body mass index above 50kg/m<sup>2</sup> - have a significantly higher risk of obstetric complications during pregnancy and birth. 51.6% of these super-obese women gave birth via caesarean section [49]. Furthermore prepregnancy obesity is associated with an increased risk of preterm birth and large for gestational age newborns [14]. Both factors increase the likelihood of caesarean section. Similar trends were found in the present study. Preterm births were excluded from the present study, but a significant association between maternal obesity and newborn macrosomia was documented. Overweight, obese and morbidly obese mothers showed extremely high rates of macrosome newborns (21.7%, 25.4%, 20.8%). Contrary, the prevalence of macrosomia among normal weight and underweight women was 14.8% and 4.1% respectively. Macrosomia, i.e. a birthweight above 4000g, increases the risk of obstetric complications and caesarean section caused by cephalopelvic disproportion or shoulder dystocia dramatically and may result in lower Apgar scores at 1 minute and reduced umbilical arterial ph-levels [19,20]. Consequently caesarean section rates are significantly higher among macrosome newborns. But newborn macrosomia and may be associated cephalo-pelvic disproportion are not the only risk factor for increased caesarean section rates among obese mothers. Maternal obesity is associated with various complications during labor but also postpartum. On the one hand maternal obesity is associated with an increased risk for spontaneous preterm birth [50], on the other hand the onset of parturition is frequently delayed among obese women [49]. Beside prolonged pregnancy among obese women there may occur severe problems during labor. It is well documented that the progress of cervical dilation in obese women is slower than among normal weight women resulting in dystocia [51]. In this case caesarean section is clearly a life-saving strategy. Consequently obese women are treated differently in labor than

women of normal weight [52-54] and caesarean section rates among obese and super-obese mothers are extremely high [49]. On the other hand caesarean section in obese and superobese women poses many surgical, anesthetic and logistical challenges [28]. Caesarean sections are abdominal surgical processes which are especially risky for obese women. Obesity and especially super-obesity represent an increased risk of intra operative complications such as increased infectious morbidity, thromboembolic events [12,28] but also postpartum haemorrhage [22], wound complications [24,55,56] prolonged hospitalization [21,57]. Therefore vaginal delivery is recommended as the preferred way of delivery in obese patients [58]. In order to avoid caesarean section among obese mothers the induction of labor is recommended for suspected macrosome fetuses between the 37th and 38th gestational week [59]. This early term induction of labor reduces the risk of shoulder dystocia and associated complications. On the other hand some guidelines advise an elective caesarean section in all cases with suspected macrosomia [60].

## Conclusion

We can conclude that maternal obesity, especially morbid obesity increase the risk of caesarean delivery significantly however, caesarean section are abdominal surgical processes which are extremely risky for obese women.

