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Pregnancy and Ramadhan Fasting

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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Review Article

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ABSTRACT

Fasting during the month of Ramadan is a religious obligation for healthy adult Muslims. Pregnant and lactating mothers are exempt from fasting but they do fast during the month of Ramadan. Numerous metabolic, endocrinal changes and adaptations occur in pregnancy. The long hours of abstinence of food and liquids during pregnancy may affect the intrauterine environment. There are reports of undesirable and harmful effects of fasting on the mother and the foetus, whereas others do not report any such significant adverse effects. The conflicting reports confuse the pregnant mothers and the caring practitioners. The object of this article is to critically analyse the outcome of pregnancy due to Ramadan fasting and whether the Ramadan fasting adversely affect the mother and her foetus.

Keywords: Ramadan; fasting; pregnancy outcome.

1. INTRODUCTION

Millions of pregnant mothers all over the world fast during the month of Ramadan [1].

The pregnant women spread across the globe and living under various geographical, climatic, social, cultural, and economic conditions. The practices and the food behaviours of the populations are not similar during this month of fasting by comparison to the remainder of the year. These modifications are accompanied by changes and disturbances of the cycle of sleep. Modification of meal frequency and

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eatingpatterns during Ramadan may affect different aspects of human health [2].

Ramadan fasting is beneficial for healthy people. However the perfectly healthy pregnant mothers may get pregnancy induced hypertension, pre eclampsia, gestational diabetes mellitus and anaemia. Some mothers may suffer from existing heart disease, renal disorders and other morbidities.

2. DISCUSSION

Ramadan is the name of the 9th month in the Islamic calendar. Islamic calendar is a lunar calendar in which the months are either 29 or 30 days. In the Gregorian (Solar) calendar the months are 30 and 31 days. Therefore the month of Ramadan advances approximately by 12 days each year. In the year 2015, the Ramadan started on the 18th of June and ended on 18th of July. In the year 2016, the Ramadan will start on 6th of June and end on 6th of July.

The fasting begins with the sun rise and ends with the sun set. The fasting is abstinence of food and drinks Therefore the duration of fasting time will differ from country to country. This year the longest fasting period of 21 hours is in Denmark. Duration of fasting in Island, Sweden and Norway are 20 hours. The duration of fasting in middle east countries are 15 hours, The shortest duration are Australia 10 hours and Argentina is little less than 10 hours The duration of fasting in most of the countries was 11-16 hours [3]. Ramadan will start around the same Gregorian date again after 33 years. This shifting over the years makes it possible to separate effects of Ramadan from seasonal effects.

There are reports of undesirable and harmful effects of fasting on the mother and the foetus. This includes risk of hyperemesisgravidarum [4], increased prevalence of urinary tract infections due to decreased fluid intake during fasting days, reduction in foetal breathing movements due to relatively low levels of maternal blood glucose and foetal compromise as indicated by a reduction in the foetal biophysical profiles [5]. Elevations in the maternal cortisol levels had also been noted [6-8] whereas others do not report such adverse effects.

2.1 Islamic Perspective of Ramadan Fasting

The Al-Quran verses about the Ramadan fasting are as follows:

(Fasting) for a fixed number of days; but if any of you is ill, or on a journey, the prescribed number (Should be made up) from days later. For those who can do it (With hardship), is a ransom, the feeding of one that is indigent. But he that will give more, of his own free will, it is better for him. And it is better for you that ye fast, if ye only knew. (2:184)

Ramadhan is the (month) in which was sent down the Qur'an, as a guide to mankind, also clear (Signs) for guidance and judgment (Between right and wrong). So every one of you who is present (at his home) during that month should spend it in fasting, but if any one is ill, or on a journey, the prescribed period (Should be made up) by days later. Allah intends every facility for you; He does not want to put to difficulties. (He wants you) to complete the prescribed period, and to glorify Him in that He has guided you; and perchance ye shall be grateful (2:185).

According to prophet, “Allah has relieved the traveler and the pregnant and nursing women of obligation of fasting” [9].

Islam clearly exempts fasting in Ramadan during sickness, pregnancy, and breastfeeding. However women prefer to fast despite realizing their increase in nutritional demand during pregnancy. Breast feeding and pregnant mothers are allowed to skip fasting if they are afraid that fasting may harm their own health or the health of their foetus [10].

Although the pregnant and lactating mothers are exempt from fasting, they continue to fast. These mothers have strong believe in religion. It is very easy to fast with other family members during Ramadan .It may be difficult to fast later all alone to cover up the missed fasting days [11].

