The Correlation between Placental Weight and Birth Weight

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Abstract. Fetal growth is influenced by the interaction between mother, placenta and fetus. This study aims to assess the correlation between maternal factors and placental weight and the corelation between placental weight and birth weight. This was a longitudinal study which was carried out at maternal and children hospital Siti Fatimah Makassar from June to October 2011. The subject were 100 pregnant women selected by quota sampling. The study was tested using multiple linear regression test and Pearson correlation test. The average of placental weight and birth weight was 587 ± 109 g vs 3114 ± 410 g, 12% of placental weight was in mild category (<500 g) and 3% of the babies had low birth weight. The multiple linear regression test showed that maternal age, antenatal care (ANC) utilization and intake of vitamin C contributed to 10,5% of the placental weight (adjusted $R^2 = 0.105$), but only two factors that significantly related to placental weight were maternal age ($p=0.005$) and ANC utilization ($p=0.039$). There was a significant correlation between placental weight and birth weight ($r=0.36$, $p=0.000$). In conclusions, the maternal age and the utilization of ANC were significantly correlated with placental weight, and the placental weight was positively correlated to the birth weight.

Keywords: birth weight, maternal characteristics, placental weight.

1. Introduction

Fetal growth was influenced by the interaction of the mother, placenta, and fetus. The placenta had a very vital role as a supplier of nutrients and respiration (O_2-CO_2) from the maternal circulation to the umbilical circulation, as well as producing and transporting some growth hormones, including generating the amount of enzyme [1], [2]. Therefore, placental organ known as two the main function were as a transfer organ and synthesis organ.

The placenta had an important role in intrauterine program. Impaired placental function was a major cause of fetal growth restriction. The size of the small placenta could limit intrauterine fetal growth and lowers the efficiency of the placenta shortly before parturition. [3] The small placenta unable to meet the needs of the fetus, while the large placenta occur due to accumulation of fluid in the placenta (placental hydrops), baby had macrosomia, and his mother got diabetes mellitus (DM).[4] The ability of the placenta to transport nutrients associated with the supply of nutrients to the fetus. If transportation of nutrients were not enough could lead it to impaired fetal growth and excess of transport cause baby had overgrowth.[5] Change absolute and relative amount of nutrients supplied to the fetus as a result of change in placental phenotype, it was likely to had long-term consequence on health and illness at the adult period.[6] Therefore, the phenotype of the placenta might be a medium or tool to understood the events in the uterus and bring substantial benefits in diagnosing the fetus was at risk of stunted growth, and predicted neonatal outcome, because the placenta was the center of fetal growth.[4], [7]

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The optimal Growth and development of the fetus could only be achieved when the delivery of nutrients and oxygen were sufficient to provided substrate utilization in the fetus. All nutrients must pass through the placental villous thropoblast. Disruption of the function of the placenta was a major cause of growth abnormalities. [8] There were some of factors that affect the growth of the placenta. Maternal factors play an important role on the growth and development of the placenta. Pregnant women who got anemia, lack of nutrient intake and smoking affect placental weight and birth weight. The size, morphology, and the ability of placental transfer of nutrients to the growing fetus was a determinant affecting fetal weight. [9] The size of the placenta and fetus at birth was associated with risk of chronic disease.

The study of Amiruddin in Mother and Child Hospital Siti Fatimah in Makassar City found that the weight of the placenta which includes mild category (<400 g) by 49%, and most baby were born with mild placenta had low birth weight (<2.5 kg) by 86% [10]. Therefore, this study will assess the maternal characteristics that influence placental weight and birth weight of the placenta to assess the impact on birth weight infants.

