REVIEW ARTICLE

•Arch Hyg Sci 2014;3(2):70-84.
•Journal Homepage: http://jhygiene.muq.ac.ir

An Overview of the Role of Effective Maternal Indicators on Birth Weight

Mehdi Gholamzadeh Baeis[a], Mojtaba Miladi Nia[b], Elham Mosavi Nori[b], Gholam Reza Sharifirad[c], Siamak Mohebi[*c]

[a] Department of Medical Sciences, Qom Branch, Islamic Azad University, Qom, Iran.
[b] Nursing Department, Joundi Shapour University of Medical Sciences, Ahwaz, Iran.
[c] Health Policy and Promotion Research Center, Qom University of Medical Sciences, Qom, Iran.
[*]**Correspondence** should be addressed to Dr. Siamak Mohebi; **Email**: smohebi@muq.ac.ir

A-R-T-I-C-L-E I-N-F-O

Article Notes:
Received: Aug 7, 2014
Received in revised form: Sep 20, 2014
Accepted: Oct 10, 2014
Available Online: Oct 19, 2014

Keywords:
Infant
Mother
Health indicators
Weight
Rreview study
Hematocrit

A-B-S-T-R-A-C-T

Background & Aims of the Study: Birth weight is one of the most fundamental and common health indicators used to assess the infants' status in each country. Maternal blood and its various cell types and parameters are of vital factors have impression on the fetus. Several risk factors are considered as the causes of low birth weight; however, in many cases it has no obvious reason. This study aims at reviewing the role of effective maternal indicators on birth weight. This research is of overview type designed using 19 papers collected from academic databases and search engines such as Pubmed, Proquest, Elsevier, Scopus. Papers were selected by cross-sectional and cohort designs, clinical trials, and systematic reviews. Papers were also searched in Persian databases, such as Iranmedex, Medlib, as well as scientific journals websites. Evaluation of various maternal parameters such as hematocrit, body mass index, hemoglobin, blood lead, and zinc and iron levels showed direct and meaningful relationship between child weight and maternal hematocrit, hemoglobin, and body mass index. Moreover, there exists an inverse relationship between child weight and maternal iron while it is noteworthy that there is no relationship between maternal blood lead level and child weight. At the end, it can be stated that many of the maternal parameters have adverse effects on the fetus; however, some of them has not been confirmed everywhere. Perhaps the reason for this difference in results comes from differences in race, geography, lifestyle, laboratory practices and etc. Thus, it is recommended that further studies be conducted in any region to determine the effect of each of these parameters.

Please cite this article as: Gholamzadeh Baeis M, Miladi Nia M, Mosavi Nori E, Sharifirad Gh, Mohebi S. An Overview of the Role of Effective Maternal Indicators on Birth Weight. Arch Hyg Sci 2014;3(2):79-84.

Background

Pregnancy is a natural phenomenon and there are annually about 180 million pregnant women throughout the world (1). Whereas pregnancy is a natural event that can result in a healthy baby born by natural childbirth process, the slightest neglect may lead this natural process to maternal and neonatal mortality (2). Results obtained from various studies around the world show that maternal indicators such as hematocrit, hemoglobin, serum levels of lead and zinc are correlated with fetal growth and birth weight. Lead is easily transmitted from mother to fetus so that the cord blood lead concentration is approximately 80-90% of maternal blood lead concentration (3). Reduction of lead during pregnancy has been

verified for various reasons (4). Anemia is the most common nutritional deficiency in the world, especially in developing countries, increasing maternal and fetal mortality during pregnancy (5). Low birth weight is one of the most basic and common health indicators used to assess the status of the infants in each country (6). Several risk factors are available for low birth weight (7); however, there is no obvious reason for it in many cases (8). During pregnancy, insufficient storage or inadequate intakes of essential supplies can cause harmful effects on mothers (9). Regardless of gestational age, status of infants weighing less than 2,500 grams is considered as low birth weight. These infants compared to the normal weight babies are more vulnerable and are prone to many health problems (10). Low birth weight is also one of the main causes of infant mortality; in different countries the rate of low birth weight is directly related to mortality during infancy. The rate of low birth weight in the U.S. increased from 6.6 percent in 1981 to 6.7 percent in 2000. This has been reported 8% in Iran. Many consequences are likely to be appeared as a result of low birth weight infants, especially in developing and underdeveloped countries. In addition to mental health problems, the high cost of healthcare and management of these infants will be imposed on their families (6). In 2001, the rate of low birth weight for singleton and multiple-birth increased to 7.7% comparing with the 6.8% in the 1980s (10). This study aimed at overviewing of the role of effective maternal indicators on birth weight.