2.2 Possible Adverse Effects of Fasting

Long hours of fasting can lead to hypoglycaemia and ketoacidosis. The prolonged hunger presents itself as hypoglycemia or hyperketonuria, which may affect the neonatal weight, neonatal mortality and disability [12,13]. During the time of fasting the pregnant and breastfeeding women experience changes in metabolism, sleep patterns and daily physical activity [14,15].

Arab et al. analyzed clinical symptoms, food intake in the previous 24 hours, as well as

ketonuria and serum glucose in 185 pregnant women just before breaking their fast. This study was preformed in 1999 and the duration of fasting in that year was 15 hours).

The positive predictive values of clinical symptoms before breaking the fast for ketonuria and hypoglycemia were 32% and 56%, respectively. The negative predictive values of clinical symptoms for ketonuria and hypoglycemia were 70% and 33%. The positive predictive values of over 500 Kcal deficiency in ketonuria and hypoglycemia were 33% and 57%. Severe calorie deficiency (more than 2000 Kcal) positively predicts ketonuria in 70% of cases and sufficient calorie intake (less than 500 Kcal deficiency) negatively predicts ketonuria in 93% of women. Clinical symptoms and calorie intake were not appropriate criteria for predicting ketonuria and hypoglycemia except in asymptomatic or severely calorie deficient cases or those with sufficient calorie intake whose ketonuria was predicted accurately [16].

Foetal programming theory: Fasting during pregnancy is expected to have negative effects because unmet excess demand for nutrition by the foetus impedes foetal growth leading to permanent effects on the body and disease development. Inadequate prenatal nutrition leads to developmental and metabolic adaptations to protect short-term survival but affect the general growth of the foetus (e.g., lower birth weight). This effect takes place despite a short period of nutritional deficiency [17].

Foetus adapts to hostile environment. It helps to survive but serious problems can occur later in adult life. The baby in later life may be predisposed to coronary heart disease and its biological risk factors such as hypertension and type 2 diabetes [18] Under nutrition leads to a reduced number of nephrons (the functional units of the kidney). Initially, this does not cause great problems, but when ageing further decreases in the number of nephrons, may result in hypertension and consequent further damage to the kidneys [19]. Prenatal exposure to stress hormones may also program the hypothalamic-pituitary-adrenal axis (a system that controls much of the hormonal system, including reactions to stress) and this may lead to higher blood pressure and type 2 diabetes [20].

Fasting and caloric restriction during pregnancy had been reported to impose negative effects on maternal health and pregnancy outcomes. Some research suggests that maternal fasting increases the potential for developing irreversible mental and physical disabilities in children. Current research suggests that maternal fasting during Ramadan has no deleterious impacts on the birth weight or biochemical and biophysical parameters of babies. Fasting may affect most micronutrient intakes; It would be prudent for pregnant and lactating women to utilize the excuse for not fasting during Ramadan [21].

A significant fall in glucose, insulin, lactate, and carnitine levels and a rise in triglyceride concentrations have been observed in pregnant women observing Ramadan. Accelerated starvation after short-term fasting in pregnant women resulted in hypoglycemia, raised circulating fatty acids and ketones, and reduced concentration of amino acids [22]. These changes are related to the duration of fasting and to gestational age [23].

The metabolic consequences of fasting during pregnancy have been studied in women by Malhotra et al. [24] He observed a significant fall in glucose, insulin, lactate and carnitine levels, and a rise in triglyceride, non-esterified fatty acid and 3-hydroxybutyrate when compared with controls.

Inadequate food intake of pregnant woman, especially in the third trimester, may trigger negative implications on the health of the foetus. The conditions of inadequate food intake and the subsequent physiological and biochemical changes that take place are described as accelerated starvation. This physiological stress condition is manifested by decreasing levels of blood glucose, increasing free fatty acids concentration and ketone bodies formation, which mainly occurs after fasting for 12 hours or more. Maternal ketonuria during pregnancy may lead to decreased foetal intelligence. Therefore fasting and restriction of carbohydrate intake should be avoided during pregnancy. On the other hand, pregnant women can adapt to food and fluid restriction without a major drop in their blood glucose level [25]. This was reflected in having no clinical symptoms for the women or their foetuses during the study period that lasted for almost one month [26]. Accelerated starvation' caused by fasting during pregnancy is correlated with the malfunctioning of certain cognitive functions [27].

