Review Article

The Effectiveness of Prenatal Care Programs on Reducing Preterm Birth in Socioeconomically Disadvantaged Women: A Systematic Review and Meta-Analysis

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Abstract

Background: Preterm Birth (PTB) is one of the leading causes of infant morbidity and mortality. Prenatal care is an effective way to improve pregnancy outcomes but there is limited evidence of effective interventions to improve perinatal outcomes in disadvantaged pregnant women. This review was conducted with the aim to assess the effectiveness of prenatal care programs in reducing PTB in socioeconomically disadvantaged women. **Materials and Methods:** We searched the Scopus, PubMed, Web of Science, and Cochrane Library databases from January 1, 1990 to August 31, 2021. The inclusion criteria included clinical trials and cohort studies focusing on prenatal care in deprived women with the primary outcome of PTB (< 37 weeks). Risk of bias was assessed using the Cochrane Collaboration's tool for assessing risk of bias and the Newcastle–Ottawa Scale. Heterogeneity was evaluated using the Q test and I^2 statistics. The pooled odds ratio was calculated using random-effects models. **Results:** In total, 14 articles covering 22,526 women were included in the meta-analysis. Interventions/exposures included group prenatal care, home visits, psychosomatic programs, integrated intervention on socio-behavioral risk factors, and behavioral intervention through education, social support, joint management, and multidisciplinary care. The pooled results showed that all types of interventions/exposure were associated with a reduction in the risk of PTB [OR = 0.86; 95% confidence interval: (0.64, 1.16); I^2 = 79.42%]. **Conclusions:** Alternative models of prenatal care reduce PTB in socioeconomically disadvantaged women compared with standard care. The limited number of studies may affect the power of this study.

Keywords: *Meta-analysis, prenatal care, preterm birth, program evaluation, socioeconomic factors*

Introduction

Preterm Labor (PTL) is defined as regular uterine contractions and cervical changes that begin before 37 weeks of gestation.[1] Almost 50% of PTL will lead to Preterm Birth (PTB).[2] About 90% of PTB occurs in developing countries, 85% of which occurs in Africa and Asia.[3] Moreover, 0.9 million cases of PTB are reported in Latin America.[3] PTB is one of the leading causes of infant morbidity and mortality.[4] PTB is related to a wide range of problems for the infant, including cerebral palsy, sensory impairment, learning disabilities, and respiratory illness.[5] PTB imposes a significant burden on the healthcare system due to the longer and more intensive hospitalization of the infant.[6] The cost of caring for these babies is significantly higher than that of caring for term babies.[7] The costs and outcomes of infancy vary based on Gestational Age (GA). According to the evidence, a one- to two-week increase in GA can reduce neonatal complications and treatment, and care costs.[8] PTB is also related to the inadequacy of maternal mental health, rise in average hospital stays, and re-hospitalization of the mother, and her care and treatment costs, which are not considered in the study of the burden of PTB.[9] PTB is a multifactorial complication in the development of which a combination of individual-behavioral and psychological, environmental, genetic, and biological factors play a role.[10] There is a high prevalence of perinatal poor outcomes and death among low-income women, homeless individuals, prisoners, asylum seekers, refugees, and ethnic minorities, known as vulnerable clusters.[11] The results of a meta-analysis in the UK showed that regional and individual deprivation are associated with neonatal

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complications (birth weight and neonatal death).[12] Although prenatal care is an effective way to improve pregnancy results, care interventions during this period have not been completely evaluated,[13] and there is limited evidence of effective interventions in improving perinatal outcomes for vulnerable pregnant women.[14] The National Health Service Clinical (NICE) Guidelines in the UK identified gaps in evidence of effective prenatal care services for women with complex social conditions and called for a reorganization of services to improve care.[15]

Due to the absence of sufficient evidence on the effectiveness of prenatal care programs in improving pregnancy outcomes in deprived women, this study was conducted with the aim to find the best available evidence on the effectiveness of prenatal care interventions in reducing PTB among women deprived of socioeconomic status.

Materials and Methods

The present study was part of a multistage mixed-method study that investigated perinatal care programs for women with high-risk pregnancies in Iran, which was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[16] Based on the standard defined in the Cochrane Handbook for Systematic Reviews of Interventions, the two researchers separately performed a comprehensive search in four major databases including PubMed, Scopus, Web of Science, and the Cochrane Library. To search the texts, keywords were determined. The keywords were obtained by searching for related articles, asking questions from experts, and referring to the MeSH search on PubMed. Then, the search strategy was determined based on the keywords [Table 1]. Determinants of socioeconomic status (education, occupation, income, and residence type) were used to identify low-income pregnant women. The socioeconomic disadvantage was defined by the study authors. We utilized a search strategy that combined keywords related to the outcomes, intervention/exposure, and populations of interest. To review the gray literature, a search was conducted in the gray literature section of the Web of Science database. Moreover, to enter as much relevant data as possible, after the initial evaluation of the abstract, the references to the found articles were examined. All databases were reviewed from January 1, 1990, to August 31, 2021.

