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Advanced Comprehension of Low Birth Weight: A Review

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Abstract

Low birth weight (LBW) has been defined by the World Health Organization (WHO), a weight at the birth time of less than 2,500g. The percentage of LBW is mostly considered as an indicator of health at population-level worldwide, and attenuating LBW incidence is the most important health strategy around the globe. Multiple elements influence the period of pregnancy and fetal growth, and consequently, the birth weight. Greater than 20 million newborns worldwide, representing 15% globally of total births bears LBW, 95.6% of these newborns belong to underdeveloped countries. The World Health Assembly has formulated a recent goal to decrease the incidence of LBW by 30% during 2010 and 2025. Among the major challenges in estimating the occurrence of the LWB is the fact that greater than half of newborns in the under-developed countries are not being weighed at the time of their birth. Previously, most measurements of LBW for under-developed countries were established on statistics collected from health facilities. Despite, these estimates are prejudiced for the majority of under-developed countries because the majority of newborns are not born in health centers. Since the last few decades, household inspection estimates have become much more extensively available, and several new methods have been adjusted to these estimates that rectify the underreporting of birth weights. In the long run, additional research in genuine LBW data collection methodology and improved interventions in the social health determinants will be the key role factors that will bring further improvements in reducing the proportion of LBW.

Introduction

The initial measurable commodity of a newly born is always it's birth weight that must be preferably measured during the first hour of live birth, before the significant postnatal loss of weight [1]. In 1992, United Nations Children's Fund (UNICEF) and WHO issued the very first universal, territorial and country's based estimation of LBW. Low birth weight (LBW) has been defined by the WHO, a weight at the time birth of less than 2,500g (5.5 pounds). The percentage of LBW is mostly considered as an indicator of health at population-level worldwide, and attenuating LBW incidence is the most important health strategy around the globe. Epidemiological observations have proven that LBW infants are approximately 20 times more likely on the verge of imminent death than heavier babies. LBW seems to be either the result of preterm birth (<37 weeks of gestation) or because of intrauterine growth restriction (IUGR). Multiple elements influence the period of pregnancy and fetal growth, and consequently, the birth weight. They impart to the infant, the mother, or the environmental conditions and play a vital part in predicting the expected birth weight and the subsequent health conditions of the infant. The attributes of LBW set by WHO specifically work for comparable health census and is not suitable for analytical care. Respective countries can select equivalent cutoff values for clinical purposes [2]. LBW is further categorized into very low birth weight (VLBW); weight at the time of birth that is (<1500g), and extremely low birth weight (ELBW); weight at the time of birth that is (<1000g) [3]. The sole perspective of this review article is to assess the recent incidence of LBW, possible causative elements, and its prevention strategies.

Risk factors and their effects on LBW

LBW seems to be either the result of preterm birth (commonly defined as <37 weeks of gestation) or the newborn being small for gestational age (SGA) caused by intrauterine growth restriction (IUGR) [4, 5]. LBW infants have a high predilection of developmental delay, death during the early infant period and later in early childhood [6, 7]. A neonate born with LBW is generally considered on the verge of multiple disadvantages. Around 27% of the four million neonatal demises per year universally are just because of preterm birth. The SGA and preterm birth also attribute to pivotal incidental elements of newborn demise. LBW is recognized for 60% to 80% of global neonatal demise [8]. Significant ethnic and racial discrepancies lie among birth end results for pregnant women and newborns. In the United States, in the year of 2013, the overall preterm birth rate was around 11.4%. Though, 16.3% neonates born to non-Hispanic black parents were born preterm, compared to 10.2% neonates born to non-Hispanic white parents and 11.3% neonates born to Hispanic parents [9]. During the year of 2013, the rate of preterm births to black parents was 60% higher than the rate of preterm births to non-Hispanic white parents and 44% higher than the rate of preterm births to Hispanic parents. Despite taking into account the recognized risk factors (e.g., smoking, overweight, hypertension), differences of preterm birth rates between black and white neonates exist [10]. Preterm birth incidence for Hispanic women ranges nearly one out of every four (23.2%) preterm births in the United States. Furthermore, the incidence of preterm birth among Hispanic population is decreasing at a slower pace from the peak year rate (declining 5.7% during peak years of 2007 and 2012) compared to non-Hispanic white population (declined to 12% during peak years of 2006 and 2012) and non-Hispanic black population (declined to 10.8% during peak years of 2006 and 2012) [11]. Risk factors that can lead to LBW include multigravida, juvenile age of conception, illicit drug abuse, women of short stature, women living in high altitude, a woman's body composition at the time of conception, women socioeconomic status, exposure to HIV, alcohol consumption, exposure to malaria, and lack of prenatal care [12-14]. Teenagers (>20 years) are not physiologically (e.g., inadequate maturation of the uterus, decreased the quantity of gonadal hormones and decreased blood supply to the uterus) and emotionally, may face unique challenges [15]. Teenagers have increased predilection to take part in hazardous trends (e.g., alcohol use and smoking) during gravidity, their gravidities are prone to be