2. Method

This study used a longitudinal design was implemented in Mother and Child Hospital Siti Fatimah Makassar, for 5 months (June-October 2011), after obtaining the permits from the Agency of Health Research Ethics Committee on Health Research and Development Ministry of Health Republic of Indonesia, and all respondents signed informed consent after they obtain an explanation from the researcher to serve as the research sample. The entire population of pregnant women with gestational age of 36-38 weeks checkup in June-October 2011 and plan to give birth in Mother and Child Hospital Siti Fatimah Makassar City. The samples was pregnant women with gestational age of 36-38 weeks who had met the inclusion criteria: maternal age 18-45 years old, single pregnancy, living fetus, body height was ≥145 cm, and clinically healthy. Exclusion criteria consisted of getting pregnancy complications (obstipation, infection) and there were abnormality of the placenta (placental abruption, placenta previa, etc.) or incomplete delivery of the placenta. The sample size was calculated based on a longitudinal design and tested correlation (correlation coefficient (r) = 0.665, [11] Fisher transformation (0.80) z1-α/2 at 95% = 1.96; z1-ß at 95% = 1.64, and considered the drop out, the distribution of data in the analysis stage, the rule of thumb for modeling then obtained a sample of 100 pregnant women were taken to the quota sampling method.

Data on maternal characteristics (age, education, occupation, parity, pregnancy interval, nutrient intake, nutritional status, utilization of antenatal care, Fe tablet consumption) was obtained through interviews using a pre-tested questionnaire and 24-hour recall form (assess 2x24-hour food intake) and check book of maternal and Child Health (MCH) pregnant women, while the rate of hemoglobin (Hb) pregnant women was measured by taking blood at the periphery of the ring or middle finger approximately 10 mL using cyanmethemoglobin method, and reading of the results is done on a machine blood HemoCue photometer (normal: Hb≥11 g/dl) [12]. Nutritional status of pregnant women was obtained by measuring weight using digital scales brand AND the level of accuracy of 0.1 kg, body height was measured using microtoice with a level of accuracy of 0.1 cm, and mid upper arm circumference (MUAC) was measured by meter tape with level of accuracy 0.1 cm. Placental weight and birth weight was obtained by weighing using a weighing scale, while the birth body length of a baby was measured using a scale infantometer within 1x24 hours.

Food intake data were processed using the Nutri Survey Program to know the nutritional content of each food consumed by pregnant women. All data were analyzed using the statistical package for social sciences (SPSS) for windows. In the first modeling candidate models were selected using Spearman's rho Correlation test, where the variables that meet the criteria of the model was the candidate had a value p≤0,25. Furthermore, to create a model of the factors related to the weight of the placenta was analyzed using multiple linear regression test. To assess the relationship of placental weight to birth weight and birth length birth weight infants with Pearson correlation test (r) with significance level (α <0.05)

3. Result

Among 100 pregnant women who meet the criteria of sample (36-38 weeks gestation), most pregnant women was at the age of 37 weeks (36%), followed by 38 weeks (33%), and 36 weeks (31%) with average

maternal age was 37.02 weeks. Almost all deliveries (96%) were aterm. Maternal age was mostly in the group of 20-35 years were classified as healthy reproductive age with an average age of 29 years, but still found about one-fifth of the sample was at an unhealthy reproductive age (age <20 years and> 35 years), most of which were in the age> 35 years (Table 1). Lowest maternal age was 18 years and the highest 40 years of age. Maternal education level was more than half-educated graduate High School to the top, and more than three quarters of respondents survey were housewives. Family income pregnant women the average was above the provincial minimum wage South Sulawesi in 2011 (Rp1.200.000) of Rp1.686.200, and more than half of the sample was above the provincial minimum wage South Sulawesi. The number of family members ≤5 the majority of respondents. The frequency of pregnancies (gravidarum), most pregnant women were 2-3 times, and about one-fifth of pregnant women had experienced abortion. More than half the respondents had given birth <4 times. Nearly three-quarters of the nutritional status of the mother before pregnancy classified in normal nutritional status. Nutritional status of pregnant women assessed based on the size of the anthropometric (weight gain during pregnancy and mid upper arm circumference = MUAC), hemoglobin levels, and nutrient intake. Average maternal weight gain was10 kg with a range of 36-38 weeks gestational age at the time of measurement, 51% of respondents had been seen weight gain categorized as less (<10 kg). Maternal nutrient reserves were measured by the size of the MUAC, the average size of the MUAC shows including normal category (26.8 ± 2.9), but there was still among pregnant women who experience chronic energy malnutrition (CEM) with the size of the MUAC <23.5 cm (13%). Hemoglobin level of pregnant women on average 11.1 ± 1.9 mg/dL, found 38% of pregnant women suffer from Fe deficiency anemia, in which 2% of them include severe anemia.