The studies were qualified if they met the subsequent criteria: (i) Population: Poor pregnant women (socioeconomically disadvantaged) and living in deprived areas; (ii) Intervention/exposure: Non-pharmacological interventions (including providing any health services, social and clinical care, and educational interventions as a complement to routine prenatal care); (iii) Control group: Standard or routine care; (iv) Primary outcome: PTB (<37 weeks gestation); (v) Secondary Outcomes: Low-birth weight (LBW: Weight <2500 grams), Apgar <7 in the first and fifth minute, hospitalization in NICU, premature neonatal death (<28 days), instrumental delivery, and cesarean section; (vi) Study design: Clinical trial and cohort with at least one comparison group; (vii) Language: English language articles. The exclusion criteria included inaccessibility to the full text of the article, protocol articles, guideline reports, and interventions focusing on labor/birth or the preconception period.

Table 1: Search strategy utilized for PubMed

(Poverty [tiab] OR "property own*" [tiab] OR "Extreme Poverty" [tiab] OR (Poverty AND Extreme) [tiab] Or "Absolute Poverty" [tiab] OR (Poverty AND Absolute) [tiab] OR Indigent* [tiab] OR "Federal Poverty Threshold" [tiab] OR (Poverty Threshold* AND Federal [tiab]) OR "Low-Income Populations" [tiab] OR (Population* AND Low-Income [tiab]) OR "Social Inequality" [tiab] OR "social class" [tiab] OR "economic inactivity" [tiab] OR deprivation [tiab] OR "financial hardship" [tiab] OR "employment status" [tiab] OR "low pay" [tiab] OR overcrowd* [tiab] OR "poor environment" [tiab] OR "poor housing" [tiab] OR unemploy* [tiab]) OR "Sensitive Population Group*" [tiab] OR "Disadvantaged Populations" [tiab] OR "socially disadvantaged" [tiab] OR vulnerable [tiab] OR "vulnerable populations" [tiab] OR "*Health Status Disparities" [tiab] OR" *Healthcare Disparities" [tiab] OR" multiethnic*" [tiab] OR "multiracial*" [tiab] OR "deprived area*" [tiab]) AND (prematurity [tiab] OR preterm [tiab] OR birth* [tiab] OR infant* [tiab] newborn* [tiab] OR infant* [tiab] OR perinat* [tiab] OR neonate* [tiab] OR postneonat*[tiab] OR "premature birth"[tiab]) AND ("Prenatal care"[tiab] OR "Ante*natal care" [tiab] OR "maternal health services" [tiab] OR "maternity care" [tiab]) AND (1999/01/01:2021/03/31[dp])

¥- ab: abstract; ti: title

All retrieved articles were entered into Endnote X8 via electronic databases and a manual search. After removing duplicate studies, the two researchers separately reviewed the titles and abstracts of possibly eligible articles based on the prescribed inclusion criteria. To extract data, including the name of the first author, year, country, target group, type of intervention, sample size, desired outcome, and the conclusion, an electronic form was used. Data extraction was performed independently by two researchers. Any disagreements in the choice of articles and data extraction were resolved by the third researcher.

Risk of bias in the clinical trials was evaluated using the Cochrane Collaboration's tool for assessing risk of bias[17] and the inclusion criteria which included random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other bias. Each item was evaluated as low-risk, unclear-risk, or high-risk. To appraise the selection bias, the primary and secondary outcomes (or main objective of the study) reported in the protocol (if any) were compared with the final reported results of each study.

One of the most commonly used scales for appraising quality and the risk of bias in observational studies is the

Newcastle-Ottawa Scale (NOS). This scale includes three domains, including selecting study groups (4 stars), comparing groups (2 stars), and determining the amount of exposure and results (3 stars). The maximum score for these three dimensions is 9 points. The total scores were classified into the three following groups: very high risk of bias (0 to 3 stars), high risk of bias (4 to 6 stars), and low risk of bias (7 to 9 stars).[18]

Statistical calculations were performed using Stata software (version 16; StataCorp, College Station, TX, USA). In the analysis of the effect of group prenatal care on PTB compared to conventional care, the odds ratio (OR) index was used. The OR logarithm was used in each study to combine the results of the studies. Heterogeneity between studies was determined using Cochran's test and the I^2 index.[19] Heterogeneity was considered significant if I^2 >50%.[20]

The OR was measured from the crude data of each study with a 95% Confidence Interval (CI). Data from the single studies were pooled using the random-effects models, regardless of whether there was evidence of statistical heterogeneity or not. This approach also leads to a more conservative estimate of the effect size. All p values <0.05 were regarded as significant.

Ethical considerations

To conduct the research, written permission was obtained from the ethics committee of Shahroud University of Medical Sciences, Shahroud, Iran (Approval ID: IR.SHMU.REC.1399.123).

Results

The results of this research included 16 articles on 23619 women with socioeconomic deprivation [Table 1]. Studies were omitted for various reasons, including lack of perinatal outcomes, intervention before pregnancy, during labor, drug interventions, lack of a control group, type of study (descriptive-analytical and review), etc., [Figure 1].

