International Journal of Clinical Obstetrics and Gynaecology

ISSN (P): 2522-6614
ISSN (E): 2522-6622

www.gynaecologyjournal.com
2018; 2(4): 01-05
Received: 01-05-2018
Accepted: 02-06-2018

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Body mass index and body adiposity index in maternal obesity and its implication on the mother and her offspring: A hospital based prospective observational study

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Abstract
Objective: Body adiposity is associated with antenatal, intranatal and postnatal complications.
Aim: The aim of the study was to determine Body Mass index and Body adiposity index in maternal obesity and its implication on the mother and her offspring.
Material and Methods: A Prospective Observational study conducted in a Single Tertiary care Centre in a 1000 singleton pregnancies with gestational age more than 28 weeks and data was collected, compiled and analysed.
Results: According to BMI 41.5% and 22.4% patients and with BAI classification, 21.1% and 3.3% women were overweight and obese respectively. In BMI Groups, GDM (14.3%), preeclampsia (27.7%) in Group 4 and in Group 2 Similarly, while evaluating BAI Groups, GDM (21.2%). Preeclampsia (24.2%) in the Group 4a and 12.6% in Group 2a was observed. In both BMI and BAI groups. NICU admission was higher infant of overweight and obese.
Conclusion: This study showed an increased risk of wide variety of pregnancy, perinatal complications and higher neonatal admissions in overweight and obese women when screened by BMI and BAI simultaneously.

Keywords: Body adiposity index, obesity, overweight

1. Introduction
Overweight and obesity has become an increasing health problem in the world, including southeastern countries like India. Maternal obesity has now been recognized as a putative causative factor which inflates the risk of gestational diabetes, preeclampsia, labor induction, cesarean delivery, macrosomia, shoulder dystocia and admission to neonatal intensive care unit (NICU) [1-6]. Adequate weight gain during pregnancy is associated with better neonatal and maternal outcomes. Body Mass Index (BMI) is one of the most widely used indices in the anthropometric evaluation [7] of a pregnant woman. Other methods now being developed and recently, the body adiposity index (BAI) were proposed as a tool to evaluate adiposity, to overcome the shortcomings of BMI.

BAI was suggested to have several advantages over BMI, including that it yields similar associations with body fat (BF%) for men and women and may be more practical to assess in field studies because it does not require a weight measurement. Only one study has determined the relationship between BMI and BAI and BF% in Asian subjects [8] and additionally, the utility of this index for metabolic risk has not yet been confirmed in this ethnicity. Therefore, it is important to validate BAI and its supplementation to BMI for predicting adiposity and metabolic risk in other Asian groups.

The antenatal period with opportunities for regular contact with health professionals, is considered an ideal time to intervene as mothers are motivated to make changes that could optimize their outcome and that of the baby [9]. There is a need to identify appropriate weight management interventions that are effective and safe in pregnancy [10]. This was the first study of this kind done in Kashmir division of India wherein the relationship of anthropometric measurements and pregnancy outcomes were evaluated.

1.1 Aims and Objectives: To determine maternal Body Adiposity Index, Body mass index and their implications on maternal and fetal outcome.

1.2 Study Design: Prospective Observational study

1.3 Sample Size: The present study was conducted in tertiary care center in Srinagar (J&K), India. The study period was of one and half years. All obstetric patients who were admitted to labor room and ward for obstetric intervention in 3rd trimester between April 1, 2014 and September 30, 2015 were taken as study subjects after fulfilling inclusion criteria. They were enrolled in the study after their written informed consent.

1.4 Inclusion criteria: Patients with singleton pregnancy, gestational age more than 28 weeks as ascertained by last menstrual period or USG done before 20 weeks.

1.5 Exclusion criteria: Non – Kashmiri women, multi-fetal gestation and patients who were known case of Type 2 Diabetes Mellitus, Chronic Hypertension.

