A Systematic Review of The Risk Factors Affecting Low Birth Weight

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KEYWORDS
Birth weight, Low birth weight, high risk pregnancy, Systematic review

ABSTRACT
Backgrounds: Low birth weight (LBW) is a significant factor in 60 to 80 percent of all neonatal fatalities and is one of the most important health indicators in the primary measure set used by the International Dietary Surveillance Application. Objectives: This systematic review was conducted to determine the factors affecting to LBW. Materials & Methods: Embase, Cochrane Library, Web of Science, Google Scholar, PubMed, and Scopus, and Persian scientific databases were searched from 2012 to 2022. Selection procedure, data screening and analysis were performed by two independent reviewers. The quality of included articles were evaluated with the 22-item strengthening the Reporting of Observational Studies in Epidemiology (STROBE) and a checklist of appropriate criteria based on the research design for each one. Results: Of the 1200 articles collected, 51 met the study inclusion criteria. The most common variables with a frequency of more than 15% that led to LBW were the mother's age (22 studies, 43/13%), mother's chronic diseases (Hypertension and diabetes mellitus), mother's iron deficiency anemia (14 studies, 27/45%), mother's weight and BMI (13 studies, 25/4%), ANC visits (12 studies, 23/52%), sex of the child (9 studies, 17/64%), parity and inter-pregnancy interval (8 studies, 15/68%). Conclusion: The mother's age, chronic diseases, mother's anemia, mother's weight and BMI, insufficient ANC visits, sex of the child, parity and inter-pregnancy interval have a great impact on the LBW. Therefore, interventions, plans and programs aimed at addressing these risk factors could potentially reduce the incidence of LBW.

1. Introduction

Birth weight is a critical factor in a baby's chance of living and an excellent way to measure how well the baby grew inside the womb, which is linked to the child's development and growth (Cole et al., 2014). Internationally, the World Health Organization (WHO) defines low birth weight (LBW) as a birth weight less than 2500 g, irrespective of gestational age (Sabbaghchi, Jalali, & Mohammadi, 2020). LBW is one of the most prominent variables influencing child morbidity and mortality globally, responsible for around one-third of newborn fatalities (Pinzón-Rondón et al., 2015). LBW results from the interaction of several maternal variables (Aras, 2013). In 2015, there were 20.5 million newborns worldwide, accounting for 14.6% of all births which, one of every seven births results in low birth weight. Southern Asia accounted for roughly half of the world's LBW incidence rates (26.4%) (Organization, 2019). In Iran, the incidence of LBW was 6.8% in Zanjan, 11.8% in Zahedan, 4.7% in Tehran, 6.3% in Ardabil, and 8.8% in Yazd (Fallah, Karbasi, Golestan, & Fromandi, 2013) (Safari, Samiee, Salehi, Ahmadi, & Ahmadi, 2016). Although the 65th World Health Assembly (WHA) aimed to reduce the incidence rate by 30% between 2012 and 2025, LBW declined from 1.4% per year in 2005-2009 to 1% per year in 2010-2015 globally, whereas the goal would require 2.74% per year. If the current rate of progress continues, the world will only be able to achieve one-third of the WHA goal and fall short of the Sustainable Development Goals (SDGs) (Organization, 2019).

Infants delivered with LBW are vulnerable to a variety of health issues, involving hypothermia, hypoglycemia, cognitive impairment, and malnourishment. Cognitive deficiencies, motor delays, cerebral palsy, and other behavioral and psychological issues are potential risks for LBW babies, in addition to neuropsychiatric conditions and lower gaining in school (Mathewson et al., 2017). Babies born with LBW may have an increased risk of developing health problems such as obesity, diabetes, and heart disease like adults. Additionally, they may also experience developmental delays and infectious issues (Howell & Powell, 2017).

Some factors are known to be associated with LBW, e.g., social economic status (Fujiwara, Ito, & Kawachi, 2013), pre pregnancy body mass index (BMI) (Yu et al., 2013) , infection during pregnancy (Weckman, Ngai, Wright, McDonald, & Kain, 2019), anemia (Figueiredo et al., 2018), hypertension disorder of pregnancy (HDP) (Kanda, Murai-Takeda, Kawabe, & Itoh, 2020),(Liu et al., 2021), traumatic stress (Sanjuan et al., 2021), caffeine intake during pregnancy (Soltani et al., 2022), nutrition status (Bouillon, Antonio, & Olarte, 2022), and environmental chemical exposure, such as particulate matter(Uwak et al., 2021).

Recently, a systematic review study has been conducted on factors affecting low birth weight in Iran (Roozbeh, Hajian, Darvish, & Kiani, 2022). The mentioned research has examined only the studies that have been published in Iran. While the current research has examined these factors at the international level and is not limited to the studied society. Due to the importance of identifying factors affecting and related to fetal weight for screening and timely action, this systematic review was conducted with the aim of identifying risk factors affecting low birth weight.