Finally, 16 studies were included in the systematic review, including 7 cohort studies (retrospective, prospective, and combined) and 9 Randomized Controlled Trials (RCTs) [Table 2]. In total, 14 studies involving 22,526 participants entered the meta-analysis section. Of the studies included, 11 were performed in the United States, 2 in Australia, 1 in Ireland, and 1 in South Africa, and 1 multicenter study was conducted in France and Spain. Moreover, 1 study was of low quality, 8 studies were of medium quality, and 8 studies were of high quality [Tables 3 and 4]. The control group was standard or routine in all care studies. The interventions/exposures include group prenatal care (4 cohort studies and 1 RCT), midwifery group practice (1 cohort study), a home visit (3 RCTs), psychosomatic program (1 RCT), integrated intervention on socio-behavioral risk factors (1 RCT), behavioral intervention care through education (1 RCT), social support program (2 RCTs), joint management (1 cohort study), and multidisciplinary care (1 cohort study) [Table 1].

Random effects meta-analysis showed that all types of interventions/exposures were associated with a reduction in risk of PTB [OR = 0.86; 95%CI: (0.64, 1.16); I2 = 79.42%] [Figure 2].

Group prenatal care

The three cohort studies by Picklesimer *et al*.,[26] Jacobs,[22] Gareau *et al*.,[21] and a clinical trial by Ickovics *et al*.[29] regarding the evaluation of the effectiveness of group prenatal care in low-income pregnant women showed that this intervention was effective in decreasing preterm delivery (P = 0.050). Nevertheless, the cohort study by Ickovics *et al*.[30] showed that the intervention failed in clinics that served low-income women, especially minority women, because of the potential risk of selection bias.

The cohort studies by Gareau *et al*.[21] and Ickovics *et al*.[30] showed that LBW in the prenatal care group was lower than standard care, while in the clinical trial by Ickovic *et al*.[29] no such result was observed.

The cohort study by Gareau *et al*.[21] indicated that group prenatal intervention would reduce admissions to the NICU, while the cohort study by Picklesimer *et al*.[26] and the clinical trial by Ickovics *et al*.[29] did not reach such a conclusion.

Midwifery group practice

Gao *et al*.,[23] in their cohort studies, found that group midwifery care was ineffective in reducing PTB (18.5% v 20.6%; p = 0.400), LBW (6.4% v 9.9%; p = 0.625), and cesarean section rates (p = 0.466) in pregnant women native to remote areas of Australia.

Home visit

Doyle *et al*.,[24] in their clinical trial, found that home care by skilled educators did not lead to a difference in neonatal outcomes, including preterm delivery (7.5% vs. 7.3%; OR = 1.01; 95% CI: 0.35 to 2.91, p = 0.490), birth weight (3302 ± 631 vs. 3268 ± 617 grams (g); p = 0.305), and caesarean section (25.0% vs. 15.1%; OR = 0.53, 95% CI: 0.27 to 1.07; p < 0.05) among unemployed pregnant women living in Dublin, Ireland, is above usual and does not lead to early school dropout.

Kemp *et al*.[28] found that despite the home nurse visit program was associated with increased duration of breastfeeding, maternal satisfaction, and mental development of children in pregnant women in disadvantaged areas of Sydney, it had no effect on PTB (OR = 1.96; 95% CI: 0.60 to 4.74) and LBW (OR = 3.22; 95% CI: 0.65 to 15.9). In this study, in addition to living in deprived areas, other socio-behavioral and psychological risk factors, such as being under 19 years of age, an Edinburgh Postnatal Depression Scale score of above 10, lack of social support, lack of psychological and practical support, initiation of prenatal care later than 20 weeks, present

