Postpartum Weight: A Guide for Calculation of the Expected Prepregnancy Weight to Study the Risk of Maternal Overweight and Obesity on Congenital Anomalies

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Introduction

Maternal obesity during pregnancy is a definite risk factor for certain congenital anomalies.

The crude measure of the body fat is the body mass index (BMI).

The BMI calculated as the = Weight (kg)/Height (m^2).

The WHO classified BMI in to four major groups:

BMI < 18.5 Kg/m2	Underweight
BMI 18.5-24.9 Kg/m2	Normal
BMI 25-29.9 Kg/m2	Overweight
BMI ≥ 30 Kg/m2	Obesity

About 30-40% of the causes of obesity are genetic and the rest are environmental factors as the high energy foods and sedentary lifestyle.

Obesity during pregnancy increase maternal incidence of gestational diabetes, hypertension, preeclampsia, thromboembolic disorders, cesarean section, and wound infections.

For the baby, it increase his incidence of macrosomia, birth injuries, perinatal death, stillbirth, preterm birth, and congenital anomalies (CAs).

Future childhood obesity increase up to 40% if one parent is obese and to 70% if both are affected.

It has been shown that women who are overweight or obese in the start of the pregnancy has more maternal and child health complications, and the more she is overweight, the more she is and her baby is likely to develop health complications.

If a mother is overweight and planned to be a pregnant, starting weight loss before pregnancy can help to reduce her complications and CAs.

Maternal obesity cause CAs by:

- Increase her liability for gestational diabetes that shares with obesity a similar teratogenic metabolic abnormalities like insulin resistance and hyperglycemia.

- The Increase liability to folate deficiency due to the increased metabolic requirements.

- The chronic hypoxia and hypercapnia of obesity which are considered fetal teratogens.

- The increased size of the baby will increase the mechanical forces in the uterine cavity causing different malformations such as the club foot or congenital hip dislocation.

- The increased difficulty of ultrasound examination specially the soft tissue anomalies resulting in a fewer prenatal diagnosis and less terminations of pregnancy.

To study the risk of maternal overweight and obesity on CAs, maternal BMI at conception and maximum up to 10 weeks of pregnancy must be used.

During our study of the risk factors of CAs in Al-Ramadi birth defects center in 2010, we found the vast majority of mothers after delivery didn't know their weight during pregnancy, and studying the relation of obesity with CAs was impossible.

The aim of this study is to use the postpartum weight to calculate the expected prepregnancy weight and BMI, to study the risk of maternal overweight and obesity on CAs, applied retrospectively on patients examined in 2010 in the birth defect center of Al-Ramadi Maternity and Children's Teaching Hospital (MCTH), western Iraq.

Methods

This is a retrospective hospital based case-control study applied from the 1st of February to the 1st of October 2015

Mother's data includes her age, height, residence, postpartum weight, and date of examination.

Baby's data include his weight, gender, gestational age, and type of associated structural CAs.

For every mother with CA-affected neonate, two age-matched mothers who delivered sex-matched CA-free neonates were selected randomly as controls.

According to the Institute of Medicine Recommendations, mothers at full term pregnancy will gain an average total pregnancy weight according to their prepregnancy BMI as follows:

- Underweight mothers: ⟶ 12.5 ± 4.2 kg.
- Normal weight mothers: ⟶ 11.6 ± 4.1 kg.
- Overweight mothers: ⟶ 10.5 ± 5.5 kg.
- Obese mothers: ⟶ 9.1 ± 7.3 kg.

Average weights of the normal pregnancy components

Pregnancy components	10 weeks	20 weeks	30 weeks	40 weeks
Baby	5g	300g	1500g	3500g
Placenta	20g	170g	430g	650g
Amniotic Fluid	30g	350g	750g	800g
Uterus	140g	320g	600g	970g
Breast	45g	180g	360g	415g
Blood Volume	100g	600g	1300g	1250g
Fluid Retention	100g	500g	800g	1300g
Body Fat	210g	1580g	2760g	3200g
Total	650g	4000g	8.5kg	12.5kg

At birth, the mother will lose the weight of the conception products (fetus, amniotic fluid and placenta), and retain the excess weight of the pregnancy components (breast, uterus, fat, fluid and blood volumes).