2. Materials and Methods: The weighing machine used was from Equinox, an electronic personal scale (Model: EB-EQ11)**.** Height was measured using Stadiometer**;** Hip circumference was measured using measuring tape. Pregnant women coming for admission to ward and labor room for obstetric intervention at the time of delivery were enrolled in the study after informed consent. A detailed history was taken. General physical examination was carried out Patients enrolled were divided on basis of BMI and BAI into: Patients enrolled were divided on the basis of BMI and BAI. Patients were divided into four groups on basis of BMI and BAI: Group 1 (Underweight): (BMI <18.5), Group 2 (Healthy): (BMI 18.5-24.9), Group 3 (Overweight): (BMI 25-29.9) and Group 4 (Obese): (BMI > 30) and On the basis of BAI groups: Group 1a (Underweight): BAI <23%. Group 2a (Healthy): BAI 23%-34.9%. Group 3a (Overweight): BAI 35%-40%. Group 4a (Obese): BAI > 40% at the time of delivery during the study period. All routine investigations and any investigation pertaining to the patient were done. After detailed history and examination and after fulfilling the criteria for inclusion in the study, anthropometric measurements were carried out on the patient. Patients were evaluated for: BAI, BMI, Weight and height. BAI was defined as ([hip circumference/height$^{1.5}$]-18). Hip circumference was measured in centimeters, at the level of greater trochanters, with legs close together. Standing height (stature) was measured without shoes and heel against the wall and head in the plan to the nearest centimeter using the height measure stadiometer to the nearest 0. 1cm.BMI was defined as weight / height [2]. Weight was measured using Equinox electronic machine, to the nearest 100 g with patients in light clothing and height (stature) was measured without shoes and heel against the wall and head in the plain to the nearest centimeter using the height measure stadiometer to the nearest 0. 1cm. Weight was measured using Equinox electronic machine, to the nearest 100 g with patients in light clothing. Standing height (stature) was measured without shoes and heel against the wall and head in the plan to the nearest centimeter using the height measure stadiometer to the nearest 0. 1cm. Patients were then classified on basis of anthropometric measurements into: Obese, Overweight, Healthy and Underweight. In all these groups, fetomaternal outcome was studied along the following lines: Abnormal GTT and Gestational Diabetes Mellitus, PIH and Pre-eclampsia, Preterm, IUGR (Intrauterine Growth Restriction). Antepartum Hemorrhage Malpresentations, mode of delivery, intrapartum complications, postpartum complications and neonatal outcome in terms of: Birth weight, APGAR scoring and Neonatal admissions if any.

2.1 Statistical Analysis: The data was entered in Microsoft Excel and SPSS 21 Quantitative data was summarized as mean and standard deviation. Categorical data was summarized as percentages. Statistical hypothesis test included chi – square test or fisher's exact test, whichever appropriate was applied. A p value of < 0.05 was taken as significant.

3. Results

Of the 1,000 study subjects, average weight of Kashmiri women presenting during late pregnancy and labour was 64.3± 10.63 Kg. According to BMI 41.5% and 22.4% patients and with BAI classification, 21.1% and 3.3% women were overweight and obese respectively. (Table 1&1a) In BMI Groups, GDM was observed in 14.3%, preeclampsia in 27.7% in Group 4 and 7.9% in Group 2. Gestational hypertension was observed in 29.0% in the Group 4 and was 8.5% in Group 2. Similarly, while evaluating BAI Groups, GDM among obese was 21.2%. Preeclampsia was found in 24.2% in the Group 4a and 12.6% in Group 2a. Gestational hypertension was 27.3% in the Group 4a and was 11.2% in Group 2a.In both BMI and BAI groups, APH were also statistically significantly higher among obese group. There was no significant association between APH, IUGR, malpresentation and preterm between obese and non-obese groups in both BAI and BMI group's. (Table 2&2a) LSCS mode of delivery was observed in 58% patients and 57.6% in BAI and BMI obese group respectively.PPH was observed in 20.1%, Post LSCS wound soakage in 19.2% patients in the obese group. Similarly in BAI group PPH (15.2%), Post LSCS wound soakage (27.3%) was observed in obese group.100% of neonates had birth weight <2.5 kg among women with BAI in the underweight group while incidence was 50% with BMI in the underweight group Macrosomia was observed in 6.1% in the Group 4a and 21.4% in the Group 4 in BMI group. NICU admission was seen in 26% and 22.3% of infant of overweight and obese women in BMI Group. Similarly, NICU admission rate were 20.9% and 30.3% of infant of overweight and obese women respectively in BAI group. (Table3&3a)

Table 1: Distribution of patients according to BMI

Group		BMI	No.	%age
1.	Underweight	<18.5	8	0.8
2.	Normal	18.5-24.9	353	35.3
3.	Overweight	25-29.9	415	41.5
4.	Obese	>30	224	22.4
Total			1000	100

Table 1a: Distribution of patients according to BAI

Group		BAI	No.	%age
1a.	Underweight	<18.5	3	0.3
2a.	Normal	18.5-24.9	753	75.3
3a.	Overweight	25-29.9	211	21.1
4a.	Obese	>30	33	3.3
Total			1000	100

Table 2: Antepartum complications among women of different BMI groups.