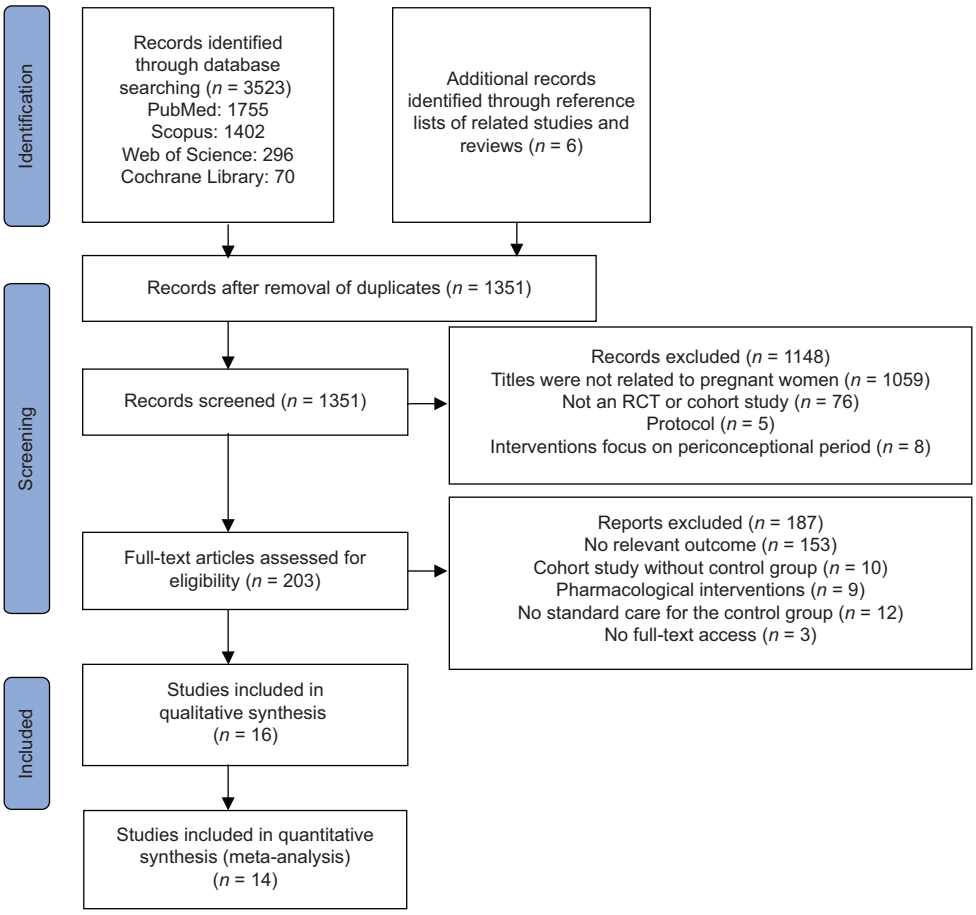

Figure 1: The PRISMA flow diagram of studies included and excluded in each review. PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RCT: Randomized controlled trials

substance abuse, a history of domestic violence in the mother, and a history of child abuse in the mother's childhood, were found to affect the efficiency of the intervention.

Kitzman *et al*.[34] also showed that home nurse visits were ineffective in reducing PTB (OR = 0.8; 95% CI: 0.60 to 1.20) and LBW (OR = 1.10, 95% CI: 0.80 to 1.60 (in low-income and single, pregnant women in Tennessee, Memphis.

Psychosomatic program

In a clinical study, Collado *et al*.[25] documented that a new care program based on Thorne's psychosomatic approach (focusing on emotions, body awareness, building a personal delivery model, and attachment) was effective in reducing PTB (4% vs. 22.4%; $p = 0.003$) and LBW (3019,01 ± 668,83 g; $p = 0.010$) among low-income pregnant women before 20 weeks of gestation and at moderate to high risk of postpartum depression.

The behavioral intervention focused on education

The Collaborative Pregnancy Prevention Group (1997), in its multicenter clinical trial in a low-income population, studied behavior-care intervention with a focus on educating the patient about the symptoms of PTL with additional visits. Due to the significant heterogeneity of the effects of the program in different centers, this intervention cannot be recommended for the prevention of preterm delivery (15.4% vs. 11.9%).[35]

Integrated intervention on socio-behavioral risk factors

Subramanian *et al*.[27] in their study showed that an integrated intervention on socio-behavioral risk factors (including a behavior change meta-theoretical model and self-help guide to quit smoking + group therapy, cognitive-behavioral therapy to treat depression + a visit program at home + individual counseling sessions) is not effective in reducing adverse pregnancy and fetal outcomes such as preterm delivery (14.5% vs. 15%), LBW (12.8% vs. 14.6%), cesarean section (28.7% vs. 28.1%), and hospitalization (12.2% vs. 15.5%) in the NICU. This study illustrates that the biomedical aspect plays a greater role in causing negative outcomes in low-income pregnant women than the psychosocial aspect. Thus, early diagnosis and management of previous hypertension, diabetes, and PTB in low-income women may reduce health disparities in birth outcomes.

Social support

Rothberg and Lits reported that psychosocial support programs (telephone support + home visits by a social worker or professional nurse) were ineffective in reducing PTL (10.8% vs. 20.5%; $p = 0.200$).[36]

Table 2: Characteristics of each study and effectiveness of antenatal care programs

Ref	Author, year, Country	Study design	Study groups/sample size*	Intervention	Effectiveness PTB**	Effectiveness Another outcome***
[21]	Gareau *et al.* 2016 USA	Retrospective cohort study	Low-income pregnant women participating in the Medicaid program I=1262 C=5066 Attrition: -	Group prenatal care	RR (95% CI): 0.64 (0.52, 0.79), $p<0.001$	%LBW (< 2500 g): (RR) (95% CI): 0.56 (0.44, 0.71), $p<0.001$ %NICU: RR (95% CI) : 0.72 (0.60, 0.88), $p<0.001$
[22]	Jacobs 2016 USA	Retrospective cohort study	African American women aged 14 to 38 years in low-income areas I=61 C=63 Attrition: -	Group prenatal care At least 3 visits	% PTB (< 37 weeks): 1.6% vs. 11.3%, $p=0.015$	%C-section: 18% vs. 19.4%, $p=0.425$
[23]	Gao *et al*., 2014 Australia	Retrospective and prospective cohort study	Indigenous pregnant women (in remote and low-incom areas (I=412 C=310 Attrition: -	Midwifery Group Practice A group of midwives (3-4) who provide ongoing care throughout pregnancy, and up to two years after delivery Midwives provide 24-h support.	% PTB (< 37 weeks): 18.5% vs. 20.6%, $p=0.415$	%C-section: 24.6% vs. 25.3%, $p=0.460$ % LBW: 6.4% vs. 9.9%, $p=0.625$
[24]	Doyle *et al.* 2014 Ireland	Randomized controlled trial	233 pregnant women from a community in Dublin, Ireland (above the national average unemployment rate, early dropouts, single-parent families) I=115 C=118 Attrition: 8%	Home care Two-month visits by trained instructors, and 10 visits until the baby is born Visits included pregnancy information and support for pregnancy-related concerns Each visit lasted approximately 1 h	% PTB (< 37 weeks): 7.5% vs. 7.3%, $p=0.491$ Adjusted odds ratio (95% CI) for PTB: 1.01 (0.35-2.91)	%C-section (any):15.1% vs. 25%, $p=0.049$ Adjusted odds ratio (95% CI) for C/S: 0.55 (0.27; 1.12) % Instrumental delivery: 18.9% vs. 21%, $p=0.250$ Adjusted odds ratio (95% CI) for Instrumental delivery: 0.78 (0.38; 1.61) % Apgar 1 min: 4.6% vs. 10.2%, $p=0.048$ Adjusted odds ratio (95% CI) for Apgar 1 min: 0.38 (0.13; 1.18) Birth weight (g): 3302±631 vs. 3268±617, $p=0.305$

