Effect of maternal exposure to seasons during the second and third trimester of pregnancy on infant birthweight in rural Bangladesh

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List of Abbreviation

FSNSP: Food Security and Nutrition Surveillance Project

HDSS: Health and Demographic Surveillance System
icddr,b: International Centre for Diarrhoeal Disease Research, Bangladesh

LBW: low birthweight

LMICs: low and middle income countries

LMP: last menstrual period

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**Abstract**

**Background**

Pregnant women belonging to agricultural communities of low- and middle-income countries often face seasonal food insecurity and energy stress.
**Objective**

To investigate the effect of maternal exposure to different seasons during the second and third trimester of pregnancy on infant birthweight in rural Bangladesh.

**Methods**

Information on 3,831 singleton live births was obtained from the electronic databases of Matlab Health and Demographic Surveillance System and Matlab hospital of the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b). We collected information on all term births from July 2011 to June 2015 and excluded congenital anomalies and observations with missing data. Each year was divided into three distinct seasons: the post-aman harvest period (January-April), the height of the monsoon (May-August) and the post-aus harvest period (September-December). Seasonal exposure was measured in weeks, and multivariable linear regression models were fitted to determine the independent effect of each week exposure of different seasons during the second and third trimesters of pregnancy on birthweight.

**Results**

We observed peak birthweight in post-aman harvest season, especially among babies born in March (2930.5±462.1 gm) and the lowest birthweight in the month of July (2830.6±385.4 gm) during the monsoon season. Regression analysis showed that exposure to post-aman harvest season during the third trimester, and post-aus harvest period during the second trimester of
pregnancy had significant positive effects on birthweight. In the final adjusted model, each week exposure to post-aman harvest season during third trimester is associated with 6.3 gm (95% CI: 1.6, 10.9; p = 0.008) increase in birthweight.

Conclusions

Infants born to women who have been exposed to the post-aman harvest season for the entire third trimester (14 weeks) are associated with 88.2 g higher weight at birth. Further investigations into the complex interplay between seasonal energy stress, maternal, and fetal nutrition and measures to alleviate it are warranted.

Keywords:
Seasonal food insecurity; prenatal exposure; birthweight; low birthweight; energy stress; rural; Bangladesh

Introduction

Birthweight is a key determinant of infant health and survival (1). Infants born with low birthweight (LBW) are at increased risk of neonatal death, stunting, poor cognitive development, and chronic diseases such as ischemic heart disease, diabetes, and metabolic syndrome later in life (2). In low- and middle-income countries (LMICs), LBW is mostly attributed to intrauterine growth restriction, which itself is a consequence of chronic maternal undernutrition as well as acute nutritional insults during pregnancy. The prevalence of maternal and child undernutrition
in Bangladesh are among the highest in the world. One in three pregnant women is underweight (3,4) and 54% of women fall short of gaining adequate weight in the third trimester (5). Besides, 22.6% infants are born with LBW (6), and 36% of children aged under five years are stunted (7).

Proper maternal nutrition before and during pregnancy is crucial for ensuring fetal growth and development. However, acute nutritional insults and inadequate weight gain during pregnancy can lead to low birthweight even if the mother has had a normal pre-pregnancy weight (8). Fetal growth has its peak velocity in the second and third trimester of pregnancy and are thus periods when fetal growth are particularly affected by nutritional perturbations (9).

In LMICs, rural communities with agriculture as the principal occupation are prone to seasonal energy stress due to an increase in food insecurity, agricultural activity, and infections, which affects maternal dietary intakes, nutritional status, gestational weight gain and eventually birthweight (10–12). Asia has the highest number of adults exposed to severe agro-climatic seasonality and seasonal energy stress and South and South-East Asia is the largest contributer of the adolescents and adult suffering from under nutrition (13,14). Despite some recent development in crop production and employment generation in Bangladesh, a large number of people, especially in rural areas are still at risk of seasonal food insecurity due to dependency on manual labor and traditional agricultural strategies, which is highly affected by climatic variables (15).