## References

- Deitel M. Overweight and obesity worldwide now estimated to involve 1.8 billion people. *Obes Surg.* 2003; 13: 329-330.
- Ford ES, Mokdad AH. Epidemiology of obesity in the Western hemisphere. *J Clin Endocrinol Metab.* 2008; 93: 1-8.
- Hossain P, Kavar B, El Nahas M. Obesity and diabetes in the developing world - a growing challenge. *New Eng J Med.* 2007; 356: 213-215.
- FAO. The state of food insecurity in the world. Food and Agriculture Organization of the United Nations, Rome. 2008.
- WHO. Obesity. Who technical Report, Geneva. 2016.
- Kulie T, Slattengren A, Redner J, Counts H, Ehglash A, Schragger S. Obesity and women's health: an evidence-based review. *J Am Board Fam Med.* 2011; 24: 75-85.
- Maheshwari A, Stofberg L, Bhattacharya S. Effect of overweight and obesity on assisted reproductive technology – a systematic review. *Hum Reprod Update.* 2007; 13: 433-444.
- Norman JE. The adverse effects of obesity on reproduction. *Reproduction.* 2010; 140: 343-345.
- Vahratian A. prevalence of overweight and obesity among women of childbearing age: Results from the 2002 National Survey of family growth. *Matern Child Health J.* 2009; 13: 268-273.
- ASRM. Obesity and Reproduction: a committee opinion. *Fertil Steril.* 2015; 104: 1116-1126.
- Denison FC, Roberts KA, Barr SM, Norman JE. Obesity, pregnancy, inflammation and vascular function. *Reproduction.* 2010; 140: 373-385.
- Leddy MA, Power ML, Schulkin J. The impact of maternal obesity on maternal and fetal health. *Rev Obstet Gynecol.* 2008; 1: 170-178.
- Kirchengast S, Hartmann B. Maternal prepregnancy weight status and pregnancy weight gain as major determinants for newborn weight and size. *Ann Hum Biol.* 1998; 25: 17-28.
- Lutsiv O, Mah J, Beyene J, McDonald SD. The effects of morbid obesity on maternal and neonatal health outcomes: a systematic review and meta-analysis. *Obes Rev.* 2015; 16: 531-546.
- Sebire NJ, Jolly M, Harris JP, Wadsworth J, Joffe M, Beard RW, et al. Maternal obesity and pregnancy outcome: a study of 287,213 pregnancies in London. *Int J Obesity.* 2001; 25: 1175-1182.
- Siega-Riz AM. Prepregnancy obesity: determinants, consequences and solutions. *Adv Nutr.* 2012; 3: 105-107.
- Nohr EA, Bech BH, Davies MJ, Frydenberg M, Henriksen TB, Olsen J. Prepregnancy obesity and fetal death. *Obstet Gynecol.* 2005; 106: 250-259.
- Nelson SM, Fleming R. Obesity and reproduction: impact and interventions. *Curr Opin Obstet Gynecol.* 2007; 19: 384-389.
- Ramsey JE, Greer I, Sattar N. Obesity and reproduction. *BMJ* 2006; 333: 1159-1162.
- Bhattacharya S, Campbell DM, Liston WA, Bhattacharya S. Effect of body mass index on pregnancy outcomes in nulliparous women delivering singleton babies. *Public health.* 2007; 7: 168-176.
- Catalano PM. Obesity, insulin resistance, and pregnancy outcome. *Reproduction.* 2010; 140: 365-371.
- Fyfe EM, Thompson JMD, Anderson NH, Groom KM, McCowan LM. Maternal obesity and postpartum haemorrhage after vaginal and caesarean delivery among nulliparous women at term: a retrospective cohort study. *Pregnancy & Childbirth.* 2012; 12: 112.
- Metwally M, Li TC, Ledger WL. The impact of obesity on female reproductive function. *Obes Reviews.* 2007; 8: 515-523.
- Yamasato K, Yoshino K, Chang AL, Caughey AB, Tsai PJ. Caesarean delivery complications in women with morbid obesity. *J Matern Fetal Neonatal Med.* 2016; 29: 3885-3888.
- Blomberg M. Maternal obesity, mode of delivery and neonatal outcome. *Obstet Gynecol.* 2013; 122: 50-55.
- Seligman LC, Duncan BB, Branchtein L, Daio DSM, Menguw SS, Schmidt MI. Obesity and gestational weight gain: caesarean delivery and labor complications. *Rev Saude Publica.* 2006; 40: 457-465.
- Chui SY, Kim SY, Schmid CH, Dietz PM, Callaghan WM, Lau J, et al. Maternal obesity and risk of caesarean delivery: a meta-analysis. *Obes Rev.* 2007; 8: 385-394.
- Machado LSM. Caesarean section in morbidly obese parturients: Practical implications and complications. *N Am J Med Sci.* 2012; 4: 13-18.
- Ovesen P, Rasmussen S, Kesmodel U. Effect of prepregnancy maternal overweight and obesity on pregnancy outcome. *Obstet Gynecol.* 2011; 118: 305-312.
- Joseph KS, Young DC, Dodds L, O'Connell CM, Allen VM, Chandra S, et al. Changes in maternal characteristics and obstetric practice and recent increases in primary cesarean delivery. *Obstet Gynecol.* 2003; 102: 791-800.
- Declercq E, MacDorman M, Osterman M, Belanoff C, Iverson R. Prepregnancy obesity and primary caesareans among otherwise low-risk mothers in 38 US States in 2012. *Birth.* 2015; 42: 309-318.
- Poobalan AS, Aucott LS, Gurung T, Smith WCS, Bhattacharya S. Obesity as an independent risk factor for elective and emergency delivery in nulliparous women - systematic review and meta-analysis of cohort studies. *Obes Rev.* 2008; 10: 28-35.
- WHO. Physical status: the use and interpretation of anthropometry. WHO technical Report Series, Geneva. 2000.
- Betran AP, Ye J, Moller AB, Gülmezoglu AM, Torloni MR. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014. *Plosone.* 2016.
- MacFarlane AJ, Blondel B, Mohangoo AD, Cuttini M, Nijhuis J, Novak Z, et al. Wide differences in mode of delivery within Europe: risk-stratified analyses of aggregated routine data from the Euro-Peristat study. *Brit J Obstet Gynecol.* 2015; 123: 559-568.
- Molina G, Weiser TG, Lipsitz SR, Esquivel MM, Uribe-Leitz T, Azad T, et al. Relationship between caesarean delivery rate and maternal and neonatal mortality. *JAMA.* 2015; 314: 2263-2270.