Prentice et al. [28] studied the metabolic consequences of fasting by measuring serum

glucose, free fatty acid, triglyceride, beta-hydroxybutyrate, alanine, insulin, glucagon and T3 levels at 0700 h and 1900 h in 22 pregnant, 10 lactating and 10 non-pregnant, non-lactating women. Results were also compared with overnight-fasted values obtained outside Ramadan. Values for the lactating women were not significantly different from the non-pregnant, non-lactating controls despite the additional metabolic stress of lactation. Ramadan-fasted (1900 h) glucose values from women in late pregnancy (3.01 +/- 0.11 mmol/l) were significantly lower than all other groups (P less than 0.01) and were 15 per cent (P less than 0.01) lower than overnight-fasted values from similar subjects. Ramadan-fasted free fatty acid and beta-hydroxybutyrate levels were significantly higher (P less than 0.05) and alanine values were significantly lower (P less than 0.05) in late than in early pregnancy. It was found that the phenomenon of 'accelerated starvation' occurs when women in late pregnancy fast during Ramadan.

Fasting and dietary restriction during pregnancy could lead to adverse health effects on pregnant women and might entail poor physical and mental development of the foetus [29]. Good nutrition with balanced diet and oxygen supply during pregnancy are important for proper foetal growth and development [30]. Especially during the first-trimester for which dietary factors are found to be associated with childhood bone mass, suggesting that foetal nutritional exposures may permanently influence bone development and mineral density [31].

Maternal nutrient restriction at specific stages of gestation has differential effects on fetal development such that the offspring are programmed to be at increased risk of adult disease. Bispham et al. [32] investigated the effect of gestational age and maternal nutrition on the maternal plasma concentration of leptin and cortisol together with effects on fetal adipose tissue deposition plus leptin, IGF-I, IGF-II ligand, and receptor mRNA abundance near to term. It was noted that the offspring of nutrition restricted mothers being at increased risk of obesity in later life.

Starvation ketosis outside pregnancy is rare and infrequently causes a severe acidosis. Placental production of hormones, including glucagon and human placental lactogen, leads to the insulin resistance that is seen in pregnancy, which in turn increases susceptibility to ketosis particularly in the third trimester. Starvation ketoacidosis in pregnancy has been reported and is usually precipitated by a period of severe vomiting. After 12 hours of fastingthe pregnant group showed significantly higher levels of free fatty acids and b-hydroxybutyrate [33].

Frequency of eating or meal patterns during pregnancy may be a component of maternal nutrition relevant to pregnancy outcome. Meal patterning during pregnancy may be important because pregnant women who sustain prolonged periods of time without food by skipping meals and/or snacks may be inducing a physiologic stress upon their pregnancy. Prolonged periods of time without food can cause hypoglycemia, which stimulates a cascade of neuroendocrine events that may ultimately affect the health of the fetus. Women who consumed food at a less optimal frequency were at a slightly higher risk for delivering preterm in general and were more likely to deliver after premature rupture of the membranes. This effect was independent of total energy intake, pre pregnant BMI, and supplement use [34].

The pregnancy accelerates and exaggerates the hypoalaninemic and hyperglycinemic effects of starvation. Lack of key endogenous substrate rather than altered intrahepatic processes may limit hepatic gluconeogenesis in pregnancy and contribute to gestational hypoglycemia; Maternal caloric deprivation profoundly alters the levels of amino acids in amniotic fluid [35]. "Accelerated starvation" can be unmasked during pregnancy even with the minor dietary deprivation common in conventional clinical circumstances. Thus, it may be desirable to avoid ketonaemia during pregnancy, the common practice of skipping breakfast should be avoided in pregnant women [36] Poor weight gain and hypoleptinaemia occur in pregnant fasted women. Food restriction in pregnant fasted women during Ramadan may induce poor weight gain during pregnancy. Ramadan fasting by pregnant women may have potential risks during pregnancy [37].

In healthy women with appropriate nutrition, Islamic fasting has no inappropriate effect on intrauterine growth and birth-time indices. Meanwhile, relative risk of low weight birth was 1.5 times in mothers on fasting at first trimester as compared to non-fasting mothers [38]. Fasting during pregnancy stimulates preterm delivery in animals and increases women's risk for preterm delivery. Fasting stimulates hypothalamic corticotropin-releasing hormone production in

animals. Elevated maternal corticotropin-releasing hormone concentrations are associated with preterm birth. Prolonged periods without food lasting 13 hours or longer were associated with elevated maternal corticotropin-releasing hormone concentrations and prone for preterm delivery [39].