Materials & Methods

This study was of review-type designed using academic databases and search engines, such as pubmed, proquest, Elsevier, and Scopus, as well as keywords, including fetus, mother, birth weight, and hematocrit. Papers by cross-sectional and cohort designs, clinical trials and systematic reviews were selected. Moreover, papers in Persian were gathered using several databases, such as Iranmedex, medlib, as well as from scientific journals' websites.

Only papers published from 1990 to 2013 were included in this study. Thus, having found 27 papers in initial search 19 papers meeting the study criteria were selected by examining each of these 27 papers. By careful study their results and conclusions are presented as follows. In selecting papers, recent studies have specifically examined the relationship between birth weight and surveyed parameters were considered. A number of papers assessed the parameters but did not examine its relationship with birth weight were excluded.
Some examples of selected papers are given in Table 1.

Table 1) Some examples of selected papers

Authors	Research year	Description	Research result
Mansouri , M . , et al	2009	Relationship between maternal blood lead levels and low birth weight infants	No meaningful relationship was observed
SharifZadeh , F ., et al	2008	Relationship between body mass index and birth weight	Meaningful relationship was observed
Alizadeh , Sh ., et al	2012	Relationship between maternal hemoglobin concentration during pregnancy and some individual characteristics	Meaningful relationship was observed
MirzaRahimi, M ., et al	2009	Relationship between maternal serum zinc level and birth weight	No meaningful relationship was observed
Haniff J, Das A, Onn LT, Sun CW, Nordin NM, Rampal S, et al	2007	Anemia in pregnancy in Malaysia	35% prevalence of anemia during pregnancy
Salimi , S ., et al	2012	Relationship between hemoglobin concentration and body mass index during pregnancy and birth weight	No relationship was observed between hemoglobin concentration and birth weight; however mother mass index is related to birth weight
Laflamme EM	2011	Matermal hemoglobin concentration of pregnancy outcome	Meaningful relationship was observed
Mirzaie F, Eftekhari N, Goldozeian S , Mahdavinia J.	2010	Prevalence of anemia risk factors in pregnant women in Kerman, Iran	Prevalence of risk factors for anemia in this study is not high.
Singh L, Chouhan C, Sidhu M	2009	Maternal factors for low birth weight babies.	There was a meaningful relationship between four maternal factors and low birth weight
Faraji, R., et al	2010	Relationship between hemoglobin concentration and BMI in the first trimester of pregnancy and birth weight	No meaningful relationship was observed
Mahmoudi, Z., et al	2011	Low birth weight and its related factors in Iran	Underweight prevalence in Iran is relatively high.
Ramezanali, F., et al	1986	Maternal hematocrit levels and birth weight	Meaningful relationship was observed
MirzaRahimi, M ., et al	1989	Relationship between maternal serum copper level and birth weight	Meaningful relationship was observed
EmamGhoreyshi, F., et al	1983	Iron status of mothers and its relationship with birth weight	Meaningful relationship was observed
Eghbalian, F., et al	1985	Assessing factors associated with low birth weight	In this study, relationship between 9 cases and low birth weight was found.
SharifZadeh , F ., et al	2008	Assessing Maternal BMI and birth weight	Meaningful relationship was observed
Alizadeh, L., et al	2012	Hemoglobin concentrations and pregnancy outcomes in teenage pregnancy	Meaningful relationship was observed
Zarbakhsh, M., et al	2009	The prevalence of low birth weight and comparing some of the biological characteristics of mothers with low weight infants with those of normal weight mothers	In this study, a relationship was found between 5 cases and low birth weight.
SharifiRad, Gh., et al	2010	Evaluation of maternal weight gain during pregnancy based on recommended standards and its relationship with birth weight in Esfahan City.	Direct and meaningful relationship between pregnancy weight gain and low birth weight was found.

