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Chapter

Low Birth Weight and Adverse Perinatal Outcomes

Melaku Desta

Abstract

Globally, annually an estimated 15–20% of all births are low birth weight (LBW). Low birth weights are at a greater risk of neonatal and postneonatal mortality and morbidities. Therefore, this chapter is aimed to highlight the prevalence of low birth weight, predictors and adverse perinatal outcomes, and the respective possible prevention modalities. Sociodemographic, obstetric (previous abortion, hypertensive disorder, antenatal visits, and prematurity), and nutritional factors increased the risk of low birth weight. Low birth weight neonates were associated with adverse perinatal and childhood outcomes: low Apgar score, neonatal death, malnutrition, academic, and mental disorders. Improving the care of women who have previous or recent morbidities, hypertensive disorders of pregnancy, and prematurity should be priorities aimed at reducing low birth weight and its adverse perinatal outcomes. Incorporating mental health in the prenatal visit, improving the care for a high-risk pregnant woman, and community-based kangaroo mother care practice were also recommended.

Keywords: low birth weight, prematurity, adverse perinatal outcome

1. Introduction

Low birth weight (LBW) is defined as a weight of <2500 g (5.5 lb) at birth. Low birth weight includes both appropriately grown preterm neonates (<37 completed weeks of gestation) and term and preterm growth-restricted neonates (less than the 10th centile of weight for gestational age). It is an important marker of maternal and fetal health, predicting mortality, stunting, and adult-onset chronic conditions [1]. Globally an estimated 15–20% of all births are low birth weight, representing more than 20 million births a year [1, 2]. In 2015, an estimated 20.5 million live births were LBW, 91% from low-and-middle-income countries, 48% in Southern Asia, and 24% at sub-Saharan Africa [3].

Low birth weight is associated with short- and long-term complications such as prematurity and its associated morbidities; 1.1 million babies die from complications of prematurity accompanied with LBW. Neonates with LBW have a higher risk of mortality than neonates with normal birth weight [4, 5]. Those who survive tend to remain that predispose newborns to many health disorders: hypoglycemia [6–8], hypothermia [9, 10], neurodevelopmental problems (mental retardation) [11], malnutrition, and have impaired immune function. Low birth weight neonates are not only at high risk of death but also are at increased risk of long-term neurologic disability, impaired language development, reduced cognitive abilities,

and greater risk of medical disorders including cardiovascular disease and diabetes [1, 12, 13]. Moreover, immaturity of multiple organs resulted in respiratory distress, interventricular hemorrhage, sepsis, blindness, and gastrointestinal disorders [14]. Medical conditions, medications prescribed, and mortality rate were significantly higher among preterm and underweight neonates admitted to NICU [15].

Maternal dietary diversity practice was associated with the risk of LBW. Low birth weight was also associated with multiple gestations, previous abortion, socioeconomic status, infections, maternal lifestyle, and complications during pregnancy: hypertensive disorders, fetal infection, and placental pathologic conditions [2, 16, 17]. Different stakeholders are working against reducing low birth weight by 30% by the year 2025 [18]. Despite those activities, low birth weight is increasing in Ethiopia based on 11% in 2011 to 13% in 2016 [10–12] and developing countries. Concerning perinatal outcomes, there is a paucity of study across the globe. Therefore, this chapter aimed to highlight the prevalence, predictors, and adverse perinatal outcomes of low birth weight newborns as well as the possible preventive modalities.

2. Epidemiology of low birth weight

Globally an estimated 15–20% of all births are low birth weight, representing more than 20 million births a year [1]. LBW was lowered in developed countries [19]. The prevalence of LBW varies in in the world, which was higher in African countries [20, 21] and which was 15.9% in 10 developing countries based on the demographic and health surveillance data [20]: 13.45 in Burkina Faso, 10.2% Ghana, 12.15 in Malawi, 15.7% in Senegal, and 10% in Uganda, respectively [22]. The incidence of LBW in Ethiopia hospital was 16.6% in Hawassa and 17% in Ethiopia based on the recent meta-analysis [23]. The findings of Zambia [24] and Tanzania [25] showed 10.6% of prevalence of LBW. The highest prevalence that occurred in developing countries might be due to the high prevalence of home delivery, preterm delivery, and hypertension during pregnancy, antepartum hemorrhage, and study area difference, which increased the referral of complicated cases and increased risk of LBW. Studies revealed that the prevalence of LBW varies across the countries: 7.3% in Nigeria [26], 40.0% in India, and 5–12% in Iran [27].

3. Predictors of low birth weight

The most common diagnoses associated with indicated low birth weight and preterm birth are hypertensive disorders, hemorrhage, and acute or chronic fetal compromise (fetal distress or intrauterine growth restriction). A recent study in Hawassa University Comprehensive Specialized Hospital, Southern Ethiopia, showed that previous abortion, hypertensive disorder of pregnancy, frequency of ANC visit, and gestational age at birth were the commonest predictors of LBW [28]. Sociodemographic (**Figure 1**),

3.1 Sociodemographic factors

Maternal age was a significant predictor of LBW. A study in developing countries [20], maternal age of 35–49 years old increased the odds of LBW. In addition, maternal age <20 years [23, 26, 29], absence of social support [27, 30] and rural