The percent of conception products is different from one study to another:

Hytten: ⟶ 38.2% of the pregnancy weight gain.
UTAH Department of Health: ⟶ 36.6% ====
Macones in the *UpToDate:* ⟶ 40.8% ====
Web MD: ⟶ 43.3% ====

The average percent of these reports is 39.7%.

Accordingly, the average retained excess weight of the pregnancy components (breast, uterus, fat, fluid and blood volumes) will be: 100 – 39.7 = 60.3%.

This 60.3% is the difference between the maternal weight after delivery and her expected prepregnancy weight (the difference factor).

After delivery, the mother will gradually lose this weight with a maximum weight loss of 0.5 kg/week during the first 6 weeks after delivery, then decreased gradually and takes about 6 to 12 months to reach about her original prepregnancy weight.

When the 60.3 % is applied on mothers of different BMI types according to the Institute of Medicine Recommendations as 60.3% of the corresponding pregnancy gain of weight, the types of the difference factors will be:

- Underweight mother = 7.5 kg $\pm$ 2.52.
- Normal weight mother = 7 kg $\pm$ 2.46.
- Overweight mother = 6.3 kg $\pm$ 3.3.
- Obese mother = 5.5 kg $\pm$ 4.38.

These difference factors are used on the non individual basis.

The expected prepregnancy weight =
maternal weight after delivery – corresponding difference factor.

In this study, all mothers were examined at 7-14 days after delivery. The average weight loss in this period will be 750 g. So;
Maternal weight at delivery = postpartum weight + 750 g.

The expected prepregnancy weight = the maternal weight at delivery (or at 7-14 days + 750g) – corresponding difference factor.

The Expected Prepregnancy BMI (EPPBMI) =
Calculated Expected Prepregnancy Weight (kg)/Maternal Height (m^2).

EPPBMI of cases is compared with controls to study the risk of obesity on the development of CAs.

Results

Number of enrolled mothers were 184, delivered 184 CA-affected neonates.

Age of mothers: 16-44 years (mean = 28.3 years).

Postpartum weight: 52-108 kg (mean = 74.6 kg).

Number of controls were 368 mothers delivered 368 sex matched healthy neonates.

Affected neonates composed of 115 males and 69 females.

- 156 (84.8%) had isolated, and 28 (15.2%) had multiple CAs.

- 126 (68.4%) had major, and 58 (31.5%) had minor CAs.

Because of the multiple CAs, the total different anomalies were 232 and exceeded the number of affected neonates.

Table (1) The changing profile in the cases and controls from the postpartum BMI to the EPPBMI after subtraction of the difference factor.

BMI Types	Cases			Control		
	Postpartum BMI No. %	Changes	EPPBMI No. %	Postpartum BMI No. %	Changes	EPPBMI No. %
Obese	93 (50.5)	-15	78 (42.4)	84 (22.8)	-38	46 (12.5)
Overweight	65 (35.2)	+15, -25	55 (29.9)	171 (46.4)	+38, -123	86 (23.3)
Normal	25 (13.6)	+25	50 (27.2)	111 (30.1)	+123, -16	218 (59.2)
Low	1 (0.54)	-	1 (0.54)	2 (0.54)	+16	18 (4.89)
Total	184 (100)		184 (100)	368 (100)		368 (100)

Higher overweight and obesity values of postpartum BMI and calculated EPPBMI in the cases than controls,

Distribution of values toward the upper level of overweight postpartum levels, making them less dropped to a down level as EPPBMI after subtraction of the difference factor than in controls.

Table (3) Recorded CAs according to the types of BMI (EPPBMI).