Results

Evaluation of Maternal hematocrit levels:

One of the major causes of low birth weight is maternal anemia during pregnancy. Moreover, in the case of high concentration of hemoglobin, the risk of adverse pregnancy outcome will be high (9). In a study conducted by Ramezanali (1986), it was found that there are relationships between risk of low weight (lower than 2500 grams) and maternal hematocrit levels in first and third trimesters, mother's height, age, nationality, gestational

age during pregnancy. No significant relationship was reported between maternal anemia and low birth weight and this is mostly emphasized in literature (9-13). In Ramezanali (1986), the average weight of babies whose mothers had normal hematocrit (between 36 and 39) was significantly more than those of whose mothers had over normal hematocrit. In addition, the average weight of babies whose mothers have naturally high hematocrit (between 39 and 42) were also significantly more than the average weight of babies whose mothers congested, hematocrit higher than 42 (9). Bondevik et al study aimed at investigation of the relationship between maternal hematocrit and risk of low birth weight and preterm delivery. It was found that maternal hematocrit item is clearly associated with higher birth weight in the first trimester (14). In the studies conducted by Ramezanali and Stevenson et al., it was concluded that high hemoglobin was related to the risk of low birth weight (9,15). In addition, in a study by Bondevik et al it was reported that high maternal hematocrit (over 40) has no relationship with increased risk of low birth weight (14). The reasons for the differences in results can be due to low birth weight of samples with high hematocrit, non-definition of high hematocrit in different studies, as well as biological and racial differences between observed populations.

Evaluation of relationship between hemoglobin concentration and body mass index and birth weight:

The rate of low birth weight as one of the most common problems in neonatology was reported 7.7% in all races. Anemia in pregnant women are approximately 56%, 18% and 80% in developing countries, developed countries, and South Asia, respectively (9,12).

Relationship between hemoglobin and birth weight:

Anemia is the most common nutritional deficiency in the world, especially in the developing countries (16-17), such that 25 to 50 percent of the world's population and almost 50 percent of pregnant women suffer from anemia (18).

In studies conducted by Salimi S, Faraji) et al (2010) and Laflam (2006) it was found that there is no relationship between low maternal hematocrit values (less than 37) and preterm delivery as well as intrauterine growth retardation and low birth weight. Moreover, Bondevik et al (2001)) showed no meaningful relationship between the hemoglobin concentration in the first and third trimesters of pregnancy and birth weight (11, 14, 19-21). Contrary, several studies revealed other results. In a study by Steer et al (1995), Scanlon et al (2000), and Ramezanali (9) (2006), it was shown that the increased risk of low birth weight in anemic women has a relationship with early pregnancy. In addition, Deshmukh et al (1998) indicated that maternal anemia was a major risk factor for low birth weight (22-24). While, Stevenson et al manifested that there was relationships between hemoglobin concentrations at first measurement during pregnancy care and an increased risk of stillbirth, preterm birth and small gestational age (SGA) (15).

The relationship between maternal BMI and birth weight:

In a study by Salimi et al and Kari (2008) a direct relationship was observed between maternal BMI and birth weight (19,25). In research by Singh et al (2009), maternal BMI less than 20 during pregnancy was among maternal factors mostly leads to low birth weight infants (26). Studies conducted by Sharifzadeh (2008) and Wise et al (2010) showed that low maternal pre-pregnancy body mass index has relationship with preterm birth and intensive low birth weight; and high maternal body mass index were related to macrosomia and high birth weight (27-28). The reason for these different outcomes can be attributed to racial differences. A common

point which was common almost in all of the studies reviewed was a direct correlation between pregnancy weight gain and birth weight (29, 30,11).
Research by Khashan et al (2009) (31) suggested that obese women have an increased risk of macrosomia and cesarean rate and a lower risk of preterm birth. Contrary to Sharifzadeh et al(2012) (27), Rosenberg et al (2003) (32) stated that the period of pregnancy and the risk of preterm birth were not correlated with BMI in Chinese mothers.

Evaluation of relationship between maternal blood lead level and low birth weight infants:

In Mansouri M. (2009) it was shown that maternal blood lead levels strongly correlated with lead levels in cord blood and breast milk. Moreover, lead is easily transmitted from mother to fetus so that the cord blood lead concentration is approximately 80-90% of maternal blood lead concentrations (33-34). Increased blood lead levels may be due to high amount of lead in air, water, dust and food (34). Based on the results of Mansouri M. et al and West et al, higher maternal blood did not lead to infant weight reduction (33,35). In Mc Michael et al, maternal blood lead levels had no relationship with miscarriage, low birth weight, intrauterine growth retardation and congenital anomalies (36). Several studies showed that there was no relationship between birth weight and maternal lead levels. Currently lead level relationship with low birth weight is unclear (37-39).