Contd...

Table 2: Contd...

Ref	Author, year, Country	Study design	Study groups/sample size*	Intervention	Effectiveness PTB**	Effectiveness Another outcome***
[25]	Collado *et al*. 2014 Spain, France	Retrospective cohort study	184 low-income pregnant women, less than 20 weeks with moderate to high risk of postpartum depression I=92 C=92 Attrition: 34% -Analysis was performed by ITT****.	Psychosomatic program includes: 10 two-hour prenatal group sessions and a telephone conversation between sessions 5 to 6 couples participated in each session. Session content: focus on emotions, body awareness, building a personal delivery model	% PTB (< 37 weeks): 4.4% vs. 22.4%, p=0.003	Birth weight(g): 3301,87±506,65 vs. 3019,01±668,83, p=0.010
[26]	Picklesimer *et al*. 2012 USA	Retrospective cohort study	Low-income pregnant women I=316 C=3767 Attrition: 6.7%	Group prenatal care 10 two-hour sessions, groups of 8 to 12 people with the same gestational age	% PTB (< 37 weeks): 7.9% vs. 12.7%, p=0.034	Birth weight (g): 7.3% vs. 8.4%, p=0.265 % NICU: 7% vs. 10%, p=0.820 % Breastfed: 64.90% vs. 60.1%, p=0.990
[27]	Subramanian *et al*. 2012 USA	Randomized controlled trial	Low-income African-American pregnant women with social risk factors (smoking, partner violence, and depression), at least 18 years old, less than 29 weeks of gestation I=510 C=515 Attrition: -	SCRIPT Program includes: Behavioral models of behavior change and self-help guide to ways to change - to quit smoking) + group therapy - Cognitive-behavioral therapy (to treat depression) + a home visit program + individual counseling sessions	% PTB (< 37 weeks): 14.5% vs. 15%, p>0.05	% LBW (< 2500 g): 12.8% vs. 14.6%, p>0.050 % NICU: 12.2% vs. 15.5%, p>0.05 %C-section: 28.7% vs. 28.1%, p>0.05 % Perinatal death: 1.9% vs. 1.7%, p>0.05
[28]	Kemp *et al*. 2011 Australia	Randomized controlled trial	208 mothers in disadvantaged areas of Sydney, under 19 years of age, mental health disorder (Edinburgh Depression Scale score above 10), lack of emotional and practical support, late onset of prenatal care after 20 weeks of gestation, current substance abuse, history of domestic violence, history Abuse in the mother's childhood I=111 C=97 Attrition:	Home visits: Home visits by a child health nurse from the 26th week of pregnancy to the 2nd year of the child, an average of 16.3 visits (0-52 visits) 60 to 90 min, the first visit after birth within the first 2 weeks after delivery The average duration of participation in the program is 57 weeks depending on the age of the child (85% before birth, 95% in the year of birth, 53% in the second year)	% PTB (< 37 weeks): 10% vs. 6%, p=0.320 Adjusted odds ratio (95% CI) for PTB: 1.69 (0.60 to 4.74)	% LBW (< 2500 g): 7% vs. 2%, p=0.150 Adjusted odds ratio (95% CI) for LBW: 3.22 (0.65 to 15.90) %Breastfeeding duration: 18.42% vs. 10.06, p=0.002 Mean difference (95% CI) for BF: 7.88 (2.89-12.88)

Contd...

Table 2: Contd...