2.3 Are There Any Adverse Effects of Fasting?

Dikensoy et al. [40] concluded that fasting during Ramadan does not lead to maternal ketonemia or ketonuria in pregnant women. In addition, fasting during Ramadan has no significant adverse effect on intrauterine foetal development or the foetal health.

Azizi et al. [41] studied the long-term impact of fasting on human capital outcomes. They find no significant effect of maternal fasting behavior, during the third trimester of pregnancy, on the intelligence quotients (IQs) of school-age children.

Fasting for less than 15 hours is not metabolically different from a physiological overnight fast for the healthy pregnant woman. Ketonemia and hypoglycemia frequently occur with more prolonged fasting; however, there is no evidence that this affects infant outcomes [42,43].

Dikensoy et al. [44] studied thirty-six consecutive healthy women with uncomplicated pregnancies with the period of gestation of 20 weeks and above who were fasting during Ramadan. They were included in the study group (group 1). The control group (group 2) consisted of 29 healthy pregnant women who were not fasting. Doppler ultrasonography was performed in all subjects in the beginning and at the end of Ramadan to evaluate the changes in the following measurements: foetal biparietal diameter; foetal femur length; and estimated foetal body weight. Foetal biophysical profile, amniotic fluid index, and umbilical artery systole/diastole ratio were measured in the beginning and at the end of Ramadan. Effects of fasting on the mother were evaluated by measuring serum concentrations of hydroxybutyrate and glucose, and urinary concentration of ketone. The mean duration of fasting in the study group was 18 +/- 2.1 days. The mean maternal glucose level was significantly lower in the study group than in the control group (P = 0.003). No statistically significant differences were found between the two groups in the comparisons of other parameters. It was concluded that fasting during Ramadan does not lead to maternal ketonemia or ketonuria in pregnant women. In addition, fasting during Ramadan has no significant adverse effect on intrauterine foetal development or the foetal wellbeing.

Fasting for less than fifteen hours is not metabolically different from a physiological overnight fast for the healthy pregnant woman. Ketonemia and hypoglycemia frequently occur with more prolonged fasting; however, there is no evidence that this affects infantoutcomes. Non-stress tests are more likely to be non-reactive during the period of fasting, but return to reactivity after dinner [45,46].

Stable gestational persons with diabetes who fast experience no increase in hypoglycemic symptoms and have improved glucose control [47].

No statistically significant difference in Doppler indices of uterine or umbilical artery, growth parameters or amniotic fluid index was observed between fasting and nonfasting pregnant women [48].

There are a number of problems inherent in most of these empirical studies in epidemiology. These include small sample sizes, estimation of effects in a given trimester instead of a comprehensive study of the entire pregnancy period. More seriously, most of these studies have attempted to evaluate the average treatment effects of Ramadan by comparing outcomes for those who actually fasted and those who did not, under the assumption that the decision to fast is exogenous.

2.4 Foetal Outcome of Fasting

2.4.1 Amniotic fluid index (AFI)

Amniotic fluid index (AFI) reflects the foetal wellbeing. Oligohydramnios in the presence of intact membranes is a common obstetric complication, occurring in 3–5% of pregnancies at term. Such pregnancies are at an increased risk of fetal distress and are associated with a high rate of operative delivery and meconium aspiration [49].

Khalaf et al. [50] studied total of 221 pregnant women who were on the 3rd and 27th days of the month of Ramadan., The sample had 97

fasting mothers and 124 non fasting mothers. As regards age, parity and the gestational age no significant differences were reported. The AFI was less affected by fasting. There was a significant difference in the AFI between fasting and non fasting pregnant women with oligohydramnios (4.00±0.82 and 2.64±1.12 respectively). A positive relationship with gravidity was observed as AFI increased with the increase of gravidity in pregnant fasting women, on the other hand there was variable non significant relation between AFI and gravidity in pregnant non fasting women.