Iron status in pregnant women and its relationship with infants:

Iron deficiency anemia is the most common type of anemia in pregnant women in the world may result in premature birth, as well as increased maternal and child mortality. Iron deficiency anemia in mothers affects fetal hematopoietic potential and fetal development. Hemoglobin, ferritin, and reticulocyte levels of infants are significantly related to maternal iron level (40). In Todd D study, it was found that birth weight and maternal hemoglobin and ferritin levels are inversely related. Because the larger and more weight infants need more iron and this further increases the risk of iron deficiency in the mother (41). In a study conducted by Emam Qureyshi F., it was extracted that there was a significant and direct relationship between increased number of deliveries and iron deficiency anemia in mothers. Iron deficiency in mothers is due to frequent pregnancies (40).

Evaluation of effect of maternal serum zinc levels on weight infants:

Zinc reduction during pregnancy can be attributed to the disproportionate increase in plasma volume, or the embryos-maternal transfer, reduction in binding of zinc, or zinc reduction in the diet, or the high volume of copper or even iron competence with zinc during absorption in the diet (41-43). In Rahimi (2010) research conducted in Ardebil City it was manifested that maternal serum zinc levels in Ardebil city were lower than normal; and it was reduced with increasing gestational age, but its level was not significant correlated with birth weight (8). In addition, in another study conducted by Osendarp et al and Tamura et al, it was concluded that the there was no significant difference among the groups receiving the zinc and placebo in terms of infants' birth weight, head circumference, arm circumference, and gestational age. These studies suggested that in patients with malnutrition the rate of zinc absorption is low, and its dose should be doubled for pregnant women (44-45). However, in a study carried out in 18 developing countries a positive relationship was observed between the level of maternal lead level and infant birth weight. This difference results in different studies may be as a result of differences in sampling, laboratory methods, and the quality as well as size of the sample (46).

Conclusion

Finally, it should be mentioned that maternal parameters have adverse effects on the fetus; however none of them have been definitively proven. Perhaps the reasons for this difference in results are due to differences in race, geography, lifestyle, laboratory practices and etc. For this reason, it is recommended to carry out larger studies in any region where the precise effect of these parameters can be determined.

Footnotes

Conflict of Interest:

The authors declared no conflict of interest.

