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Intention to Become Pregnant and Low Birth Weight and Preterm Birth: A Systematic Review

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Abstract Increased stress, psychosocial problems, economic disadvantages, and lack of prenatal care are proposed to explain discrepancies in the outcome of unintended pregnancies. Studies of maternal intention and pregnancy outcomes have yielded varied results. Objective is to review studies of the risk of low birth weight (LBW)/preterm births (PTB) associated with unintended pregnancies ending in a live birth. We reviewed studies reporting on maternal intentions and outcomes from Medline, Embase, CINAHL, and bibliographies of identified articles. An unintended pregnancy was further classified as mistimed (not intended at that time) or unwanted (not desired at any time). Studies reporting an association between pregnancy intention and any of the outcomes were included. Study quality was assessed for biases in selection, exposure assessment, confounder adjustment, analyses, outcomes assessment, and attrition. Unadjusted and adjusted data from included studies were extracted by two reviewers. There were significantly increased odds of LBW among unintended pregnancies [odds ratio (OR) 1.36, 95% confidence interval (CI) 1.25, 1.48] ending in a live birth. Within the unintended category, mistimed (OR 1.31, 95% CI 1.13, 1.52) and unwanted (OR 1.51, 95% CI 1.29, 1.78) pregnancies were associated with LBW. There were

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statistically significantly increased odds of PTB among unintended (OR 1.31, 95% CI 1.09, 1.58), and unwanted (OR 1.50, 95% CI 1.41, 1.61) but not for mistimed (OR 1.36, 95% CI 0.96, 1.93) pregnancies. Unintended, unwanted, and mistimed pregnancies ending in a live birth are associated with a significantly increased risk of LBW and PTB.

Keywords Low birth weight · Preterm birth · Unintended pregnancy

Abbreviations

LBW	Low birth weight
PTB	Preterm birth
SGA	Small for gestational age

Background

The desire of a couple or woman either to achieve or avoid pregnancy involves an intricate decision making process [1]. According to reports from developed countries, approximately one-third of pregnancies that result in live births and half of all pregnancies irrespective of outcome are unintended [2]. Despite dissemination of information about the availability, safety and effectiveness of contraceptive devices, legalization of abortion, female sterilization and post-coital contraception, unintended pregnancies occur [3]. Unintended pregnancies are reported to have effects on maternal outcomes [4], maternal health and well being [5], and childhood outcomes [6]. A higher usage of medications, higher rates of chronic medical problems and complications during pregnancy, including infections, were reported with unintended pregnancies [1]. Suggested mechanisms for adverse outcomes include higher levels of stress [2], social and economic disadvantages, adoption of risky behaviors such as smoking [3, 7], delayed initiation or inadequate prenatal care [2, 8], and reduced willingness to seek social support for problem solving [5] among women with unintended pregnancies compared to women with intended pregnancies. Unintended pregnancies and adverse outcomes are also reported among women who are highly educated and of higher socioeconomic status [9].

An unintended pregnancy can be mistimed (not intended at that time) or unwanted (not desired at any time). A few women report being unsure about the intention of their pregnancy at the time when they became pregnant. Studies of an association between maternal intention regarding pregnancy and outcomes of low birth weight (LBW)/preterm births (PTB) yield varied results.

Our primary objective was to systematically review studies of the association between LBW/PTB and unintended and intended pregnancies ending in a live birth. The secondary objectives were (a) to review studies of an association between small for gestational age (SGA) births and unintended and intended pregnancies and (b) to investigate effects of mistimed and unwanted pregnancies within the category of unintended pregnancy.

Methods

We followed "Meta-analyses of Observational Studies in Epidemiology" guidelines in preparing this report [10]. The data were extracted from already published manuscripts and thus, no institutional research ethics board approval was needed.

Criteria for Considering Studies

Observational studies (matched, unmatched, or historical controls; longitudinal studies; and case–control studies) that explored the association of the intention to become pregnant and the outcomes of LBW/PTB/SGA births were included in this review. If the study provided adequate information on the method of ascertainment of the intention to become pregnant and its effects on any of the outcomes of interest, the study was eligible for inclusion in the review. Reports of data from national or local Vital Statistics not reported as published manuscripts were not included. Studies published only as abstracts were not included.