Table 1: Socio-Economic Characteristic of Pregnant Women

Socio-economic	Mean±SD	%
Maternal Age (years)	29,3±5,9	
<20		4,0
20–35		79,0
>35		17,0
Mother's education (years)	11,5±3,2	
None		1,0
Unfinished primary school		2,0
Completed elementary school		10,0
Completed secondary school		17,0
High school graduate		53,0
Diploma/Graduate		17,0
Mother's Occupation		
Work		23,0
Jobless		77,0
Family Income per month (Rp)	1.686.200±1.141.345	
<1.200.000,-		41,0
≥1.200.000,-		59,0
Family Size (person)		
≤5	4,8±2,1	54,0
>5		46,0
Gravid	2,2±1,2	
1		35,0
2–3		51,0
>3		14,0
Parity (n=60)	1,2±0,4	
≥4		4,0
<4		56,0
Spacing pregnancies (n=65)	49,2±39,3	
< 24 month		23,4
≥24 month		77,6
Abortion	1,1±0,3	
Never		88,0
Ever		22,0
BMI Before Pregnancy (kg/m^2)	22,4±3,4	
<18,5		10,0
18,5–22,9		52,0
≥23		38,0

Based on nutrient intake, it was known that the average nutrient intake of macronutrients and micronutrients pregnant women compared with recommended dietary allowance (RDA) were all below of

RDA for third trimester pregnant women except for vitamin B12 (Fig. 1). However, most of the pregnant women were found (80.4%) supplements consuming during pregnancy.
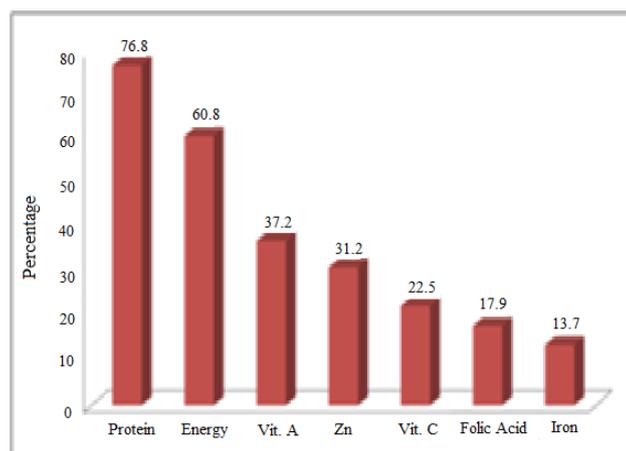

Fig. 1: Nutrients Intake of Pregnant Women Based on The RDA of Indonesian, 2013

Based on the frequency of Ante Natal Care (ANC), the average pregnant women checking the pregnancy as much as 6 times, 90% of pregnant women during their pregnancy ≥4 times. Nearly half of pregnant women prepare for childbirth in Mother and Child Hospital Siti Fatimah, in health centers during their pregnancy, and most examined by a midwife. Almost all women received ANC at least weighing, measuring of fundus height, blood pressure measurement, immunization of tetanus toxoid (TT), and the provision of Fe tablets, except for the provision of tetanus toxoid immunization and Fe tablets which still contained 17% never get these two types of services. However, it was still less than half the number of pregnant women (45%) who claimed never obtain counseling on maternal health. Average Iron-Folic Acid Supplement received by pregnant women as many as 55 tablet, taken 38 grains, 30 grains spared. Nearly half of pregnant women receiving Fe tablets in the second trimester. Among the approximately 20% of pregnant women who have been ill, more than three-quarters had a cough/fever/flu.

Almost all pregnant women gave birth to at term gestation (≥37 week) at (96%), the rest was labor serotinus (> 40 weeks), and the majority of birth mothers was done normally. Based on the gender of the baby that was born more than half of the sample were male. Almost all baby born had a normal birth weight. The body length of a baby's birth was still about a quarter of baby who had a body length below the average of the sample, while the average weight of the placenta were examined in this study was 587.8 g, and contained 12% of whom have mild placenta (<500 g) (Table 2).