Ref	Author, year, Country	Study design	Study groups/sample size*	Intervention	Effectiveness PTB**	Effectiveness Another outcome***
[29]	Ickovics *et al*. 2007 USA	Randomized controlled trial	458 low-income pregnant women of black and Hispanic descent I: 229 C: 229 Attrition:	Group prenatal care The timing and content of the visits were based on the American Gynecological and Midwifery Guideline from the 18th week of pregnancy until delivery. Each 2-hour session facilitated prenatal care, including physical assessment, training and skills, and support through group discussion.	% PTB (< 37 weeks): 9.8% vs. 13.85, p=0.450 Adjusted odds ratio (95% CI) for PTB: 0.67 (0.44-0.98)	% LBW (< 2500 g): 3,160.6±626.3 vs. 3,111.8±636.8, p=0.240 odds ratio (95% CI) for LBW: 0.86 (0.59 to 1.24) % NICU: 8.5% vs. 7.8%, p=0.800 Adjusted odds ratio (95% CI) for NICU: 1.06 (0.66-1.72)
[30]	Ickovics *et al*. 2003 USA	Retrospective cohort study	1,047 African-American pregnant women aged 14 to 25 years I=653 C=394 Attrition: 8.5% of the intervention group	Group prenatal care (Similar to the study above)	% PTB (< 37 weeks): 8.3% vs. 6.5%, p=0.830	% LBW (< 2500 g): 7% vs. 10%, p=0.380 % Neonatal deaths: 0 vs. 1.3%, p=N/A (Cell sizes too small to permit statistical testing)
[31]	Jackson *et al*. 2003 USA	Retrospective cohort study	2957 low-income pregnant women I=1808 C=1149 Attrition: -	Collaborative Care: Its main components: (1) Joint practice of registered nurse-obstetrician and obstetrician, (2) extensive perinatal services including case management, health education, nutrition counsel, and social services, and (3) Delivery in a maternity center Independent for women who remain at low risk for childbirth. The birth center promotes family participation and focuses on the psychological and social components of childbirth.	% PTB (< 37 weeks): 6.4% vs. 6.5%, Adjusted Difference (95% CI) for PTB: 0.2 (-1.7 to 2.1)	% LBW (< 2500 g): 3.8% vs. 4%, Adjusted Difference (95% CI) for LBW: 0.5 (-1.7, 2.7) % NICU: 9.7% vs. 11.8%, Adjusted Difference (95% CI) for NICU -1.3 (-3.8, 1.1)

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Table 2: Contd...

Ref	Author, year, Country	Study design	Study groups/sample size*	Intervention	Effectiveness PTB**	Effectiveness Another outcome***
[32]	Reece *et al*. 2002 USA	Retrospective cohort study	818 low-income and single pregnant women I=437 C=381 Attrition: -	Temple Infant and Parent Support Services program (TIPS): Comprehensive multidisciplinary care includes: Psychosocial counseling and care, nutritional counseling, health education, social medical services, communication with community-based organizations, follow-up of forgotten visits	% PTB (< 37 weeks): 4.3% vs. 12%, p=0.005	% LBW (< 2500 g): 5.2% vs. 11%, p<0.05 % NICU: 2.8% vs. 6.6%, p<0.05
[33]	Moore *et al*. 1998 USA	Randomized controlled trial	Socioeconomically deprived women with extra risk factors for PTB/LBW I=775 C=779 Attrition: -	Nurse telephone intervention	% PTB (< 37 weeks): 9.7% vs. 11%, p=0.415 RR (95% CI): 0.87 (0.62-1.22) Subgroup: Black women, aged ≥19 years: 8.7% vs. 15.4% RR: 0.56 (0.38-0.84), p=0.004	-
[34]	Kitzman *et al*. 1997 USA	Randomized controlled trial	1139 Low-income and single pregnant women I=518 C=681 Attrition: -	Home visits by nurses: On average, 8 visits at home and 26 visits from the time of birth of the child until the birth of the second child	% PTB (< 37 weeks): 13% vs. 11%, Mean odds ratio (95% CI) for PTB: 0.8 (0.6 to 1.2)	% LBW (< 2500 g): 14% vs. 15% odds ratio (95% CI) for LBW: 1.1 (0.8-1.6) % Apgar 5 min: 8.7% vs. 8.6%, Mean difference (95% CI) for Apgar 5 min: 0.1(-0.1-0.3)
[35]	Depp *et al*. 1993 USA	Randomized controlled trial	Socioeconomically disadvantaged women with additional risk factors for PTB/ LBW I=1200 C=1195 Attrition: -	Programs focusing on educating the patient about the symptoms of preterm labor plus additional visit	% PTB (< 37 weeks): 16.1% vs. 15.4%, p>0.05	-
[36]	Rothberg and Lits Africa 1991	Randomized controlled trial	80 poor black pregnant women with hypertension and gestation of 26 weeks I=41 C=39 Attrition: < 5%	Counseling with a social worker when visiting the clinic, in a group meeting or at a home visit (or a hospital visit if the mother is hospitalized)	% PTB (< 37 weeks): 0.5% vs. 10.8%, p>0.05	% LBW (< 2500 g): 12.8% vs. 12.9%, p>0.05

I: Intervention group ; C: Control group. *p < 0.05 was considered significant, **PTB: Preterm birth; RR: Relative risk. ***LBW :Low-birth weight ; NICU: Neonatal intensive care unit. ****ITT: Intention to treat analysis

Table 3: Risk of bias assessment in randomized controlled trials based on the Cochrane guidelines*