Zahra et al did a cross-sectional study on pregnant women between the 20th to 36th weeks of gestational age to assess the influence of Ramadan fasting on amniotic fluid volume. Two groups of fasting (n=28) and non-fasting (n=25) pregnant women were investigated for amniotic fluid index (AFI) and deepest vertical pocket of amniotic fluid in November (Ramadan month) of 2001-2002. The mean of gestational age based on the last menstrual period and ultrasound reports were 29.6±5.8 week and 29.5±4.2 week in fasting and non-fasting groups. There was no significant difference between the 2 groups in age, gestational age, gravidity, parity and systolic/diastolic blood pressures. The mean deepest vertical pocket in fasting and non-fasting groups was 65.9±12.9 mm and 62.7±6.5 mm and there was no significant difference between the 2 groups in this regard. Mean AFI in fasting group (189.9±35.9 mm) and in non-fasting group (166.8±25.3 mm) showed a significant difference ($p<0.05$).Fasting in Ramadan has no significant effect on the decrease of AFI, deepest vertical pocket and amniotic fluid volume [51].

Moradi [52] observed no statistically significant difference between fasting and non-fasting pregnant women in terms of Doppler indices of uterine or umbilical arteries, growth parameters, and amniotic fluid index.

2.4.2 Birth weight of the foetus

Is there any intra uterine growth restriction and reduction of birth weight of the infant due to Ramadan fasting?

NahidSarafraz et al. [53] evaluated 293 cases among whom 31.7% did not fast. They matched fasting and non- fasting groups, age, parity, gestational age, body mass index (BMI), mother's occupation, prenatal care attendance and intended or unintended pregnancy. For the statistical analysis of the data, covariance analysis and SPSS v16.0 were used. The mean birth weight was 3338 g (±498 g) and 3343 g (±339 g) in fasting and non-fasting groups respectively. The results showed that the mean birth weight of the neonates in fasting and non-fasting groups was not significantly different (P=0. 931). Nahid concluded that Ramadan fasting does not affect neonatal birth weight. In addition, in healthy women with appropriate nutrition. Ramadan fasting has no negative effect on intrauterine growth and birth weight indices.

Shagheibi et al. [54] studied the effects of third trimester fasting on birth weight. The average weight of newborn babies in exposure group was 3313±533 gm. compared with 3346±337 gm. in non-exposure group. The length in exposure group was 49/74±1/84 cm. compared with 49/9±1/89 cm. in non-exposure one. The average size of the head circumference was 34/65±1/57 in the exposure one, whereas; in non exposure group it was 34/57±1/57. In all this above the observer found no significant relation.The relative- risk low birth weight (LBW) in exposure group was1.9 (0.61-5.98). Fasting of pregnant mothers during their third trimester of pregnancy did not have an affect on the growth indices of their newborn babies.

Alwasel [55] in a retrospective study, observed the babies of mothers who were in the second or third trimester of gestation during the Ramadan fasts. He noted reduced placental weight at birth. However the birth weights of the newborns was not affected. This concluded that the placentas were able to maintain levels of activity despite their reduced size. The placental growth slowed, but their efficiency increased, so that foetal growth is sustained.

Makvandi et al. [56] studied the effects of Ramadan fasting on neonatal anthropometric measurements during the third trimester of pregnancy. This was a cross-sectional study, carried out on 300 delivering women in 2013. All participants were divided into fasting (n=150) and non-fasting (n=150) groups. Neonatal anthropometric measurements were compared in both groups. They reported that there were no significant differences between the two groups in terms of birth weight (p=0.97), head circumference (p=0.09), and the height (p=0.12) of the neonates. In addition, the prevalence of low birth weight (LBW) was similar in fasting and non-fasting groups (p=0.33). They concluded that Ramadan fasting in the third trimester of

pregnancy has no adverse effects on neonatal anthropometric measurements.

Ziaee et al. [57] evaluated the effect of fasting on pregnancy outcomes. In this cohort study, the women were divided into four groups: non-fasting, 1-10-day fasting, 11-20-day fasting, and 21-30-day fasting groups. 189 cases were evaluated. Their mean age, weight, and BMI were 25.9 years, 61.7 kg, and 23.9 kg/m2, respectively. The mean number of fasting days was 13 days, and 66 cases (34.9%) avoided fasting. There was no significant difference between the groups in terms of BMI at the beginning of pregnancy, maternal age, number of pregnancies, and history of abortion. It was found that there was no significant association between the number of fasting days and the mean of infants birth weight, height, and head circumference. Furthermore, there was no significant correlation between pregnancy outcomes and fasting in different trimesters.