In Bangladesh, the majority of people reside in rural areas and 87% of the rural households directly or indirectly rely on agriculture (16). About 80% of the total cropped area is occupied by rice cultivation, which accounts for more than 90% of total grain production (17). Ultimately, production of rice and the availability of agricultural work determines the household food security status in rural Bangladesh (18–20). Cultivation and production of rice varies across the
country by regions and seasons. Traditionally, Bangladesh has three major rice crops: aus, aman and boro. “Aman” is the most extensively cultivated rice crop during the wet monsoon season in the coastal (flood-prone islands and char areas of the country) areas as well as elsewhere and harvested from November to December. During the pre-monsoon season, drought-resistant variety of rice “aus” is usually cultivated in the northern part of the country and harvested between July and August (21). However, the dry season “boro” rice (usually cultivated in November-December and harvested during the March-April) is making an increasingly larger contribution to the total rice production of Bangladesh and is grown throughout the country especially in the northern part (21).

In Bangladesh, 57% of the people are food-insecure (22), where food-insecurity was defined as a situation when there is a lack of access among people towards safe and nutritious food in a sufficient amount (23). The food insecurity varies with the season because of the variation in crop production and agricultural employment. The seasonal pattern of food insecurity also varies among different regions of the country. For example, households from the areas of costal belt, eastern hills and haor (is a wetland which is physically is a bowl or saucer shaped shallow depression, also known as a back swamp) (24,25) are more food insecure during rainy monsoon season but households from northern chars (a riverine island which is often unstable, usually temporary and re-formed during and after the monsoons each year) (24) and northwest are opposite in terms of food insecurity during that period of the year (24). This seasonal nutritional stress due to household level food insecurity has been found to be associated with an increased rate of maternal and child undernutrition in Bangladesh (26,27). However, how prenatal exposure to seasons by trimesters of gestation influences birthweight remains largely unknown. Such information might help design targeted intervention programs for pregnant women in rural
agrarian communities. In this study, we aimed to investigate the effect of maternal exposure to seasons during the second and third trimester of pregnancy on infant birthweight in rural Bangladesh at Matlab.

**Methods**

**Setting**

The study was conducted in rural Bangladesh at Matlab, a subdistrict of Chandpur, which is a low-lying riverine area, situated 55 km southeast of the capital of Bangladesh. Matlab is located between the south of the Surma-Kusiyara floodplain and the northern edge of the Young Meghna estuarine floodplain. It is comprised of smooth, almost level, floodplain ridges and shallow basins. The river Dhonagoda flows from the north to the south, bisecting this area into two approximately equal parts. Numerous canals also exist in the study area. These canals remain dry in the winter and become full of water during the monsoon (28). Due to its similarity to coastal areas in terms of geography, vulnerability and agricultural practice, Matlab has been considered by some a part of the costal belt food insecure zone in Bangladesh (24). The areas under the coastal belt are prone to natural and manmade disasters due to its constantly changing geographic and geomorphologic situation. This particular zone consists of banks of the large river called as chars which is similar to Matlab (29,30).

Since 1966, icddr,b has been running an internationally recognized and unique Health and Demographic Surveillance System (HDSS) involving 142 villages of Matlab, comprising a population of 230,000 (31). Total surveillance area is divided into 7 blocks from which 4 of the blocks containing 67 villages called icddr,b service area. The people residing in those areas
receive maternal and neonatal care services from icddr,b. The rest of the 3 blocks consisting of 75 villages called as comparison area receive similar services from government hospitals (32). icddr,b has a large, central health facility in Matlab, which provides free-of-cost maternity and child health care to the women of reproductive age and children under five years of age coming from half of the HDSS area service area (31).

**Study Population and Data Source**

We used Matlab SHEBA, an electronic database of Matlab hospital, to extract data for this study. SHEBA contains birth history including birthweight of infants born at Matlab hospital as well as of those who are born at nearby hospitals/clinics and later admitted to Matlab hospital for neonatal care within 72 hours of birth. We extracted birth related data for all infants born during July 2011 to June 2015, whose birth history were recorded in SHEBA. Data on mothers’ socio-demographic information were retrieved from the electronic database of Matlab HDSS.

A total of 10,332 births were taken place at the Matlab service area (67 villages of the study area) and from where 5,392 (52.2% of total births in the designated area) births were recorded in the Matlab SHEBA during the specified period. After retrieval of birth history, we excluded cases with abortions and stillbirths (44), preterm (child birth occurred before 37 completed weeks) (33) and post-term (child birth occurred after 42 completed weeks of gestation) (34) births (362) and any congenital anomaly (49). We also excluded births where information about birthweight (510), gestational age at birth (305), mother’s height (69) and asset score (178) were missing. The final dataset contains information on 3,831 singleton live births (37.1% of entire childbirth of this area) at gestational ages 37 to 42 weeks taking place during July 2011 to June 2015 at Matlab. Gestational age was based on last menstrual period (LMP) and confirmed by
ultrasonography when mothers came for antenatal care services at Matlab Hospital. Trained nurses conducted the weight measurements of the newborns at Matlab hospital using a Tanita-1584 Baby Scale (digital weighing scale) with 20 g sensitivity.

