European Journal of Obstetrics & Gynecology and Reproductive Biology 206 (2016) 48–52

Contents lists available at ScienceDirect

European Journal of Obstetrics & Gynecology and Reproductive Biology

journal homepage: www.elsevier.com/locate/ejogrb

Placental weight in pregnancies with high or low hemoglobin concentrations

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ARTICLE INFO

Article history:
Received 11 May 2016
Accepted 19 August 2016

Keywords:
Anemia
Birthweight
Hemoglobin concentrations
Placental weight
Pregnancy

ABSTRACT

Objectives: To study the associations of maternal hemoglobin concentrations with placental weight and placental to birthweight ratio.
Study design: In this retrospective cohort study, we included all singleton pregnancies during the years 1998–2013 at a large public hospital in Norway (n = 57 062). We compared mean placental weight and placental to birthweight ratio according to maternal hemoglobin concentrations: <9 g/dl, 9–13.5 g/dl or >13.5 g/dl. The associations of maternal hemoglobin concentrations with placental weight and placental to birthweight ratio were estimated by linear regression analyses, and adjustments were made for gestational age at birth, preeclampsia, parity, maternal age, diabetes, body mass index, smoking, offspring sex and year of birth.
Results: In pregnancies with maternal hemoglobin concentrations <9 g/dl, mean placental weight was 701.2 g (SD 160.6 g), followed by 678.1 g (SD 150.2 g) for hemoglobin concentrations 9–13.5 g/dl and 655.5 g (SD 147.7 g) for hemoglobin concentrations >13.5 g/dl (ANOVA, $p < 0.001$). Mean placental to birthweight ratio was highest in pregnancies with maternal hemoglobin concentrations <9 g/dl (0.203 (SD 0.036)). We found no difference in mean placental to birthweight ratio for maternal hemoglobin concentrations 9–13.5 g/dl (0.193 (SD 0.040)) and >13.5 g/dl (0.193 (SD 0.043)). Adjustments for our study factors did not alter the estimates notably.
Conclusions: Placental weight decreased with increasing maternal hemoglobin concentrations. The high placental to birthweight ratio with low maternal hemoglobin concentrations suggests differences in placental growth relative to fetal growth across maternal hemoglobin concentrations.

Introduction

Anemia is common in pregnant women, and low maternal hemoglobin concentrations have been associated with increased risk of giving birth to offspring with low birthweight [1–3]. Also high maternal hemoglobin concentrations have been associated with low offspring birthweight [3–5].

A well-functioning placenta is important for fetal growth. As opposed to the relation with birthweight, low maternal hemoglobin concentrations seem to be associated with high placental weight [6–8], but the evidence is conflicting [9–11]. Few studies have compared placental weight in pregnancies with low hemoglobin concentrations to pregnancies with high hemoglobin concentrations [12–15]. In two of these studies, placental weight decreased significantly by increasing maternal hemoglobin concentrations [14,15].

Placental weight relative to birthweight has previously been used as an indicator of placental function, and both high and low placental to birthweight ratio have been associated with adverse pregnancy outcomes [16,17]. Knowledge about the association of hemoglobin concentrations with placental to birthweight ratio could provide insight to consequences of aberrant maternal hemoglobin concentrations in pregnancy. Some studies report high placental to birthweight ratio in pregnancies with low hemoglobin concentrations [14,18,19], whereas other studies found no such association [15,20]. One study found that placental to birthweight ratio decreased significantly by increasing hemoglobin concentrations [14]. Since previous studies report conflicting results, new and larger studies are needed.

Therefore, we compared placental weight and placental to birthweight ratio according to low, normal or high maternal hemoglobin concentrations in 57 062 pregnancies in Norway.

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http://dx.doi.org/10.1016/j.ejogrb.2016.08.039
0301-2115/

Materials and methods

In this retrospective cohort study, we included all singleton pregnancies from gestational week 26 at Akershus University Hospital in Norway during the years 1998–2013 (n = 60 826). Akershus University Hospital is a large public hospital located close to Oslo, the capital of Norway, and the catchment area includes almost half a million people living in urban or rural areas. Almost all pregnant women who live in the catchment area give birth at this hospital and antenatal and obstetric care is free of charge.

We used data from the electronic patient delivery records to which information about the pregnancy, the delivery and the offspring is entered shortly after delivery. We excluded 1392 women with missing information on hemoglobin concentrations in pregnancy. Also, we excluded 449 pregnancies with offspring birthweight less than 250 grams (g) or above 6500 g, and 1923 pregnancies with placental weight less than 25 g or above 2500 g since we considered these values to be outlying and thus erroneously recorded. Hence, a total of 57 062 pregnancies could be included in statistical analysis.