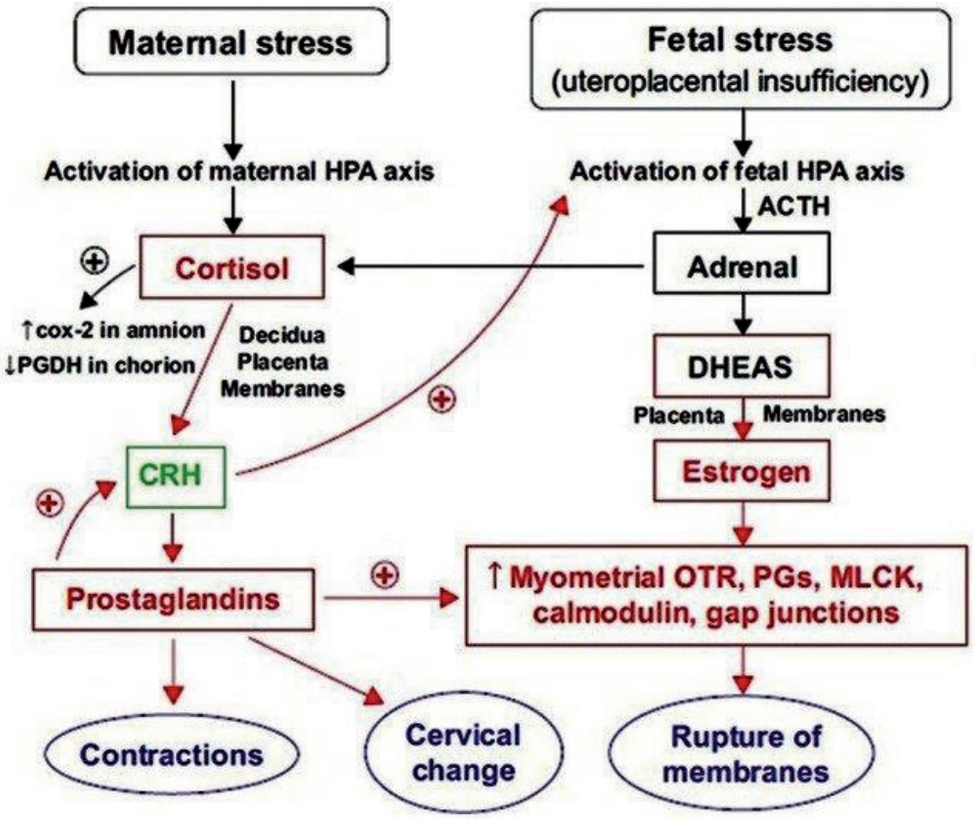

Figure 1.
Pathophysiology of preterm birth and low birth weight due to stress.

residence [31, 32], and absence of formal education [20, 27, 33, 34] were another factor associated with LBW.

3.2 Obstetrical factors

Prematurity was the single most predictive of LBW in the world. It is evidenced by different studies [26, 29, 34–37], and gestational age below 37 weeks significantly increased the risk of LWB. Those women who deliver before 37 completed weeks are more at risk to give low-weight births. This is in accordance with different studies [36], and a systematic review and meta-analysis done in Ethiopia [23] reported that preterm birth was significantly associated with the increased odds of LBW. When the neonates were delivered before reaching the recommended due date of delivery or 37–42 weeks, they are likely to be small and to have decreased skeletal muscle mass and subcutaneous fat tissue. Moreover, hypertension, preeclampsia and eclampsia [29, 35], lack of antenatal care follow-up [20, 27, 30, 36, 38–41], pregnancy interval <24 months [23, 39], depression during pregnancy [42], and maternal near miss [37, 43–45] were also other common predictors of LBW. A recent study done in Ethiopia also found that mothers who have a previous abortion, frequency of ANC visit, gestational age at birth, and hypertensive disorders of pregnancy were significant predictors of low weight at birth.

Moreover, hypertensive disorder of pregnancy, a leading cause of maternal near miss and perinatal mortality, has a significant effect on the increasing trend of LBW in Africa. There was a higher risk of delivering a low-weight infant among mothers with hypertension during pregnancy as compared with their counterparts [28]. The association is increased if the delivery occurs before reaching

37 weeks of gestation [46]. Other studies have similar findings [36]. This can be due the reason that hypertension results in uteroplacental insufficiency. Similarly, the studies also reported that mothers who had fewer ANV visit than the WHO recommendations (<4 ANC visit) were more likely to give a low-weight newborn than those who adhered to the recommended ANC visits, who have more than four times [28]. This is also supported by other evidences [36, 40, 47]. This is similar with studies done by Gizaw et al. [27], Mahmud et al. [20], Outlay et al. [40], and Kamala et al. [48].

In addition, findings also showed that those women who have at least one previous abortion were at greatest risk of giving LBW neonates as evidenced by a study done in Ethiopia [28], Denmark, and the USA [49, 50] and a meta-analysis in Canada [17]. The report also in-line with the study by Bossley [51] showed that women who had an abortion in the first or second trimester had a 35% increased risk of a LBW baby and a 36% raised risk of a preterm baby in later pregnancies and Ethiopia [52] found that previous adverse pregnancy outcomes were associated with recent outcome. This can be explained by physical damage to the cervix caused by types of abortion, reduced tensile strength of the cervical plug, preterm birth subsequently causing LBW, and stress/depression for the previous occurrence of the event. Thus, stress-depression is significantly associated with previous abortion [53, 54] and lowers dietary diversity of women, reduces fetal nutrients vital for development, and leads to an increased risk of LBW. In addition, untreated antenatal depression was also another significant predictor of; a meta-analysis revealed that women who have antenatal depression [55] and maternal anemia [56, 57] were more likely to have LBW.