unexpected and/or undesired, more prone to seek late or not at all prenatal care, and least expected to gain appropriate gain of weight during gravidity in comparison to adult women (20 years or more) [16]. Smoking during the period of gravidity is an imperative adjustable risk element for unwanted gravidity outcomes and childhood mortality and morbidity. Maternal use of tobacco during pregnancy is correlated with elevated risks of LBW and birth of preterm newborn, spontaneous abortion [17-20]. Evidence of elevation in the risk of childhood asthma, psychopathology, and newborn demise, have been reported [21-25]. Abeyance of smoking during gravidity has shown to lower the rates of preterm births and LBW [26].

Mothers with active smoking during pregnancy have a twofold increase to give birth to LBW neonates. Neonates with LBW have been found to be expected in a mother with environmental tobacco exposure (ETS) [27, 28]. Exposure to environmental toxins during pregnancy, such as increased levels of blood lead, even significantly below than 10 ug/dl may lead to preterm birth, stillbirth, abortion, and parturition of LBW newborn [29]. Developing countries where indoor air pollution is produced by the combustion of solid fuel is significantly higher; the risk of having a LBW infant is as high as 21% [30]. A study to rule out the correlation between LBW and increased level of ambient carbon monoxide (CO) showed that the effect of elevated level of ambient CO on birth weight was equal to the effect of maternal tobacco usage during pregnancy [31]. It has been found directly that aircraft noise is associated with the birth of LBW and preterm neonates [32, 33]. Heavy metals exposure, such as mercury during pregnancy has been associated with an elevated possibility of LBW neonates in mothers; who have consumed oily fish [34]. An infant's weight right after the birth is attributed as a paramount indicator of infant and maternal nutrition and health. Intrauterine undernourishment significantly elevates the possibility of demise in very infancy and childhood period. Neonates which manage to survive tend to have poor immunity, a higher predilection towards a different kind of diseases and are prone to be underweighted, with decreased IQ, intellectual skills and muscle strength overall their lifetime [35]. Neonatal and maternal outcomes are highly dependent on the nutritional condition of the mother during pre and post gravidity. To avoid LBW, appropriate nutrient intake and supplements are required [36]. LBW and inappropriate fetal growth are always associated with maternal malnutrition. Wherever it is necessary, maternal nutrition should be supplemented with folic acid, iron, and micronutrients. It has been observed that mothers provided with multiple micronutrients during the course of pregnancy; showed a reduction of LBW about% in low-income countries [37]. The appropriate amount of iodine and folic acid near the fertilization and of iodine and iron throughout gravidity are beneficial for the appropriate growth of the growing neonatal central nervous system. It has been found that a balanced protein-energy diet in undernourished women helps in reducing the incidence of LBW [38]. The intake of lipid-derived formulas for gravidas; especially for undernourished, has been used as a method to enhance fetal developmental outcome [39]. Furthermore, interventions such as preventing unplanned pregnancy, early age pregnancy and late age of marriage are also required [40].