Assessment of Exposure

Maternal intention to become pregnant for the index pregnancy was classified broadly as (a) intended—when mother indicated that she wanted to become pregnant at that time or sooner and (b) unintended—when mother indicated that she wanted to become pregnant later (also classified as mistimed) or never wanted to become pregnant (also classified as unwanted). Women who responded that they were unsure or undetermined regarding their pregnancy intention were included in the unintended group because at least they did not report that they intended the pregnancy.

Outcomes

Studies reporting data on any of the outcomes were included. Outcomes of interest included [1] low birth

weight defined as birth weight <2.5 kg; [2] preterm birth defined as gestational age <37 weeks; [3] birth weight in grams; [4] gestational age in weeks; and [5] small for gestational age (SGA) defined as birth weight below 10th centile for gestational age.

Search Strategy for Identification of Studies

Electronic databases (Medline, Embase, and CINAHL) were searched from their inception to March 2009 for all published studies in the English language. The search terms were modified according to database requirements. The reference lists of the identified articles were reviewed to locate further eligible studies. The articles were scanned initially based on titles and abstracts by two authors and recorded on a study relevance sheet. The reviewers were not blinded to study institutions or authors. Articles selected by either author were retrieved in full and were assessed for eligibility by both authors. Discrepancies were resolved by consensus. Differences for final eligibility were resolved by consensus. Search terms used were: *pregnancy, unwanted; pregnancy, unplanned; high risk pregnancy; infant, premature; preterm (text word); prematurity; infant, newborn; low birth weight; and small for gestational age*.

Methods of the Review

Data Extraction

Data from each eligible study were extracted using custom-made data collection forms by two authors independently. We included only information available from the publications and did not contact primary authors. No modification of original data was performed. Confounders adjusted for in the analyses in the individual studies were reported. Data on mistimed or unwanted pregnancy were extracted if they were reported. Raw numbers and adjusted results were collected from eligible studies when available.

Assessment of Risk of Bias in Included Studies

Methodological quality of studies was assessed using a pre-defined checklist based on criteria for sample selection, exposure assessment, confounders, analytical methods, outcome assessment and attrition biases (Appendix 1). The classification in each category was no bias, low risk, moderate risk and high risk of bias. Assessment was performed by two authors independently and discrepancies were resolved by consensus. Overall bias was ascertained based on the highest bias reported in any of the categories. Studies with high risk of bias in three or more domains were excluded. Retrospective (1 year after the birth) assessment of maternal intention was considered "moderate risk" of bias.

Data Synthesis

Adjustment for confounders in observational studies of this nature always varies between studies. Thus, a priori, a decision was made to primarily meta-analyze unadjusted data. Data were compared including odds ratio (OR) and 95% confidence intervals (CI). As is traditional with other meta-analyses, no adjustments for multiple analyses were made. Weighting of the studies in the meta-analyses was calculated based on the inverse variance of the study. Meta-analytic software (Revman) was used [11]. The random effects model was chosen because it accounts for both random variability and the variability in effects among the studies as we expected a degree of clinical and statistical heterogeneity. For categorical measures, odds ratios were reported and for continuous measures, mean differences were used. Summary estimates with 95% confidence intervals (CI) were calculated and total number of participants that contributed to individual analyses was reported. Subgroup analyses based on comparison of outcomes among unwanted and intended, and mistimed and intended pregnancies were performed. If the variable was identified as significant, population attributable risk (PAR) was calculated using the following formula:

$$\text{PAR} = \frac{\text{Incidence in the population} - \text{Incidence in the intended pregnancy group}}{\text{Incidence in the population}}$$

We intended to perform sensitivity analyses of studies of high risk populations (multiple births, previous history of preterm births, and mothers with history of smoking during pregnancy); however, we could not identify studies that differentiated such populations.

Some authors have reported both adjusted and unadjusted risks in their population controlling for confounders perceived (or statistically proven) to have effect on the summary estimate. We pooled data from these studies, which reported adjusted risk estimates, and performed

random effects model meta-analyses using the generic inverse variance method [12].

Heterogeneity and Publication Bias Assessment

Clinical heterogeneity was assessed and reported in the table of included studies. Statistical heterogeneity was assessed by calculating I^2 values [13]. Funnel plots were assessed for the possibility of publication bias.

Results

Description of Studies

The results of the search, the study selection log, and the number of studies are reported in Fig. 1. Fifteen studies were included in this review [1–6, 9, 14–21] (Tables 1, 2). Thirteen studies were cohort studies with matched or unmatched controls and two studies were case–control studies. Three studies assessed maternal intentions during pregnancy, six studies assessed it immediately (within 3 months) after the birth of the child and six studies assessed it later (after 3 months postpartum).