Our outcome measures were placental weight and placental to birthweight ratio. The placentas were weighed with membranes and umbilical cord attached within one hour after birth, according to Norwegian standards. Birthweight was based on routine weighing of the newborn shortly after birth. Weight was measured in grams, and the placental to birthweight ratio was calculated as placental weight/birthweight. Hence, a high placental to birthweight ratio indicates a high placental weight relative to birthweight.

Maternal hemoglobin concentrations were measured in the first and in the second trimester according to Norwegian guidelines for antenatal care. Almost all women who give birth in Norway attend the public antenatal program, and results from antenatal clinical examinations are routinely recorded in standardized antenatal patient journals. Maternal hemoglobin concentrations during pregnancy were reported as <9 grams/deciliter (g/dl) (yes or no) or >13.5 g/dl (yes or no). Thus, women without such values had hemoglobin concentrations at 9–13.5 g/dl during pregnancy. We categorized maternal hemoglobin concentrations as: <9 g/dl, 9–13.5 g/dl or >13.5 g/dl.

Other study factors included in our data analyses were: gestational age at birth, preeclampsia, parity, maternal age (years), diabetes, body mass index (BMI), smoking, offspring sex and year of birth. Gestational age at birth was based on term date estimated at routine fetal ultrasonographic examination in gestational weeks 17–19. Preeclampsia (yes/no) was defined as presence of blood pressure ≥140/90 mmHg in addition to proteinuria (protein dipstick 1+ or >0.3 g/24 h) after 20 weeks of gestation. Parity was coded: 0 or ≥1 previous deliveries. Maternal diabetes (yes/no) included diabetes type 1, diabetes type 2 and gestational diabetes. Maternal BMI was calculated as weight (kg)/height $(m)^2$ at admission to the delivery ward, and was categorized as <25, 25–29, 30–35, >35 kg/m^2 or missing. Occasional or daily smokers were defined as being smokers and smoking was categorized as yes, no or missing.

We calculated mean placental weight and placental to birthweight ratio for each category of maternal hemoglobin concentrations (<9 g/dl, 9–13.5 g/dl and >13.5 g/dl). Differences in means were tested by applying one-way ANOVA with Bonferroni-correction. The associations of hemoglobin concentrations with placental weight and placental to birthweight ratio were estimated as crude and adjusted unstandardized regression coefficients (B) with 95% confidence interval (CI) by applying linear regression analyses. Hemoglobin concentrations 9–13.5 g/dl were used as the reference group. The unstandardized regression coefficient (B) can be interpreted as the estimated change in placental weight (grams) by change in category of hemoglobin concentrations. Adjustments were made for the study factors presented above. We performed sensitivity analyses in subsamples of pregnancies without preeclampsia and pregnancies with term delivery (gestational week ≥37).

All statistical analyses were conducted by using the IBM SPSS Statistics Version 22.0, (IBM Corp., Armonk, NY, USA).

Our study was approved by the Data Protectorate at Akershus University Hospital (License number 11-018/July 2011).

Table 1
Distributions of study factors according to maternal hemoglobin concentrations.

n (%)	Hemoglobin concentrations		
	<9 g/dl 679 (1.2)	9–13.5 g/dl 54 849 (96.1)	>13.5 g/dl 1534 (2.7)
Mean placental weight, g (SD)	701.2 (160.6)	678.1 (150.2)	655.5 (147.7)
Mean birthweight, g (SD)	3473.2 (589.5)	3531.9 (572.9)	3444.1 (646.1)
Mean placental to birthweight ratio, g (SD)	0.203 (0.036)	0.193 (0.040)	0.193 (0.043)
Mean gestational age at birth, days (SD)	277.3 (13.5)	278.3 (13.4)	278.1 (15.4)
Mean maternal age, years (SD)	29.5 (6.4)	30.3 (5.1)	30.1 (4.8)
Nulliparous, n (%)	206 (30.6)	19 747 (36.1)	608 (40.1)
Preeclampsia, n (%)	48 (7.1)	1758 (3.2)	148 (9.8)
Maternal diabetes, n (%)	18 (2.7)	657 (1.2)	23 (1.5)
Maternal BMI (kg/m^2), n (%)			
<25	111 (16.5)	6424 (11.7)	167 (11.0)
25–30	228 (33.9)	19 406 (35.5)	518 (34.2)
30–35	103 (15.3)	11 766 (21.5)	347 (22.9)
>35	37 (5.5)	5002 (9.1)	213 (14.1)
Missing	194 (28.8)	12 109 (22.1)	271 (17.9)
Offspring sex, n (%)			
Boy	320 (47.5)	27 951 (51.1)	858 (56.6)
Girl	353 (52.5)	26 757 (48.9)	658 (43.4)
Smoking, n (%)			
No	530 (78.8)	40 536 (74.1)	1110 (73.2)
Yes	83 (12.3)	7874 (14.4)	254 (16.8)
Missing	60 (8.9)	6298 (11.5)	152 (10.0)