# ORIGINAL ARTICLE

# Low birth weight infant among teenage pregnancy in Terengganu, Malaysia: A cross-sectional study

Siti Fatimah Samsury, Tengku Alina Tengku Ismail, Raihan Hassan

**Authors:**

**Tengku Alina Tengku Ismail**
(Corresponding author)
MD (USM), PhD (USM)
Department of Community Medicine
School of Medical Sciences, Universiti Sains Malaysia, Kubang Kerian
Kelantan, Malaysia
Email: dralina@usm.my

**Siti Fatimah Samsury**
MD, Master of Public Health (USM)
Department of Community Medicine
School of Medical Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia

**Raihan Hassan**
MD (USM), MMed (Family Medicine)
Klinik Kesihatan Kuala Besut, Besut Terengganu, Malaysia

## Abstract

**Introduction:** The purpose of this research is to determine the factors associated with low-birth-weight (LBW) infants in teenage pregnancy.

**Methods:** A cross-sectional study was conducted in Terengganu, Malaysia, from January 1, 2020, to May 31, 2020. Records of teenage pregnancies in 2018 were retrieved from the Maternal Health Record Book and Pregnant Woman and Postnatal Book Registry. Simple logistic and multiple logistic regression analysis was used to analyse the factors associated with LBW infants in teenage pregnancy.

**Results:** All 357 cases that fulfilled the study criteria were included. LBW infants were the most common perinatal outcome among teenage pregnancies (19.3%), followed by preterm birth (9.0 %), and both low Apgar score and stillbirth (1.4% each). Factors associated with low-birth-weight infants in teenage pregnancy in Terengganu were a teenage husband (AOR 2.0; 95% CI: 1.01, 3.96; p=0.047) and a mother with a low level of education (AOR 3.07; 95% CI: 1.20, 7.85; p=0.019).

**Conclusion:** Teenage husband and low level of maternal education are significant factors that need to be addressed to improve teenage pregnancy outcomes. Interventions to improve these factors should continue to be encouraged.

## Introduction

A low-birth-weight (LBW) infant is defined as an infant who is born with a birth weight less than 2,500 grams.[1] The World Health Organization documented a global prevalence of LBW infants of 15%.[1] About 20 million LBW infants are born each year, mostly in developing countries.[1] The prevalence of low birth weight in Malaysia was 10% in 2000 and increased to 11.3% in 2012 and 2015.[2] In Malaysia, the number of LBW infants admitted to neonatal intensive care units increased from 32.8% to 38.6% between 2012 and 2016, respectively.[3,4] LBW presents a burden to the hospitals and the Ministry of Health to provide optimal treatment with limited resources.

Common causes of LBW are restricted intrauterine foetal growth or intrauterine growth retardation (IUGR), small for gestational age (SGA), foetal malnutrition, and preterm birth.[5] Birth weight is one of the predictors for foetal growth, and it is a significant determinant of mortality and morbidity in infancy and childhood. LBW can predict short-term survival and influence the long-term health of the newborn.[6]

LBW has become the leading cause of neonatal death; it is responsible for nearly 80% of all neonatal deaths.[1] LBW has also been associated with complications such as hypothermia, respiratory problems, gastrointestinal problems like necrotising enterocolitis, anaemia, impaired nutrition with low weight gain, neurological problems, and sudden infant death syndrome.[7] A systematic analysis found evidence that lower birth weight was associated with increased adult morbidity and mortality. The results also showed strong evidence that LBW had a significant association with metabolic syndrome, including type 2 diabetes mellitus, hypertension, and coronary heart disease.[6]

The World Health Assembly Resolution 65.6 endorsed a policy that aimed to reduce the prevalence of LBW by 30% between 2012 and 2025.[8] Malaysia is still struggling to achieve this target, as our progress in reducing the prevalence of LBW has stagnated since 2000; therefore, increased understanding of

the factors leading to LBW is needed. Studies in Malaysia and other countries reported teenage pregnancy as a factor that increased the risk of delivering a LBW infant.[9-12] One of the studies was conducted using data from the National Longitudinal Study of Adolescent Health in the United States. Prevalence of LBW was 8.5% among female participants younger than 20 years of age in this study.[11] A WHO multi-country study conducted in 2013 reported that LBW had significant perinatal outcomes in teenage pregnancy cases.[12]