Ten studies were excluded: Baydar [22] reported on a sub-sample already reported by Joyce et al. [6]; Sable et al. [8] reported on a sub-sample of Kost et al. [19], Keeton et al. [23] only reported on very preterm and very low birth weight infants who were admitted to a neonatal intensive care unit. McCormick et al. [24] did not provide data except to remark that there was no difference in PTB between intended and unintended groups. The other six studies [7, 21, 25–28] failed to meet eligibility criteria. Although the study by Kost et al. [19] met the inclusion criteria for our systematic review, study data were not in the required format and could not be included in a meta-analysis. Baseline characteristics of included studies are reported in Table 1 and details of exposure ascertainment are included in the Table 2.

Methodological Quality of Included Studies

The results of the quality assessments of the included studies are reported in Table 3. All studies had low to moderate risk of overall bias. Seven studies had moderate

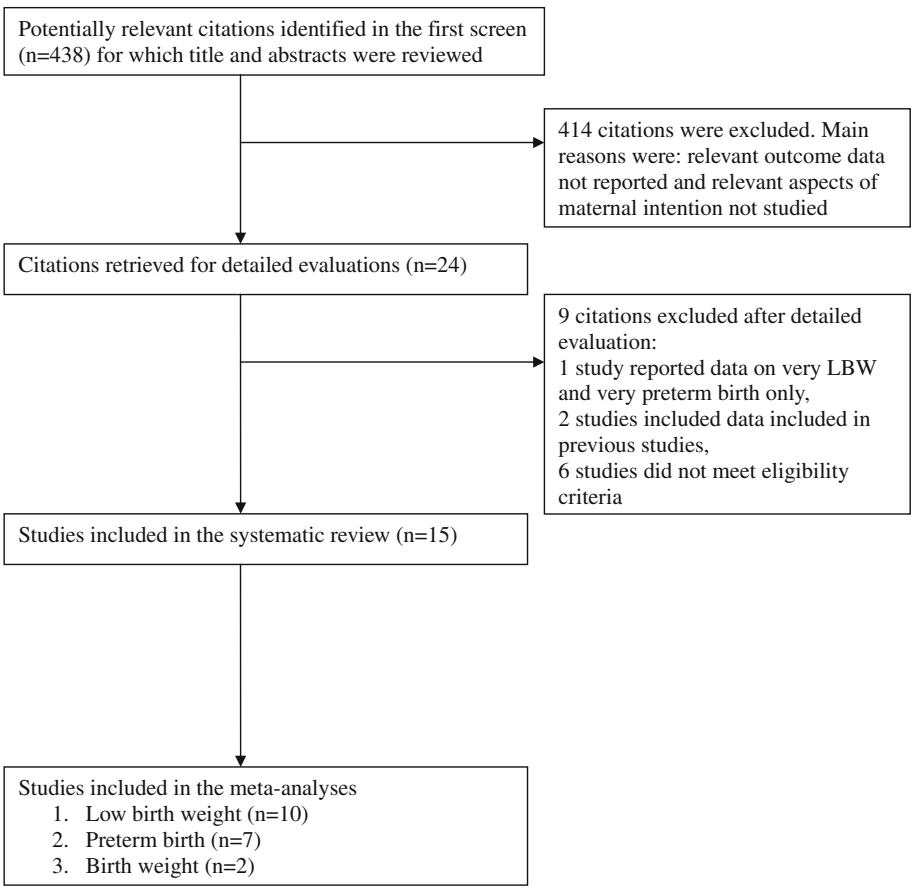

Fig. 1 Flow chart for selection of studies

Table 1 Characteristics of included studies

Author	Place/population of study	Baseline differences in the population studied
Hultin [18]	1,566 Women who had refusal of abortion application from Sweden	Higher incidence of young and late maternal age among unintended pregnancies
Morris [9]	7,921 Postpartum mothers in wards at sixty hospitals in the US	Lower educational level among mothers with unintended pregnancies
Cartwright [3]	1,486 Postpartum women from ten regions in England	More young, single and women with >2 children in unintended group
Sharma [21]	1,004 Women who had a live birth in six high risk geographic areas Pennsylvania, US	No differences between two groups
Bitto [1]	656 Women using natural family planning in Chile, Colombia, Italy and Washington	More young and late age mothers, more medical problems, multipara, less number with previous loss, higher infections, among unintended pregnancies
Gadow [17]	5,155 Women who had live birth at South American hospitals	Higher incidences of multiparity, reduced incidence of fetal loss, and low inter-pregnancy interval among unintended pregnancies
Kost [19]	9,122 Women who had live birth-NMIHS and NSFG surveys in the US	None reported
Joyce [6]	7,751 Pregnant or postpartum women from National Longitudinal Survey of Youth study in US	None reported
Orr [2]	922 Pregnant black women of >18 years of age from Baltimore, US	None reported
Eggleston [16]	2,490 Postpartum women who had live singleton birth in Ecuador	Differences were not reported
Pulley [20]	19,526 Women who had live birth in National Survey of Family Growth Database of 1995 in the US	Higher rates of young, unmarried, primipara, and black women in the unintended group
Durousseau [15]	5,961 Postpartum women of >15 years age from California, US	Differences were not reported
Messer [5]	1,908 Pregnant women in Pregnancy, infection, and nutrition study from North Carolina, US	None reported
Mohllajee [4]	87,087 Women who gave live birth in 18 states in the US	Higher incidences of young mothers, non-Caucasian, low educational status and with history of previous LBW/PTB among unintended pregnancies
Afable-Munsuz [14]	17,017 Women who gave birth in San Francisco, California, US	Higher incidence of unintended pregnancies among US-born Latina, Native American and black women