2. Methods

2.1 Study design

This systematic review was conducted according to Preferred Reporting Items for Systematic review and Meta-Analysis Protocols (Moher, Liberati, Tetzlaff, Altman, & Group, 2009) and the Cochrane Collaboration methodology.

2.2 Search strategy

The researcher conducted a preliminary search on Google Scholar to find an insight into the subject and identify keywords for the consequent search. English databases "(PubMed, Science Direct, Google Scholar, Cochrane library, Psych INFO, Scopus and Web of Science) and Persion databases (Magiran, SID and IranDoc)" were searched for research published between January1, 2012 and December 30, 2022. It was determined that a mixture of the Cochrane Library as well as the PubMed databases yield excellent outcomes to health science investigators. The year 2012 was selected as the starting point for the keywords. To narrow the search, curtailment (to use a phrase to * next to the term), as well as Binary approaches, have been used. The key words/MESH terms and their synonyms were low birth weight and high risk pregnancy. Terms were searched alone and combined with Boolean Operators (and/or). Search syntax used in PubMed was: ((“Low-Birth-Weight Infant”[tiab] OR “Infant*, Low-Birth-Weight”[tiab] OR “Low Birth Weight Infant*”[tiab] OR “Low Birth Weight*”[tiab] OR “Birth Weight*, Low”) AND (“Pregnancy, High Risk” [tiab] OR “Pregnancies, High-Risk” [tiab] OR “High-Risk Pregnanc*”[tiab] OR “High Risk Pregnancy”)).

2.3 Selection criteria

Inclusion criteria: Observational English and Persian language research based primarily on risk factors with low birth weight. The exclusion criteria were as follows: case reports, review and animal studies, dissertations or editorial articles; gray literature (including posters presented in presentations, health authority letters, and departmental initiatives) as unpublished scholarly articles; Publications on topics other than risk factors for having a low birth weight baby, articles to which full-texts access could not be obtained, and articles not written in English and Persian language.

2.4 Data screening

The selection procedure was performed by two independent authors with relevant expertise, whose interrater reliability was calculated using Cohen's kappa and was 0.86. If agreement could not be reached, a third author was consulted. For all included articles, a bibliometric analysis was performed on study design, participants, and main findings or results. Eligible articles were selected based on the relevance of their titles and abstracts. Then, full-text versions of the determined articles were obtained. These articles also were evaluated by the researchers in terms of their eligibility. The

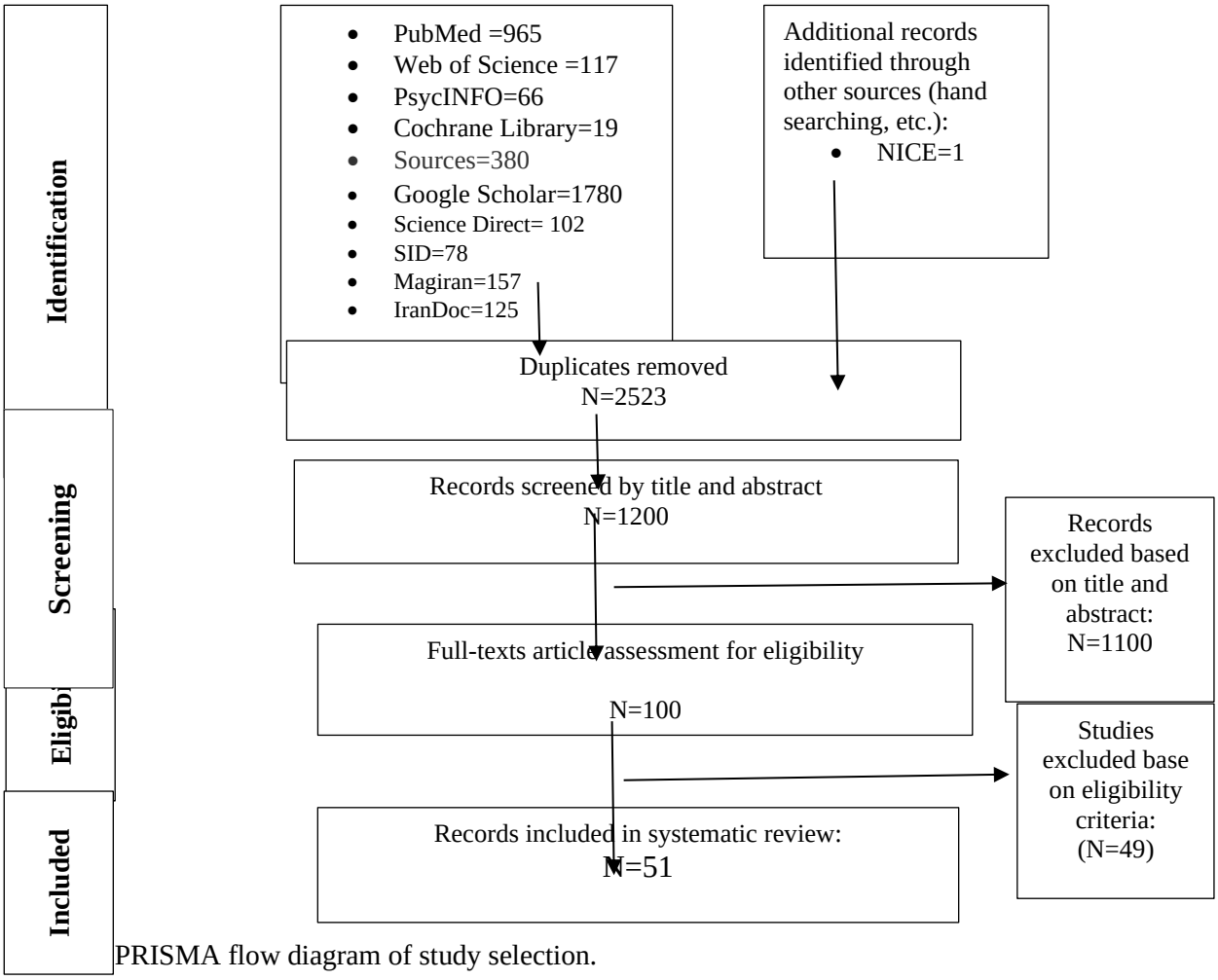
researchers checked the reference lists of selected articles to find any potential additional articles.