The most common CAs related with overweight and obesity were:

Cardiovascular System	**74**	**(31.9)**	**-**	**16**	**(21.6)**	**22**	**(29.7)**	**36**	**(48.6)**
VSD	27	(36.4)	-	5	(6.7)	5	(6.7)	17	(22.9)
ASD	25	(33.7)	-	5	(6.7)	10	(10.3)	10	(13.1)
Common A-V Canal	6	(8.1)	-	1	(1.3)	2	(2.7)	3	(4.01)
PS	7	(9.4)	-	2	(2.7)	3	(4)	2	(2.7)
Tricuspid valve Incompetence	2	(2.7)	-	1	(1.3)	-	-	1	(1.3)
Mitral valve regurgitation	1	(1.3)	-	-	-	-	-	1	(1.3)

Ventricular Septal Defects (VSD), Atrial Septal Defects (ASD), and Common A-V Canal in Cardiac Anomalies

Genitourinary system	**36**	**(15.5)**	**-**	**17**	**(47.2)**	**10**	**(27.7)**	**9**	**(25)**
Undescended testis	15	(41.6)	-	7	(19.4)	5	(13.8)	3	(8.3)
Hydrocele	7	(19.4)	-	2	(5.5)	3	(8.3)	2	(5.5)
Hypospadias	8	(22.2)	-	4	(11.1)	1	(2.7)	3	(8.3)
Ambiguous genitalia	3	(8.3)	-	2	(5.5)	1	(2.7)	-	-
Bartholin gland cyst	1	(2.7)		1	(2.7)				

Undescended Testis, Hydrocele and Hypospadias in Genitourinary Anomalies

Congenital anomalies			EPPBMI Types							
Types	No.	%	Low		Normal		Overweight		Obese	
			No.	%	No.	%	No	%	No.	%
Musculoskeletal system	**32**	**(13.8)**	-		**7**	**(21.8)**	**15**	**(46.8)**	**10**	**(31.2)**
Congenital Hip Dislocation	9	(28.1)	-		1	(3.1)	4	(12.5)	4	(12.5)
Polydactyly	4	(12.5)	-		3	(9.3)	-	-	1	(3.1)
Club foot	3	(9.3)	-		1	(3.1)	1	(3.1)	1	(3.1)
Hip subluxation	2	(6.2)	-		-	-	2	(6.2)	-	-
Sandactyly	3	(9.3)	-		-	-	1	(3.1)	2	(6.2)
Single hand creases	1	(3.1)	-		-	-	1	(3.1)	-	-
Hyperextension of hip & knee	2	(6.2)	-		1	(3.1)	-	-	1	(3.1)
Absent thumb	1	(3.1)	-		1	(3.1)	-	-	-	-
Absent forearm	1	(3.1)	-		-	-	-	-	1	(3.1)
Meromelia	1	(3.1)	-		-	-	1	(3.1)	-	-
Short hands + Absent radius	1	(3.1)	-		-	-	1	(3.1)	-	-
Central Nervous System	**30**	**(12.9)**	**1**	**(3.33)**	**6**	**(20)**	**8**	**(26.6)**	**15**	**(50)**
Hydrocephalus	9	(30)	-		2	(6.6)	3	(10)	4	(13.3)
Microcephaly	6	(20)	1	(3.3)	1	(3.3)	3	(10)	2	(6.6)
Meningomyelocele	5	(16.6)	-		1	(3.3)	-	-	4	(13.3)
Spina bifida occulta	1	(3.3)	-		-	-	-	-	-	-
Meningocele										
Craniocynostosis	1	(3.3)	-		1	(3.3)	-	-	-	-
Flat occiput	1	(3.3)	-		1	(3.3)	-	-	-	-

Congenital Hip Dislocation, Polydactyly, & Club foot in Musculoskeletal Anomalies

Hydrocephalus, Microcephaly and Meningomyelocele in CNS Anomalies

Congenital anomalies	EPPBMI Types									
Types			Underweight		Normal	No.	Overweight No		Obese	
	No.	%	No.	%	%		%		No.	%
Digestive system	**19**	**(8.1)**	-		**1**	**(5.26)**	**9**	**(47.3)**	**9**	**(47.3)**
Cleft palate + Cleft lip	3	(15.7)	-		-	-	1	(5.2)	2	(10.2)
Clift lip	3	(15.7)	-		-	-	1	(5.2)	2	(10.2)
Imperforated anus	3	(15.7)	-		1	(5.2)	1	(5.2)	1	(5.2)
Esophageal atresia	1	(5.2)	-		-	-	-	-	1	(5.2)
Trachioesophageal fistula	1	(5.2)	-		-	-	-	-	1	(5.2)
Umbilical hernia	1	(5.2)	-		-	-	1	(5.2)	-	-
Ranula	1	(5.2	-		-	-	1	(5.2)	-	-
Tongue Tie	2	(10.2)	-		-	-	1	(5.2)	1	(5.2)
Diaphragmatic hernia	1	(5.2)	-		-	-	1	(5.2)	-	-
Skin	**13**	**(5.6)**	-		**4**	**(30.7)**	**6**	**(46.1)**	**3**	**(23.1)**
Hemangioma	8	(61.5)	-		3	(23)	3	(23)	2	(23)
Skin tag	3	(23)	-		-	-	2	(15.1)	1	(7.6)
Congenital skin nevus	1	(7.6)	-		-	-	1	(7.6)	-	-