Worldwide, it is reported that 16 million teenage pregnancies occur each year,[13] and the global population of teenagers continues to rise. In Malaysia, the prevalence of teenage pregnancy was 10.0% in 2001,[14] which decreased to 5.0 % in 2010 and increased to 2.8% in 2016.[10,15]

In view of the limited studies on teenage pregnancy in Malaysia, especially on factors associated with LBW infants in teenage pregnancy, this study provides valuable information on the existing problems in our local setting. Furthermore, reducing the prevalence of LBW in teenage pregnancies would help to reduce the number of admissions to the neonatal intensive unit. Subsequently, it would decrease the burden on the workload and resources of the Ministry of Health for managing infants with LBW and the subsequent complications. In addition, we suggest several strategies to reaching the target 30% reduction in low-birth-weight prevalence between 2012 and 2025. This can be achieved by performing interventions focused on the factors associated with LBW in teenage pregnancy. Finally, by reducing the prevalence of LBW, perinatal, neonatal, and child mortality and morbidity may also be reduced in Malaysia. Therefore, this study aimed to determine the factors associated with LBW infants in teenage pregnancy in Terengganu, Malaysia, in 2018.

## Methods
### Study design and participants
A cross-sectional study was conducted from January 1, 2020, to May 31, 2020, in Terengganu, Malaysia. We reviewed the records of pregnant teenagers younger than 20 years of age who were registered in government health clinics with available information on infant birth weight. Records from January 2018 to December 2018 were retrieved. Non-Malaysian citizens were excluded.

Sample size calculation was performed by using SPSS software version 24 to calculate sample size comparing two independent proportions. The power of the study was set at 80%, with α=0.05. The largest sample size was underweight mothers, which was 359. P0 was the probability of having an underweight mother in a teenage pregnancy with a normal birth weight infant, and was 8%.[16] P1 was the estimated probability of having an underweight mother in a teenage pregnancy with a LBW infant, and was set at 20%. Only 357 cases fulfilled the study criteria. The pooled data were smaller than the calculated sample size needed; therefore, universal sampling was applied.

### Research tools and data collection
Secondary data was collected using a proforma from January 2018 until December 2018. The information was obtained from the Teenage Pregnancy List of 2018, Maternal Health Record Book KIK 1/(b)/96, and Pregnant Woman and Postnatal Book Registry KIB 101 (pind2/2007) and was reviewed at the respective district office. A single researcher documented the relevant information based on the proforma checklist. The proforma checklist consisted of three main components of the data: a) women's socio-demographic data, b) obstetric data, and c) obstetric and perinatal outcomes. The socio-demographic data consisted of the age of the pregnant teenager, age of the husband, ethnicity, marital and employment status, and educational level. The obstetric data consisted of parity, history of miscarriages, gestational age at booking, body mass index (BMI) at booking, number of antenatal care visits, and status of the conception (whether premarital or not). Eleven obstetric and perinatal outcomes were measured in this component. The first outcome was infant birth weight, which refers to the weight of the infant, measured at birth (in grams). The infant was then classified as 'LBW' if the weight was less than 2,500 grams, as stated in the antenatal card record book (KIK 1/(b)/96).[17] The other outcomes were maternal mortality, anaemia, pregnancy-induced hypertension, pre-eclampsia or eclampsia, gestational diabetes mellitus, caesarean section, postpartum haemorrhage, preterm birth, low Apgar score, and stillbirth.