2.5 Quality appraisal

All of the included papers were thoroughly check, and the quality of the identified articles was individually assessed by two researchers, with a third researcher consulted to find agreement in the event of a dispute. A checklist of appropriate criteria was used for each study, based on the research design used in each one, according to the critical appraisal skills program for observational cohort and cross-sectional studies. This assessment included both descriptive studies (N – 6), cohort studies (N- 15), cross-sectional studies (N- 22). Following the quality assessment, the 22-item strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist was used. No articles were excluded.

2.6 Data extraction

Data related to study characteristics (i.e. authors, year of publication, location, population, sample size, and statistical methods), study type and outcome variables were extracted separately by two authors. A third author validated the final dataset. Where necessary, authors were contacted by e-mail for missing information or additional data.



PRISMA flow diagram of study selection.

3. Results

3.1 study selection

In this review, initially, 3328 papers were identified. 2128 articles were entered and evaluated according to the inclusion criteria. Of the 100 articles collected, 51 articles met the eligibility criteria, including 23 cross-sectional studies, 3 descriptive studies, 2 population-based study, one time series, one longitudinal study, 10 case-and-control studies, 9 Cohort study and 2 Prospective study (Figure 1).

3.2 Study characteristics

The characteristics of included studies are summarized in Table 1. Most of the studies were related to 2020 (9 studies, 17/64%) There were 277466 pregnant women and 934395 low birth weight infants in the study. Of the 51 evaluated studies, most studies (12 studies, 23/52%) were conducted in Iran and most study designs were related to cross-sectional studies (22 studies, 43/13%).The STROBE checklist assessed the standard reporting of all the research, and the results varied from 14 to 21. (Table 2).

The studies examined various items influencing how much a baby weighed at birth. These factors were classified into 3 categories, including maternal factors, fetal and neonatal factors, and environmental factors. The category of maternal factors was wide and divided into 4 other categories including: demographic factors, socio-economic factors, medical and disease-related factors, and family factors. Respectively most key items were the mother's age (22 studies, 43/13%), mother's chronic diseases (Hypertension and diabetes mellitus), mother's iron deficiency anemia (14 studies, 27/45%), mother's weight and BMI (13 studies, 25/4%), ANC visits (12 studies, 23/52%), sex of the child (9 studies, 17/64%), parity and inter-pregnancy interval (8 studies, 15/68%), family income, short maternal height and gestational age (7 studies, 13/72%), mother's weight gain during pregnancy, rural area, mother's education level and smoking (6 studies, 11/76%), gravida and socioeconomic status (5 studies, 9/8%), preterm delivery and maternal occupation (4 studies, 7/84%), urinary tract infections, poverty, pregnancy hypertensive disorders, preeclampsia, maternal lifestyle, type of delivery and domestic violence (3 studies, 5/88%), maternal depression, drinking of alcohol, maternal malaria, premature rapture of membrane, birth order, type of family, previous abortion, and cardiovascular disease (2 studies, 3/92%).

Some elements that influence birth weight but have received less attention in the literature include the relationship between seasonal patterns and the birth of low-weight infants, ethnicity, husband occupation, husband education, unintended pregnancy, planned pregnancy, intimate partner, history of stillbirth, ante-partum haemorrhage, quality of prenatal care, mother's time rest less than 2 h in a

day, tobacco use by father, institutional place of delivery, hyperemesis graviduram, history of bleeding during pregnancy, self-medication, mother's awareness, multiple births, mother's awareness, unsafe water supply, air pollution, infertility, and the use of assisted reproductive techniques.