References

1. Ellertson C, Elul B, Ambardekar S, Wood L, Carroll J, Coyaji K. Accuracy of assessment of pregnancy duration by women seeking early abortions. Lancet 2000;355(9207):877-81.
2. Marandi A. Women's health in the world. Medicat Treat 1998:78.
3. Schonwald S. Lead. IN, Schonwald S. Medical toxicology: a synopsis and study guide. Philadelphia: Lippincott and Wilkins; 2001. P. 680.
4. Tamura T, Goldenberg RL, Johnston KE, DuBard M. Maternal plasma zinc concentrations and pregnancy outcome. Am J Clin Nutr 2000;71(1):109-13**.**
5. Alizade SH, Namazi A. Relationship between Maternal Hemoglobin during Pregnancy and Maternal Demographic Characteristic. Iranian J Gynecol Infertil 2012; 15(9):23-30. (Full Text in Persian)
6. Mahmoodi Z, Karimloo M, Sajadi H, Dezhman M, Vameghi M. Low birth weight and its association factors in Iran: according world health organization model. Bimonthly J Rehabil 2012;13(3):75-87. (Full Text in Persian)
7. Stoll BJ, Kliegman RM. The high- risk infant. In: Behrman RE, kliegman RM, Jenson HB, editors. Nelson textbook of pediatrics. 17th ed. Philadelphia: W.B Saunders; 200. P. 543-559.
8. Mirzarahimi M, Saadati H, Enteshari A, Mazani M, Shahizadeh S. The Relation between Maternal Serum Zinc Level and Infant Birth Weight. Sci J Zanjan 2010;18(73):11-17. (Full Text in Persian)
9. Ramezanali F; Dastjerdi MV; Beygi A, Moini A. The relationship between maternal HCT levels, birth weight and risk of low birth weight. Iran J Pediatr 2006;16(4):447-454. (Full Text in Persian)
10. Allen LH. Iron-deficiency anemia increases risk of preterm delivery. Nutr Rev 1993 Feb;51(2):49-52.
11. Faraji R, Mirbolok F, Sharemi SH, Asgharnia M, Joafshani M, Gholamzadeh M. Relationship between maternal hemoglobin concentration and BMI during the first trimester in primiparous women and her neonatal's birth weight. Iran J Surg 2010;18(1):62-8. (Full Text in Persian)
12. Shobeiri F, Begum K, Nazar M. A prospective study of maternal hemoglobin status of Indian women during pregnancy and pregnancy outcome. Nutr Res 2006;26(5):209-13.
13. Perry IJ, Beevers DG, Whincup PH, Bareford D. Predictors of ratio of placental weight to fetal weight in multiethnic community. BMJ 1995 Feb 18;310(6977):436-9.
14. Bondevik GT, Lie RT, Ulstein M, Kvale G. Maternal hematological status and risk of low birth weight and preterm delivery in Nepal. Acta Obstet Gynecol Scand 2001 May;80(5):402-8.
15. Stephansson O, Dickman PW, Johansson A, Cnattingius S. Maternal hemoglobin concentration during pregnancy and risk of stillbirth. JAMA 2000;284(20):2611-7.
16. Haniff J, Das A, Onn LT, Sun CW, Nordin NM, Rampal S, et al. Anemia in pregnancy in Malaysia: a crosssectional survey. Asia Pac J Clin Nutr 2007;16(3):527-36.
17. Ma AG, Schouten E, Wang Y, Xu RX, Zheng MC, et al. Anemia prevalence among pregnant women and birth weight in five Areas in China. Med Princ Pract 2009;18(5):368-72.
18. Mirzaie F, Eftekhari N, Goldozeian S, Mahdavinia J. Prevalence of anemia risk factors in pregnant women in Kerman, Iran. Iran J Reprod Med 2010 Spring;8(2):66-9.
19. Salimi S, Nokhostin B, Jahan R, Hazrati S. Investigating the Relationships between Maternal Hemoglobin Concentration and Maternal Body Mass Index in Pregnancy and Neonatal Birth Weight. Iranian J Obstetr Gynecol Infertil 2012;15(14):14-20. (Full Text in Persian)
20. Laflamme EM. Maternal hemoglobin concentration of pregnancy outcome: A study of the effects of elevation in EL alto bolivia. Mcgill J Med 2011 Jun;13(1)47.
21. Lu ZM, Goldenberg RL, Cilver SP, Gutter G, Blankson M. The relationship between maternal

