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Secular increase in placental weight in Saudi Arabia

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Abstract

Background—Ramadan is an annual period of day-time fasting during which people in Saudi Arabia, including pregnant women, change their diets and physical activity. We recently reported that among babies who were in the second or third trimester of gestation during Ramadan placental growth slowed. We also found that, over the four years of the study, placental weight increased by 29 g per year. We have now extended our data collection in order to examine this trend in more detail.

Methods—We studied the birth records of 17 660 singletons born in King Saud Hospital, Unizah, Saudi Arabia, over a ten year period. The records included birth weight, placental weight and gestational age.

Results—During the first six years of the study period mean placental weight rose by more than 100 g while mean birth weight was unchanged. This secular increase in placental weight was accompanied by a change in the placenta's response to Ramadan. During the first half of the study period babies who were in their second or third trimester of gestation during Ramadan had reduced placental weight (475 g and 476 g compared with 484 g, $p < 0.001$ for both). During the second half of the study period babies who were in their first trimester of gestation during Ramadan had reduced placental weight (533 g compared with 539 g, $p = 0.03$).

Conclusions—We suggest that the secular increase in placental weight reflects changes in maternal body composition. These have altered placental responses to the dietary changes during Ramadan. The biological processes underlying these responses are not known.

Keywords

Fetal programming; Ramadan; Placental weight; Placental/birth weight ratio

1. Introduction

We recently reported on a series of 7083 births in a maternity hospital in Unizah, a small city 350 km to the north of Riyadh, the capital city of Saudi Arabia [1]. We found that among babies who were in the second or third trimester of gestation during Ramadan placental growth slowed but fetal growth was sustained, presumably by an increase in placental functional capacity.

In Islam, Ramadan is an annual period of day-time fasting. It lasts for one month and occurs at different seasons in different years because the Arabic calendar depends on the moon. Therefore the hours of daily fasting will depend on the season. During Ramadan people in Saudi Arabia change their life style. They take no food or water from dawn to sunset, when they break their fast by eating sweet and fried meals. The next meal is “Sahoor” which is usually eaten before dawn and comprises fat-rich foods. People reduce their activities during the day, but are more active at night. Studies have shown that body weight and body mass index (weight/height²) are reduced during Ramadan in both men and women [2,3]. This may reflect the changes in diet and pattern of eating rather than the effects of fasting. Although pregnant women are allowed to defer fasting until after the pregnancy in Saudi Arabia they usually prefer to share the spiritual and social experiences of Ramadan with their families.

Placental function is a major influence on fetal programming, the process whereby nutrition and other influences during gestation permanently change the structure and function of the body in ways that affect long-term health [4]. People who were born at term but whose birth weights were towards the lower end of the normal range are at increased risk of cardiovascular disease and type 2 diabetes [4,5]. Both fetal and placental size at birth are associated with the later risk of chronic diseases [6].

In our previous analysis we found, unexpectedly, that while birth weights remain constant throughout the four years of the study, placental weight increased by 29 g per year [1]. The ratio of placental weight to birth weight therefore rose. We have now extended our data collection to an additional six years of births to ascertain whether the increase in placental size continued. We also examined whether the secular increase in placental size changed the placenta's response to Ramadan. Secular changes in placental size and its responses to Ramadan could change fetal programming, and could therefore have long-term implications for the health of the next generation [6].

2. Methods

In our previous study [1] we examined the birth records of 7083 babies born in King Saud Hospital, Unizah, Saudi Arabia during Arabic years 1421–1424 (western years August 2000–April 2004). We have now added 10 577 birth records for 1425 to 1430 (western years May 2004–April 2009). Unizah is a small city 350 km to the north of the capital city, Riyadh. It is an agricultural and administrative centre with a population of 140,000. The King Saud Hospital is one of two maternity centres in the city. We restricted our data collection to singletons born to Saudi nationals at term (37 weeks of gestation or more). These were the only exclusion criteria. The data were abstracted from the maternity log-books. Ramadan is the ninth month of the Muslim year. The months are determined by the lunar cycle, rather than the solar cycle which determines the years in the western calendar. During the ten year period of our study Ramadan occurred in different western calendar months, from late November through to early September. We calculated whether each baby was in utero during Ramadan and, if so, during which trimester. The maternity log-books included date of birth, maternal age, parity, birth weight, placental weight and gestational age, estimated from the date of the last menstrual period. Pregnant women are first seen

around 40 days after their expected menstrual period did not occur. Women in Saudi Arabia are careful in knowing their menstrual cycles as menstrual bleeding affects religious practices. The majority of the mothers were born in Unizah. The techniques for trimming and weighing the placenta are similar to those used in Europe and the United States. They remained unchanged throughout the study period and were supervised by the same midwife.

2.1. Statistical methods

We defined four groups of exposure to Ramadan using the date of birth and the duration of gestation estimated from the date of the last menstrual period. For example, births in months one to three (Muharram, Safar and Rabi' al-awwal) were treated as exposed to Ramadan in the second trimester. We analysed birth weight, placental weight and the ratio of placental to birth weight using multiple linear regression, adjusting for gender, time through the study and gestational age, by including them as predictors. We included in the regression dummy variables for the trimester of exposure to Ramadan to assess trimester-specific effects, treating the group not exposed to Ramadan in pregnancy as the baseline group for comparison. We used SPSS version 18 to analyse the data.