Table 1: Characteristics of included studies.

num	Author (Year)	Location	Population	Statistical Methods	Study type	Results	STROBE Score
1	(Bahrami et al., 2012)	Iran	3076 women	Software: SPSS-17; Tests: Independent t-test, ANOVA, linear regression; Level of significance: P<0.05	Descriptive cross-sectional	Significant relationships were observed between the seasonal pattern and the birth of low-weight infants, and the highest frequency of LBW was observed in the summer	21
2	(Khorshidi, Nooshirvanpour, & Najafi, 2013)	Iran	3792 LBW newborns	Software: SPSS-15; Tests: Chi-squared, Fisher; Level of significance: P<0.05	Longitudinal	Multiple births and preterm labor	16
3	(HASHEMIAN, Pejhan, Rakhshani, & Hoseini, 2014)	Iran	481 LBW infants	Software: SPSS-11.5; Tests: ANOVA and t-test; Level of significance: P<0.05	Descriptive analytical	Income, mother's awareness and urinary tract infections affected birth weight	18
4	(Chang et al., 2014)	Korea	691 women	Software: SPSS-18; Tests: Chi-squared and t-test; Level of significance: P<0.05	Prospective cohort	Maternal depression and birth weight a reflection of the impact of depression on offspring gestational age	14
5	(Hayat, Khan, Hayat, & Hayat, 2013)	India	500 women	Software: SPSS-; Tests: Chi-squared; Level of significance: P<0.05	cross sectional study	Maternal age, socioeconomic and educational status, pregnancy interval and number of antenatal visits along with maternal anemia, hypertension and urinary tract infection, during pregnancy	16
6	(Kayode et al., 2014)	Canada	6,900 mothers	Software: SPSS-15; Tests: MMLR and OR; Level of significance: P<0.01	population-based study	Rural dweller, Living in a community with a high concentration of poverty and a low coverage of safe water supply	17
7	(Sutan, Mohtar, Mahat, & Tamil, 2014)	Malaysia	279 LBW infants	Software: SPSS-; Tests: Chi-squared and t-test; CI,Level of significance: P<0.01	Matched case control study	Maternal age, ethnicity, gravida, parity, gestational age, maternal booking weight, height and body mass index (BMI), history of low birth weight infants, Birth interval, booking hemoglobin levels, hypertension, diabetes mellitus and mode of delivery.	15
8	(Takai, Bukar, & Audu, 2014)	Nigeria	854 women	Software: SPSS-; Tests: Chi-squared and t-test; multivariate logistic regression	a prospective study	Non-use of haematinics index pregnancy, previous history of stillbirth, hypertensive disorders of pregnancy,	19

				,Level of significance: P<0.05		ante-partum haemorrhage, less than 4 ANC visit, previous history of premature delivery, previous history of LBW and non-use of intermittent preventive therapy in the index pregnancy, and teenage mother	
9	(Pinzón-Rondón et al., 2015)	Colombia	10,692 infants	Software: SPSS-20; Tests: Chi-squared and t-test; Level of significance: P<0.05	cross-sectional study	Quality of prenatal care, prenatal visits, first prenatal visits during pregnancy were related significantly to LBW	17
10	(Gupta, Swasey, Burrowes, Hashan, & Al Kibria, 2019)	Afghanistan	431 LBW newborns	Software: SPSS Tests: OR, multivariate logistic regression ,Level of significance: P<0.05	cross-sectional	No intake of iron tablets by the mother during pregnancy, Inadequate and adequate ANC visits	21
11	(Rajashree, Prashanth, & Revathy, 2015)	India	131 mothers	Software: Epi-Info-7 version Tests: Chi-squared , adjusted odds ratio and multivariate logistic regression ,Level of significance: P<0.05	cross-sectional study	mothers who took day time rest less than 2 h in a day, among anemic mothers, history of tobacco chewing associated with LBW	17
12	(Demelash, Motbainor, Nigatu, Gashaw, & Melese, 2015)	South-East Ethiopia	387 mothers	Software: SPSS-15; Bivariate logistic regression, Level of significance: P<0.05	case–control study	maternal age, residence, maternal education, maternal occupation, husband's occupation, husband's education, monthly income and participation on decision on how money be used	19
13	(Baghianimoghadam, Baghianimoghadam, Ardian, & Alizadeh, 2015)	Iran	250 newborns	Software: SPSS-15; Tests: Chi-squared and t-test; Level of significance: P<0.05	Descriptive cross-sectional	The mother's age and weight was related significantly to the infant's birth weight	21
14	(Taywade & Pisudde, 2017)	India	307 women	Software: Epi-Info-7 version Tests: CI , adjusted odds ratio and multivariate logistic regression ,Level of significance: P<0.05	case–control study	Maternal age less than 20 years or more than 30 years, nuclear family, poor standard of living, tobacco use by father, female sex of the baby, and among environment and housing characteristics, the absence of sanitary latrine	14
15	(Khan, Nasrullah, & Jaleel, 2016)	Karachi	947 women	Software: SPSS-15; Tests: Chi-squared and OR; Level of significance: P<0.01	cross-sectional study	Low socio economic status, anemia, prim parity, short maternal height and less than average weight were related significantly to LBW.	16
16	(Ghouse & Zaid, 2016)	Pakistan	100 women	Software: SPSS-; Tests CI, Logistic regression and; Level of significance:	Cross Sectional Study	Mother's education; Mother's working status, wealth index of family, gender of child, Place of residence, age of mother	16