hematocrit and pregnancy outcome. Obstet Gynecol 1991 Feb;77(2):190-4.
22. Steer P, Alam MA, Wadsworth J, Welch A. Relation between maternal haemoglobin concentration and birth weight in different ethnic groups. BMJ 1995 Feb 25;310(6978):489-91.
23. Scanlon KS, Yip R, Schieve LA, Cogswell ME. High and low hemoglobin levels during pregnancy: differential risks for preterm birth and small for gestational age. Obstet Gynecol 2000 Nov;96(5 Pt 1):741-8.
24. Deshmukh JS, Motghare DD, Zodpey SP, Wadhva SK. Low birth weight and associated maternal factors in an urban area. Indian Pediatr 1998 Jan;35(1):33-6.
25. Carey C, Gibbs RS. Preterm labor and post-term delivery. In: Gibbs RS, Karlan BY, Haney AF, Nygaard IE. Danforth's obstetrics and gynecology. 10th ed. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 165-85.
26. Singh LC, Chouhan CR, Sidhu MK. Maternal factors for low birth weight babies. MJAFI 2009;65(1):10-12.
27. Sharifzadeh F, Kashanian M, Jouhari S. Study of the Relationship between Body Mass Index and Birth Weight, Spontaneous Preterm Labor and Maternal Anemia in Shahid Akbarabadi Hospital, Tehran, 2008. Iranian J Obstetr Gynecol Infertil 2012; 15(14):14-20. (Full Text in Persian)
28. Wise LA, Palmer JR, Heffner LJ, Rosenberg L. Prepregnancy body size, gestational weight gain, and risk of preterm birth in African-American women. Epidemiology 2010 Mar;21(2):243-52.
29. Zarbakhsh Bhari M.R, Hoseinian S, Afrooz GH, Hooman HA. Prevalence of Low Birth Weight and Comparison of Many Biological Characteristics of Low Birth Weight Newborns, Mothers with those of normal weight- newborns' counterparts. J Guilan Univ Med Sci 2012; 21(81):37-44. (Full Text in Persian)
30. Sharifirad Gh, Mohebi S. A Survey of Maternal Weight Gain during Pregnancy Based on Recommended Standards and its Correlation with Infant Birth Weight in Esfehan – Iran. Health Sys Res 2012;8(3). (Full Text in Persian)
31. Khashan AS, Kenny LC. The effects of maternal body mass index on pregnancy outcome. Eur J Epidemiol 2009;24(11):697-705.
32. Rosenberg AG, Wang X, Xing H, Chen C, Chen D, Guang W, et al. Low preconception body mass index is associated with birth outcome in a prospective cohort of Chinese women. J Nutr 2003 Nov;133(11):3449-55.
33. Mansouri M, Shahfahat A, Mohamadzade A. The evaluation of the effect of maternal blood lead concentration on the incidence of delivery of low birth weight neonate. Sci J Kurdistan Univ Med Sci 2009;14(1):41-46. (Full Text in Persian)
34. Miranda ML, Kim D, Hull AP, Paul CJ, Galeano MA. Changes in blood lead levels associated with use of chloramines in water treatment systems. Environ Health Perspect 2007;115(2): 221-225.
35. West WL, Lnight EM, Edwards CH, Manning M, Spurlock B, James H, et al. Maternal low level lead and pregnancy outcomes. J Nutr 1994;124(6 Suppl):981S-986S.
36. MC Michael AJ, Vimpani GV, Robertson EF, Baghurst PA, Clark PD. The Port Pirie cohort study: Maternal blood lead and pregnancy outcome. J Epidemiol Community Health 1986;40(1):18-25.
37. Lin S, Hwang SA, Marshall EG, Marion D. Does Paternal Occupational Lead Exposure Increase the Risks of Low Birth Weight or Prematurity? Am J Epidemiol 1998;148(2):173-181.
38. Kristensen P, Irgens LM, Daltveit AK, Andersen A. Perinatal outcome among children of men exposed to lead and organic solvents in the printing industry. Am J Epidemiol 1993;137(2):134-44.
39. Andrews KW, Savitz DA, Hertz-Picciotto I. Prenatal lead exposure in relation to gestational age and birth weight: a review of epidemiologic studies. Am J Ind Med 1994;26(1):13-32.
40. Emam Ghoreyshi F, Mahboob E, Rezai M. The relationship between maternal iron whit neonate. Hormozgan Med J 2003,7(3):145-149. (Full Text in Persian)
41. Todd D, Kan PS. Anemia in pregnancy in Hong Kong. J Obstet Gynaecol Br Commonw 1965;72(5):738-744.
42. Tuttle S. Trace element requirements during pregnancy. In: Campbell DM, Gillmer MDG, editors. Nutrition in pregnancy. London: Royal College of Gynaecologists; 1983. p. 47-54
43. Sheldon WL, Aspillaga MO, Smith PA, Lind T. The effect of oral iron supplementation on zinc and magnesium levels during pregnancy. Br J Obstet Gynaecol 1985;92(9):892-8.
44. Tamura T, Goldenberg RL, Johnston KE, DuBard M. Maternal plasma zinc concentrations and pregnancy outcome. Am J Clin Nutr 2000;71(1):109-13.
45. Osendarp SJ, van Raaij JM, Arifeen SE, Washed M, Baqui AH, Fuchs GJ. A randomized, placebo-controlled trial of the effect of zinc supplementation during pregnancy on pregnancy outcome in Bangladeshi urban poor. Am J Clin Nutr 2000;71(1):114-9.
46. Iqbal A, Shahidullah M, Islam MN, Akhter S, Banu S. Serum zinc and copper levels in maternal blood and cord blood of neonates. Indian J Pediatr 2001;68(6):523-6.