Cleft Lip, Cleft Lip + cleft palate , imperforated anus in Digestive Tract Anomalies

Hemangioma in Skin Anomalies

Down's Syndrome in Syndrome's Anomalies

Syndromes	**11**	**(4.7)**	-	**3**	**(27.3)**	-	-	**8**	**(72.7)**
Down syndrome	9	(81.8)	-	3	(27)	-	-	6	(54.5)
Turners syndrome	1	(9)	-	-	-	-	-	1	(9)
Achondroplasia	1	(9)	-	-	-	-	-	1	(9)
Eye	**7**	**(3.01)**	-	**1**	**(14.3)**	**2**	**(28.5)**	**4**	**(57.1)**
Microphthalmia	2	(28.5)	-	-	-	1	(14.2)	1	(14.2)
Aniridia	1	(14.2)	-	-	-	-	-	1	(14.2)
Small palpebral fissure	1	(14.2)	-	-	-	-	-	1	(14.2)
Cataract	1	(14.2)	-	-	-	-	-	1	(14.2)
Absent left eye	1	(14.2)	-	-	-	1	(14.2)	-	-
Hypertelorism	1	(14.2)	-	1	(14.2)	-	-	-	-
Ear	**7**	**(3.01)**	-	**3**	**(42.8)**	**2**	**(28.5)**	**2**	**(28.5)**
Accessory auricle	5	(71.4)	-	2	(28.5)	1	(14.2)	2	(28.5)
Low set ears	2	(28.5)	-	1	(14.2)	1	(14.2)	-	-
Respiratory system	**3**	**(1.3)**	-	**1**	**(33.3)**	**1**	**(33.3)**	**1**	**(33.3)**
Laryngomalacia	1	(33.3)	-	-	-	-	-	1	(33.3)
Saddle nose	1	(33.3)	-	-	-	1	(33.3)	-	-
Bilateral choanal atresia	1	(33.3)	-	1	(33.3)	-	-	-	-
Total	232	(100)	1	(0.43)	61	(26.3)	75	(32.3)	95	(41)

Obese mothers associated with 41% of the CAs, overweight mothers with 32.3%, normal mothers with 26.3%, and less than 1% with underweight mothers

Table (2) The risk of EPPBMI types on the development of CAs.

EPPBMI types	Cases (184) No. %	Controls (368) No. %	OR (95% CI) †	*P* value
Low	1 (0.54)	18 (4.89)	0.242 (0.24-1.85)	0.0683
Normal	50 (27.1)	218 (59.2)	- -	-
Overweight	55 (29.9)	86 (23.3)	2.79 (1.76-4.40)	0.0001
Obese	78 (42.4)	46 (12.5)	7.39 (4.54-11.9)	0.0001

Both overweight and obese mothers found risk factors significantly associated with the development of CAs, while no relation was found between underweight mothers and CAs.

Table (4) The risk of EPPBMI types on the most common recorded CAs.