LBW and ethnic disparities

Significant racial and ethnic inequalities coexist among birth outcomes for gravidas and neonates. The inequalities in birth weight among people of particular ethnic groups and races are profoundly studied [41-43]. Several studies conducted in the United States have shown that the magnitude of LBW is higher among African-American population [44-47]. Neonates born to Non-Hispanic black parents have notably elevated rates of LBW, infant demise, and preterm birth compared to neonates born to Hispanic parents and neonates born to non-Hispanic white parents. In 2013, the rate of LBW for live single births was 6.3%. The measured rate of LBW of total births was 8.0%. Although, the rate LBW neonates to black parents (13.1%) was nearly twice that of LBW neonates born to white parents (7%) and LBW neonates born to Hispanic parents

(7.1%) [48]. The neonatal demise percentage has decreased in comparison with their peak in 1960, although the racial disparity among births to black gravidas compared to white gravidas has been increased from 1960 to 2011 [49]. Similar findings are observed in the United Kingdom (UK) in neonates born in South-Asian, Black-Caribbean, and Black-African-descent in comparison with neonates born in the UK-origin white mothers [50]. Similar findings showed discrepancies in the percentage of LBW and birth weight among the non-Dutch and Dutch communities in Netherlands [51, 52]. Perinatal and infant mortality is strongly related to birth weight [53, 54]. The possibility of unfavorable consequences has been found not merely in those born with a LBW, yet in an extensive range of birth weight. Although, weight at the time of birth is also correlated with poor outcome and early death in the subsequent span of life, e.g., correlation of LBW with illnesses during the adolescent period, such as diabetes type II and cardiovascular diseases have been documented [55, 56]. The raised percentage of LBW and birth weight of lower mean between different ethnic communities might be the consequence of several factors [57, 58]. Numerous factors have been documented that are related to birth weight, such as socioeconomic conditions, maternal height, maternal age, BMI, preconception weight, smoking, gestational age, parity, alcohol use, and marital status [59-67].

Global incidence and trends of LBW

The percentage of LBW is mostly considered as an indicator of health at population-level worldwide, and attenuating LBW incidence is the most important health strategy around the globe [68]. In the year of 1992, the LBW rate for less developed countries was between 5-33%, with an average of 17%, and for industrialized countries; LBW was around 7%. In the year of 2000, efforts for estimating global and country's LBW were enhanced by WHO and UNICEF. The monitoring process of LBW prevalence worldwide helped in the recognition of the limitations of data available. A large proportion of neonates not weighted at the time of birth carry an inevitable limitation towards the infallible monitoring of LBW. In order to overcome these limitations, UNICEF proposed the procedure developed by Boerma et al. [69] for collecting LBW data. The percentage of LBW, described as the magnitude of newborns having a weight of <2,500 grams, is checked through by household surveys and health department's inspection [70]. During 2011, greater than 20 million neonates, an approximated 15% universally, had LBW at the time of birth. In South Asian countries, the one-third universal burden of LBW was solely carried by India (Fig.1).

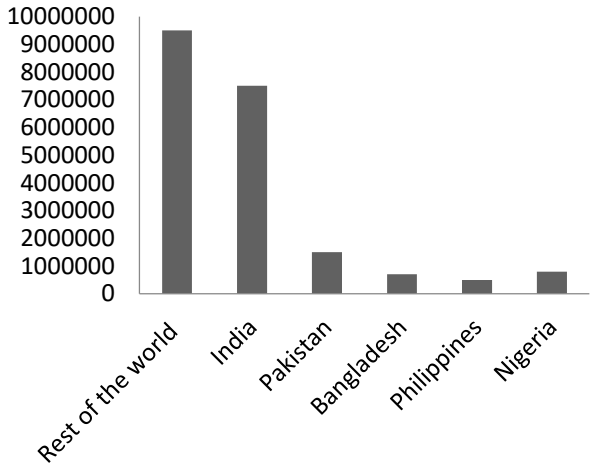

Fig. 1 Five countries responsible for more than half of the universal LBW load (Global Nutritional Database conducted by UNICEF, 2012). The Y-axis shows the number of LBW reported incidences.