Group	BMI		Antepartum Complications						
			GDM	PIHh	Pre-eclampsia	aphPH	Malpresentation	IUGR	Preterm
1.	Under-weight (n=8)	No.	0	0	0	0	0	0	0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.	Normal (n=353)	No.	11	30	28	10	8	28	22
		%	3.1	8.5	7.9	2.8	2.3	7.9	6.2
3.	Over-weight (n=415)	No.	21	72	62	15	12	40	26
		%	5.1	17.3	14.9	3.6	2.9	9.6	6.3
4.	Obese (n=224)	No.	32	65	62	7	8	19	18
		%	14.3	29.0	27.7	3.1	3.6	8.5	8.0
P-value			<0.001*	<0.001*	<0.001*	0.826	0.649	0.696	0.641
*Statistically Significant Difference (P-value<0.05)									

Table 2a: Antepartum complications among women of different BAI groups.

Group	BAI		Antepartum Complications						
			GDM	PIH	Pre-eclampsia	APH	Malpresentation	IUGR	Preterm
1a.	Under-weight (n=3)	No.	0	0	0	0	0	0	0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2a.	Normal (n=753)	No.	27	84	95	24	18	66	48
		%	3.6	11.2	12.6	3.2	2.4	8.8	6.4
3a.	Over-weight (n=211)	No.	30	74	49	4	9	20	15
		%	14.2	35.1	23.2	1.9	4.3	9.5	7.1
4a.	Obese (n=33)	No.	7	9	8	4	1	1	3
		%	21.2	27.3	24.2	12.1	3.0	3.0	9.1
P-value			<0.001*	<0.001*	<0.001*	0.008*	0.345	0.473	0.786
*Statistically Significant Difference (P-value<0.05)									

Table 3: Apgar scoring & NICU admission of neonates among women of different BMI groups.

Group	BMI	Apgar Score 0 Min	Apgar Score 5 Min	NICU Admissions
1.	Underweight (n=8)	7.57±2.22	8.43±1.51	0 (0)
2.	Normal (n=353)	7.31±1.31	8.82±0.66	17 (4.8)
3.	Overweight (n=415)	7.38±1.13	8.90±0.48	108 (26)
4.	Obese (n=224)	7.33±1.27	8.85±0.62	50 (22.3)
p value		-	-	<0.001*
*Statistically Significant Difference (p value<0.05)				

Table 3a: Apgar scoring & NICU admission of neonates among women of different BAI groups.

Group	BAI	Apgar Score 0 Min	Apgar Score 5 Min	NICU Admissions
1a.	Underweight (n=3)	7.27±2.42	8.27±2.41	0 (0)
2a.	Normal (n=753)	7.41±1.64	8.89±1.06	167 (22.2)
3a.	Overweight (n=211)	7.18±1.33	8.62±0.78	44 (20.9)
4a.	Obese (n=33)	7.03±1.65	8.35±0.79	10 (30.3)
P-value		-	-	0.478

4. Discussion

4.1 Main findings and interpretation

In this prospective observational study we found high prevalence of antepartum, intrapartum complications and postnatal late preterm and term neonates requiring NICU admissions delivered to Obese women who were screened by both BAI and BMI anthropometeric measurement scale for classifying an obesity and overweight in mothers Body Mass Index (BMI) is one of the most widely used indices in the anthropometric evaluation [7] of a pregnant woman. To overcome the shortcomings of BMI we supplemented it by BAI which is suggested to have edge over BMI, including that it yields similar associations with body fat (BF%) for both sex and may be more practical to assess in field studies because it does not require a weight measurement and hence more validation of obesity if used concurrently with BMI. Our study supports that