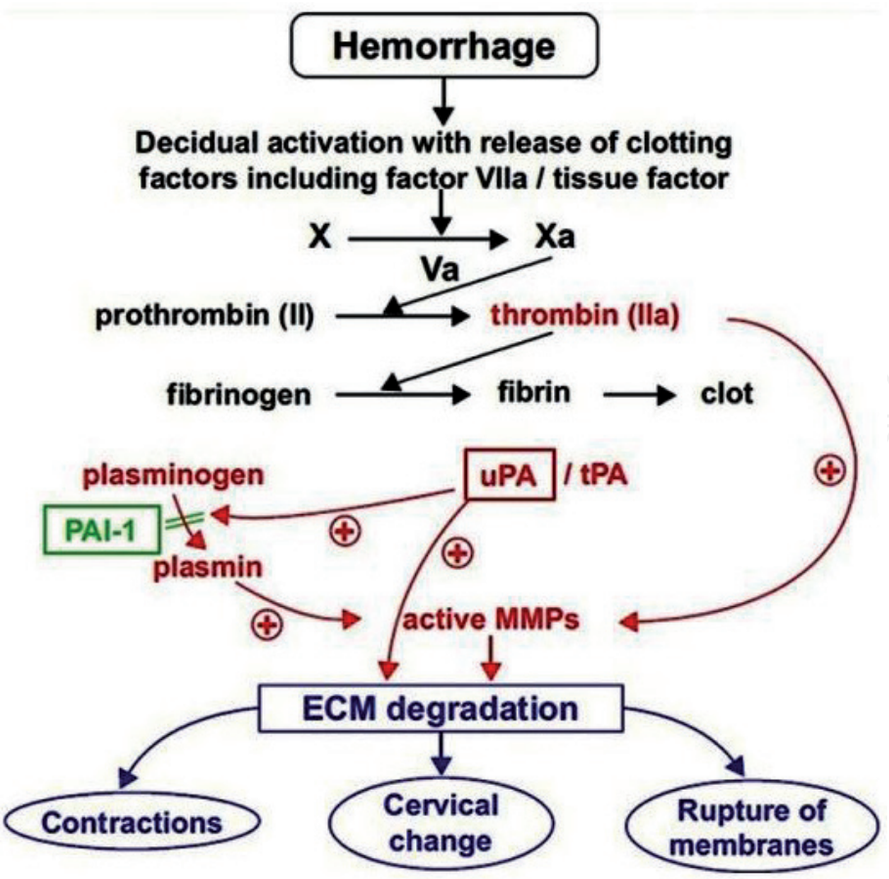

Figure 2.
Association of hemorrhage and preterm labor/LBW.

3.3 Nutritional factors

A study in Tanzania showed that pregnant women with malnutrition were another factor that increased the risk of LBW [35]. Studies done in developing countries [20, 39], meta-analysis done in Ethiopia [22, 23], and another study [29, 31] showed that BMI <18.5 kg/m increased the odd of LBW. Another study done in Ethiopia also showed that lacking nutrition counseling during pregnancy, lacking iron/folic acid supplementation during pregnancy [34, 36, 58–60], not taking snacks during pregnancy, maternal undernutrition, maternal anemia, and inadequate minimum dietary diversity score of women were independently associated with LBW.

An evidence-based medicine showed that the benefits of iron supplements in improving birth weight illustrate the need for increased efforts to improving coverage of antenatal programs and promoting food fortification. Underlying social factors, such as poverty and women's status, are also important, especially in South Asia [61]. Strategies that combine nutrition-based interventions, such as improving food intakes and micronutrient status, especially iron status, with approaches that improve women's status and reproductive health are needed to reduce LBW (**Figure 2**).

4. Adverse perinatal outcomes of low birth weight

Important birth outcomes related to LBW include both fetal and neonatal death, postneonatal death, short-term morbidities such as respiratory distress syndrome and necrotizing enter colitis, and long-term morbidities such as blindness, deafness, hydrocephaly, mental retardation, and cerebral palsy.

A recent study revealed that 68% of the LBW neonates and 48% of the NBW neonates had adverse perinatal outcomes [28]. LBW newborns significantly increased the greater risk of low Apgar score (42%), early neonatal death (19.3%) and NICU admission (22.6%) [28], and increased chronic kidney disease (CKD) [62]. Similarly, LBW newborns are associated with an increased risk of a low Apgar score and early neonatal death as evidenced with a study in Brazil [63] and Tanzania [25]; Bangladesh [63] showed that the probability of early neonatal mortality was increased among LBW newborns. The possible reason for this can be explained due to that low weight increases the risk of intrauterine growth restriction and early neonatal death. It is also explained due to the high burden of preterm birth and its complications. Hence, several organ systems of the human fetus usually immature before the end of 37 weeks of gestational age lead to difficult to maintain extrauterine environment.