Zohreh et al. [58] did a retrospective cohort study to determine the effects of maternal Ramadan fasting during pregnancy on neonatal birth weight as an important aspect of foetal health. Neonates of 284 mothers with a history of Ramadan fasting during pregnancy were compared with neonates of 255 mothers who did not have a history of fasting during their pregnancies. On univariate analysis, neonatal birth weight of the fasted group was 100 g more than those of the nonfasted group (p=0.009). However, body mass index (BMI) of the fasted mothers was greater than that of the nonfasted mothers. When controlling for maternal BMI on neonatal birth weight, multiple linear regression models showed that neonates of fasted women were 71 g heavier than those of the nonfasted group, which was not statistically significant (p=0.1). It was concluded that maternal fasting during Ramadan did not have a significant effect on the neonatal birth weight.

Azizi (59) indicated no adverse effects of Ramadan fasting on heart, lung, liver, kidney, eyes, hematologic profile, endocrine, and neuropsychiatric functions of the pregnant mother and neonatal weight. Similarly, Shaghy by (2005) conducted a study in Sanandaj, Iran, which showed that maternal fasting in the third trimester of pregnancy has no significant effect on neonatal anthropometric measurements such as birth weight [60].

A mixed cohort (retrospective and prospective) study was conducted on Malaysian pregnant women attending a rural health centre in Muar district of Malaysia. Among the 605 women who were eligible for the study, 477 were fasting during Ramadan. The remainders were non fasting. The study showed that there was no difference in weight gain during pregnancy and the birth weight of new born (61).

The birth weights of 13,351 babies born at full term from 1964-84 to Asian Moslem mothers in Birmingham were analysed to see if the effect of the Ramadan fast on maternal biochemical profiles was of any clinical relevance. These were compared with two age matched control groups comprising white and non-Moslem Asian babies. Ramadan had no effect on mean birth weight at whatever stage of pregnancy it occurred. There was an increase in the prevalence of low birth weights (4.5% to 8%) among babies who were born at full term when Ramadan had occurred during the second trimester, but this was not significant. The Ramadan fast has no effect on the birth weights of babies born at full term [62].

Ramadan fasting does not affect birth time weight, height, and head circumference. In healthy women with appropriate nutrition, Islamic fasting has no inappropriate effect on intrauterine growth and birth-time indices. However relative risk of low birth weight was 1.5 times in mothers on fasting at first trimester as compared to non-fasting mothers [63].

The calorie input and weight gain in mothers on fasting is lower than non-fasting ones [64].

Emily et al. [65] assessed the prevalence, characteristics of fasting behaviours and offspring health outcomes in Asian and Asian British Muslim women within a UK birth cohort. Prospective cohort study conducted at the Bradford Royal Infirmary UK from October to December 2010 comprising 310 pregnant Muslim women of Asian or Asian British ethnicity that had a live singleton birth at the Bradford Royal Infirmary. The main outcome of the study was the decision to fast or not during Ramadan. Secondary outcomes were preterm births and mean birthweight. Logistic regression analyses were used to investigate the relationship between covariables of interest and women's decision to fast or not fast. Logistic regression was also used to investigate the relationship between covariables and preterm birth as well as low birth weight. Mutually adjusted analysis showed that the odds of any fasting were higher

for women with high -BMI at booking compared to women with a normal BMI, (OR 2.78 (95% C.I. 1.29-5.97)), for multiparous compared to nulliparous women (OR 3.69 (95% C.I. 1.38-9.86)), and for Bangladeshi origin women compared to Pakistani origin women (OR 3.77 (95% C.I. 1.04-13.65)). Odds of fasting were lower in women with higher levels of education (OR 0.40 (95% C.I. 0.18-0.91)) and with increasing maternal age (OR 0.87 (95% C.I. 0.80-0.94). No associations were observed between fasting and health outcomes in the offspring. Pregnant Muslim women residing in the UK who fasted during Ramadan differed by social, demographic and lifestyle characteristics compared to their non-fasting peers. Fasting was not found to be associated with adverse birth outcomes in this sample although these results require confirmation using reported fasting data in a larger sample before the safety of fasting during pregnancy can be established.

2.4.3 Preterm labour

Can the Ramadan fasting leads to preterm labour?