*Statistical analysis*

Data were entered and analysed using SPSS version 24. Descriptive statistics were used for the analysis of socio-demographic characteristics, obstetric characteristics, nutritional status, and the perinatal and obstetric outcomes of the teenage pregnancy. Univariable analysis using simple logistic regression was used to identify preliminary factors associated with LBW infants in teenage pregnancy. The dependent variable was a LBW infant, and the independent numerical variable was age. The independent categorical variables were marital status, age of the husband, employment status, education level, parity, history of miscarriages, gestational age at booking, uncertain date of last menstruation, number of antenatal care visits, premarital conception, and BMI at booking. Multivariable analysis using multiple logistic regression was used to identify factors associated with low-birth-weight infants in teenage pregnancy; only variables with a p-value less than 0.25 were selected for multiple logistic regression. Age, marital status, age of husband, education level, uncertain date of last menstruation, number of antenatal care visits, premarital conception, and BMI at booking were variables with a p-value less than 0.25. The forward (Likelihood ratio) LR and backward LR methods were used to compare the models, and a preliminary main effect model was obtained. The preliminary main effect consisted of two variables, which were the age of husband and level of education. The level of significance was set at a p-value less than 0.05 with a two-tailed test.

*Statement about ethics*

Ethical approval to conduct this study was obtained from the Human Research Ethics Committee Universiti Sains Malaysia (USM/JEPeM/19100594) and the Medical Research and Ethics Committee Malaysia (MREC) Ministry of Health Malaysia (NMRR-19-3112-512730).

## Results

*Socio-demographic characteristics of teenage pregnancies*

After excluding cases involving non-Malaysian citizens and incomplete data, a total of 357 cases were included in the study. **Table 1** presents the socio-demographic characteristics of the study sample. Maternal ages were between 12 and 19 years, with a mean (SD) of 17.47 (1.33) years. All 357 (100%) cases were Malay. Most of the mothers were married (299 [83.8%]) and unemployed (317 [88.8%]).

**Table 1.** Socio-demographic characteristics of teenage pregnancies in Terengganu in 2018 (n=357).

| Variables | Mean (SD) | n (%) |
|---|---|---|
| *Age (years)* | 17.47 (1.33) | |
| *Marital status* | | |
| Married | | 299 (83.8) |
| Single | | 58 (16.2) |
| *Age of husband (years)[a]* | 22.92 (4.67) | |
| Adult | | 230 (78.2) |
| Teenage | | 64 (21.8) |
| *Employment status* | | |
| Employed | | 40 (11.2) |
| Unemployed | | 317 (88.8) |
| *Education level* | | |
| Secondary or higher | | 328 (91.9) |
| Primary or lower | | 29 (8.1) |

[a] Among married cases only (n=294, 1.7% missing data)

*Obstetric characteristics and nutritional status of teenage pregnancies*

**Table 2** shows the obstetric characteristics and nutritional status of the teenage pregnancies. Among the pregnancy cases in this study, 61 (17.1%) were multiparous, and half of them (51.8%) attended their first antenatal booking after 12 weeks gestation.

**Table 2.** Obstetric characteristics and nutritional status of teenage pregnancies in Terengganu in 2018 (n=357).

| Variables | Mean (SD) | n (%) |
|---|---|---|
| *Parity* | 1.20 (0.46) | |
| Multiparous | | 61 (17.1) |
| Primiparous | | 296 (82.9) |
| *History of miscarriage* | | |
| No | | 348 (97.5) |
| Yes | | 9 (2.5) |
| *Gestational age at booking (weeks)* | 15.82 (8.71) | |
| ≤12 | | 172 (48.2) |
| >12 | | 185 (51.8) |
| *Uncertain date of last menstrual period* | | |
| No | | 124 (34.7) |
| Yes | | 233 (65.3) |
| *Number of antenatal care visits* | 15.43 (8.42) | |
| ≥8 | | 289 (81.0) |
| <8 | | 68 (19.0) |
| *Premarital conception[a]* | | |
| No | | 215 (61.1) |
| Yes | | 137 (38.9) |
| *Body mass index (BMI) (kg/m$^2$)[b]* | 22.64 (4.77) | |
| Underweight | | 59 (17.4) |
| Normal weight | | 189 (55.8) |
| Overweight or obese | | 91 (26.8) |