LBW low birth weight, *PTB* preterm birth, *NMIHS* national maternal and infant health survey, *NSFG* national survey of family growth

risk of bias because of lack of confounding factor adjustment.

Outcomes

Detailed results of the reported outcomes from individual studies are reported in Appendix 2.

1. LBW: Ten studies reported on this outcome. There was a statistically significant increase in the unadjusted odds of LBW birth (Fig. 2, Table 4) among unintended pregnancies vs. intended pregnancies with a population attributable risk of 13.4%. Results of subgroup analyses of mistimed and unwanted pregnancies are reported in Table 5. Meta-analyses of adjusted data revealed increased odds of LBW among unintended pregnancies but not for subgroups of mistimed and unwanted pregnancies.
2. Preterm birth: Seven studies reported on this outcome. There was a statistically significant increase in the odds of PTB (Fig. 3, Table 4) among unintended pregnancies vs. intended pregnancies with a population attributable risk of 9.2%. Subgroup analyses revealed an increased odds of PTB among mistimed pregnancies and among unwanted pregnancies vs. intended pregnancies (Table 5). Meta-analyses of adjusted data revealed no difference in odds of PTB among unintended pregnancies or mistimed pregnancies but higher odds for the unwanted pregnancies (Table 5).
3. Small for gestational age infants: Only one study reported on this outcome. There was a statistically significant increase in the odds of SGA births among unintended pregnancies vs. intended pregnancies (1 study [4], 87,087 participants, 9.0 vs. 7.5%; OR

Table 2 Assessment of maternal intention in included studies

Author	Exposure assessment	Time of assessment of exposure	Rate of response	Confounders adjusted
Hultin [18]	Parents record	Postpartum period	Not reported	No
Morris [9]	Interview	Postpartum ward	100%	No
Cartwright [3]	Postal questionnaire	Postpartum period	79%	No
Sharma [21]	Telephone interview	Women who had a live birth in the last 3 years	Not reported	Yes
Bitto [1]	Direct questioning	At 5 weeks gestation	100%	Maternal age, birth order, previous LBW or PTB, sex, hypertension, smoking, vaginal bleeding, weight gain and centre
Gadow [17]	Interview	Postpartum period	100%	No
Kost [19]	Interview	Postpartum period	Not reported	No
Joyce [6]	Data collection	During pregnancy or within 1 year of birth	90%	No
Orr [2]	Questionnaire	At first prenatal visit	91%	Alcohol, drugs, bleeding, medical conditions, hospitalization, weight gain, pre-eclampsia, smoking and past history
Eggleston [16]	Interview	Postpartum period	~40%	Site of delivery, blood pressure, alcohol, smoking, anemia, prenatal care, age, education, sex, birth order, urban/rural residence
Pulley [20]	Interview	Mothers who had live births in the last 5 years	Not reported	No
Durousseau [15]	Questionnaire and telephone follow up	2–4 month post partum	71%	Race, age, education, insurance type, prenatal care, income, smoking, alcohol use, weight gain, violence and history of LBW
Messer [5]	Questionnaire, telephone interview and hospital records	At 24–29 weeks gestation	75%	No
Mohllajee [4]	Birth certificate, questionnaire, telephone interview	Postpartum mothers who had live birth in last 3 years	70%	Race, education, parity, prenatal care, previous LBW or PTB, smoking and alcohol
Afable-Munsuz [14]	Postal survey	10–14 weeks postpartum	72%	Family income, maternal and paternal education and marital status

LBW low birth weight, *PTB* preterm birth

1.22, [95% CI 1.16, 1.28]). Population attributable risk was 9.0%.