The greatest regional incidence of LBW has been found only in South Asia so far, with one in four neonates weighing less than 2,500g at birth (Fig. 2). The percentage of LBW has exceeded 20% in India, Pakistan, Philippines, Mauritania, and the Nauru, and in the Sub-Saharan African region, the percentage has been found more than 10%. According to the report by UNICEF Global Nutrition Database, 2012, greater than 50% of the global load of LBW has been associated with 5 of the 24 countries included in it. Among the major challenges in estimating the occurrence of the LBW is the fact that greater than half of newborns in the under-developed countries are not being weighed at the time of their birth, as in 2011 too. This has significantly revealed a discrepancy of adequate care of a newborn and also presented as a big hurdle in precisely measuring

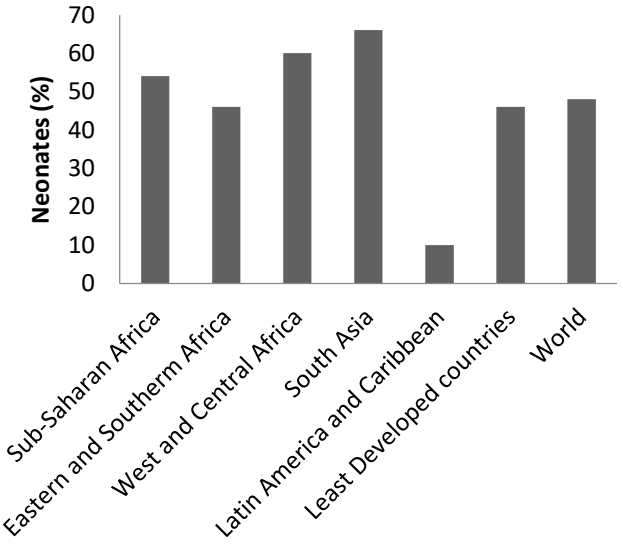

Fig. 2 Percentage of neonates having a weight less than 2,500 g at the time of birth (Global databases conducted by UNICEF, 2014).

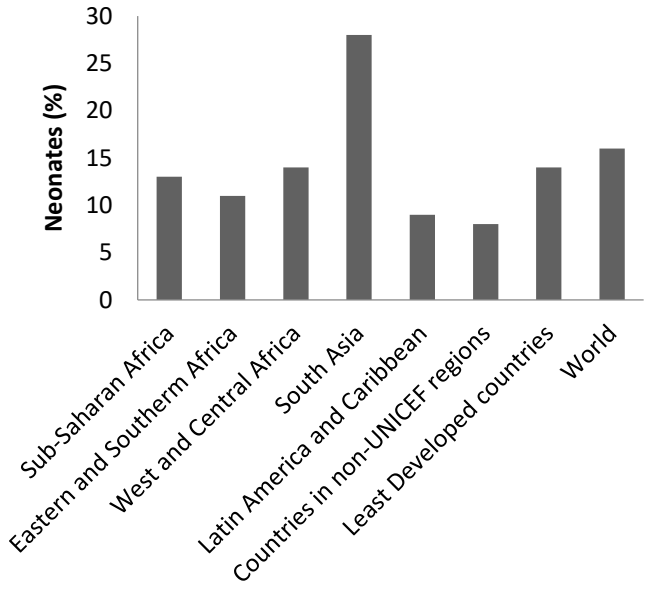

Fig. 3 Percentage of neonates not weighed at the time of birth (Global databases conducted by UNICEF in 2014)

LBW percentage. Several possible arrangements have been applied to overcome the issues of birth weights under reporting; still the rates are prone to miscalculate the exact gravity of the issue [71]. According to epidemiological analysis based on international comparison; neonates having <2,500g have been found relatively 20 folds more prone to death in comparison with healthy heavier infants. A novel goal has been formulated by World Health Assembly to decrease the incidence of LBW by 30% during 2010 to 2025. While in 2013; in contrast to 2011, approximately 22 million neonates (an approximated 16% of total neonates born worldwide that specific year) had LBW. Still, precise monitoring of real incidence is greatly demanding, although around half of the world's neonates are not being weighed right after their birth (Fig. 3). Globally, between regions, the highest percentage of LBW belongs to South Asia, where one in four neonates is having <2,500 grams. Approximately, 66% of neonates in South Asia are not being weighed at the time of their birth [72]. The available trend data from house-based analysis such as, multiple indicator cluster surveys (MICS) and demographic and health surveys (DHS) are confined, encircling around 60% of the under-developed world's population, with the exception of China. An assay of recent tendencies in LBW is challenging due to the limitation of comparison of estimates among countries and within the countries over the time. Although, the statistics show that the percentage of LBW has been consistent since the 1990s to 2010 in both Sub-Saharan Africa and Asia. Statistical analysis was inadequate to measure the LBW incidence of other regions of the world [73].