**Climate and Seasons**

Bangladesh has a tropical climate with a hot and rainy summer and a dry winter. April and May are the hottest months of the year and temperatures range between 36-41°C. Temperature swoops in the winter and averages 15-20 °C during December to February. The climate is one of the wettest ones in the world having an average of 2320 mm rainfall yearly (21,35); about 80% of which falls in the rainy monsoon (36). Agriculture of this country largely depends on these variations in rainfall and temperature across the year. The nationally representative Food Security and Nutrition Surveillance Project (FSNSP) has used a meaningful and practical classification of seasons which separates the harvest and lean periods in Bangladesh. This classification is convenient for tracking the variation in food security and associated changes in nutritional status at the population level throughout the year. For the present study, following the FSNSP, each year was divided into three seasons: the post-aman harvest period (January-April), the height of the monsoon (May-August) and the post-aus harvest period (September-December) (24).

**Variables of Interest**

In this study, the length of maternal exposure (in weeks) to a season during the second and third trimester of pregnancy was the predictor variable and infant birthweight (in grams) was the
outcome variable. The second and the third trimesters were defined as the period of pregnancy from the beginning of the 15\textsuperscript{th} to the 28\textsuperscript{th} completed week (37) and from the beginning of the 29\textsuperscript{th} through the 42\textsuperscript{nd} completed week, respectively (37). Each trimester has an equal length of 14 weeks. Therefore, maternal exposure to a certain season during a specific trimester could be as high as 14 weeks to as low as no exposure at all.

Following maternal and infant characteristics were considered as covariates: maternal age (≤19 years, 20-34 years or ≥35 years) (38,39), height (≤145 cm or >145 cm) (40), religion (Muslim or Hindu), socioeconomic status (wealth quintile) (5), mode of delivery (vaginal or cesarean) (41), infant sex (male or female) (42), birth order (1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} or ≥4\textsuperscript{th}) (43), and gestational age at birth (weeks) (42). Wealth quintile, an indicator of household-level wealth consistent with expenditure and income measures, was computed by HDSS using household asset data via principal component analysis (31).

**Ethics Statement**

This study used de-identified routinely collected data which were available through the electronic databases of Matlab HDSS and Matlab hospital. The study did not involve any interviews with the participants. The study protocol was reviewed and approved by the icddr,b research and ethical review committees (Institutional Review Board of icddr,b).
**Statistical Analysis**

We found birth weight to be normally distributed, and did not consider any transformations (data not shown). We presented the background characteristics of the participants as mean ± standard deviation for continuous variables and frequency measures for categorical variables. We visualized the mean maternal exposure to different seasons during the second and third trimester of pregnancy and mean birth weight by seasons. We used Pearson correlation test to evaluate the bivariate relationships between the length of exposure to seasons during each trimester and birthweight. We fitted six separate multiple linear regression models to estimate the independent effect of exposure to each individual season during each trimester on birthweight. To further investigate the effect of exposure during one trimester adjusted for the effect of exposure during another, we built three additional multiple linear regression models keeping both the second- and third trimester exposure to two consecutive seasons. All the covariates of a priori interest were included in the multivariable models. To estimate the strength of association, we calculated regression coefficients (β) with 95% confidence intervals (95% CI). Statistical significance was set at p < 0.05. All the statistical analyses were performed with Stata/PC (StataCorp, College Station, Texas 77845 USA, version 14.1).

**Results**

The mean maternal age was 24.8 ± 5.7 years (data not shown in the tables), and 19.1% of the mothers were adolescents. About fifteen percent of the women were short-statured (≤145 cm). The majority of women were Muslim (90.9%), and about half belonged to families in the fourth
(20.8%) or the highest (24.3%) wealth quintiles. The majority of the infants were delivered vaginally (77.6%), and 43% were born to primiparous mothers (Table 1). The mean gestational age at birth was 39.2 ± 1.2 weeks (Table 2). In the present sample, the mean birthweight of the infants was 2866.9 ± 417.3 g and 15.6% child born with low birthweight. (Table 2).