Awwad et al. [66] studied the women who attended the prenatal care from 20–34 weeks of gestation during the month of Ramadan, September 2008. To determine the effect of fasting during the month of Ramadan on the rate of preterm delivery (PTD) A total of 402 were included in the study. There were no differences in smoking history and employment. There was no difference in the proportion of women who had PTD at <37 weeks (10.4% versus 10.4%) or PTD at <32 weeks (1.5% versus 0.5%) in the Ramadan-fasted group and the controls, respectively. The PTD rate was also similar in those who fasted before or during the third trimester. The mean birthweight was lower (3094±467 g versus 3202±473 g, P= 0.024) and the rate of ketosis and ketonuria was higher in the Ramadan-fasted women. On multivariate stepwise logistic regression analysis, fasting was not associated with an increased risk of PTD (odds ratio 0.72; 95% confidence interval 0.34–1.54; P= 0.397). The only factor that had a significant effect on the PTD rate was body mass index (odds ratio 0.43; 95% confidence interval 0.20–0.93; P= 0.033). It was concluded that fasting during the month of Ramadan does not seem to increase the baseline risk of preterm delivery in pregnant women regardless of the gestational age during which this practice is observed.

Hassan et al. [67] did a descriptive, analytical study, 641 newborns, whose mothers had fasting experience during pregnancy, were enrolled. The average fasting hours was 14 hours a day. Group A: 10 days or less, group B: 11-20 days, and group C: 21-30 days. During Ramadan, 515 (80%), 88 (13.5%), and 37 (6.5%) mothers were in the first, second, and third trimesters, respectively. Number of fasting days during pregnancy was less than 10 days in 137 (21.4%) women, 10-20 days in 160 (25%) women, and more than 20 days in 344 (53.7%. The current study indicated that increased Ramadan fasting days did not lead to decreased neonatal birth weight or maternal weight. Incidence of pre-term labour and low birth weight did not increase, while higher number of fasting days had a significant direct effect on 1- and 5-minute Apgar scores.

2.5 Other Findings

Mirghani [68] determined the foetal biophysical profile changes in women observing Ramadan fasting with uncomplicated singleton pregnancy. In this cross-sectional observational study healthy women who were observing Ramadan at 30 weeks or more of gestation were recruited as well as a non-fasting control group matched for age, parity, and gestational age. Ultrasound examination included assessment of amniotic fluid volume, foetal bladder volume, foetal biophysical profile, and umbilical artery Doppler flow. A total of 162 pregnant women were observed. Mean umbilical artery pulsatility index, vertical amniotic pool depth, and foetal bladder volume were similar in the study and control groups. However, there was a significant difference in biophysical scores between the two groups. In the fasting group, 30 of 81 foetuses (37%) had a score of 6/8 compared with 11 of 81 foetuses (13.6%) in the control group (P=0.001). All foetuses in both groups with a biophysical score of 6/8 showed no breathing movements. Foetal breathing movements are reduced during maternal fasting.

Alwasel et al. [69] studied the birth weight, placental weight and gestational age of 7083 babies over the period of four years. Among babies who were in the second or third trimester of gestation during Ramadan the mean placental weight and ratio were below those of babies who were not in utero during Ramadan. Among boys the mean placental ratios were 14.4 percent (second trimester) and 14.5 percent (third trimester) compared with 14.9 percent (p=<0.001

and 0.002). The corresponding figures for girls were 14.8 and 14.6 percent compared with 15.1 percent (p=0.02 and <0.001).Placental growth slows but efficiency is increased so that foetal growth is sustained, albeit with a reduced reserve capacity. The lifestyle changes associated with Ramadan further slow placental growth. Ramadan may influence placental growth through dietary changes other than day-time fasting. Changes in placental growth during Ramadan could be associated with altered foetal programming, and may therefore have long-term implications for the health of the next generation.

The exposure to maternal fasting during Ramadan has adverse effects on foetal health and beyond, such as foetal breathing, foetal heart rate, admission to the special care baby unit, mental and psychomotor development, symptoms of coronary heart problems, and type 2 diabetes in old age Meanwhile, empirical evidence, especially from economic studies, suggests a persistently negative impact on childhood and adult life, such as birth weight, language ability during early childhood, number of males compared to females, learning disabilities for adults, crude wealth measures, general health, and math and reading test scores for children [70].

The changes in the lifestyle of pregnant women during Ramadan affect more than one generation. In a series of new born babies in Saudi Arabia, those whose mothers had been in utero during Ramadan differed from those whose mothers had not been in utero during Ramadan. These were unexpected findings and require replication. The birth weight of 1,321 babies (682 boys and 639 girls) was analysed. The babies whose mothers had been in utero during Ramadan were smaller and thinner, and had smaller placentas, than those whose mothers had not been in utero during Ramadan. After adjustment for sex, the babies were 93 g lighter (95% confidence interval, 32–153, P=0.003) than those whose mother had not been in utero during Ramadan, their mean ponderal index was 0.52 kg/m3 lower (0.24–0.79, P<0.001) and their placental weight was 21 g lower (5–37, P=0.01). The findings did not differ by trimester of maternal exposure to Ramadan. They were similar in boys and girls and in primiparous and multiparous mothers. This study provides further evidence that changes in lifestyle during Ramadan have intergenerational effects [71].