[a]  n=352 (1.4% missing data)
[b]  n=339 (5% missing data)

*Obstetric and perinatal outcomes of teenage pregnancies*

The obstetric and perinatal outcomes of the teenage pregnancies are presented in **Table 3**. The most common obstetric outcome was anaemia in 148 cases (41.5%), followed by caesarean section in 39 cases (10.9%) and gestational diabetes mellitus in 10 cases (2.8). There was no maternal mortality reported among the teenage pregnancies in Terengganu in 2018. LBW infants were the most common perinatal outcome among teenage pregnancies, with 69 cases (19.3%), followed by preterm birth in 32 cases (9.0 %) and both low Apgar score and stillbirth, with 5 cases (1.4%) each.

**Table 3.** Obstetric and perinatal outcomes of teenage pregnancies in Terengganu in 2018 (n=357).

| Variables | n (%) |
|---|---|
| Anaemia | 148 (41.5) |
| Pregnancy-induced hypertension | 5 (1.4) |
| Pre-eclampsia | 2 (0.6) |
| Gestational diabetes mellitus | 10 (2.8) |
| Caesarean section | 39 (10.9) |
| Postpartum haemorrhage | 2 (0.6) |
| Low-birth-weight infant | 69 (19.3) |
| Preterm birth | 32 (9.0) |
| Low Apgar score | 5 (1.4) |
| Stillbirth | 5 (1.4) |

*Factors associated with low-birth-weight infants in teenage pregnancy*

Simple logistic regression analysis determined that the age at pregnancy, the number of antenatal care visits, and the BMI at booking were significantly associated with LBW infants in teenage pregnancies (**Table 4**).

**Table 4.** Simple logistic regression analysis of factors associated with LBW infants in teenage pregnancies in Terengganu in 2018.

| Variable | Low birth weight | | Normal birth weight | | Crude OR (95% CI) | Wald statistic (df) | p-value |
|---|---|---|---|---|---|---|---|
| | Mean (SD) | n (%) | Mean (SD) | n (%) | | | |
| *Age (years)* | 17.10 (1.72) | | 17.56 (1.20) | | 0.78 (0.65, 0.95) | 6.53 (1) | 0.011 |
| *Marital status* | | | | | | | |
| Married | | 53 (76.8) | | 246 (85.4) | 1 | | |
| Single | | 16 (23.2) | | 42 (14.6) | 1.77 (0.93, 3.38) | 2.97 (1) | 0.085 |
| *Age of husband* | | | | | | | |
| Adult | | 37 (69.8) | | 193 (80.1) | 1 | | |
| Teenage | | 16 (30.2) | | 48 (19.9) | 1.74 (0.89, 3.39) | 2.65 (1) | 0.104 |
| *Employment status* | | | | | | | |
| Employed | | 6 (8.7) | | 34 (11.8) | 1 | | |
| Unemployed | | 63 (91.3) | | 254 (88.2) | 1.41 (0.57, 3.49) | 0.54 (1) | 0.464 |
| *Education level* | | | | | | | |
| Secondary or higher | | 60 (87.0) | | 268 (93.1) | 1 | | |
| Primary or lower | | 9 (13.0) | | 20 (6.9) | 2.01 (0.87, 4.63) | 2.69 (1) | 0.101 |
| *Parity* | | | | | | | |
| Multiparous | | 11 (15.9) | | 50 (17.4) | 1 | | |
| Primiparous | | 58 (84.1) | | 238 (82.6) | 1.11 (0.54, 2.26) | 0.08 (1) | 0.779 |
| *History of miscarriage* | | | | | | | |
| No | | 66 (95.7) | | 282 (97.9) | 1 | | |
| Yes | | 3 (4.3) | | 6 (2.1) | 2.14 (0.52, 8.76) | 1.11 (1) | 0.292 |
| *Gestational age at booking (weeks)* | | | | | | | |
| ≤12 | | 31 (44.9) | | 141 (49.0) | 1 | | |
| >12 | | 38 (55.1) | | 147 (51.0) | 1.18 (0.69, 1.99) | 0.36 (1) | 0.548 |
| *Uncertain date of last menstrual period* | | | | | | | |
| No | | 19 (27.5) | | 105 (36.5) | 1 | | |
| Yes | | 50 (72.5) | | 183 (63.5) | 1.51 (0.85, 2.70) | 1.94 (1) | 0.164 |
| *Number of antenatal care visits* | | | | | | | |
| ≤8 | | 49 (71.0) | | 240 (83.3) | 1 | | |
| >8 | | 20 (29.0) | | 48 (16.7) | 2.04 (1.11, 3.74) | 5.33 (1) | 0.021 |
| *Premarital conception* | | | | | | | |
| No | | 35 (50.7) | | 180 (63.6) | 1 | | |
| Yes | | 34 (49.3) | | 103 (36.4) | 1.70 (1.00, 2.89) | 3.82 (1) | 0.051 |
| *Booking BMI (kg/m²)* | | | | | | | |
| Normal weight | | 31 (48.4) | | 158 (57.5) | 1 | | |
| Underweight | | 18 (28.1) | | 41 (14.9) | 2.24 (1.14, 4.40) | 5.47 (1) | 0.019 |
| Overweight or obese | | 15 (23.4) | | 76 (27.6) | 1.01 (0.51, 1.98) | 0.00 (1) | 0.986 |