Figure 1 demonstrates the monthly and seasonal variation of birthweight and maternal exposure to different seasons during the second and third trimester of pregnancy. Birthweight was found to be the highest in March (2930.5 ± 462.2 g) and lowest in July (2830.7 ± 385.4 g). Pearson correlation showed that infant birthweight was significantly associated with the length of maternal exposure to Post-aus harvest period during the second trimester (R= 0.034, p < 0.037) and Post-aman harvest period during the third trimester (R=0.067, p < 0.001) (Table-3).

Bivariate analysis between different periods with second and third trimester of pregnancy showed only significant association between post-aman harvest period with the third trimester and post-aus harvest period with second trimester (Table 3). In the adjusted model, similar trend was present. We found significant association along with an increase of infant birthweight of 4.7 g (95% CI: 1.9, 7.5; p = 0.001) and 2.7 g (95% CI: 0.2 g, 5.1 g; p = 0.037) for each week exposure to post-aman harvest period during the third trimester and for post-aus harvest period during the second trimester consecutively (Table 4). However, the combined exposure models revealed that, when adjusted for the exposure to post-aus harvest period during the second trimester, each week increase in the length of exposure to post-aman harvest period during the third trimester was associated with a 6.3 g (95% CI: 1.6, 10.9; p = 0.008) increase in infant birthweight. The effect of exposure to post-aus harvest period disappeared in this model (Table 5).
Discussion

This study evaluated the effect of prenatal exposure to the major seasons during different trimesters of gestation on birthweight. The mean birthweight found in this study (2866.9 ± 417.3 g) was similar to the estimate reported in a recent nationwide survey (2898.5 ± 405.3 g) (6). We found that exposure of post aman harvest season (January-April) on third trimester of pregnancy is significantly associated with the birthweight. A significant increase of 6.3 g in birthweight for each week exposure to post-aman harvest season during the third trimester of pregnancy. This can be interpreted as: Infants born to women who have been exposed to the post-aman harvest season for the entire third trimester (14 weeks) are likely to be heavier by 88.2 g at birth.

Our finding is consistent with that of a study previously done in developing countries, which concluded that those communities which heavily depend on agriculture experience seasonal variation in average birthweight (22). Our study conforms to a prospective study conducted in India which showed that seasonal energy insufficiency was associated with lower birthweight and the effect was trimester specific (15). Fallis and Hilditch, 1989 found that average monthly birthweight in Zaire was as high as 2,806 g at the beginning of dry season (June) and reached the minimum (2,610 g) in the wet season (November) (44). They reasoned that fetal growth was maximum during dry season because of higher availability of food compared to wet season (44). Similar findings were reported by Ceesay et al. and Prentice et al. in a Gambian study (45,46) and by Kinabo et al. in a study in Tanzania (47). Shaheen et al. showed that birthweight had a dose response relationship with food supplementation among pregnant women in Bangladesh (48,49). Food insecurity was found to have a strong association with birth size reported in
another study done in Bangladesh; however, this study lacked data on actual birthweight and used mother’s perceived size at birth instead (50).

Infant survival is directly related to the fetal growth and birthweight. The difference in fetal growth is not only related to quantity and quality of maternal diet but also to differences in timing and duration of nutritional insults during pregnancy. Food insecurity resulting from the seasonal food shortage can cause energy stress to mothers. Like many developing countries, agriculture plays a vital role in the livelihood of Bangladesh. Rice is the staple cereal grain in Bangladesh, so its seasonal production and price dynamics have an immense effect on the food security situation of this country (18–20). In the recent decades, it has been seen that increase in the rice production has a major contribution to increasing food availability per capita, stability in grain price and an overall reduction in poverty (19). However, this production of rice fluctuates due to seasonal variation in different harvest periods (51–53). Traditionally, the largest harvest was aman followed by aus (54). However, boro has taken over the lead and is the high yielding variety of rice transplanted mostly at the dry season during December-February and harvested in April-June (18,21). In the recent decades, boro has gained enormous popularity and is contributing to one third of the total rice production (55), which ultimately creates a great amount of employment during its transplant and harvest season. During the monsoon season, aman is the principle crop occupying almost half of the land for agricultural production and harvested in December (18). However, the post-harvest period of aman coincides with transplant period of boro. This results in a lower price and an increase in the availability of rice along with higher income among general population due to increase in the opportunity of agricultural work. In recent years, there has also been an upward trend in the cultivation of winter robi crops and other cereal grains including maize, wheat and mung bean during October to November, which
are harvested in winter (56). This ultimately generates additional employment and increases food sources and improves dietary diversity in agricultural society during the post-aman harvest period. On the other hand, people living in coastal areas, where one quarter of people are involved in unskilled labor, often are subjected to reduced working opportunity during the rainy monsoon season (35). In 2014 Bangladesh was ranked in the top most position in Climate Change Vulnerability Index and which will get worse by 2025 resulting in reduction of overall crop production (57). Due to the geographical characteristics Bangladesh is vulnerable to flood, land erosion, crop damage in those riverine areas (58). Being flat and low-lying, and intersected with many canals and rivers, Matlab has to endure a high rainfall and annual flooding (59). All these phenomena have tremendous impact on family income and food security during the monsoon season which exposes pregnant mothers to increased food insecurity and poor dietary diversity.