Accordingly, LBW infants experienced a higher fold of mortality rate and hospitalization than appropriate birth weight infants in the postneonatal period. LBW infants also experienced 33% more days with diarrhea and 32% more days with vomiting [64]. Moreover, studies revealed that LBW affects adulthood social relationships and lower educational qualifications, decreased rate of employment, and increased rate of receipt of social benefits in adulthood [65, 66], disability [67], and common chronic health conditions [68]. A systematic review and meta-analysis supported that adults born with LBW were less likely to have ever experienced a romantic partnership, to have had sexual intercourse to have become parents (OR) [66]. This might be due to the lack of sexual or partner relationships that might increase the risk of decreased well-being and poorer physical and mental health and subsequent psychiatric disorders. Thus, children born with LBW had an increased risk of neurocognitive impairment [69].

5. Prevention of low birth weight and associated adverse outcomes

5.1 Prevention of preterm birth or prematurity

Prematurity is the single leading cause of neonatal mortality, resulting from 35% of the world's deaths annually (3.1 million) and risk of lifelong impairment among survivor [70, 71], and cause of child death in all high- and middle-income countries [71] when accompanied with LBW. For this, prevention of preterm birth is the major area of intervention. As a result, the March of Dimes plans to reduce prematurity to 8.1% in 2020 and 5.5% in 2030 in the USA [72]. To achieve this goal, the following roadmap interventions in the area and in the globe should be followed in appropriate manner:

- Elimination of nonmedically indicated early elective deliveries
- Access to progesterone shots for women with a previous preterm birth
- Smoking cessation
- Birth spacing and expanding group prenatal care
- Low-dose aspirin to prevent preeclampsia
- Vaginal progesterone and cerclage for short cervix
- Reduce multiple births conceived through assisted reproductive technology

5.1.1 Elimination of nonmedically indicated elective deliveries

Inductions and cesarean sections (CS) scheduled before 39 weeks gestation without medical reason increase the risk of early-term and late-preterm birth and their health consequences [72]. The rate of cesarean section is increasing globally.

5.1.2 Use of progesterone to prevent recurrent preterm birth

The weekly progesterone injections for at-risk women starting at 16–21 weeks gestation is a proven recommendation to reduce very early as well as later preterm birth effectively in women with a prior preterm birth [72]. Different clinical trials supported that early initiation of intramuscular 17-alpha hydroxyprogesterone caproate is recommended to prevent preterm birth [73]. Women starting with early initiation (at a mean $17^{6/7}$ ± 2.5 weeks) of 17-alpha hydroxyprogesterone caproate trended toward lower rates of preterm birth <37 weeks than those with late-start 17-alpha hydroxyprogesterone caproate (17P), which reduce a woman's risk of recurrent preterm birth by 33% [74]. Later initiation of 17-alpha hydroxyprogesterone caproate was significantly associated with increased odds of preterm birth <37 weeks. In addition to this, women with early 17-alpha hydroxyprogesterone caproate initiation also had lower rates of major neonatal morbidity than those with later 17-alpha hydroxyprogesterone caproate initiation [73]. The effectiveness of 17-hydroxyprogesterone caproate is reduced as the gestational age increased; nonresponders increased as evidenced by a study done by Manuck and his collaborator's [75]. Consideration of the factors that increased nonresponse for the hormone should be considered during initiation, mainly placental abruption or significant

vaginal bleeding, gonorrhea and/or chlamydia in the current pregnancy carriage of a male fetus. For thus, a clinical prediction score is needed before prescribing the hormone [75].

A meta-analysis of clinical trial showed that regarding the safety or efficacy of vaginal progesterone versus injections, daily vaginal progesterone (either 100–200 mg suppository daily or 90 mg gel daily) started at about 16 weeks' gestation is reasonable, if not weekly 17-OHPC injection for prevention of SPTB in women with singleton gestations and prior SPTB despite low level of quality [76]. The rate of women who reported recurrence of preterm birth adverse drug reactions and rate of neonatal intensive care unit admission was significantly lower in the vaginal progesterone group than the 17-OHPC neonatal outcomes. In addition, cervical Pessary is another prevention of spontaneous preterm birth in women with singleton pregnancies and short cervical length based on a recent clinical trial [77].

5.1.3 Low-dose aspirin and birth spacing

Preeclampsia can only be cured by delivering the infant, regardless of the gestational age in case of severe preeclampsia and eclampsia. The US Preventive Services Task Force and Prematurity Campaign recommends that all at-risk women should take a daily low-dose aspirin [72]. The initiation of daily low-dose (60–80 mg) aspirin beginning in the late first trimester for women with a medical history of early-onset preeclampsia and preterm delivery at <34.0/7 weeks of gestation or preeclampsia in more than one prior pregnancy was recommended by the American College of Obstetrics and Gynecology. In addition, appropriate inter-birth interval according to the WHO recommendations at least 24 months is better to reduce preterm birth. A meta-analysis [78] supported that short birth interval was associated with preterm birth.