				P<0.05		at first birth with birth weight of infant, birth-interval, birth order and institutional place of delivery, and male sex of infant	
17	(Karamzad et al., 2016)	Iran	6027 newborns	Software: STATA; Tests: Chi-squared, Fisher and OR; Level of significance: P<0.01	Case control	Mother's age, age at marriage and mother's weight gain before pregnancy were related significantly to LBW	16
18	(Kandel & Kafle, 2017)	Nepal	480 births	Software: SPSS-20; Tests Fisher's exact test , Logistic regression and OR; Level of significance: P<0.01	cross sectional study	age of mother at delivery, weight gain by mother during pregnancy, short, low body mass index and hyperemesis gravidarum	17
19	(Monjezi, Rostami, Boland, & Cheraghian, 2017)	Iran	1500 newborns	Software: SPSS-20; Tests: ANOVA, t-test and logistic regression; Level of significance: P<0.05	Descriptive analytical	Cardiovascular diseases, anemia before pregnancy, hypertension and urinary tract infection during pregnancy and gestational diabetes	19
20	(Kumar et al., 2017)	India	800 newborns	Software: SPSS-20; Tests: Chi-squared, Level of significance: P<0.05	cross-sectional study	sex of baby, type of family, socioeconomic status, educational status of mother, occupation of mother, anemia and intake of IFA	18
21	(Moradi et al., 2017)	Iran	182 mothers with LBW newborns and 364 controls	Software: SPSS-20; Tests: ANOVA, t-test, logistic regression; Level of significance: P<0.05	Case control	Iron deficiency anemia, blood pressure during pregnancy, history of bleeding during pregnancy	17
22	(Ahmadi et al., 2017)	Iran	600 pregnant women	Software: Statistical R version 3.2.2; Tests: PPV, NPV and regression; Level of significance:-	Cross-sectional	Gestational age, BMI in the third trimester of pregnancy and mother's age and BMI in the first trimester of pregnancy	17
23	(Habib et al., 2018)	Pakistan	950 (475 cases and 475 controls)	Software: SPSS-19Tests: Chi-square, ORs, and CIs; Level of significance: P<0.05	matched case–control study	Illiteracy, null parity, previous miscarriage or abortion, number and timing of ANC visits, lack of iron and folic acid supplementation during pregnancy, presence of hypertension or anemia during pregnancy and postpartum maternal < 45	19
24	(Alemu, Abageda, Assefa, & Melaku, 2019)	southern Ethiopia	341 mother	Software: SPSS-20, Epi-Info version-7 Tests: ORs, confidence intervals, and logistic regression Level of significance: P<0.05	cross-sectional study	Mothers' non-employment, residing in the rural, unintended pregnancy, not attending antenatal care, mothers with greater than three births, birth interval less than or equal to two years and intimate partner violence during	21