4. Birth weight in grams: Two studies reported on this outcome. There was no statistically significant difference in the BW among unintended pregnancies and intended pregnancies (2 studies [17, 18], 6,708 participants, weighted mean difference-3 g, [95% CI -30 g, 25 g]).
5. Gestational age: No studies reported on this outcome.

Heterogeneity Assessment and Publication Bias

Clinical heterogeneity among studies is described in Tables 1 and 2. Statistical heterogeneity was identified in both primary outcomes of meta-analyses ($I^2 = 39\%$ for LBW and 86% for PTB). Sensitivity analysis excluding the study with the largest sample size did not change the results significantly (OR for LBW [1.34, 95% CI 1.19, 1.51]). Sensitivity analysis based on the time of exposure assessment revealed an OR of 1.29 for studies that assessed intention during pregnancy or within 3 months of birth compared to OR of 1.37 for studies that assessed intention after 3 months postpartum. Five studies reported data from mothers with "unsure or ambiguous" intention. The results were similar to the group of mothers who had unintended pregnancies. Funnel plot assessment identified the possibility of publication bias for the LBW outcome for potential lack of publication of studies of small sample size that may have had insignificant and relatively smaller effect.

Table 3 Risks of biases among included studies

Author	Type of study	Selection Bias	Exposure assessment bias	Outcome assessment bias	Confounding factor bias	Attrition bias	Analytical bias	Overall likelihood of bias
Hultin [18]	Matched control	None	Low	None	Moderate	Low	None	Moderate
Morris [9]	Unmatched control	None	None	None	Moderate	None	None	Low
Cartwright [3]	Unmatched concurrent controls	Low	Low	Low	Moderate	Low	None	Moderate
Sharma [21]	Unmatched controls	Low	Low	None	Low	Can't tell	None	Low
Bitto [1]	Matched concurrent control	Moderate	None	None	None	None	None	Moderate
Gadow [17]	Matched control	None	None	None	Low	None	None	Low
Kost [19]	Matched controls	Low	None	None	Moderate	Can't tell	None	Moderate
Joyce [6]	Matched controls	None	Low	None	Moderate	Low	None	Moderate
Orr [2]	Matched control	Low	None	None	None	Low	None	Low
Eggleston [16]	Matched controls	Can't tell	Low	Low	None	None	Moderate	Moderate
Pulley [20]	Matched concurrent controls	None	Moderate	None	Moderate	Low	None	Moderate
Durousseau [15]	Matched concurrent control	None	Low	Low	None	Moderate	None	Moderate
Messer [5]	Matched controls	Low	None	None	Moderate	None	Low	Moderate
Mohllajee [4]	Cohort study	None	Low	None	None	None	None	Low
Afable-Munsuz [14]	Unmatched concurrent controls	Low	Low	None	None	Low	Low	Low