5.2 Improving kangaroo mother care (KMC) utilization

Kangaroo mother care (KMC) is the placement of the newborn baby into skin-to-skin contact with the mother's chest and abdomen coupled with frequent and preferably exclusive breastfeeding. Thus, the premature baby or LBW newborn is kept warm in the maternal pouch and close to the breasts for unlimited feeding. KMC has emerged as a nonconventional low-cost method for newborn care that provides warmth and touch and confers significant survival benefit. An updated Cochrane review has reported that KMC benefits breastfeeding outcomes and cardiorespiratory stability in infants without negative effects [79]. Thus, findings of the clinical trial done in India support that wider implementation of KMC has a significant improvement in vital physiological parameters of LBW newborn; individual abnormalities (hypothermia, bradycardia, tachycardia, and low SpO_2) were corrected during the KMC sessions [80] and 51% reduction of early neonatal mortality and series morbidities associated with preterm birth based on the meta-analysis findings [81]. The utilization of KMC service is lower in LMICs among preterm newborn; only 14% of LBW newborn and <25% of preterm babies receive KMC in Ethiopia. For this, to improve the service provision of training of health-care facilities, community-based education on KMC should be focused, and community-based KMC should be improved [82]. Hence, provision of training of hospital-provided KMC services increases to 36% of preterm babies in Ethiopia [83]. In addition, a KMC indicator has been included in the HMIS. It is expected that there will be a national-level data about the preterm babies who are initiated in KMC [84].

Kangaroo mother care adapted from a meta-analysis done in LMICs (put on cover page) [81].

6. Conclusions

Sociodemographic, obstetrical factors (previous abortion, hypertensive disorder, antenatal visits and prematurity), and nutritional factors increased the risk of low birth weight. Low birth weight neonates were associated with adverse perinatal and childhood outcome: low Apgar score, neonatal death, malnutrition, academic, and mental disorders. Improving the care of women who have previous or recent morbidities, hypertensive disorders of pregnancy, and prematurity should be priorities aimed at reducing low birth weight and its adverse perinatal outcomes. Incorporating mental health in the prenatal visit, improving the care for a high-risk pregnant woman, and community-based kangaroo mother care practice were also recommended.

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Abbreviations

ANC	ante natal care
ARR	adjusted relative risk
LBW	low birth weight
NBW	normal birth weight
WHO	World Health Organization

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References

[1] WHO. Global Nutrition Targets 2025: Low Birth Weight Policy Brief. Geneva: World Health Organisation; 2014

[2] Wardlaw TM et al. Low Birthweight: Country, Regional and Global Estimates. New York: UNICEF; 2004

[3] Blencowe H, Krasevec J, de Onis M, Black RE, An X, Stevens GA, et al. National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: A systematic analysis. The Lancet Global Health. 2019;**7**(7):e849-ee60

[4] Kramer MS et al. Determinants of low birth weight: Methodological assessment and meta-analysis. Bulletin of the World Health Organization. 1987;**65**(5):663

[5] Badshah SML, McKelvie K, Payne R, Lisboa PJ. Risk factors for low birthweight in the public-hospitals at Peshawar, NWFP-Pakistan. BMC Public Health. 2008;**8**(1):197

[6] Azoumah K, Djadou K, Aboubakari A, Bothon A, Agbodjan-Djossou O, Agbèrè A. Evaluation of the glycemia of low-weight newborns within the 24th hour of life at Lomé University Hospital (Togo). Archives de Pediatrie: Organe Officiel de la Societe Francaise de Pediatrie. 2011;**18**(10):1037-1043

[7] Zhou W, Yu J, Wu Y, Zhang H. Hypoglycemia incidence and risk factors assessment in hospitalized neonates. The Journal of Maternal-Fetal & Neonatal Medicine. 2015;**28**(4):422-425

[8] Lubchenco LO, Bard H. Incidence of hypoglycemia in newborn infants classified by birth weight and gestational age. Pediatrics. 1971;**47**(5):831-838

[9] Tasew H, Gebrekristos K, Kidanu K, Mariye T, Teklay G. Determinants of hypothermia on neonates admitted to the intensive care unit of public hospitals of central zone, Tigray, Ethiopia 2017: Unmatched case-control study. BMC Research Notes. 2018;**11**(1):576

[10] Seyum T, Ebrahim E. Proportion of neonatal hypothermia and associated factors among new-borns at Gondar University teaching and Referral hospital, Northwest Ethiopia: A hospital based cross sectional study. General Medicine: Open Access. 2015;**2015**

[11] Gutbrod T, Wolke D, Soehne B, Ohrt B, Riegel K. Effects of gestation and birth weight on the growth and development of very low birth weight small for gestational age infants: A matched group comparison. Archives of Disease in Childhood. Fetal and Neonatal Edition. 2000;**82**(3):F208-F214

[12] Zerbeto AB, Cortelo FM, Élio Filho B. Association between gestational age and birth weight on the language development of Brazilian children: A systematic review. Jornal de Pediatria (Versão em Português). 2015;**91**(4):326-332

[13] UNICEF. Undernourishment in the Womb Can Lead to Diminished Potential and Predispose Infants to Early Death. New York: UNICEF; 2016

[14] You DHL, Ejdemyr S, Idele P, Hogan D, Mathers C, et al. Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: A systematic analysis by the UN inter-agency group for child mortality estimation. Lancet. 2015;**386**(10010):2275-2286

[15] Undela K, Mohammed BTS, Gurumurthy P, Doreswamy SM. Impact of preterm birth and low birth weight

on medical conditions, medication use and mortality among neonates: A prospective observational cohort study. World Journal of Pediatrics. 2019:1-8