						pregnancy .	
25	(Rosy et al., 2018)	Bangladesh	300 women	Software: SPSS-20 Tests: Chi-square,; Level of significance: P<0.05	a prospective case control study	Maternal height, maternal weight, pre-eclampsia, PROM, chronic hypertension & PPH, heart disease and DM	17
26	(Victora et al., 2020)	Brazil	19,625 newborns	Software SPSS-24 Tests: Chi-squared, regression analysis; Level of significance: P<0.01	cross-sectional	Maternal age, income and type of delivery for very low birth weight.	20
27	(Rao et al., 2018)	China	109,780 births	Software R for Windows version 3.4.1.,Tests: CI, two-sided tests, regression analysis; Level of significance: P<0.01	A retrospective observational study	Maternal age, hypertensive disorders complicating pregnancy (HDCP), and diabetes	21
28	(Gogoi, 2018)	India	300 mothers	Software: SPSS-18 Tests: Bivariate and multivariate logistic regression, Level of significance: P<0.05	cross sectional study	Maternal age , height of the mother , history of ANC visit ,history of high risk behavior (use of tobacco) ,multiple pregnancy ,gestational age ,normal mode of delivery, Female child and preterm birth, weight gain during pregnancy	19
29	(Trisnawati, Salimo, & Murti, 2018)	Indonesia	200 newborn	Software SPSS-Tests: Chi-squared, CI; Level of significance: P<0.01	observational study with a case control	Gestational age, infant sex, maternal mid-upper arm circumference (MUAC), maternal gestational stress, maternal education, family income at gestational period, and sanitation	17
30	Photisan et al. (2019)	Thailand	299 women	Software R Tests: Exact probability test, t-test, CI and RR Level of significance: P<0.05	retrospective cohort study	maternal age, gestational age, hematocrit level, birth order, completeness of antenatal care visits and oral health status	15
31	(Seid, Tolosa, & Adugna, 2019)	Ethiopia	3546 newborn	Software: SPSS-23 Tests: Chi-square, and independent t-tests; Level of significance: P<0.05	cross sectional descriptive	Maternal age, parity, and Antenatal care follow up as well as new-born related factors like sex of the neonate and gestational age	17
32	(Anand, Gupta, & Sudan, 2019)	India	330 women	Software: SPSS-24 Tests: Chi-square, and Binary logistic regression; Level of significance: P<0.05	A cross-sectional	Maternal age, parity, and Antenatal care follow up as well as new-born related factors like sex of the neonate and gestational age	15
33	(Sarizadeh, Dastoorpoor, Goudarzi, & Simbar, 2020)	Iran	150,766 pregnant women	Software: R, Amulti-pollutant Test: generalized additive model (GAM) was used to estimate the risk ratio (RR), Level of significance: P<0.05	A time-series	Air pollution	20

34	(Wubetu, Amare, Haile, & Degu, 2021)	Ethiopia	337 mothers	Software: Epi-data version 3.1, and SPSS-20 Tests: CI and linear regression; Level of significance: P<0.05	cross-sectional study	Maternal nutritional factors, Age of the mother, family average monthly income, being single, alcohol use, education, female sex, had no abortion history and multigravida	19
35	(Utami, Rahayuningtyas, Santy, Hidaayah, & Yulis, 2020)	Indonesia	54 newborns	Software: SPSS-19, Tests: multiple logistic regression; Level of significance: P<0.05	explanatory research design survey with a cross-sectional	History of antenatal care, antenatal care (ANC) ≥ 4 times and complications in the pregnancy	20
36	(Asgarian, Sourani, Afrashteh, Mohammadbeigi, & Aligol, 2020)	Iran	602 newborns	Software: SPSS-18 Tests: Chi-square, Fisher exact, and independent t-tests; Level of significance: P<0.05	Retrospective	Preterm labor, premature rupture of membrane (PROM)	18
37	(Xi et al., 2020)	China	1964 LBW neonate	Software: SPSS-22 Tests: ORs, confidence intervals, and logistic regression Level of significance: P<0.05	Case-control study	Maternal physical activity during pregnancy had relationship with LBW	17
38	(KC, Basel, & Singh, 2020)	Nepal	369; 123 cases and 246 controls.	Software: Epi data Version 3.1SPSS-21 Tests: Chi-square, OR, and Multivariate logistic regression, Level of significance: P<0.05	case-control study	Having the kitchen in the same living house, iron intake less than 180 tablets during pregnancy, maternal weight gain less than 6.53 kg during the second and third trimester, comorbidity during pregnancy and preterm birth	16
39	(Sharifi et al., 2020)	Iran	160 women	Software: SPSS-18 Tests: Pearson regression and linear logistics tests. Level of significance: P<0.05	Cross-sectional	Low maternal hemoglobin levels	17
40	(Rahman, Uddin, Lata, & Uddin, 2022)	India	11,423 women	Software: STATA; 15 Tests: Chi-squared, regression analysis; Level of significance: P<0.01	a population-based Survey	Intimate partner violence exposure was associated with a significant LBW	20
41	Liuet al. (2021)	China	890 LBW neonates	Software: SAS 9.4 software with the RCS_Reg macro Tests: The chi-square test and Kruskal-Wallis test were used for univariable analyses. The multinomial logistic regression model and restrictive cubic spline model were used to explore the relationships; Level of significance:	prospective cohort study	Pre-pregnancy BMI, Gestational weight gain (GWG) rate	19