Author Year	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other bias
Doyle *et al*. 2014[24]	L**	L	H***	L	L	L	L
Collado *et al*. 2014[25]	L	L	L	L	L	L	L
Subramanian *et al*. 2012[27]	L	U	U	U	L	L	L
Kemp *et al*. 2011[28]	L	L	U	L	U	U	U
Ickovics *et al*. 2007[29]	L	L	H	L	L	L	U
Moore *et al*. 1998[33]	L	L	H	L	L	U	U
Kitzman *et al*. 1997[34]	L	L	H	L	L	L	U
Depp *et al*.1993[35]	U	U	U	U	H	H	U
Rothberg and Lits 1991[36]	U	U	L	L	L	L	L

* $p < 0.05$ was considered significant; ** low-risk of bias; *** high-risk of bias

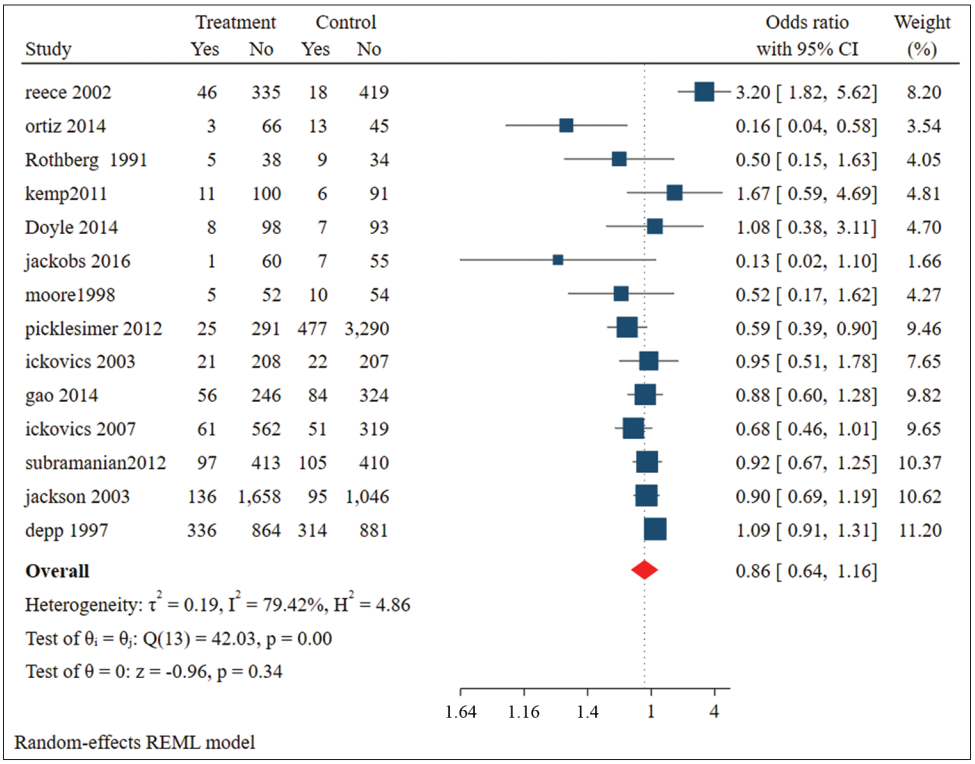

Figure 2: Forest plot of effects of interventions versus standard care on preterm birth

The clinical trial by Moore *et al*.[33] also showed no significant beneficial effect on preterm delivery but indicated a more beneficial effect in a subgroup of 19-year-old black women (RR = 0.56; 95% CI (0.38-0.84); $p = 0.004$). As it is not clear whether the subgroup analysis was pre-defined based on age and ethnic group, the subgroup analysis was considered unlikely.

Rothberg and Lits reported a reduction in LBW, especially in African-American women,[36] as a result of a social support program, but Moore *et al*.[33] reported no differences in LBW between the intervention group (telephone support by a nurse) and the control group (usual care).

Comprehensive multidisciplinary care

Reece *et al*.[32] evaluated comprehensive multidisciplinary care, which included psychosocial counseling and care, nutritional counseling, health education, social, and medical services, contact with community-based organizations, and follow-up of missed visits. They reported it to be effective in reducing PTB (4.2% vs. 12%; $p < 0.005$) and LBW (5.2% vs. 11%; $p < 0.05$). Despite its methodological limitations, this intervention can be considered as promising.

Collaborative care

Jackson *et al*.[31] compared nurse-midwife joint care registered with a gynecologist at a birth center to traditional physician-based care. Although it is associated with more spontaneous vaginal examinations (MD = 14.9; 95% CI: 11.5 to 18.3), it does not cause a difference in

Table 4: Risk of bias assessment of the cohort studies included based on the Newcastle-Ottawa Scale (NOS)

Author Year	Selection				Comparability	Outcome			Quality assessment
	Representativeness of the Exposed Cohort	Selection of the Non exposed cohort	Ascertainment of exposure	Demonstration that outcome of interest was not present at start of study	Comparability of cohorts on the basis of the design or analysis	Assessment of outcome	Was follow-up long enough for outcomes to occur?	Adequacy of follow-up of cohorts	
Gareau *et al*. 2016 (23)	☆	☆	☆	☆	☆☆	☆	☆	☆	High
Jacobs 2016 (22)		☆	☆	☆			☆	☆	Medium
Gao *et al*., 2014 (26)	☆	☆	☆	☆	☆	☆	☆	☆	High
Picklesimer *et al*. 2012 (21)	☆	☆	☆	☆	☆	☆	☆	☆	High
Ickovics *et al*. 2003 (25)	☆	☆	☆	☆		☆	☆	☆	High
Jackson *et al*. 2003 (36)	☆	☆	☆	☆	☆☆	☆	☆	☆	High
Reece *et al*. 2002 (35)	☆	☆	☆	☆	☆☆	☆	☆	☆	High

PTB (MD = 0.2; 95% CI: –1.7 to 2.1) and LBW (MD = 0.5; 95% CI:–1.7 to 2.70).