[16] Villar JPA, Knight HE, Gravett MG, Iams J, Waller SA, et al. The preterm birth syndrome: A prototype phenotypic classification. American Journal of Obstetrics and Gynecology. 2012;**206**(2):119-123

[17] Shah PS, Zao J, Births KSGoDoPL. Induced termination of pregnancy and low birthweight and preterm birth: A systematic review and meta-analyses. BJOG: An International Journal of Obstetrics & Gynaecology. 2009;**116**(11):1425-1442

[18] WHO. WHA Global Nutrition Targets 2025: Low Birth Weight Policy Brief. Geneva: WHO; 2014. [Accessed on: 1 June 2017]

[19] Goldenberg RL, Culhane JF. Low birth weight in the United States. The American Journal of Clinical Nutrition. 2007;**85**(2):584S-590S

[20] Mahumud RA, Sultana M, Sarker AR. Distribution and determinants of low birth weight in developing countries. Journal of Preventive Medicine and Public Health. 2017;**50**(1):18

[21] Qadir M, Bhutta ZA. Low birth weight in developing countries. In: Small for Gestational Age. Vol. 13. Karger Publishers; 2009. pp. 148-162

[22] He Z, Bishwajit G, Yaya S, Cheng Z, Zou D, Zhou Y. Prevalence of low birth weight and its association with maternal body weight status in selected countries in Africa: A cross-sectional study. BMJ Open. 2018;**8**(8):e020410-e

[23] Endalamaw A, Engeda EH, Ekubagewargies DT, Belay GM, Tefera MA. Low birth weight and its associated factors in Ethiopia: A systematic review and meta-analysis. Italian Journal of Pediatrics. 2018;**44**(1):141

[24] Chibwesha CJ, Zanolini A, Smid M, Vwalika B, Kasaro MP, Mwanahamuntu M, et al. Predictors and outcomes of low birth weight in Lusaka, Zambia. International Journal of Gynecology & Obstetrics. 2016;**134**(3):309-314

[25] Mitao M, Philemon R, Obure J, Mmbaga BT, Msuya S, Mahande MJ. Risk factors and adverse perinatal outcome associated with low birth weight in Northern Tanzania: A registry-based retrospective cohort study. Asian Pacific Journal of Reproduction. 2016;**5**(1):75-79

[26] Dahlui M, Azahar N, Oche OM, Aziz NA. Risk factors for low birth weight in Nigeria: Evidence from the 2013 Nigeria demographic and health survey. Global Health Action. 2016;**9**(1):28822

[27] Karimlou M, Sajjadi H, Dejman M, Vameghi M. Low birth weight and its association factors in Iran: According world health organization model. Archives of Rehabilitation. 2012;**13**(3):75-87

[28] Desta M, Tadese M, Kassie B, Gedefaw M. Determinants and adverse perinatal outcomes of low birth weight newborns delivered in Hawassa University Comprehensive Specialized Hospital, Ethiopia: A cohort study. BMC Research Notes. 2019;**12**(1):118

[29] Sutan R, Mohtar M, Mahat AN, Tamil AM. Determinant of low birth weight infants: A matched case control study. Open Journal of Preventive Medicine. 2014;**4**(03):91

[30] Wado YD, Afework MF, Hindin MJ. Effects of maternal pregnancy intention, depressive symptoms and social support on risk of low birth weight:

A prospective study from southwestern Ethiopia. PLoS One. 2014;**9**(5):e96304

[31] Valadbeigi T, Tabatabaee HR, Etemad K, Keyghobadi N, Mahdavi S, Enayatrad M, et al. The association between low birth weight and mothers diseases in Iran: A case-control study. Journal of Neonatal-Perinatal Medicine. 2019

[32] Mekie M, Taklual W. Magnitude of low birth weight and maternal risk factors among women who delivered in Debre Tabor Hospital, Amhara Region, Ethiopia: A facility based cross-sectional study. Italian Journal of Pediatrics. 2019;**45**(1):86

[33] Apte A, Patil R, Lele P, Choudhari B, Bhattacharjee T, Bavdekar A, et al. Demographic surveillance over 12 years helps elicit determinants of low birth weights in India. PLoS One. 2019;**14**(7):e0218587

[34] Adam Z, Ameme DK, Nortey P, Afari EA, Kenu E. Determinants of low birth weight in neonates born in three hospitals in Brong Ahafo region, Ghana, 2016—An unmatched case-control study. BMC Pregnancy and Childbirth. 2019;**19**(1):174

[35] Siza J. Risk factors associated with low birth weight of neonates among pregnant women attending a referral hospital in northern Tanzania. Tanzania Journal of Health Research. 2008;**10**(1):1-8

[36] Asmare G, Berhan N, Berhanu M, Alebel A. Determinants of low birth weight among neonates born in Amhara regional state referral hospitals of Ethiopia: Unmatched case control study. BMC Research Notes. 2018;**11**(1):447

[37] Hailu LD, Kebede DL. Determinants of low birth weight among deliveries at a referral Hospital in Northern Ethiopia. BioMed Research International. 2018;**2018**

[38] Zeleke BM, Zelalem M, Mohammed N. Incidence and correlates of low birth weight at a referral hospital in Northwest Ethiopia. The Pan African Medical Journal. 2012;**12**(1)