Table 2: Characteristic of parturition, baby, and placenta

Variable	Min-Max	Mean±SD	n	%
Status of birth				
Aterm			96	96,0
Serotinus			4	4
Type of Parturition				
Per Vaginam			89	89,0
Sectio Caesaria			11	11,0
Sex				
Male			57	57,0
Female			43	43,0
Birth weight (g)	2020–3800	3114±410		
Low birth weight			3	3,0
Normal			97	97,0
Birth length (cm)	45–52	48,44±1,52		
<48 cm			27	27,0
≥48 cm			73	73,0
Placental Weight (g)	400–800	587±109		
<500			12	12,0
≥500			88	88,0

Spearman's rho correlation test results showed that the only variable maternal age (p = 0.026), intake of vitamin C (p = 0.149), and utilization of ANC (p = 0.069) which may be included in the multivariate model,

because the *p* value ≤ 0.25. Based on the results of multivariate analysis using multiple linear regression showed that 10.5% [the coefficient of determination (adjusted $R^2 = 0.105$)] placental weight was affected by maternal age, utilization of ANC, and vitamin C intake of pregnant women. It showed that maternal age and the utilization of ANC significantly affect placental weight ($p \leq 0.05$). Maternal age was a factor associated with placental birth weight ($p = 0.005$), if the mother's age increased, the increased placental weight approximately 5.1 g (Table 3). Correlation test results showed that placental weight was significantly associated with body weight and body length of baby born ($r = 0.36$, $p = 0.000$ vs. $r = 0.30$, $p = 0.002$).

Table 3: Some factor to influence of placenta weight

Independent Variable	B	β	t	p
Constant	469,802			0,000
Mother's age	5,137	0,279	2,895	0,005
ANC utilization	-10,169	-0,200	-2,089	0,039
Vitamin C Intake	0,720	0,091	0,945	0,347
F	4,888			
R^2	0.105			

4. Discussion

The results of this study showed that the average of placental weight was 587 g, it was still considered in the normal category. It was not much different from the results of study in Nigeria that showed an average placenta weight was 565.2 g. [13] The placenta weight disproportionately (placental hypertrophy), indicated the possibility of an adaptive response to bad intrauterine environment. Placental hypertrophy could occur because the mother suffering from anemia, smoking or exposure to cigarette smoke, and low socioeconomic status. Pre-pregnancy body mass index and weight gain during pregnancy was associated with a reduced likelihood of growth restriction and the possibility of increasing hypertrophy of the placenta dimensions was researched. [14]

This study showed that maternal age was a factor that affects the placental weight. Maternal age associated with change in maternal metabolism, decline of myometrium function, lower placental perfusion, thus disturb the flow of nutrients with increased maternal age. Impaired circulation and reduced oxygenation of the placenta deteriorates in older mothers, could initiate placental growth through angiogenesis. Impaired balance of angiogenesis was a threat to intrauterine growth restriction. These findings coincided with the results of studies conducted in pregnant women in Norwegia that there was a significant correlation between maternal age and increased placental weight, maternal age was increasing the weight of the placenta was born. [15] Placental weight was an indicator of function and development of the placenta, and correlated with maternal age, gestational age, history of diabetes, pre-eclampsia, parity, body height and body weight of mother, and serum ferritin level. Light of placenta was likelihood of decrease of placental function. The placenta was important for normal fetal growth, and the failure of the placenta can cause problems in fetal. [16]