Discussion

The objective of this study was to assess the efficiency of interventions focused on prenatal care to diminish preterm delivery in socioeconomically disadvantaged women. We found that interventions were associated with lower rates of PTB. Of the studies included in this systematic review, 11 were conducted in the United States. Although adverse outcomes of pregnancy and birth due to socioeconomic inequalities exist around the world, Western countries such as the United States and the United Kingdom (UK) are showing a growing rate of adverse outcomes in women and children with poorer socioeconomic backgrounds. This inequality has a mostly ethnic foundation in the United States and a "social class" foundation in the UK.[11] Therefore, interventions to address this disparity have recently become an eminent feature of health systems in the United States and UK, and researchers recommend the assessment and comparison of the various models of health care in this regard.[37]

Research has also shown more obstetric interventions such as induction of labor, instrumental delivery, epidural anesthesia, and cesarean section in socially disadvantaged women in high-income countries, which are associated with poor pregnancy outcomes.[15] Of the 16 studies included in this systematic review, 1 study had poor internal validity and the rest had acceptable internal validity (good and moderate). There was a wide range of variation in the types of interventions evaluated in the studies. Some studies did not target a decrease in preterm delivery, but indicated it as a consequence. The question, therefore, arises as to whether these studies were robust enough to identify differences in the resulting improvement, including decreased preterm delivery. The follow-up periods of the studies were also considerably different. Despite numerous risk factors for participants in some studies, data analysis was not performed by adjusting the effect of confounders. Our findings show that one type of intervention is unlikely to be significantly superior to another, but a combination of interventions may have a better effect. However, some interventions were effective. Among the interventions evaluated in this study, group prenatal care was effective in reducing preterm delivery. Nevertheless, due to the limited number of studies, quality of evidence, small sample size in some primary studies, and variability in the number of sessions, duration of each session, and follow-up time, these results should be interpreted with caution. The results of a meta-analysis also indicated that group prenatal care (compared to standard care) was not related to a reduced rate of preterm delivery and hospitalization in the NICU, or beginning of breastfeeding overall, or with the type of study (subgroup analysis). Nevertheless, subgroup analysis of this study shows that group prenatal care in low-income women of color is related to a decrease of 3 PTBs per 100 live births.[38] This is a potentially significant result because the rate of PTB in African American women is approximately twice as high as in white women, even after controlling for factors such as socioeconomic status.[39] One feasible interpretation of improved

outcomes in African-American women is the provision of social support, coping strategies, and tension reduction via group prenatal care.[40]

As suggested in a systematic review that assessed group prenatal care in women with high-risk pregnancies with behavior-social and biomedical risk factors, further high-quality, well-controlled studies are needed to confirm the effectiveness of group prenatal care in improving the outcomes and costs of pregnancy-related care.[41] Consistent with previous reviews,[42-44] studies with adequate internal validity, the present review has shown that prenatal visits at home do not reduce PTB. The number of home visits (average: 5 times),[45] home visits by an expert compared to an unprofessional, and the characteristics of the participants[42] may be effective in improving pregnancy outcomes. Developing a standard home visit plan for a specific cultural environment with specific characteristics (start time, frequency, intensity, and content) remains a critical issue for healthcare providers. In addition, home visits can be implemented via a mixture of in-situ handbooks and mobile information technology (such as distance nursing).[46]

In this study, social support for women with socioeconomic deprivation reduced PTB. The results of a systematic review and meta-analysis also showed that programs that provide additional social support during pregnancy are unlikely to have a significant impact on the proportion of LBW, PTB, stillbirths, or neonatal death.[47] The results of another systematic review showed that continued midwife-led support for women with mixed levels of risk during pregnancy and childbirth is associated with a reduction in PTB (RR = 0.76; 95% CI: 0.64 to 0.91), but has no impact on LBW (RR = 0.96; 95% CI: 0.82 to 1.13).[48]

Although this study has provided us with the key knowledge that there is some existing evidence of the effectiveness of alternative models of prenatal care in reducing PTB in socioeconomically disadvantaged women compared with standard care, it has also helped to identify that this is an area where further research is needed. However, the limited number of studies and the quality of the evidence may affect the power of this study, so interpretation of the results should be done with caution.

Conclusion

A random-effects meta-analysis showed that all types of interventions were associated with a reduction in the risk of PTB. Given the limited number of studies and the quality of the evidence, these findings need to be interpreted with great caution. Randomized trials are needed to obtain more conclusive evidence about how to reduce preterm delivery and negative perinatal outcomes.

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Conflicts of interest

Nothing to declare.

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