				P<0.05			
42	(Wang et al., 2020)	China	3585 Women	Software: SPSS-21 Tests: CI; Level of significance: P<0.05	cross-sectional	Mother's age, weight, height, anemia, birth interval, bad obstetric history with complications and family income.	21
43	(Manouchehri et al., 2021)	Iran	327 LBW neonate	Software: SPSS-11 Tests: ANOVA and t-test; Level of significance: P<0.05	Cross sectional	History of hypertension, preeclampsia, infertility, the use of assisted reproductive techniques, and self-medication had relationship with LBW	18
44	(Wangdi et al., 2020)	Malaysia	45 cases and 90 controls	Software: SPSS-Tests: CI,OR; Level of significance: P<0.05	case-control study	Height at booking, Weight at booking, Body Mass Index (BMI), Weight gain during pregnancy, Parity, Period of gestation at booking, History of low birth weight, Birth spacing/interval, Number of visits for antenatal care, Pre-existing Hypertension, Pre-existing Diabetic Mellitus	20
45	(Lewandowska, 2021)	Poland	912 women	Software: STATA; 13 Tests: Chi-squared, interquartile ranges and IQR; Level of significance: P<0.01	a prospective cohort study	Gestational weight gain (GWG), primiparity, maternal age, maternal height, smoking in the first trimester, fetal sex, preeclampsia and gestational diabetes mellitus in this pregnancy, and gestational age at childbirth, as well as prior pregnancy-induced hypertension.	19
46	(Uchinuma et al., 2021)	Japan	98,052 newborns	Software: STATA; Tests: a multinomial logistic regression and OR; Level of significance: P<0.01	nationwide cohort study	Gestational body weight gain from pre-pregnancy to the first trimester had a small effect on the risk of LBW. From the first to second trimesters, insufficient GWG, and from the second trimester to delivery, a GWG of less than 2 kg	18
47	(Diabelková et al., 2022)	Slovak Republic	271 LBW neonate	Software: SPSS-23 Tests: Chi-square, and independent t-tests; Level of significance: P<0.05	cross-sectional study	Maternal lifestyle, maternal care before, during and after birth, and strengthen social support	18
48	(Lingani et al., 2022)	Burkina Faso	600 neonates	Software: STATA; Tests: a multinomial logistic regression and OR; Level of significance: P<0.05	cross-sectional study	Maternal malaria, fever and low uptake of sulfadoxine pyrimethamine	19
49	(Nishihama, Nakayama, & Tabuchi, 2022)	Japan	91,559 mother–child dyads	Software: R; Tests: a logistic regression and OR; Level of significance:	cross-sectional study	Parity, history of adenomyosis, hypertension disorder of pregnancy, maternal age at birth, prepregnancy	16

				P<0.05		body mass index, gestational weight gain (GWG), maternal smoking and lead (Pb) exposure.	
50	(Bandyopadhyay et al., 2023)	UK	693,377 children	Software: SPSS-23; Tests: a logistic regression and OR; Level of significance: P<0.05	cohort study	Pregnancy interval less than one year , maternal diabetes, maternal hospital admission for anemia, depression, serious mental illness, anxiety and use of anti-depressant medication during pregnancy, Additional maternal risk factors include smoking, alcohol-related hospital admission, substance misuse, living in areas of high deprivation, and evidence of domestic abuse.	21
51	(Odongkara et al., 2022)	Uganda	1877 women	Software: SPSS-; Tests: IPT, CI; Level of significance: P<0.05	Based Cohort Study	Maternal age years, history of a small newborn in the previous pregnancy, maternal malaria in pregnancy and intermittent preventive treatment (IPT) for malaria	19

4. Discussion

This systematic review examined 51 papers about low birth weight (LBW) and the factors affecting birth weight. Based on the included studies, the most common factors that led to LBW with a frequency of more than 15% were, respectively, the mother's age, chronic diseases, mother's anemia, mother's weight and BMI, insufficient ANC visits, sex of the child, parity and inter-pregnancy interval.

Researchers in the US found that teenage mothers were more likely to have trouble giving birth than older mothers (Dennis & Mollborn, 2013), (Restrepo-Méndez et al., 2015). Recently, cases of LBW in women above 35 years have increased. Several factors are thought to be involved in this increase, including underlying disorders and lower cardiovascular reserve, use of infertility techniques. The increased incidence of LBW in the two age groups (adolescents and over 35) may be due to socioeconomic concerns (Restrepo-Méndez et al., 2015); that, the current study suggested this criteria as a one risk factor contributing to LBW.

Same to the present study, studies show that LBW is linked to mother's health problems, such as heart and kidney diseases, high blood pressure, smoking (Moradi et al., 2017), diabetes mellitus (Sutan et al., 2014), and kidney problems (Berglund, Westrup, Hägglöf, Hernell, & Domellöf, 2013; Monjezi et al., 2017; Roozbeh et al., 2022). Therefore, it seems important to screen and monitor women of reproductive age in terms of the presence of these health problems.

Same to this study, mother's anemia as one of the risk factors for the LBW reported in recent systematic reviews and meta-analyses (Azizah, Dewi, & Murti, 2022; Figueiredo et al., 2018). Maternal anemia, by disrupting the transfer of hemoglobin to the fetus through the placenta, leads to disruption of fetal weight gain and, as a result, low birth weight (Novianti & Aisyah, 2018).