**Table 5**. Multiple logistic regression analysis of factors associated with LBW infants of teenage pregnancies in Terengganu in 2018.

| Variable | B | Adjusted OR (95% CI) | Wald statistic (df) | p-value |
|---|---|---|---|---|
| *Age of husband* | | | | |
| Adult | | 1 | | |
| Teenage | 0.692 | 2.0 (1.01, 3.96) | 3.94 (1) | 0.047 |
| *Education level* | | | | |
| Secondary or higher | | 1 | | |
| Primary or lower | 1.122 | 3.07 (1.20, 7.85) | 5.49 (1) | 0.019 |

Forward LR method was applied
No multicollinearity and no interaction
Hosmer-Lemeshow test, p-value 0.713
Classification table 82.2% correctly classified
The area under the curve, Receiver Operating Characteristic (ROC) was 57.9%

**Table 5** shows factors associated with LBW infants of teenage pregnancies using multiple logistic regression analysis. The significant variables were the age of the husband and maternal education level. Pregnant teenagers with teenage husbands were twice as likely to have LBW infants as compared with those with adult husbands, when other variables were controlled. Pregnant teenagers with primary education or lower had 3.07 times the odds of having a LBW infant as compared with those with secondary education or higher, when other variables were controlled.

## Discussion

This study revealed that 16% of the teenage mothers were single. Compared with other teenage pregnancy studies in Malaysia, the prevalence of single teenage mothers in our study was considered low. Other studies reported a higher prevalence of single teenage mothers; for example, 35% in[10] study and 52.0% in Omar, et al.[9] study. We observed a lower prevalence of teenage pregnancies because our study was conducted in the outpatient setting, which had a diverse population of outpatient maternal and paediatric cases, unlike the studies conducted in obstetric departments in hospitals that had specific antenatal clinics.[9,10] In addition, we observed a premarital conception rate of 38%, and only 16% were single teenage mothers. It is possible that some of the teenage pregnancies were registered after conception and others after marriage registration.

The majority of teenage mothers in this study were unemployed. There are varying opinions regarding the association of maternal occupational status and LBW. Some studies suggested that working mothers had a higher risk of having poor perinatal outcomes, such as LBW and preterm birth.[16] Another study reported that unemployed mothers had a higher likelihood of having LBW infants.[18] Unemployed mothers had poor perinatal outcomes due to their lower socio-economic status, which affected their health due to decreased access to nutritious food and healthcare.[18] We postulate that the teenage mothers in our study likely had low socio-economic status, which contributed to the observed LBWs.