Recommendations

Despite decades of continuous research and prevention attempts, LBW remains a leading public health issue. More research is needed to highlight how the many factors affecting LBW interplay because, for every lucid finding, there are numerous pending questions. There is an increasing concurrence that the complicated concerns enclosing preterm and LBW births call for a broad approach, one that addresses a broad range of risk factors. Just-in-time solutions (those introduced during pregnancy) are not enough. Preventing LBW requires a lifetime approach to the health of men and women, one that takes complete coverage of socioeconomic and environmental as well as medical concerns and integrates effective public awareness campaigns. Following strategies are required to reduce the incidence of LBW: (1) Broad availability of medical

and dental assistance, taking a lifetime approach to health facilities; (2) emphasis on smoking prevention and abeyance; (3) ensure that women undergoing pregnancy get appropriate nutrition, (4) focus on social, demographic, and environmental risk factors and (5) continuous research on the causes of LBW.

Conclusions

LBW is still a consistent debatable health problem over the globe because of its threatening consequences for the well-being of infants, in their later life span. Several factors have been proven directly responsible for the occurrence of LBW worldwide. Among the most seriously accountable factors; preterm birth, intrauterine growth restriction, smoking, multigravida, race, ethnicity, socioeconomic status, extremes of ages (<20years and >40 years), unplanned pregnancy, lack of appropriate weight gain before pregnancy, usage of illicit drugs , alcohol consumption, exposure to HIV and other infectious organisms, lack of essential micro-nutrients, imbalance of energy-rich diet, chronic illness, exposure to heavy metals, and lack of prenatal visits during pregnancy; are still considered the main culprit of LBW. Under-developed countries of South-Asian region, especially India alone, carry the highest burden of LBW worldwide and the incidence of LBW is still rising in South-Asian region. Poor socioeconomic conditions of under-developed countries are the chief attributes leads towards the increased incidence of LBW, as compared to developed countries. The requisite of LBW prevention for decades have been smoking cessation and prenatal care. Recently, it has been analyzed that both preterm birth and IUGR, cannot be effectively prevented by prenatal care in its current state because there is not a single specific diagnostic tool that can warn us about imminent preterm birth and a very little information is available about how a preterm birth can be prevented. The preponderating methods to prevent LBW basically concentrate on instigating modifiable particular factors, such as maternal psychological stress or obesity. Recently, the most favorable steps to reduce LBW seem to be the following; ameliorating women's overall health status over the life span (ameliorating health conditions such as diabetes, psychological illness, asthma, and various others that are directly linked to unexpected birth outcomes), improving health behaviors of pregnant women (including appropriate weight gain, quitting illicit drug usage, and smoking cessation), improving family planning to reduce unexpected pregnancies, appropriate gap of preferably 18 months for the subsequent pregnancy, engaging in advised preconception attitudes like recommended intake of folic acid supplements, and appropriate screening for certain medical conditions during pregnancy. A large proportion of neonates not weighted at the time of birth carry an inevitable limitation towards the infallible monitoring of LBW. In the longer term, additional research in genuine LBW data collection methodology and improved interventions in the social health determinants will be the key role factors that will bring further improvements in lowering the incidence of LBW.

Conflict of interest

The authors declare that they have no conflict of interest.

References

[1] World Health Organization, International statistical classification of diseases and related health problems, tenth revision, World Health Organization, Geneva; 1992.

[2] World Health Organization, Low Birth Weight: A tabulation of available information, WHO/MCH/92.2, World Health Organization, Geneva, and UNICEF, New York; 1992.

[3] Siva Subramanian KN, Barton AM, Montazami S, Cassady G, Windle ML, Carter BS. Extremely low birth weight infant Ted Rosenkrantz, 2011.

[4] Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. Bull World Health Organ 1987; 65(5):663-737.

[5] Simhan HN, Caritis SN. Prevention of preterm delivery. N Engl J Med 2007; 357(19):1979-1980.

[6] Ashworth A. Effects of intrauterine growth retardation on mortality and morbidity in infants and young children. Eur J Clin Nutr 1998; 52(1):34-41.

[7] McCormick MC. The contribution of low birth weight to infant mortality and childhood morbidity. N Engl J Med 1985; 312(2):82-90.