System's CAs	No.	Types of EPPBMI						
		Normal	low		Overweight		Obese	
Cardiovascular			cases		cases	OR (95% CI)†	cases	OR (95% CI)
VSD	27	5	-	-	5	2.53(0.71-8.97)	17	16.1(5.65-45.89)*
ASD	25	5	-	-	10	5.06(1.68-15.2)*	10	9.47(3.09-29.03)*
Genitourinary								
Undescended testis	15	7	-	-	5	1.81(0.55-5.86)	3	2.03(0.50-8.14)
hydrocele	7	2	-	-	3	3.80(0.62-23.1)	2	4.73(0.65-34.5)
Hypospadias	8	4	-	-	1	0.63(0.63-0.06)	3	3.55(0.76-16.4)
Musculoskeletal								
Cong. Hip dislocation	9	1	-	-	4	7.60(0.78-74.1)	4	14.2(1.44-139.7)*
Sandactyly	3	-	-	-	1	33.3%	2	66.6%
Club foot	3	1	-	-	1	2,53(0.56-40.9)	1	4.73(0.291-77.1)
Central nervous system								
Hydrocephalus	9	2	-	-	3	3.80(0.62-23.1)	4	9.74(1.68-53.3)*
Meningomyelocele	5	1	-	-	-	-	4	18.9(2.07-17.5)*
Microcephaly	6	1	-	-	3	7.60(0.78-74.1)	2	9.47(0.84-106.7)
Digestive system								
Cleft lip + cleft palate	3	-			1	33.3%	2	66.6%
Cleft lip	3	-			1	33.3%	2	66.6%
Syndromes								
Down's syndrome	9	3	-	-	-	-	6	9.47(2.28-39.2)*
Control	368	218	18		86		46	

Obesity found a risk factor associated with the development of VSD, ASD, congenital hip dislocation, hydrocephalus, meningomyelocele, down's syndrome and all cleft lip and cleft palates, while overweight found associated with the development of ASD only

Discussion

In areas with high social health education, family medicine system and prepregnancy health care systems, mothers usually started their antenatal care visits early, and the access to mothers before, at, or near conception is easy, and a large number of pregnant mothers can be collected early in pregnancy for prospective, or retrospective studies.

Areas with no family doctor system, no prepregnancy care systems, and low social health education, the first antenatal care may be late or absent, and the medical records will be poor, and collection of adequate number of mothers in this stage will be difficult.

The problem in our population is the difficulty to find an adequate number of mothers who expose their early pregnancy because of the social or other factors, and the majority of mothers in our populations didn't know their prepregnancy weight when examined after delivery.

Accordingly, the number of mothers seen near conception is very limited and studying the relation of BMI types with congenital anomalies is difficult.

In other countries specially western countries such problem is less available, and the access for mothers in the prepregnancy stage is easier.

Postpartum weight is easier to access and more practical, and when a multicenter method is used in high delivery rate hospitals or health centers, large number of mothers can be collected in short period, and a uniform perfect well-adjusted weight, height, and BMI measures will result in a rapid, easy and practical method, to study the risk of obesity on CAs.

In this study, the calculation of the EPPBMI involves in addition to the excess weight of the retained pregnancy components, the weight of the excessive fat gain secondary to excessive food intake which may give a false high overestimated results in some of the calculated EPPBMI.

Food intake and weight gain during pregnancy must be limited according to the prepregnancy weight.

Studies showed that the increased appetite and excessive fat gain during pregnancy occurred mostly in those who are already overweight or obese before conception than in those who are underweight or normal weight mothers.

This may reduce the overestimation effect of this study since underweight and normal mothers are less liable for excessive weight gain and so will be less overestimated during the calculation of the EPPBMI.

And when overweight mother has additional fat gain and estimated as obese EPPBMI, or an obese mother has additional fat gain and estimated as excessive obesity EPPBMI, this may minimally affect the net result, since both these types are risk factors for CAs.

In this study, the calculated difference factor is 60.3% of all maternal BMI types. For a more precise calculation, the percent must be different according to the types of maternal BMI.

In spite of the extensive review of literatures in this study, we couldn't find any record of neither the percent of the conception products nor the percent of the retained pregnancy components according to the BMI types.

Studies that depended on maternal self-record or recording the BMI at the first 10 weeks of pregnancy may carry a weight difference possibly not less than what we expect in this study.

Conclusion

Calculation of the EPPBMI from the postpartum weight is easy and practical, and useful in areas with poor social health education and antenatal care.

Overweight and obesity is a risk factor for the development of CAs.

Recommendations

To prove the accuracy of this method, another prospective study is required to follow up four groups of BMI types mothers from conception till delivery, and calculate the total pregnancy weight gain, the weight of the conception products, and the difference factors of each type, and our method will be accurate if the difference factor was equal or near to the 60% of the pregnancy weight gain according to the types of prepregnancy BMI.

Thank You For Your Attention