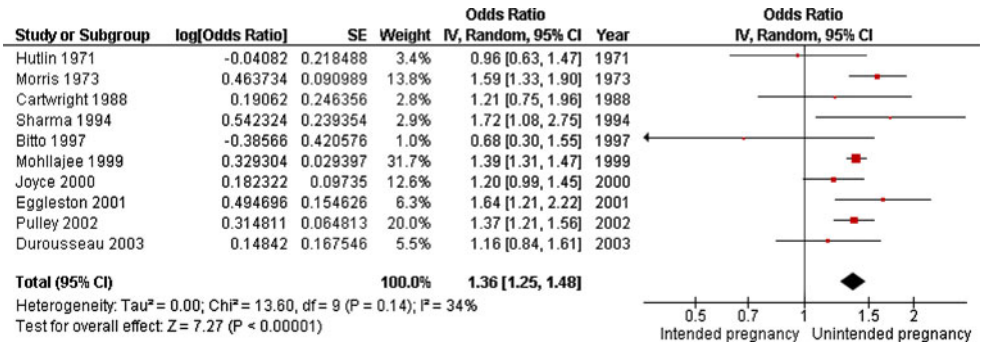

Fig. 2 Forest plot of low birth weight among unintended vs. intended pregnancies

Discussion

In this systematic review of 15 studies, we identified significantly increased unadjusted odds of LBW/PTB/SGA births among unintended pregnancies ending in live births compared to pregnancies that were intended. Subgroup analyses revealed higher unadjusted odds of LBW/PTB among mistimed and unwanted pregnancies compared to intended pregnancies ending in a live birth. Meta-analyses of adjusted estimates confirmed higher odds of LBW but not of PTB. There were clinical heterogeneities among studies included in this review; however, all studies used similar definitions for exposure. Overall assessment of clinical characteristics of the included studies revealed a common underlying theme (assessment of risk of outcomes following an unintended pregnancy ending in a live birth) in all studies and thus, we felt meta-analyses were appropriate.

There were heterogeneities among studies included in this systematic review. This was not beyond what one would have predicted from the outset. Certain studies controlled for confounders whereas other studies failed to control for confounders. Even the confounders controlled for varied from study to study. We included unadjusted data to obtain direct comparable estimates between studies and performed exploratory analyses with adjusted data. It is a methodological challenge to interpret results of meta-analyses of adjusted results from studies that controlled for different factors. We assessed publication bias but this method for assessment of publication bias is exploratory and indirect. No adjustment for publication bias was made in the analyses.

Table 4 Results of meta-analyses for outcomes of LBW and Preterm birth

Infant status	Results	Unintended pregnancy	Mistimed pregnancy	Unwanted pregnancy
Infant LBW	Number of studies	10	5	5
	Participants	>130,917	106,627	82,184
	Risk in exposed (%)	6.7	6.5	7.6
	Risk in unexposed (%)	5.0	5.0	5.0
	Unadjusted OR (95% CI)	1.36 (1.25, 1.48)	1.31 (1.13, 1.52)	1.51 (1.29, 1.78)
	Adjusted OR	1.60 (1.03, 2.49)	1.0 (0.79, 1.25)	1.29 (0.84, 1.97)
		2 Studies	2 Studies	2 Studies
Infant preterm	Number of studies	6	3	3
	Participants	>109,934	89,336	69,512
	Risk in exposed	9.9%	9.1%	11.6%
	Risk in unexposed (%)	8.1	8.0	8.0
	Unadjusted OR (95% CI)	1.31 (1.09, 1.58)	1.36 (0.96, 1.93)	1.50 (1.41, 1.61)
	Adjusted OR	1.33 (0.80, 2.21)	0.94 (0.86, 1.02)	1.18 (1.05, 1.34)
		3 Studies	2 Studies	2 Studies

OR-odds ratio

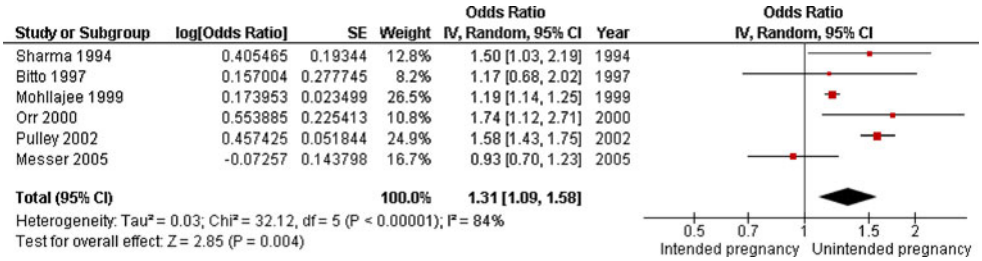

Fig. 3 Forest plot of preterm birth among unintended vs. intended pregnancies

The strengths of this systematic review include a focused question, extensive literature search, large total sample size of the studied population, robust effect size, and narrow confidence intervals. The limitations of this review include small number of studies with reported adjusted estimates for various confounders. Some studies assessed exposure sometime after the birth of the index child, which may have affected exposure classification. These data only include live birth after unintended or intended pregnancies. Differential abortion rates among different population for abortion after an unintended pregnancy could also have influenced the results. Individual studies have limited power to assess the independent impact of mistimed and unwanted pregnancies, a limitation that was overcome in our meta-analyses.