Aziziet [72] investigated the effect of fasting on the intelligence quotient (IQ) of children of mothers who fasted during their corresponding pregnancies for at least 27 days. This is a retrospective cohort study conducted on 191 children aged between 4 to 13 years, 98 whose mothers fasted throughout Ramadan when they were pregnant (case group) and 93 children whose mothers did not fast (control group). The children were selected from 15 schools via a questionnaire filled out by their mothers. No significant differences were observed between the IQ scores of the two groups. Fasting during gestation did not adversely affect IQ of children whose mothers had fasted during Ramadan while being pregnant.

Children exposed to famine during the first trimester had a more atherogenic lipid profile [73] somewhat higher fibrinogen concentrations and reduced plasma concentrations of factor VII [54,74] a higher BMI [75] and they appeared to have a higher risk of CHD [76]. Offspring whose mothers consumed little protein relative to carbohydrate during the third trimester of pregnancy had higher blood pressures at adult age [77]. The implication is that blood pressure may be linked to a disruption in the balance of macronutrients in the maternal diet during late gestation rather than to absolute amounts of nutrients.

intrauterine exposure to famine has been associated with not only negative infant outcomes (low birth weight, still birth and congenital anomalies) but also with adult diabetes, obesity, cardiovascular disease, schizophrenia and cognitive aging, as well as the changes in the epigenome, such as hypomethylation of IGF2 and INSIGF, hypermethylation of ABCA1, GNASAS, IL10, LEP, and MEG3 stochastic methylation changes of several metastable epialleles [78,79]. Much of these long-term effects were observed during the Dutch Hunger Winter Study, which not only confirmed the hypothesis of developmental origin of health and disease, but also emphasized the significance of timing in the fetal programming of adult disease.

Those who were exposed to the famine only during late gestation were born small and continued to be small throughout their lives, with lower rates of obesity as adults than in those born before and after the famine [80]. Those offspring exposed during early gestation experienced elevated rates of obesity, altered lipid profiles, and cardiovascular disease. Additionally, those exposed in mid-pregnancy demonstrated reduced renal function [81,82].

Those exposed to famine during early gestation later showed a significant impairment in a test of selective attention at age 56–59 years [83] These observations represented first critical windows of development preceding the developmental origins of health disease hypothesis.

These cohort studies do not prove that Ramadhan fasting is safe for pregnant women and their infants. A randomised controlled trial of pregnant women intending to fast for Ramadhan with a fasting group and non-fasting would be required [84].

3. CONCLUSION

Most of the existing studies are small or methodologically flawed. The fasting is not starving and should not be categorised as malnutrition. The body adapts to different nutritional status.

The first trimester is the time of organogenesis. This period is particularly sensitive to nutrient deficiencies and hence fasting in this period could be harmful for foetus. The effects of fasting during first twelve weeks of pregnancy is not studied accurately. The gravid mothers are prone to nausea, vomiting in early pregnancy and this may be aggravated by fasting. Therefore it is prudent to avoid fasting in early pregnancy.

There is lack of a conclusive evidence of the negative effects of fasting on maternal and foetal health, It is not advisable for the undernourished and sick pregnant women to fast during Ramadan, Possible negative pregnancy outcomes, long-term consequences (so called “fetal programming”), as well as trans-generation transmission the effects cannot be assessed due to the lack of long term studies.

Most of the studies had only evaluated the birth weight of the new born. This is a good parameter of the foetal well being but this not the only parameter. The metabolic changes and the long term complications had not been evaluated.

Ramadan slowly rotates through the seasons. The number of fasting hours varying by country depending on the period of time between sunrise and sunset, which changes subject to latitude and longitude.

The fasting hours can differ from 11 hours to 20 hours per day. The temperature and the humidity of the countries differ to a great extent. Some pregnant mothers may rest at home with ample domestic support whereas some had to do strenuous manual work in the hot sun for a considerable period. Therefore the fasting of pregnant mothers during the month of Ramadan is an individual preference and not a general rule to be implemented.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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