[8] Lawn JE, Cousens S, Zupan J. 4 million neonatal deaths: When? Where? Why? The Lancet 2005; 365(9462):891-900.

[9] Hamilton BE, Martin JA, Ventura SJ. Births: preliminary data for 2008. Natl Vital Stat Rep 2010; 58(16).

[10] Lu MC, Halfon N. Racial and Ethnic Disparities in Birth Outcomes: A Life-Course Perspective. Matern Child Health J 2003; 7(1):13-30.
[11] Maternal and Infant Health in US Hispanic Populations: Prematurity and Related Health Indicators; 2014.
[12] Rawlings JS, Rawlings VB, Read JA. Prevalence of Low Birth Weight and Preterm Delivery in Relation to the Interval between Pregnancies among White and Black Women. N Engl J Med 1995; 332(2):69-74.
[13] Wilcox AJ. On the importance and the unimportance of birthweight. Int J Epidemiol 2001; 30(6):1233-41.
[14] Martin JA, Hamilton BE, Sutton PD. Births: final data for 2007. Natl Vital Stat Rep 2010; 58(24).
[15] Shah P, Ohlsson A. Literature Review of Low Birth Weight, Including Small for Gestational Age and Preterm Birth. Department of Pediatrics, Mount Sinai Hospital, Toronto, Ontario; 2002.
[16] Center for Disease Control and Prevention. Adolescent reproductive health, teen pregnancy. Atlanta, GA: US Department of Health and Human Services; 2010.
[17] Henriksen T, Hjollund NH, Jensen TK, Bonde JP, Andersson AM. Alcohol consumption at the time of conception and spontaneous abortion. Am J Epidemiol 2004; 160(7):661-7.
[18] Cliver SP, Goldenberg RL, Cutter GR, Hoffman HJ, Davis RO, Nelson KG. The Effect of Cigarette Smoking on Neonatal Anthropometric Measurements. Obstet Gynecol 1995; 85(4):625-30.
[19] Bernstein IM, Mongeon JA, Badger JG, Solomon L, Heil SH, Higgins ST. Maternal smoking and its association with birth weight. Obstet Gynecol 2005; 106(5):986-91.
[20] Shah NR, Bracken MB. A systematic review and meta-analysis of prospective studies on the association between maternal cigarette smoking and preterm delivery. Am J Obstet Gynecol 2000; 182(2):465-72.
[21] Kleinman JC, Pierre MB Jr, Madans JH, Land GH, Schramm SH. The effects of maternal smoking on fetal and infant mortality. Am J Epidemiol 1988; 127(2):274-82.
[22] Jouni JK, Mika Gissler. Maternal Smoking in Pregnancy, Fetal Development, and Childhood Asthma. Am J Public Health 2004; 94(1):136-140.
[23] Ernst M, Moolchan ET, Robinson ML. Behavioral and neural consequences of prenatal exposure to nicotine. J Am Acad Child Adolesc Psychiatry 2001; 40(6):630-41.
[24] Wakschlag LS, Levental BL, Pine DS, Pickett KE, Carter AS. Elucidating early mechanisms of developmental psychopathology: the case of prenatal smoking and disruptive behavior. Child Dev 2006; 77(4):893-906.
[25] Lumley J, Chamberlain C, Dowswell T, Oliver S, Oakley L, Watson L. Interventions for promoting smoking cessation during pregnancy. Cochrane Database Syst Rev 2009; 55(3):13-29.
[26] Knopik VS. Maternal smoking during pregnancy and child outcomes: real or spurious effect? Dev Neuropsychol 2009; 34(1):1-36.
[27] Salmasi G, Grady R, Jones J, McDonald SD. Environmental tobacco smoke exposure and perinatal outcomes: a systematic review and meta-analyses. Acta Obstet Gynecol Scand 2010; 89(4):423-41.