The results of this study showed that mother's BMI is another thing that affects birth weight. The health and development of the fetus also depended a lot on how well the mother ate. Both the mother's and the baby's health were affected by the mother's BMI before pregnancy and her weight gain during pregnancy. Studies have shown that these two factors significantly affect a pregnancy's results, especially in developing nations (Al-Hinai, Al-Muqbali, Al-Moqbali, Gowri, & Al-Maniri, 2013; Daliri, Karimi, Sayehmiri, Bazyar, & Sayehmiri, 2016). In particular studies, LBW and the mother's BMI at the start of pregnancy were positively correlated. A high incidence of LBW births was present in mothers with a BMI under 18. (Da Costa, Cevallos, Altman, Rutjes, & Egger, 2011). On the other hand, a study in the Poland reported that the highest BMI was associated with the highest odds ratios of LBW (Lewandowska, 2021). Anyway, studies have linked the mother's weight at the start of pregnancy to the baby's birth weight. Miletić and Murakami's research shows a direct correlation between high BMI and a significant rise in birth weight (Miletić & Stoini, 2005; Murakami et al., 2005).

Similar to the results of the present study, previous researchers revealed that insufficient, low-quality, less than 4 times with long interval ANC visits were the other factor affecting LBW (Gupta et al., 2019; Habib et al., 2018; Hayat et al., 2013; Pinzón-Rondón et al., 2015; Takai et al., 2014). Limited or absent antenatal care and pregnancy problems raised the risk of low birth weight in newborns (Dasa, Kassie, Roba, & Kelel, 2020; Han, Lutsiv, Mulla, McDonald, & Group, 2012; Mahecha-Reyes & Grillo-Ardila, 2018). This finding emphasizes the increase in the design of awareness programs about the positive effects of ANC visits for pregnant mothers and health care workers.

In line with current study, last systematic review in 2015 reported that baby's gender specially female sex had a significant relationship with the low birth weight (Bazyar, Daliri, Sayehmiri, Karimi, & Delpisheh, 2015). Also other studies discovered that LBW was more common amongst female than male infants (Taywade & Pisudde, 2017; Wubetu et al., 2021).

Similar to current study, multiparity in other studies revealed as one of the affecting factor for incidence of LBW (Bekele, Seyoum, Tesfaye, & Fantahun, 2019; Iltaf, Shahid, & Khan, 2017). Contradicting this finding, Garces et al (2020) reported that nulliparity was associated with low birth weight (Garces et al., 2020). Also, Lin et al (2021) in their retrospective study showed lower risk of LBW in multiparous women (Lin, Lu, Chen, Li, & Guo, 2021). Although low birth weight is a multifactorial condition, but basic studies with high sample size and valid design are needed to resolve these contradictions.

Inter-pregnancy interval, the other result of current study, was as one of the risk factors for the LBW. This finding was in line of previous study that reported inter-pregnancy interval less than 12 month had negative effects at the 5th and 10th quantiles of the birth weight (BW) distribution (Zhang et al., 2018). Contradictory to the mentioned study, Shi et al (2021) reported Inter-pregnancy interval more than 120 months is associated with a higher risk of LBW (Shi, Zhang, Kang, Dang, & Yan, 2021). It seems that both short and long Inter-pregnancy interval can have negative effect on the baby's weight. But designing strong clinical trial studies for solve this issue are critical.

According to current study, many other maternal, environmental, fetal and neonatal factors are important and effective for LBW. This alone is one of the strengths of the present study. For future studies, it provides the possibility of designing appropriate studies to independently investigate each of the factors affecting low birth weight, and by identifying a wide range of effective factors and also the most important of them, it paves the way for designing effective programs for better management for LBW. However, further research is needed to develop effective strategies for reducing the incidence of LBW and improving outcomes for affected infants.

4.1 Limitation

Some of the limitations that we faced with during the study included the lack of access to the full text of some of the studies, sufficient information in the studies, and inadequate of samples in some of the studies.

5. Conclusion

Based on the results of present study, the mother's age, chronic diseases, mother’s anemia, mother's weight and BMI, insufficient ANC visits, sex of the child, parity and inter-pregnancy interval have a great impact on the LBW. Therefore, interventions, plans and programs aimed at addressing these risk factors could potentially reduce the incidence of LBW. Also, this study highlights the importance of early identification and management of LBW risk factors to improve maternal and infant health.

Author Contributions

PO, DSR, and SH: Study design. DSR, PO: Data collection, data analysis and interpretation. DSR, PO, SH, and MKH: Manuscript writing. PO, SH, and MKH: Critical revisions for important intellectual content.

Ethics statement

As a part of doctoral dissertation, this study has been approved by the ethics committee of Shahid Beheshti University of Medical Sciences. (IR.SBMU.PHARMACY.REC.1401.248).

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Declaration of interest

The authors declare that they have no competing interests.

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