In addition to maternal age had a significant effect on placental weight, utilization of ANC also showed a significant relationship, but negatively related if the ANC increases, could reduce the weight of the placenta. This suggest that the utilization of ANC high quantity, did not guarantee the quality of outcomes of pregnancy (placental weight). It was proved in this study, that the weight of the placenta average higher in the group of pregnant women who use ANC <4 times (<4 times: 597 ± 104 g vs. ≥4 time: 586 ± 110 g). Therefore, the quality of service became an important point to note for health workers in providing ANC services to pregnant women, who not only provide 5 types of services, namely height and weight body measurements, blood pressure measurement, fundus height measurement, tetanus toxoid immunization, and the provision of Iron-Folic Acid tablets, but education about nutrition and health in pregnant women should be given optimally. The results of this study, similar to that produced by Amiruddin R that pregnant women who gave birth to lighter placenta was more common in pregnant women who use ANC ≥4 times (58.9%). [10]

From the results of multivariate analysis found that intake of vitamin C had no effect on placental weight. This study was similar with study in the General Hospital Studies in animals showed placental weight was not related to the intake of nutrients of mothers. [17] In contrast to the results of studies Ahn et.al who found an inverse relationship between plasma vitamin C concentrations at 37 weeks gestational age and activity throphoblast apoptosis. [18] The main effect of a number of vitamins against hypoxic placenta could be explained by a decrease in local expression of angiogenic factors, which resulted in a decrease in the vessels and mass of placenta. Appropriate micronutrient intake depends not only on the quality but also the bioavailability. Bioavailability of micronutrients during pregnancy varies depend on the metabolic mechanisms because pregnancy was a anabolic phase and dynamic was influenced by hormones that work to divert certain nutrients to the special tissues of the mother and transferred on nutrients for fetal growth. [19]

From the results of this study prove that placental weight correlated with birth weight infants significantly. This was consistent with the findings of Thame et al. [20], and Salafia et.al. [21], that placental size was correlated with birth size. Studies in Norwegia show that more than 200,000 births reported the Medical Birth Registry of Norway showed a placental weight relationship with birth weight [22]. The same thing was reported by Asgharnia et.al. [16] and Risnes et.al. [23], that there was a relationship of placental weight to birth weight infants (p <0.0001, and p = 0.001), as well as the results Alwasel et.al. [24] found that placental weight correlated with birth weight (r = 0.34). Baby were born with placental weight (≥500 g) had an average birth weight higher 472 g than birth weight baby with light placental, as well as the average of body length of a baby's birth showed 1.2 cm taller than baby born with mild placenta (<500 g). It showed that placental weight had a significant role to the growth of the fetus, [25] therefore not only serves as placenta transfers nutrients from mother to fetus, but also had an effect on metabolic and endocrine function that regulates the metabolism of the mother and fetus. The placenta not only as a passive filter, but also play an active role as a major regulator of fetal metabolism-plasenta. [26]

Conclusion, placental weight born by pregnant women studied influenced by maternal age, utilization of ANC, and intake of vitamin C by 10.5%. Placental weight were significantly correlated to body weight and body length of the baby was born. Further research was needed to examine the extent to which growth and development, nutritional status, and health of children born in the study.

5. Acknowledgements

6. References

[1]   IHE REPORT. Placental factors. Determinant and prevention of LBW: a synopsis the evidence. Canada, Insitute of Health Economics Albert Canada, 2008.

[2]   Mahajan S, Aalinkeel R, Shah P, Singh S, Kochupillai N. Nutritional anemia dysregulates endocrine control of fetal growth. *Br. J. Nutr.* 2008, **100** (2):408–17.

[3]   Fowden AL, Forhead JA, Coan PM, Burton GJ. The placenta and intrauterine programming. Review Article. *J Neuroendocrinol.* 2008, **20** (4):439–50.

[4]   Robert DJ. Placental pathology, a survival guide. *Arch. Pathol. Lab. Med*. 2008**, 132** (4):641–51.

[5]   Jones HN, Powell TL, Jansson T. Regulation of placental nutrient transport-a review. Placenta. 2007, **28** (8–9):763–74.

[6]   Fowden AL, Sferruzzi-Perri AN, Coan PM, Constancia M, Burton GJ. Placental efficiency and adaptation;endocrine regulation. Symposium review. *J. Physiol*. 2009, **587** (14):3459-72.

[7]   Sibley CP. Understanding placental nutrient transfer-why bother? New biomarkers of fetal growth (symposium review). *J. Physiol*. 2009, **587** (24):3431-40.