[39] Demelash H, Motbainor A, Nigatu D, Gashaw K, Melese A. Risk factors for low birth weight in Bale zone hospitals, South-East Ethiopia: A case–control study. BMC Pregnancy and Childbirth. 2015;**15**(1):264

[40] Oulay L, Laohasiriwong W, Phajan T, Assana S, Suwannaphant K. Effect of antenatal care on low birth weight prevention in Lao PDR: A case control study. F1000 Research. 2018;**7**

[41] Aboye W, Berhe T, Birhane T, Gerensea H. Prevalence and associated factors of low birth weight in Axum town, Tigray, North Ethiopia. BMC Research Notes. 2018;**11**(1):684

[42] Grote NK, Bridge JA, Gavin AR, Melville JL, Iyengar S, Katon WJ. A meta-analysis of depression during pregnancy and the risk of preterm birth, low birth weight, and intrauterine growth restriction risk of PTB, LBW, and IUGR with antenatal depression. JAMA Psychiatry. 2010;**67**(10):1012-1024

[43] Liyew EF, Yalew AW, Afework MF, Essén B. Maternal near-miss and the risk of adverse perinatal outcomes: A prospective cohort study in selected public hospitals of Addis Ababa, Ethiopia. BMC Pregnancy and Childbirth. 2018;**18**(1):345

[44] Adeoye IA, Onayade AA, Fatusi AO. Incidence, determinants and perinatal outcomes of near miss maternal morbidity in Ile-Ife Nigeria: A prospective case control study. BMC Pregnancy and Childbirth. 2013;**13**(1):93

[45] Oliveira LC, Costa AA. Fetal and neonatal deaths among cases of maternal near miss. Revista

da Associação Médica Brasileira. 2013;**59**(5):487-494

[46] Xiong X, Demianczuk NN, Saunders LD, Wang F-L, Fraser WD. Impact of preeclampsia and gestational hypertension on birth weight by gestational age. American Journal of Epidemiology. 2002;**155**(3):203-209

[47] Nobile CG, Raffaele G, Altomare C, Pavia M. Influence of maternal and social factors as predictors of low birth weight in Italy. BMC Public Health. 2007;**7**(1):192

[48] Kamala BA, Mgaya AH, Ngarina MM, Kidanto HL. Predictors of low birth weight and 24-hour perinatal outcomes at Muhimbili National Hospital in Dar es Salaam, Tanzania: A five-year retrospective analysis of obstetric records. The Pan African Medical Journal. 2018;**29**(1):1-13

[49] Zhou W, Sørensen HT, Olsen J. Induced abortion and low birthweight in the following pregnancy. International Journal of Epidemiology. 2000;**29**(1):100-106

[50] Brown J, Adera T, Masho S. Previous abortion and the risk of low birth weight and preterm births. Journal of Epidemiology and Community Health. 2008;**62**(1):16-22

[51] Boseley S. Abortions may pose risk to future babies, according to study. The Guardian. 2009

[52] Tsegaye B, Kassa A. Prevalence of adverse birth outcome and associated factors among women who delivered in Hawassa town governmental health institutions, South Ethiopia, in 2017. Reproductive Health. 2018;**15**(1):193

[53] Bisetegn TA, Mihretie G, Muche T. Prevalence and predictors of depression among pregnant women in Debre Tabor town, Northwest Ethiopia. PLoS One. 2016;**11**(9):e0161108

[54] Abajobir AA, Alati R, Kisely S, Najman JM. Are past adverse pregnancy outcomes associated with maternal anxiety and depressive symptoms in a sample of currently pregnant women? Ethiopian Journal of Health Sciences. 2017;**27**(4):351-362

[55] Jarde A, Morais M, Kingston D, Giallo R, MacQueen GM, Giglia L, et al. Neonatal outcomes in women with untreated antenatal depression compared with women without depression: A systematic review and meta-analysis. JAMA Psychiatry. 2016;**73**(8):826-837

[56] Rahman MM, Abe SK, Rahman MS, Kanda M, Narita S, Bilano V, et al. Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: Systematic review and meta-analysis. The American Journal of Clinical Nutrition. 2016;**103**(2):495-504

[57] Bodeau-Livinec F, Briand V, Berger J, Xiong X, Massougbodji A, Day KP, et al. Maternal anemia in Benin: Prevalence, risk factors, and association with low birth weight. The American Journal of Tropical Medicine and Hygiene. 2011;**85**(3):414-420

[58] Ismail IM, Venugopalan P. Case-control study on risk factors of low birth weight in a tertiary care hospital, Kerala. Annals of Community Health. 2016;**4**(3):5-12

[59] Girma S, Fikadu T, Agdew E, Haftu D, Gedamu G, Dewana Z, et al. Factors associated with low birthweight among newborns delivered at public health facilities of Nekemte town, West Ethiopia: A case control study. BMC Pregnancy and Childbirth. 2019;**19**(1):220

[60] Mosha D, Liu E, Hertzmark E, Chan G, Sudfeld C, Masanja H, et al. Dietary iron and calcium intakes during pregnancy are associated with

lower risk of prematurity, stillbirth and neonatal mortality among women in Tanzania. Public Health Nutrition. 2017;**20**(4):678-686

[61] Ramakrishnan U. Nutrition and low birth weight: From research to practice. The American Journal of Clinical Nutrition. 2004;**79**(1):17-21