37. WHO: Appropriate technology for birth. *Lancet*. 1985; 326: 436-437.
38. Statistik Austria. Demographic Yearbook. Vienna. Austria. 2016.
39. Kirchengast S, Hartmann B. Short stature is associated with an increased risk of caesarean deliveries in a low risk population. *Acta Med Lituanica*. 2007; 14: 1-6.
40. Barnhard YB, Divon MY, Pollack RN. Efficacy of the maternal height to fundal height ratio in predicting arrest of labor disorders. *J Matern Fetal Med*. 1997; 6: 103-107.
41. Kara F, Yesildaglar N, Uygur D. Maternal height as a risk factor for Caesarean section. *Arch Gynecol Obstet*. 2005; 271: 336-337.
42. Merchant KM, Villar J, Kestler E. Maternal height and newborn size relative to risk of intrapartum caesarean delivery and perinatal distress. *BJOG*. 2001; 108: 689-696.
43. Moller B, Lindmark G. Short stature. An obstetric risk factor? A comparison of two villages in Tanzania. *Acta Obstet Gynecol Scand*. 1997; 76: 394-397.
44. Sheiner E, Levy A, Katz M, Mazor M. Short stature – an independent risk for Caesarean delivery. *Eur J Obstet Gynecol Rep Med*. 2005; 120: 175-178.
45. Scott RT, Strickland DM, Hankins GD, Gilstrap LC. Maternal height and weight gain during pregnancy as risk factors for caesarean section. *Mil Med*. 1989; 154: 365-367.
46. Witter FR, Caulfield LE, Stoltzfus RJ. Influence of maternal anthropometric status and birth weight on the risk of Cesarean delivery. *Obstet Gynecol*. 1995; 85: 947-951.
47. McGuinness BJ, Trivedi AN. Maternal height as a risk factor for Caesarean section due to failure to progress in labour. *Aust N Z J Obstet Gynecol*. 1999; 39: 152-154.
48. Al-Kubaisy W, Al-Rubaey M, Al-Naggar RA, Karim B, Noor NA. Maternal obesity and its relation with caesarean section: a hospital based cross sectional study in Iraq. *Pregnancy & Childbirth*. 2014; 14: 235-239.
49. Sullivan EA, Dickinson JE, Vaughan GA, Peek MJ, Ellwood D, Homer CS, et al. Australasian Maternity Outcomes Surveillance System. Maternal super-obesity and perinatal outcomes in Australia: a national population-based cohort study. *BMC Pregnancy Childbirth*. 2015; 15: 322-332.
50. Nohr EA, Bech BH, Vaeth M, Rasmussen KM, Henriksen TB, Olsen J. Obesity, gestational weight gain and preterm birth: a study within the Danish National Birth Cohort. *Paediatr Perinat Epidemiol*. 2007; 21: 5-14.
51. Carlson NS, Hernandez TL, Hurt KJ. Parturition dysfunction in obesity: time to target the pathophysiology. *Reprod Biol Endocrinol*. 2015; 13: 135-149.
52. Abenheim HA, Benjamin A. Higher Caesarean section rates in women with higher body mass index: are we managing labor differently? *J Obstet Gynaecol Can*. 2011; 33: 443-448.
53. Pulman KJ, Tohidi M, Pudwell J, Davies GA. Emergency caesarean section in obese parturients: Is a 30-Minute decision-to-incision interval feasible? *J Obstet Gynecol Can*. 2015; 37: 988-994.
54. Trisovic M, Kontic O, Babovic I, Plecas D, Kistic-Tepavcevic D. The influence of obesity on abdominal caesarean section delivery. *Clin Exp Obstet Gynecol*. 2015; 42: 498-500.
55. Smid MC, Kearney MS, Stamilio DM. Extreme obesity and post-caesarean wound complications in the maternal-fetal medicine unit caesarean registry. *Am J Perinatol*. 2015; 32: 1336-1341.
56. Stamilio DM, Scifres CM. Extreme obesity and postcaesarean complications. *Obstet Gynecol*. 2014; 124: 227-232.
57. Lydon-Rochelle M, Holt VL, Martin DP, Easterling TR. Association between mode of delivery and maternal rehospitalisation. *JAMA*. 2000; 283: 2411-2416.
58. Devlieger R, Benhalima K, Damm P, Van Assche A, Mathieu C, Mahmood T, et al. Maternal obesity in Europe: where do we stand and how to move forward? A scientific paper commissioned by the European Board and College of Obstetrics and Gynecology (EBCOG). *Eur J Obstet Gynecol Rep Biol*. 2016; 201: 203-208.
59. Boulvain M, Senat MV, Perrotin F, Winer N, Beucher G, Subtil D, et al. Induction of labour versus expectant management for large-for-date fetuses: a randomised controlled trial. *Lancet*. 2015; 27: 2600-2605.
60. Chauhan SP, Gherman R, Hendrix NW, Bingham JM, Hayes E. Shoulder dystocia: comparison of the ACOG practice bulletin with another national guideline. *Am J Perinatol*. 2010; 27: 129-136.