Differential adverse pregnancy outcomes following unintended pregnancies have been reported based on maternal race, Medicaid status [8], and maternal age [1]. Morris et al. [9] reported adverse outcomes following unintended pregnancies for women with higher levels of education possibly associated with expectations for control over the timing of their pregnancy. For this review, unintendedness was collapsed into one category and subgroups were also analyzed. Some researchers have cautioned against this approach noting the complexity of the mistiming construct and the amount of time in which pregnancies occur eventually. They assessed impact of mistimed pregnancies with respect to the duration of mistiming [20]. Fallacies in classification of intentions regarding pregnancy were reviewed extensively and agree with our approach of separating unwanted and mistimed categories [29].

Intention to become pregnant is a complex process [8]; knowledge of pregnancy evokes many emotions ranging from worry and fear, to happiness and excitement. These emotions may vary during pregnancy and may change following the birth particularly with varied birth outcomes [8]. Recall bias may play a role depending upon the duration of the time lag between the event and the interview [30]. Maternal responses to the same questions are influenced by events during the pregnancy, after the pregnancy, while parenting, during changing relationships with the partner, and throughout the physical, social, and environmental changes of conceiving, growth of the fetus

and giving birth [8]. Many women who reported unintended pregnancy reported that they were not using any means to prevent the pregnancy [28] and that they were pleased with the pregnancy [3]. The studies varied in terms of the methods of exposure ascertainment; however, this did not affect results to a significant extent. Maternal or paternal response to questions regarding intention of pregnancy will vary based on the time lag between the actual pregnancy and the timing of assessment [2]. It is possible that unintended pregnancy from the paternal perspective can lead to lack of social support for the mother, stress, and result in adverse outcomes. Most of the studies focused on maternal intention as a "sense of control" concept regarding pregnancy [15]. This may not be true in isolation. Unintended pregnancies may arise from issues of interpersonal violence, power dynamics and partner/interpersonal relationships. Unintended pregnancies arising from sexual abuse or sexual violence (e.g. rape) were not reported separately in any of the studies and were beyond the scope of this review. Advances in overall empowerment or entitlement of women in society may ultimately reduce these effects. We have restricted ourselves to explore the relationship of intention to become pregnant and pregnancy outcomes. It was not our intention to indicate that LBW/PTB/SGA births are solely restricted to unintended pregnancy or that unintended pregnancies lead only to LBW/PTB/SGA births. Several biomedical, social, environmental, life-style related, genetic, and other factors contribute to a LBW/PTB and this needs to be kept in mind in interpreting our results.

Implications for Practice

Our results highlight the importance of planning of pregnancy. In addition to adverse maternal consequences, unintended pregnancies are associated with adverse neonatal outcomes. This information should be passed onto women of child-bearing age. Potential areas for knowledge transfer include education of adolescent girls/women enrolled at schools or colleges, during routine visits to family doctors or specialists, and during the postpartum period regarding the importance of planning and timing subsequent pregnancies. Helpful advice presented in ways that women can understand and apply regarding family planning, contraception and control over their reproductive decisions may result in improved pregnancy outcomes. A sense of control over one's health has been shown to improve health care related activities [15].

Conclusion

Unintended, unwanted, and mistimed pregnancies are associated with increased risk of LBW/PTB/SGA births.

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Conflict of interest statement None for any authors.

Appendix

See Appendix Tables 5 and 6.

Table 5 Assessment of quality of included studies

Bias	None	Low	Moderate	High	Can't tell
Selection	Consecutive unselected population Sample selected from general population rather than a select group Rationale for case and control selection explained Follow up or assessment time explained	Sample selected from large population but selection criteria not defined A select group of population (based on race, ethnicity, residence etc.) studied	Sample selection ambiguous but sample may be representative Eligibility criteria not explained Rationale for case and controls not explained Follow up or assessment time not explained	Sample selection ambiguous and sample likely not representative A very select population studied making it difficult to generalize findings	Not reported or unclear