This study has several implications. First, this study identifies the vulnerable period of pregnancy that is more susceptible to possible energy stress and its effect such as low birthweight. Healthy birthweight may be achieved by taking proper amount of nutritious food during this period. Secondly, potential interventions such as giving supplementary food, food voucher or cash transfer during the lean periods can be evaluated through well-designed trials which will help improve maternal health and optimize birthweight. Thirdly, this finding enunciates to take steps to include this information in the maternal counseling package given by the health workers. The pregnant women passing their third trimester during food insecure seasons should be prioritised for intensive nutrition education and counseling during antental care. Counselling can also increase the diversity of food which will ultimately reduce the pressure on rice consumption and better nutritional outcome for mothers. Fourthly, this result can give a hint to policymakers if and
how they need to increase and rearrange the seasonal cultivation of rice and other food grains to increase the production, especially to address the issues of seasonal food insecurity. The nutritional supply of rural community is highly depended on rice production, but they have to rely on the mercy of the nature to ensure the food supply. A better way can be introducing more flood and salinity resistant rice variant and increase the productivity of the others food grains. Policy makers also need to focus on the counselling among mothers to increase the food diversity. Finally, this result can help stakeholders to identify the most vulnerable population such as pregnant women living in the food insecure regions and redirect their current effort to support vulnerable population towards them to provide necessary support package during natural disasters and economic crisis.

There have been several studies conducted in Bangladesh on food security where they tried to find out the lean season of year and few of them wanted to look at the impact on the growth among children and adults (49,60). However, none of them have seen the impact of seasonal food insecurity on maternal pregnancy to find out the trimester specific impact. Despite being a retrospective study such uniqueness of this analysis has created a value for thoughts for future researchers. The strengths of the present study include the availability of data on birthweight from about four thousand infants along with data on maternal socioeconomic, demographic, and anthropometric data to adjust for which helps to understand the independent effect of seasonal food insecurity on birthweight. However, the study is not without limitations. The retrospective nature of the data which were collected as a part of routine measures make it prone to measurement error. This study lacked data on individual level pre-pregnancy weight, gestational weight gain and nutrition intake during pregnancy. In addition, we didn’t have trimester specific fetal growth data to see the acute effect of nutritional insufficiency.
To conclude, exposure to post-aman harvest period during the third trimester increases birthweight among infants in rural Bangladesh at Matlab. Policymakers may need to think about taking measures to address the issue of seasonal food insecurity, especially for the rural agrarian population.

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Author Contributions

S. I. A: contributed to concept, design, data interpretation, data visualization and writing the first draft of the manuscript, had primary responsibility for final content; S. M. T. H.: contributed to concept, data acquisition, data analysis, data interpretation and critically revised the manuscript; M. A. K.: critically revised the manuscript; T. A.: contributed to conception or design, critically revised the manuscript; and all authors: read and approved the final manuscript.

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Figure 1: Mean maternal exposure to seasons during the second and third trimester and birthweight by seasons
Table 1. Background characteristics of mothers and infants (N = 3831)