BAI is a reasonable consideration as a screening method for obesity and henceforth predicts complications in higher frequency when compared to BMI and can be used as a risk-reducing strategy for anticipated maternal complications during pregnancy and postpartum period in addition to BMI alone. On the basis of the BMI, out of the 1000 women, 415 (41.5%) and 224 (22.4%) women were from the overweight and obese categories respectively. While on the basis of BAI, out of the 1000 women, 211 (21.1%) and 33 (3.3%) women were from the overweight and obese categories respectively. So, considerable difference between identifying overweight and obese cases were observed while calculating with BAI and BMI differently. Multiple studies evaluating the effect of maternal obesity have been done earlier and have demonstrated increased maternal pregnancy related complications. In our study, the frequency of preeclampsia remained significantly high in obese and overweight group as compared to women with normal BMI and BAI. The difference was statistically significant for both BMI and BAI with a p value <0.001. Similar results were observed by other studies [11, 12]. our study concluded that Gestational Hypertension was significantly more in overweight and obese as compared to women with normal BMI and BAI. The difference was statistically significant for both BMI and BAI. Similarly observations were demonstrated by other authors [14- 16]. In our study, the frequency of APH was found to be higher among obese and overweight as compared to non-obese women but the association was not statistically significant in the BMI group while it was statistically significant in the BAI group [Table 2&2a]. Similarly observations was made by other researchers which showed no significant difference of placenta previa in the different BMI groups [11, 20]. Our study showed no significant association between IUGR, malpresentation and preterm between obese and non-obese groups. The association was statistically insignificant for both BMI and BAI groups. Similar results were reported by Aly H *et al*. in their respective study [17]. In our study no significant association was found when obese and non obese groups were compared for IUGR delivery who found that the difference was statistically insignificant with a p value of 0.646 [18]. Non progression of labor was found to be statistically significantly associated with increasing BMI while the association was statistically insignificant with increasing BAI in our study. Similar results by shown by western countries authors showed that there was more than three-fold higher rate of arrest of dilatation among very obese women when compared to those who were lean [19, 20]. In our study we found no patient with shoulder dystocia due to the practice of taking patients with cephalopelvic disproportion for LSCS. There was increased frequency of LSCS and decreased frequency of vaginal deliveries in women who were overweight and obese as compared to non-obese in our study. The association was statistically significant both in the BMI and BAI groups. Similarly, a study [14, 21] concluded that caesarean section rate was found to be higher with a higher maternal BMI (p<0.001), thus carrying an extra risk of higher perioperative morbidity. Our study observed that there was a greater percentage of postpartum hemorrhage and post LSCS wound soakage among women with higher BMI and BAI. The difference was statistically significant in both the groups. Similar results were shown by different researchers [14, 22]. Neonatal intensive care unit (NICU) admissions of neonates were significantly increased among obese women in our study. 50% of neonates had NICU admission in women with Group 4 (BMI >30) [Table3&3a]. Similarly, another study found that even after adjusting for confounding factors, the risk of admission to the neonatal unit was still statistically significant for the obese group with p<0.001 [14, 24]. The reason for this increased rate of neonatal complications in obese women is unknown but could be related to increased maternal pelvic soft tissue, as well as difficulty in estimating the fetal weight, and intrapartum complications such as inability to adequately monitor the fetus and contractions

4.2 Strengths and limitations

Although our sample size was large (N=1000), our study was not adequately powered for our outcomes. We acknowledge that the sample size may be underpowered for thorough assessment of maternal and neonatal complications. Another limitation of our study is the lack of knowledge of the BAI as compared with standard BMI on tracking maternal obesity and which is to be considered as a better tool than other. Conclusive evidence regarding BAI and BMI tracking as a single instrument and an effective validation of both is still away. Similarly, their joint effectiveness at the time of screening in hospital based population is also unknown. Finally, 120 women approached for inclusion into the study declined to participate. Limited information regarding previous obesity status and their monitoring before admission to our centre is available about this group, which may affect generalizability of our findings and their implications on maternal pregnancy related complications and also effect on their offspring's. The strength of our study was that it was hospital-based with a low rate of missing data and a large set of covariates. Our findings were similar to other studied but large sample size and mother with more of meat eating population and larger weight babies as compared to other studies.

5. Conclusion

Our study showed an increased risk of wide variety of pregnancy and perinatal complications and higher neonatal admissions in overweight and obese women which confers and extends to the result of most of other studies

6. Compliance with Ethical Standards

6.1 Conflict of Interest None

6.2 Source of Funding None

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