[8]   Baschat AA. Fetal responses to placental insufficiency: an update (review). *BJOG*. 2004, **111** (1) :1031–41.

[9]   Belkacemi L, Nelson MD, Desai M, Ross MG. Maternal undernutrition influences placental-fetal development: Minireview. *Biology of Reproduction*. 2010, **83** (3): 325–31.

[10] Amiruddin R. Analisis risiko asap rokok dan variasi gen CYP2A6 terhadap berat plasenta dan dampaknya pada kejadian bayi berat lahir rendah [disertasi]. Makassar: Universitas Hasanuddin, 2007.

[11] Reihaneh , dkk. Haemoglobin and serum ferritin levels in newborn babies born to   anaemic iranian women: a cross-sectional study in an Iranian hospital. *Pak. J. Nutr.* 2010, **9** (6): 562-566.

[12] WHO. Iron deficiency anemia: assessment, prevention and control. Geneva: WHO, 2001.

[13] Adebami OJ, Owa JA, Oyedeji GA. Factor associated with placenta weight and placental weight/birtweight percent (placental ratio) among mothers in Ilesa, Southwesttern Nigeria. *Int J Trop Med*. 2007, **2** (2):68–73.

[14] Baptiste-Roberts K, Salafia CM, Nicholson WK , Duggan A, Wang NY, Brancati FL. Maternal risk factors for abnormal placental growth: The National Collaborative Perinatal Project. *BMC Pregnancy Childbirth.* 2008, **8** (1):44.

[15] Haavaldsen C, Samuelsen SO, Eskild A. The association of maternal age with placental weight: a population-based study of 536,954 pregnancies. *BJOG*. 2011, **118** (12):1470–6.

[16] Asgharnia M, Esmailpour N, Poorghorban M and Atrkar-Roshan Z. Placental weight and its association with maternal and neonatal characteristics. *Acta Med Iran*. 2008, **46** (6):467–72.

[17] Langley-Evan AJ, Langley-Evans SC. Relationship between maternal nutrient intakes in early and late pregnancy and infants weight and proportions at birth: prospective cohort study. *Perspect Public Health*. 2003, **123** (4):210–6

[18] Ahn YM, Kim YJ, Park H, Park B, Lee H. Prenatal vitamin C status is associated with placental apoptosis in normal-term human pregnancies. *Placenta*. 2007, **28** (1):31–8.

[19] Berti C, Decsi T, Dykes F, Moran VH, Hermoso M, Koletzko B, dkk. Critical issues in setting micronutrient recommendations for pregnant women: an insight. *Matern Child Nutr*. 2010, **6** (2):1–17.

[20] Thame M, Osmond C, Bennett F, et al. Fetal growth is directly related to maternal anthropometry and placental volume. *Eur J Clin Nutr*. 2004, **58** (6):894–900.

[21] Salafia CM, Charles AK, Maas EM. Placenta and fetal growth restriction. *Clin Obstet Gynecol*. 2006, **49** (2):236–56.

[22] Thompon JM, Irgens LM, Skjaerven R, Rasmussen S. Placental weight percentile curves for singleton deliveries. *BJOG*. 2007, **114** (6):715–20.

[23] Risnes KR, Romundstad PR, Nilsen TIL, Eskild A, Vatten LJ. Placental weight relative to birth weight and long-term cardiovascular mortality: findings from a cohort of 31.307 men and women. *Am J Epidemiol*. 2009, **170** (5): 622–31.

[24] Alwasel SH, Abotalib Z, Aljarallah JS, Osmond C, Alkharaz SM, Alhazza IM, dkk. Changes in placental size during ramadan. *Placenta*. 2010, **31** (7): 607–10.

[25] Lo YF, Jeng M, Lee YS, Soong WJ, Hwang B. Placental weight and birth characteristics of healthy singleton newborns. *Acta Paediatr Taiwan*. 2002, **43** (1): 21–25.

[26] Cetin I, Alvino G, Radaelli T, Pardi G. Fetal nutrition: a review. *Acta Paediatr*. 2005, **94** (449):7–13.