| Characteristic   | n (%)          |
|------------------|----------------|
| Maternal age     |                |
| ≤ 19 years       | 730 (19.04)    |
| 20-24 years      | 2,865 (74.73)  |
| ≥ 35 years       | 239 (6.23)     |
| Maternal height  |                |
| ≤ 145 cm         | 570 (14.87)    |
| > 145 cm         | 3,264 (85.13)  |
| Religion         |                |
| Muslim           | 3,485 (90.9)   |
| Hindu            | 349 (9.1)      |
| Wealth quintile  |                |
| Lowest           | 665 (17.34)    |
| Second           | 691 (18.02)    |
| Middle           | 749 (19.54)    |
| Fourth           | 797 (20.79)    |
| Category                | Count    |
|------------------------|----------|
| Highest                | 932 (24.31) |
| Mode of delivery       |          |
| Vaginal                | 2977 (77.65) |
| Cesarean section       | 857 (22.35) |
| Infant sex             |          |
| Male                   | 1897 (49.48) |
| Female                 | 1937 (50.52) |
| Birth order            |          |
| 1st                    | 1646 (42.93) |
| 2nd                    | 1103 (28.77) |
| 3rd                    | 711 (18.54) |
| ≥ 4th                  | 374 (9.75)  |
Table 2: Characteristics related to birth distributed among the different seasons

| Variable                      | Post-aman harvest season (January-April) | Height of the Monsoon (May-August) | Post-aus harvest (September-December) | Overall   |
|-------------------------------|------------------------------------------|-----------------------------------|---------------------------------------|-----------|
| Number of births              | 1218                                     | 1198                              | 1415                                  | 3831      |
| Birthweight Mean ± sd         | 2879.07 ± 443.79                         | 2868.02 ± 399.27                  | 2855.41 ± 408.47                      | 2866.88 ± 417.25 |
| Low birthweight n (%)         | 202 (16.58)                              | 169 (14.11)                       | 228 (16.11)                           | 599 (15.64) |
| Gestational age Mean ± sd     | 39.25 ± 1.25                             | 39.16 ± 1.15                      | 39.20 ± 1.13                          | 39.20 ± 1.15 |
Table 3: Results of Pearson correlation test to evaluate the bivariate relationships between the length of exposure to seasons during each trimester and birthweight

| Exposure                        | Second trimester | Third trimester |
|---------------------------------|------------------|-----------------|
|                                 | r, p value       | r, p value      |
| Post-aman harvest period        |                  |                 |
| (January-April)                 | -0.007, 0.683    | 0.067, 0.000    |
| Height of the Monsoon           |                  |                 |
| (May-August)                    | -0.026, 0.109    | -0.002, 0.893   |
| Post-aus harvest period         |                  |                 |
| (September-December)            | 0.034, 0.037     | -0.006, 0.722   |
Table 4: Results of multiple linear regression showing the effect of maternal exposure (in weeks) to each season during the second and the third trimester on birthweight (g)*

| Exposure                          | Second trimester | Third trimester |
|-----------------------------------|------------------|-----------------|
|                                   | β (95% CI), p value | β (95% CI), p value |
| Post-aman harvest period (January-April) | -0.82 (-3.3, 1.7); 0.520 | 4.73 (1.9, 7.5); 0.001 |
| Height of the Monsoon (May-August) | -1.66 (-4.0, 0.7); 0.171 | -2.282 (-5.1, 0.5); 0.173 |
| Post-aus harvest period (September-December) | 2.67 (0.2, 5.1); 0.037 | -2.14 (-4.8, 0.5); 0.115 |

*All regression models are adjusted for maternal age, height, religion, socioeconomic status, mode of delivery, infant sex, birth order, birth period and gestational age at birth.
Table 5: Results of multiple linear regression showing the effect of maternal exposure (in weeks) to two consecutive seasons during the second and the third trimester on birthweight (g)*

| Scenario 1                          | Combined exposure                                                                 | β (95% CI), p value               |
|-------------------------------------|----------------------------------------------------------------------------------|-----------------------------------|
| **Exposure to Post-aman harvest**   | period during the second trimester                                              | 2.25 (-1.9, 6.4); 0.291           |
| **Exposure to the height of the**   | Monsoon during the third trimester                                              | -4.31 (-9.0, 0.4); 0.073          |
| **Scenario 2**                      | **Exposure to the height of the** Monsoon during the second trimester            | -0.38 (-4.3, 3.5); 0.850          |
| **Exposure to Post-aus harvest**    | period during the third trimester                                                | -1.80 (-6.2, 2.6); 0.422          |
| **Scenario 3**                      | **Exposure to Post-aus harvest** period during the second trimester              | -1.69 (-5.8, 2.4); 0.416          |
| **Exposure to Post-aman harvest**   | period during the third trimester                                                | 6.25 (1.6, 10.9); 0.008           |

*All regression models are adjusted for maternal age, height, religion, socioeconomic status, mode of delivery, infant sex, birth order, birth period and gestational age at birth.