There were limited studies regarding paternal age in teenage pregnancies. One study conducted in 2018 by Goisis, et al.[19] found an association between paternal age and the risk of LBW and preterm birth; however, the prevalence of teenage husbands in this study was only 10.1%. In our study, the proportion of teenage husbands was higher, at 21%. This difference may be due to different study populations; our study population involved teenagers, while the study by Goisis, et al.[19] involved the general population. Problems may arise when there is an increased prevalence of teenage husbands. Studies have shown a strong association between teenage fathers and poor perinatal outcomes, such as LBW, preterm birth, small for gestational age, low Apgar score, and infant mortality.[20]

In this study, two factors were significantly associated with having a LBW infant in a teenage pregnancy. Pregnant teenagers with teenage husbands had two times the odds of having a LBW infant compared with mothers with adult husbands. Several studies support these results. A study in 2018 on infants in Finland also revealed that having a father younger than 25 years old was associated with a 1% higher risk of having a LBW infant (95% CI: 0.6, 1.3).[19] A large population-based study in the United States reported that teenage fathers had an increased risk of having a LBW infant, preterm birth, small for gestational age infant, low Apgar score, and higher infant mortality, independent of other risk factors.[20]

The role of teenagers as husbands and parents may explain why teenage husbands represent a significant factor for having a LBW infant. Issues that may arise when teenagers become parents include their incompetence in performing the caregiving task of parent and husband, their lack of interest in the infant, and their lack of knowledge of normal infant development.[21] The teenage period represents the gradual shifting of independence away from the family. The early onset of fatherhood in a teenage husband can be challenging, especially if the husband is still financially and emotionally dependent on his family. Once the teenage husband has committed to their new family, it is difficult for them to simultaneously continue their schooling and work; usually, they tend to terminate their formal education. Unfortunately, with a low level of education, there are limited choices of occupations with sufficient incomes.[22]

Having a stable and adequate income is essential for a husband, as his main expenses will be food, clothing, housing, transport, maternal care, childcare, and health. Therefore, a teenage father with a low income who is married to a teenage wife might be unable to provide proper nutrition and adequate health care, leading to late and inadequate antenatal care and subsequently giving rise to poor perinatal outcomes, such as LBW.[20] Further studies must be conducted to assess the knowledge of teenage husbands regarding parenthood, as this could be one of the determining factors in the high prevalence of LBW infants.

The second significant finding in our study was that pregnant teenagers with only primary education or lower had 3.07 times the odds of having a LBW infant as compared with teenagers with a secondary education or higher. This result is not surprising considering that education in an indicator that, in part, measures

early life socio-economic position, and is an important determinant of health. This finding was supported by a study that reported that having some high school education was associated with lower odds of having a LBW infant than women with no primary education.[23] In addition, when the level of education of mother increases, the prevalence of LBW decreases. For example, the prevalence of LBW infants decreased when their mothers were educated from middle school to matriculation and bachelor level.[7] In evaluating education levels, the likelihood of having a LBW infant for illiterate mothers was three times higher than educated mothers; therefore, illiterate mothers were more vulnerable.[16] The aforementioned association could be because teenage mothers with low education levels lack the knowledge and awareness regarding pre-pregnancy care, the importance of early antenatal booking, adequate antenatal care, nutritional requirements during pregnancy, essential diet, and the effects of maternal behaviour on the foetus.[7] Knowledge and skills learned through education could develop the cognitive functioning of a teenager and make them more receptive to health education, or make it easier for them to communicate and access appropriate health services.[24]

Pregnant women who are highly educated have a better understanding of the health education provided by health care providers or by other media, such as social media or television. The health knowledge obtained will influence their behaviour to choose a diet that benefits their health. Moreover, a low level of education in women may be correlated with less decision-making power in the household regarding food acquisition, distribution, and financial issues, which may also contribute to their low nutritional status.[25] Maternal education is thus considered a significant predictor when evaluating inequalities in health care, socio-economic status, and in determining birth outcomes.