[28] Cleveland LM, Minter ML, Cobb KA, Scott AA, German VF. Lead hazards for pregnant women and children: part 1: immigrants and the poor shoulder most of the burden of lead exposure in this country. Part 1 of a two-part article details how exposure happens, whom it affects, and the harm it can do. Am J Nurs 2008; 108(10):40-9.
[29] Pope DP, Mishra V, Thompson L, Siddiqui AR, Rehfuess EA, Weber M, et al. Risk of low birth weight and stillbirth associated with indoor air pollution from solid fuel use in developing countries. Epidemiol Rev, 2010; 32(1):70-81.
[30] Lewtas J. Air pollution combustion emissions: characterization of causative agents and mechanisms associated with cancer, reproductive, and cardiovascular effects. Mutat Res 2007; 636(1-3):95-133.
[31] Kawada T. The effect of noise on the health of children. J Nip Med Sch 2004; 71(1):5-10.
[32] Matsui T, Matsuno T, Ashimine K, Miyakita T, Hiramatsu K, Yamamoto T. Association between the rates of low birth-weight and/or preterm infants and aircraft noise exposure. Nihon Eiseiqaku Zasshi 2003; 58(3):385–94.
[33] Gochfeld M, Burger J. Good fish/bad fish: a composite benefit-risk by dose curve. Neurotoxicol 2005; 26(4):511-20.
[34] Barker DJ. Fetal and Infant Origins of Adult Disease. BMJ 1990; 301(6761):1111.
[35] Susan PW, Theodore DW, Sally GM, Maureen MB, Charles AN, Sandra L, et al. Inequality in early childhood: risk and protective factors for early child development. The Lancet 2011; 378(9799):1325-1338.
[36] Haider BA, Yakoob MY, Bhutta ZA. Effect of multiple micronutrient supplementation during pregnancy on maternal and birth outcomes. BMC Public Health 2011; 11(3):19.
[37] Imdad A, Bhutta ZA. Maternal Nutrition and Birth Outcomes: Effect of Balanced Protein-Energy Supplementation. Paediatr Perinat Epidemiol 2012; 26:178-90.
[38] Chaparro, Camila M., Kathryn G. Dewey. Use of lipid-based nutrient supplements (lns) to improve the nutrient adequacy of general food distribution rations for vulnerable sub-groups in emergency settings. Matern Child Nutr 2010; 6:1–69.
[39] UNICEF Global Databases; 2012.
[40] David RJ, Collins JWJ. Differing Birth Weight among Infants of U.S.-Born Blacks, African-Born Blacks, and U.S.-Born Whites. N Engl J Med 1997; 337(17):1209-1214.
[41] Guendelman S, Buekens P, Blondel B, Kaminski M, Notzon FC, Masuy-Stroobant G. Birth outcomes of immigrant women in the United States, France, and Belgium. Matern Child Health J 1999; 3(4):177-87.
[42] Migone A, Emanuel I, Mueller B, Daling J, Little RE. Gestational duration and birthweight in White, Black and mixed-race babies. Paediatr Perinat Epidemiol 1991; 5(4):378-391.
[43] Hessol NA, Fuentes-Aick E, Bacchetti P. Risk of low birth weight infants among black and white parents. Obstet Gynecol 1998; 92(5):814-22.
[44] Mathews TJ , Miniño AM, Osterman MJ, Strobino DM, Guyer B. Annual summary of vital statistics: 2008. Pediatrics 2011; 127(1):146-57.
[45] Buekens P, Notzon F, Kotelchuck M, Wilcox A. Why do Mexican Americans give birth to few low-birth-weight infants? Am J Epidemiol. 2000; 152(4):347-51.
[46] Fuentes-Afflick E, Lurie P. Low birth weight and Latino ethnicity: Examining the epidemiologic paradox. Arch Pediatr Adolesc Med 1997; 151(7):665-74.