3. Results

There were 17660 birth records (8933 boys, 8727 girls). Placental weight was correlated with birth weight ($r = 0.34$, Fig. 1) and with gestational age ($r = 0.05$). Table 1 shows the mean birth weight, placental weight, gestational age and maternal age for boys and girls. Boys had higher mean birth weights and placental weights than girls but the ratio of placental weight to birth weight was lower. Fig. 2 shows the trend in birth and placental weight through the years of the study. The mean values are unadjusted. While babies' birth weights remained constant throughout the ten years of the study, their mean placental weights rose steeply during the first six years so that the ratio of placental weight to birth weight rose. The trends were similar in boys and girls.

In Table 2 the babies are divided according to whether or not they were in utero during Ramadan and if so, whether it was during the first, second or third trimester of gestation. The mean values for birth and placental size are adjusted for baby sex, length of gestation and year of birth. Among all babies those who were in utero during Ramadan had similar birth weights to those who were not in utero during Ramadan. Those in utero during the second or third trimester had lower placental weights and lower placental to birth weight ratios than those who were not in utero during Ramadan. Those in utero during the first trimester had lower placental to birth weight ratios. In Table 2 the babies are further divided according to whether they were born during the first or second half of the study period: the dividing point was in early 1426. Among babies born during the first half of the period those who were in the second or third trimester during Ramadan had lower placental weights and lower placental birth weight ratios than those who were not in utero during Ramadan. In contrast, among babies born during the second half of the period, those who were in the first trimester during Ramadan had reduced placental weights and placental to birth weight ratios. We examined the statistical significance of the changing relationships between placental weight and exposure to Ramadan in each of the three trimesters through the ten-year study period. We constructed an interaction test to measure these effects. The p values for the interactions were 0.06 for the first trimester effect, and <0.001 for the second and third trimester effects. The relation between Ramadan exposure and placental weight was similar in boys and girls.

4. Discussion

We have examined the body and placental weight of 17 000 babies born over a recent ten Arabic year period in a small city in Saudi Arabia. During this time mean birth weight was unchanged but mean placental weight at birth rose by more than a 100 g. This secular increase in placental weight was accompanied by a change in the association between placental size and Ramadan. During the first five years of the study period babies who were in their second or third trimester of gestation during Ramadan had reduced placental weight. During the second five years of the study period babies who were in their first trimester of gestation during Ramadan had reduced placental weight.

Placental weight was correlated with both birth weight and gestational age, as would be expected [7,8]. Fig. 1 shows that, consistent with findings in other studies, the same birth weight may be related to a wide range of placental weights. Some of the babies that weighed 3 kg, for example, had placentas that weighed 200 g or less while others had placentas that weighed 800 g or more. A low ratio of placental weight to birth weight has been used as an index of nutritional efficiency because if the placenta is small in relation to body size the fetus has had to expend less of its energy maintaining it [9,10]. During our study period placental efficiency seems to have been reduced (Fig. 2). Placental efficiency is known to be related to the availability of food. It changed during the wartime famine in Holland (Roseboom, unpublished). In our study the mean birth weight approached the mean for western populations [11]. The mean placental weight and placental to birth weight ratio at the beginning of the study (Table 1) were well below those in a recent compilation of European reference values [11]. The reference values for the 50th centile of placental weight and placental to birth weight ratio, among babies delivered vaginally, were 545 g and 16.1%. During the first 6 years of our study period placental size rose sharply to reach to levels close to these reference values.

Comparisons of studies of placental size are complicated by variation in the methods of preparation. One possible explanation for the steep increase in placental size during our study is that the techniques used for trimming and weighing the placenta changed. We have enquired about the techniques used in the King Saud Hospital. They are similar to those used in Europe and the United States and were supervised by the same midwife throughout the study. Measurements of placental weight during routine clinical practice are subject to random errors, which may be greater than those associated with birth weight. In Saudi Arabia, however, the placenta is handled carefully: it remains valued after birth and is taken to a mortuary for burial. The catchment area of this hospital did not change during the study period. We therefore conclude that the increase in placental weights recorded in our study reflect a secular increase in placental size. Furthermore, measurement error is unlikely to explain the change in the effects of Ramadan on placental size. The secular increase in placental weight and the varying effects of Ramadan are a further demonstration of the plasticity of placental growth. In humans, placental growth responds to maternal influences. Maternal anaemia and high maternal body mass index are associated with a high ratio of placental to birth weight [12–14]. Maternal smoking reduces both placental weight and birth weight, but the suppression of the placenta is less and the ratio of placental weight to birth weight is thereof increased [15]. The diets of mother's during pregnancy, their body composition and physical activity, are also known to be associated with altered placental size [16,17]. We suggest that the secular increase in placental weight reflects changes in maternal diet and body composition. The mean body mass index in late pregnancy in a subgroup of the mothers who delivered in the eighth year of our study period was 31 kg/m². This indicates that many of them were overweight before pregnancy. We do not know the mean body mass index of mothers at the beginning of the study but a secular increase in

maternal body mass is one possible explanation for the increase in the placental/birth weight ratio (Fig. 2).