The main limitation of this study was the use of secondary data. Some vital information was unavailable in these tools, such as household income, social support, and mental health assessment of the teenage mothers. This study only included two measurements of socio-economic status, which were maternal education and occupation. Other measurements or social determinants of health, such as household income and paternal occupation, were not included in this study. Similarly, the potential link between psychosocial factors and LBW was not addressed. Therefore, we could not determine the impacts of high levels of environmental stress, lack of social support, and poor economic support, which could be risk factors for LBW.

Having a teenage husband and a low maternal education level were the factors associated with LBW infants in teenage pregnancies. Identifying these factors may help to improve the prevention and management of these pregnancies, and to subsequently improve pregnancy outcomes. Modifiable factors, such as maternal education, access to antenatal advice, and nutritional education during antenatal visits can be addressed and may subsequently lead to a reduction in the prevalence of LBW infants in teenage pregnancies.

### Conflicts of interest
The authors declare no conflicts of interest.

---

**How does this paper make a difference in general practice?**

- In view of limited studies on teenage pregnancy in Malaysia, and especially on factors associated with LBW infants among teenage pregnancy, this study may provide valuable information on the existing problems in our local setting.
- By reducing LBW prevalence among teenage pregnancy, it will help reduce the number of admissions to the neonatal intensive unit. It will decrease the burden of workload and resources in managing infants with LBW and its complications.
- By reducing the prevalence of LBW, it may help to reduce perinatal, neonatal and child mortality and morbidity in Malaysia.

# References

1. World Health Organization. Low birth weight: Country, regional and global estimates. 2004. World Health Organization (WHO), United Nations Children's Fund (UNICEF). Accessed 2 April 2020, https://apps.who.int/iris/handle/10665/43184

2. United Nations Children Emergency Fund - World Health Organization. UNICEF-WHO Low birthweight estimates, levels and trends 2000–2015. Geneva: World Health Organization. Accessed 3 April 2020, https://www.who.int/nutrition/publications/UNICEF-WHO-lowbirthweight-estimates-2019/en/

3. Malaysian National Neonatal Registry. *Report of The Malaysian National Neonatal Registry. A Study of Critically Ill Babies in Neonatal Intensive Care Units 2016*. 2015.

4. Malaysian National Neonatal Registry. Report of The Malaysian National Neonatal Registry. *A Study of Critically Ill Babies in Neonatal Intensive Care Units 2015*. 2017.

5. Alam DS. Prevention of low birthweight. *Nestle Nutr Workshop Ser Pediatr Program*. 2009;63:209-268. doi:10.1159/000209983

6. Risnes KR, Vatten LJ, Baker JL, et al. Birthweight and mortality in adulthood: a systematic review and meta-analysis. *Int J Epidemiol*. 2011;40(3):647-661. doi:10.1093/ije/dyq267

7. Khan MW, Arbab M, Murad M, Khan MB, Abdullah S. Study of Factors Affecting and Causing Low Birth Weight. *J Sci Research*. 04/25 2014;6(2):387-394. doi:10.3329/jsr.v6i2.17090

8. World Health Organization. WHA global nutrition target 2025: Low birth weight policy brief. *World Health Organization*. Accessed 2 Mei 2020, https://www.who.int/nutrition/publications/globaltargets2025_policybrief_lbw/en/

9. Omar K, Hasim S, Muhammad NA, Jaffar A, Hashim SM, Siraj HH. Adolescent pregnancy outcomes and risk factors in Malaysia. *Int J Gynaecol Obstet*. 2010;111(3):220-223. doi:10.1016/j.ijgo.2010.06.023

10. Sulaiman S, Othman S, Razali N, Hassan J. Obstetric and perinatal outcome in teenage pregnancies. *S Afr J Obstet Gynaecol*. 09/09 2013;19doi:10.7196/sajog.679

11. Harville EW, Madkour AS, Xie Y. Predictors of birth weight and gestational age among adolescents. *Am J Epidemiol*. 2012;176 Suppl 7(Suppl 7):S150-S163. doi:10.1093/aje/kws231