[62] White SL, Perkovic V, Cass A, Chang CL, Poulter NR, Spector T, et al. Is low birth weight an antecedent of CKD in later life? A systematic review of observational studies. American Journal of Kidney Diseases. 2009;**54**(2):248-261

[63] Gebremedhin M, Ambaw F, Admassu E, Berhane H. Maternal associated factors of low birth weight: A hospital based cross-sectional mixed study in Tigray, Northern Ethiopia. BMC Pregnancy and Childbirth. 2015;**15**(1):222

[64] PIC Lira AA, Morris SS. Low birth weight and morbidity from diarrhea and respiratory infection in Northeast Brazil. The Journal of Pediatrics. 1996

[65] Bilgin A, Mendonca M, Wolke D. Preterm birth/low birth weight and markers reflective of wealth in adulthood: A meta-analysis. Pediatrics. 2018;**142**(1)

[66] Mendonça M, Bilgin A, Wolke D. Association of preterm birth and low birth weight with romantic partnership, sexual intercourse, and parenthood in adulthood: A systematic review and meta-analysis. JAMA Network Open. 2019;**2**(7):e196961-e

[67] Doyle LW, Anderson PJ. Adult outcome of extremely preterm infants. Pediatrics. 2010;**126**(2):342-351

[68] Saigal S, Day KL, Van Lieshout RJ, Schmidt LA, Morrison KM, Boyle MH. Health, wealth, social integration, and sexuality of extremely low-birth-weight prematurely born adults in the fourth decade of life lifestyle, social integration, and sexuality of ELBW adults lifestyle, social integration, and sexuality of ELBW adults. JAMA Pediatrics. 2016;**170**(7):678-686

[69] Aarnoudse-Moens CSH, Weisglas-Kuperus N, van Goudoever JB, Oosterlaan J. Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. Pediatrics. 2009;**124**(2):717-728

[70] Murray CJ, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: A systematic analysis for the global burden of disease study 2010. Lancet. 2012;**380**:2197-2223

[71] Liu L, Johnson HL, Cousens S, Perin J, Scott S, Lawn J, et al. Global, regional and national causes of child mortality: An updated systematic analysis for 2010 with time trends since 2000. The Lancet. 2012;**379**:2151-2161

[72] Edward RBM, Carrino GE, Russell RB, Howse JL. Fighting for the next generation: US prematurity in 2030. American Academy of Pediatrics. 2014

[73] Ning A, Vladutiu CJ, Dotters-Katz SK, Goodnight WH, Manuck TA. Gestational age at initiation of 17-alpha hydroxyprogesterone caproate and recurrent preterm birth. American Journal of Obstetrics and Gynecology. 2017;**217**(3):371.e1-371.e7

[74] ACOG Committee Opinion. Prediction & prevention of preterm birth. 2012

[75] Manuck TA, Stoddard GJ, Fry RC, Esplin MS, Varner MW. Nonresponse to 17-alpha hydroxyprogesterone caproate for recurrent spontaneous preterm birth prevention: Clinical prediction

and generation of a risk scoring system. American Journal of Obstetrics and Gynecology. 2016;**215**(5):622.e1-622.e8

[76] Saccone G, Khalifeh A, Elimian A, Bahrami E, Chaman-Ara K, Bahrami MA, et al. Vaginal progesterone vs intramuscular 17-alpha-hydroxyprogesterone caproate for prevention of recurrent spontaneous preterm birth in singleton gestations: Systematic review and meta-analysis of randomized controlled trials. Ultrasound in Obstetrics & Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology. 2017;**49**(3):315-321

[77] Saccone G, Maruotti GM, Giudicepietro A, Martinelli P. Effect of cervical pessary on spontaneous preterm birth in women with singleton pregnancies and short cervical length: A randomized clinical trial. Journal of the American Medical Association. 2017;**318**(23):2317-2324

[78] Conde-Agudelo. Birth spacing and adverse perinatal outcomes: A meta-analysis. JAMA. 2006;**295**(15):1809-1823

[79] Moore ER, Anderson G, Bergman N, Dowswell T. Early skin-to-skin contact for mothers and their healthy newborn infants. Cochrane Database of Systematic Reviews. 2012;**5**

[80] Bera A et al. Effect of KMC on physiology of newborn. Indian Journal of Community Medicine. 2014;**39**(4)

[81] Lawn JE, Mwansa-Kambafwile J, Horta BL, Barros FC, Cousens S. 'Kangaroo mother care' to prevent neonatal deaths due to preterm birth complications. International Journal of Epidemiology. 2010;**39**(suppl_1):i144-ii54

[82] Sloan NL, Ahmed S, Mitra SN, Choudhury N, Chowdhury M, Rob U, et al. Community-based kangaroo mother care to prevent neonatal and infant mortality: A randomized, controlled cluster trial. Pediatrics. 2008;**121**(5):e1047-e1e59

[83] Mathewos B, Sitrin D, Valsankar B, Musena Y, Tadesse L, Chan G, et al. Delivery of kangaroo mother care in ethiopian facilities: Results from a rapid assessment in three zones. 2015

[84] Central Statistical Agency (CSA) [Ethiopia] and ICF. Ethiopia Demographic and Health Survey 2016 [Online]. Available from: www.dhsprogram.com/data/dataset/Ethiopia_StandardDHS_2016.cfm?flag=1 2016