Table 5 continued

Bias	None	Low	Moderate	High	Can't tell
Exposure assessment	Direct questioning (interview) or completion of survey by mother at the time of exposure or close to the time of exposure Direct measurement of exposure (laboratory)	Assessment of exposure from global dataset Indirect assessment (postal survey, mailed questionnaire) Recall of exposure <1 year of birth	Recall 1–5 years after birth Extrapolating data from population exposure sample (with some assumptions) and not direct assessment at any time	Recall >5 years after birth Indirect method of assessment (obtaining data from others and not from mother or father)	Not reported or unclear
Outcome assessment	Assessment from hospital record, birth certificate or from direct question to mother regarding birth weight	Assessment from administrative database Direct question to mother regarding gestational age	Assessment from 'open-ended' questions (was your baby early? or premature? or small? or before due date)	Assessment from non-validated sources or generic estimate from overall population	Not reported or unclear
Confounding factor	Controlled for common confounders	Only certain confounders adjusted	Not controlled for confounders		
Analytical	Analyses appropriate for the type of sample Analytical method accounted for sampling strategy in cross-sectional study Sample size calculation performed and adequate sample studied	Analyses not accounting for common statistical adjustment (e.g. multiple analyses) when appropriate Sample size calculation not performed, but all available eligible patients studied Sample size calculated and reasons for not meeting sample size given	Sample size estimation unclear or only sub-sample of eligible patients studied	Analyses inappropriate for the type of sample/ study	Not reported or unclear
Attrition	0–10% attrition and reasons for loss of follow up explained All subjects from initiation of study to the final outcome assessment were accounted for	0–10% attrition and reasons for loss of follow up not explained 11–20% attrition, reasons for loss of follow up explained	11–20% attrition but reasons for loss of follow up not explained >20% attrition but reasons for loss of follow up explained All subjects from initiation of study to final outcome assessment not accounted	>20% attrition, reasons for loss of follow up not explained	Not reported or unclear

Table 6 Outcomes reported in individual studies

Author	LBW		LBW Odds ratio (95% CI)	PTB		PTB Odds ratio (95% CI)	Birth weight (mean ± SD)g
	Intended	Unintended		Intended	Unintended		
Hultin [18]	46/790 (5.8%)	44/789 (5.6%)	N/A	N/A	N/A	N/A	3,462 ± 580 vs. 3,439 ± 542
Morris [9]	208/3,758 (5.5%)	355/4,163 (8.5%)	N/A	N/A	N/A	N/A	N/A
Cartwright [3]	58/1,093 (5.3%)	25/393 (6.4%)	N/A	N/A	N/A	N/A	N/A
Sharma [21]	N/A	N/A	AOR 1.72 (1.08, 2.76)	N/A	N/A	AOR 1.5 (1.04, 2.22)	N/A
Bitto [1]	14/323 (4.3%)	10/333 (3.0%)	0.69 (0.30, 1.58) AOR 0.90 (0.24, 3.44)	26/323 (8.0%)	31/333 (9.3%)	1.3 (0.70, 2.41) AOR 0.57 (0.23, 1.43)	N/A
Gadow [17]	N/A	N/A	N/A	N/A	N/A	N/A	3,217 ± 570 vs. 3,228 ± 581
Kost [19]	5.1%	6.5% for mistimed, 9.7% for unwanted	N/A	6.7%	10.2% for mistimed, 12.9% for unwanted	N/A	N/A
Joyce [6]	277/4,325 (6.4%)	200/2,638 (7.6%)	N/A	N/A	N/A	N/A	N/A
Orr [2]	N/A	N/A	N/A	29/303 (9.6%)	95/610 (15.5%)	1.63 (1.12, 2.71) ARR 1.82 (1.08, 3.08)	N/A
Eggleston [16]	N/A	N/A	1.64 (1.2, 2.2)	N/A	N/A	N/A	N/A
Pulley [20]	687/13,473 (5.1%)	405/5,897 (6.9%)	N/A	1,037/13,473 (7.6%)	685/5,897 (11.6%)	N/A	N/A
Durousseau [15]	70/3,062 (2.3%)	74/2,793 (2.6%)	1.1 (0.7, 1.7) for mistimed and 1.2 (0.6, 2.3) for unwanted	N/A	N/A	N/A	N/A
Messer [5]	N/A	N/A	N/A	107/885 (12.0%)	116/1,023 (11.3%)	N/A	N/A
Mohllajee [4]	2,209/44,178 (5.0%)	2,918/42,909 (6.8%)	1.59 (1.49, 1.70) for unwanted and 1.26 (1.20, 1.32) for mistimed	3,578/44,178 (8.1%)	4,076/42,909 (9.5%)	1.51 (1.36, 1.67) for unwanted and 1.07 (0.99, 1.15) for mistimed	N/A
Afable-Munsuz [14]	N/A	N/A	N/A	N/A	N/A	1.20 (1.05, 1.37) for mistimed and 1.39 (1.15, 1.67) for unwanted	N/A

LBW low birth weight, *PTB* preterm birth, *N/A* not available, *CI* confidence interval, *AOR* adjusted odds ratio, *ARR* adjusted relative risk, *SD* standard deviation

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