12. Ganchimeg T, Ota E, Morisaki N, et al. Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multicountry study. *BJOG*. 2014;121 Suppl 1:40-48. doi:10.1111/1471-0528.12630

13. United Nations Population Fund. Girlhood, not motherhood: Preventing adolescent pregnancy. United Nations Population Fund. Accessed 3 April 2020, https://www.unfpa.org/publications/girlhood-not-motherhood

14. Kim KS, Alan LIC, Azwan Z, Fuad A, Aishah S. Antenatal profile and obstetric outcome of adolescent pregnancy in a Malaysian semi-rural clinic. *Fam Physician* 2001;Volume II(3)

15. Maimunah F, Nor Idayu AR, Tham SW, et al. Teenage Pregnancy Review From NOR. presented at: *6th National Conference for Clinical Research*; 26-28 September 2012 2012; PWTC, Kuala Lumpur, Malaysia.

16. Bhaskar RK, Deo KK, Neupane U, et al. A Case Control Study on Risk Factors Associated with Low Birth Weight Babies in Eastern Nepal. *Int J Pediatr*. 2015;2015:807373. doi:10.1155/2015/807373

17. World Health Organization. WHO recommendations on interventions to improve preterm birth outcomes, World Health Organization. Accessed 10 January 2020, https://www.who.int/reproductivehealth/publications/maternal_perinatal_health/preterm-birth-guideline/en/

18. Manyeh AK, Kukula V, Odonkor G, et al. Socioeconomic and demographic determinants of birth weight in southern rural Ghana: evidence from Dodowa Health and Demographic Surveillance System. *BMC Pregnancy Childbirth*. 2016;16(1):160. Published 2016 Jul 15. doi:10.1186/s12884-016-0956-2

19. Goisis A, Remes H, Barclay K, Martikainen P, Myrskylä M. Paternal age and the risk of low birth weight and preterm delivery: a Finnish register-based study. *J Epidemiol Community Health*. 2018;72(12):1104-1109. doi:10.1136/jech-2017-210170

20. Chen XK, Wen SW, Krewski D, Fleming N, Yang Q, Walker MC. Paternal age and adverse birth outcomes: teenager or 40+, who is at risk?. *Hum Reprod*. 2008;23(6):1290-1296. doi:10.1093/humrep/dem403

21. National Research Council (US) Panel on Adolescent Pregnancy and Childbearing. Chapter 7 Teenage Fatherhood. In: Hofferth SL HC, editors, ed. *Risking the Future: Adolescent Sexuality, Pregnancy, and Childbearing, Volume II: Working Papers and Statistical Appendices*. National Academies Press (US) Copyright © National Academy of Sciences.; 1987:chap 7.

22. Card JJ, Wise LL. Teenage mothers and teenage fathers: the impact of early childbearing on the parents' personal and professional lives. *Fam Plann Perspect*. 1978;10(4):199-205.

23. Sebayang SK, Dibley MJ, Kelly PJ, Shankar AV, Shankar AH; SUMMIT Study Group. Determinants of low birthweight, small-for-gestational-age and preterm birth in Lombok, Indonesia: analyses of the birthweight cohort of the SUMMIT trial. *Trop Med Int Health*. 2012;17(8):938-950. doi:10.1111/j.1365-3156.2012.03039.x

24. Orielle S, Alec I. A conceptual framework for action on the social determinants of health. Social Determinants of Health Discussion Paper 2 (Policy and Practice). Accessed 19 April 2020, https://apps.who.int/iris/handle/10665/44489

25. Kumera G, Gedle D, Alebel A, Feyera F, Eshetie S. Undernutrition and its association with socio-demographic, anemia and intestinal parasitic infection among pregnant women attending antenatal care at the University of Gondar Hospital, Northwest Ethiopia. *Matern Health Neonatol Perinatol*. 2018;4:18. Published 2018 Sep 12. doi:10.1186/s40748-018-0087-z