[47] Mathews TJ, MacDorman MF. Infant mortality statistics from the 2006 period linked birth/infant death data set. Natl Vital Stat Rep 2010; 58(17):1-31.
[48] Willis E, McManus P, Magallanes N, Johnson S, Majnik A. Conquering Racial Disparities in Perinatal Outcomes. Clin Perinatol 2014; 41(4):847-75.
[49] Harding S, Rosato MG, Cruickshank JK. Lack of change in birthweights of infants by generational status among Indian, Pakistani, Bangladeshi, Black Caribbean, and Black African mothers in a British cohort study. Int J Epidemiol 2004; 33(6):1279-85.
[50] Doornbos JP, Nordbeck HJ, Van Enk AE, Muller AS, Treers PE. Differential birthweights and the clinical relevance of birthweight standards in a multiethnic society. Int J Gynaecol Obstet 1991; 34(4):319-24.
[51] Goedhart G, van Eijsden M, van der Wal MF, Bonsel GJ. Ethnic differences in term birthweight: the role of the constitutional and environmental factors. Paediatr Perinat Epidemiol 2008; 22(4):360-8.
[52] Alexander GR, Kogan M, Bader D, Carlo W, Allen M, Mor J. US birth weight/gestational age-specific neonatal mortality: 1995-1997 rates for whites, hispanics, and blacks. Ped 2003; 111(1):61-6.
[53] Wilcox AJ, Russell IT. Birthweight and perinatal mortality: II. On weight-specific mortality. Int J Epidemiol 1983; 12(3):319-25.
[54] Barker DJ. Fetal origins of coronary heart disease. BMJ 1995; 311(6998):171-4.
[55] Curhan GC, Willett WC, Rimm EB, Spiegelman D, Ascherio AL, Stampfer MJ. Birth weight and adult hypertension, diabetes mellitus, and obesity in US men. Circulation 1996; 94(12):3246-50.
[56] Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. Bull World Health Organ 1988; 65(5):663-737.
[57] Valero De Bernabe J, Soriano T, Albaladejo R, Juarranz M, Calle ME, Martínez D, Domínguez-Rojas V. Risk factors for low birth weight: a review. Eur J Obstet Gynecol Reprod Biol 2004; 116(1):3-15.
[58] Kramer MS, Séguin L, Lydon J, Goulet L. Socio-economic disparities in pregnancy outcome: why do the poor fare so poorly? Paediatr Perinat Epidemiol 2000; 14(3):194-210.
[59] Lee KS, Corpuz M. Teenage pregnancy: Trend and impact on rates of low birth weight and fetal, maternal, and neonatal mortality in the United States. Clin Perinatol 1988; 15(4):929-42.
[60] Fraser AM, Brockert JE, Ward RH. Association of young maternal age with adverse reproductive outcomes. N Engl J Med 1995; 332(17):1113-7.
[61] Mohanty C, Prasad R, Srikanth Reddy A, Ghosh JK, Singh TB, Das BK. Maternal anthropometry as predictors of low birth weight. J Trop Pediatr 2006; 52(1):24-9.
[62] Cnattingius S, Bergstrom R, Lipworth L, Kramer MS. Prepregnancy weight and the risk of adverse pregnancy outcomes. N Engl J Med 1998; 338(3):147–52.
[63] Cliver SP, Goldenberg RL, Cutter GR, Ho man HJ, Davis RO, Nelson KG. The effect of cigarette smoking on neonatal anthropometric measurements. Obstet Gynecol 1995; 85(4):625-30.
[64] Wilcox AJ, Skjaerven R. Birth weight and perinatal mortality: the effect of gestational age. Am J Public Health 1992; 82(3):378-82.
[65] Bai J, Wong FW, Bauman A, Mohsin M. Parity and pregnancy outcomes. Am J Obstet Gynecol 2002; 186(2):274-8.
[66] Abel EL, Hunninghan. 'J-shaped' relationship between drinking during pregnancy & birth weight: reanalysis prospective epidemiological data. Alcohol Alcohol 1995; 30:345-55.
[67] Raatikainen K, Heiskanen N, Heinonen S. Marriage still protects pregnancy. Int J Obstet Gynaecol 2005; 112(10):1411-1416.
[68] WHO, Core Health Indicators; 2008.
[69] Boerma JT, Weinstein KI, Rutstein SO, Sommerfelt AE. Data on Birth Weight in Developing Countries: Can surveys help?, Bull World Health Organ 1996; 74(2):209–216.
[70] UNICEF and WHO, Low Birthweight: Country, regional and global estimates, UNICEF, New York; 2004.
[71] UNICEF Global Nutrition Database, based on MICS, DHS and other national surveys, 2007–2011, except for India; 2012.
[72] UNICEF global databases, based on Multiple Indicator Cluster Surveys (MICS), Demographic and Health Surveys (DHS) and other nationally representative surveys, 2009─2013 (for % not weighted is 2008-2012), with the exception of India and Indonesia; 2014.
[73] Blanc AK, Wardlaw T. Monitoring low birth weight: an evaluation of international estimates and an updated estimation procedure. Bull World Health Organ 2005; 83(3):178-85.