We have previously suggested that the effect of Ramadan on placental growth could be mediated through the altered pattern of daily food consumption. We now suggest that the effect of this change in food consumption was altered over the ten years of our study because it is modulated by the mother's body composition. In the early years of the study when, we hypothesize, maternal body mass index was lower, Ramadan may have slowed expansion of the chorionic plate during its period of rapid growth in mid-late gestation. In the later years of the study, Ramadan could have influenced recruitment or remodelling of the spiral arteries, which occur during the first trimester [18]. Another possibility is that Ramadan increased the balance of differentiation to growth in the trophoblast, but at different times of gestation through the study period. Throughout the study Ramadan was associated with increased placental efficiency as birth weight remained unchanged. In contrast, among babies who were in the second or third trimesters of their gestation during the Dutch famine the placenta became less efficient, so that the birth weights adjusted for placental size were reduced (Roseboom, unpublished).

4.1. Limitations of the study

Our study was based on measurements of placental and birth weights made during routine clinical practice. We have discussed the possible measurement errors. Our study sample came from one city in Saudi Arabia and may not represent the country as a whole. Our data came from log-books kept in the labour ward. We did not have access to the patients' case records and were therefore unable to explore whether the changes in placental weight at birth according to year of birth and the timing of Ramadan during gestation were associated with changes in maternal weight, weight gain or haemoglobin. Neither were we able to examine the effects of parity on placental weight. Our measurements of the length of gestation were based on the date of the mother's last menstrual period and would therefore be subjected to error.

4.2. Conclusion

Over a ten-year period, 2000–2009, the placental weights of babies delivered in one maternity hospital in Saudi Arabia rose by more than 100 g while birth weight was unchanged. We suggest that this secular increase in placental weight reflected changes in maternal diet and body composition. In the later part of the study period many women were overweighted. The increase in placental weight was accompanied by a change in the placental response to Ramadan. During the first five years of the study period babies who were in their second or third trimester of gestation during Ramadan had reduced placental weight. During the second five years of the study period babies who were in the first trimester of gestation during Ramadan had reduced placental weight. The biological processes by which Ramadan alters placental growth are not known and neither do we know which aspects of the dietary change influence the placenta.

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Fig. 1.
Birth weights and placental weights of 17 660 singleton babies born at term.

Fig. 2.
Mean (95% CI) birth weight, placental weight and placental to birth weight ratio according to year of birth.

Table 1

Mean birth size and gestational age in boys and girls.

Measurements	Boys		Girls		<i>p</i> value for difference
	Mean (SD)	<i>n</i>	Mean (SD)	<i>n</i>	
Birth weight (kg)	3.28 (0.48)	8916	3.18 (0.46)	8710	<0.001
Placental weight (g)	512 (93)	8859	505 (89)	8668	<0.001
Placental/birth weight (%)	15.8 (3.0)	8859	16.1 (3.0)	8668	<0.001
Gestational age (weeks)	39.7 (1.1)	8916	39.8 (1.1)	8710	0.03
Mother's age (years)	29.5 (6.3)	8795	29.5 (6.1)	8587	0.92

Table 2

Mean birth size (SD) according to timing of Ramadan during pregnancy.

Measurement	Timing of Ramadan during pregnancy			
	Outside pregnancy	First trimester	Second trimester	Third trimester
<i>All babies</i>				
Number	4406	4684	4302	4234
Birth weight (kg)	3.22 (0.46)	3.23 (0.47)	0.19 3.23 (0.46)	0.50 3.24 (0.47)
Placental weight (g)	512 (81)	510 (84)	0.12 507 (83)	0.001 507 (83)
Placental/birth weight (%)	16.1 (2.7)	16.0 (2.8)	0.02 15.9 (2.8)	<0.001 15.9 (2.7)
<i>First Half of Study Period</i>				
Number	2272	2132	2186	2225
Birth weight (kg)	3.22 (0.47)	3.24 (0.48)	0.12 3.23 (0.47)	0.46 3.25 (0.48)
Placental weight (g)	484 (76)	487 (81)	0.21 475 (78)	<0.001 476 (78)
Placental/birth weight (%)	15.3 (2.7)	15.3 (2.9)	0.91 14.9 (2.7)	<0.001 14.9 (2.7)
<i>Second Half of Study Period</i>				
Number	2134	2552	2116	2009
Birth weight (kg)	3.22 (0.45)	3.22 (0.46)	0.85 3.22 (0.44)	0.89 3.23 (0.45)
Placental weight (g)	539 (86)	533 (85)	0.03 540 (87)	0.59 538 (88)
Placental/birth weight (%)	16.9 (2.7)	16.7 (2.7)	0.04 17.0 (2.8)	0.65 16.9 (2.8)

p^* = p value for comparison with babies not in utero during Ramadan.