Breastfeeding after cesarean delivery: a systematic review and meta-analysis of world literature

Emily Prior, Shalini Santhakumaran, Chris Gale, Lara H Philipps, Neena Modi, and Matthew J Hyde

ABSTRACT
Background: The rate of exclusive breastfeeding remains low in many countries. Furthermore, cesarean delivery (CD) is increasing and may affect breastfeeding success.

Objective: The objective was to conduct a systematic review and meta-analysis of observational studies to determine whether CD (prelabor or in-labor) is associated with a lower rate of breastfeeding compared with vaginal delivery (VD).

Design: Studies published before January 2011 that reported breastfeeding up to 6 mo postpartum and compared outcomes after CD or VD, including foreign language publications, were identified through PubMed and bibliographic review. Prespecified data were extracted independently by multiple observers. The types of CD [prelabor (elective/scheduled) or in-labor (emergency)] were compared by subgroup analyses. Potential sources of study-level bias were analyzed by using meta-regression and sensitivity analyses.

Results: The systematic review included 53 studies (554,568 subjects, 33 countries); 25 authors contributed additional data (245,455 subjects), and 48 studies (553,306 subjects, 31 countries) were included in the meta-analysis. Rates of early breastfeeding (any initiation or at hospital discharge) were lower after CD compared with after VD (pooled OR: 0.57; 95% CI: 0.50, 0.64; P < 0.00001) and lower after prelabor but not after in-labor CD (prelabor OR: 0.83; 95% CI: 0.80, 0.86; P < 0.00001; in-labor OR: 1.00; 95% CI: 0.97, 1.04; P = 0.86). In mothers who initiated breastfeeding, CD had no significant effect on any breastfeeding at 6 mo (OR: 0.95; 95% CI: 0.89, 1.01; P = 0.08).

Conclusions: There was a negative association between prelabor CD and early breastfeeding. If breastfeeding is initiated, mode of delivery has no apparent effect on the number of mothers still breastfeeding at 6 mo. Women and health care workers should be aware of the negative associations between CD and early breastfeeding and consequent implications for infants’ well-being. Am J Clin Nutr 2012; 95:1113–35.

INTRODUCTION
Breastfeeding is associated with benefits to lifelong health (1–4), yet the rate of exclusive breastfeeding remains low in many countries. In the United States only 33% of infants are exclusively breastfed at age 3 mo and <14% are exclusively breastfed at age 6 mo (5). Mode of delivery, in particular cesarean delivery (CD), is widely believed to affect breastfeeding adversely, but individual population studies examining the association between CD and breastfeeding are inconsistent. Some studies reported no association (6–9) and others an inverse relation (10–12). CD has increased rapidly worldwide. It is the most common surgical procedure carried out in the United States (13), where it accounts for 31.8% (14) of all births, and it is even more widespread in China and parts of South America, where rates are reported to be between 40% and 50% (15, 16), figures far in excess of the WHO recommended rate of 15% (17). Many women prefer CD even in the absence of medical indications (18), including a third of female obstetricians (19). Given the health benefits of breastfeeding, understanding the impact of mode of delivery is relevant to pregnant women and health care providers worldwide. The aim of this systematic review and meta-analysis was to determine the association between mode of delivery and early breastfeeding and continuation of breastfeeding to 6 mo postpartum.

METHODS

Literature search
A systematic review of published studies that reported breastfeeding outcomes by mode of delivery was conducted following a review protocol (Prior et al, unpublished observations, 2010) and PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (20). Outcomes studied were early breastfeeding (defined as breastfeeding at discharge from hospital postpartum or any report of breastfeeding initiation) and breastfeeding at 6 mo, by mode of delivery. Breastfeeding was classed as “exclusive” or “partial” in accordance with the WHO definitions (21) when these were used. Studies in which authors used an alternative classification were reclassified if possible either as “exclusive,” if in keeping with the WHO classification, or as “any breastfeeding” if not compatible. Type of exposure included all types of vaginal delivery (VD) and CD (elective/scheduled/prelabor and emergency/after labor onset). Studies that reported any breastfeeding outcome in VD and CD groups in the same cohort were included. PubMed (www.ncbi.nlm.nih.gov/pubmed) was used to search for studies published before 31 January 2011; the search strategy is outlined in Figure 1. Searches were carried out

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Received November 16, 2011. Accepted for publication February 28, 2012. First published online March 28, 2012; doi: 10.3945/ajcn.111.030254.
by EP, who was assisted by LHP. Reference lists of retrieved articles were hand searched. Relevant studies were identified by reading the abstract or the full article if no abstract was available. We excluded studies in which subjects were defined by disease state—for example, on the basis of maternal diabetes.

**Data extraction**

Data on study design, location, population, exposure classification, outcomes, and potential sources of bias were independently extracted by EP and CG and checked by MJH and SS. For foreign language publications, native speakers extracted required information by using a standardized form, including information on study-level biases. We corroborated foreign language data extraction by using a web-based translation package (22). Results from analyses with adjustment for confounders were collected where available. MJH contacted the authors to obtain additional data for studies in which it appeared these data might exist. Authors were asked to provide raw and adjusted data and details of factors adjusted for in regression analyses. In cases in which the same cohort was reported in different publications, data from only the most recent publication were used.

**Analyses**

A meta-analysis of studies (comparable in exposure definition and outcome measures) that reported the association between mode of delivery and early breastfeeding and breastfeeding at 6 mo was carried out. The unadjusted ORs, SEs, and 95% CIs for any early breastfeeding and any/exclusive breastfeeding at 6 mo for CD compared with VD were calculated from the raw data (23). If a multivariable logistic regression was carried out, the adjusted ORs and CIs were obtained and the log OR and its SE were calculated for use in the meta-analysis. If the OR for not breastfeeding was provided, this number was inverted to obtain the OR for breastfeeding. Similarly, if the OR comparing VD with CD was provided, this number was inverted to obtain the OR comparing CD with VD. In cases in which the rate of early breastfeeding was provided, this number was inverted to obtain the OR comparing CD with VD. In cases in which the rate of early breastfeeding was provided together with breastfeeding at 6 mo, the unadjusted OR and SE for continuation of breastfeeding after initiation for CD compared with VD was calculated. If continuation rates were available only for a subgroup of studies, any difference in breastfeeding at 6 mo given initiation of breastfeeding could be a subgroup effect. Therefore, to confirm that any difference in results for continuation was not a subgroup effect, the OR for any breastfeeding at 6 mo for all women (regardless of whether or not they initiated breastfeeding) was calculated for that subgroup as a comparison. If authors presented adjusted results separately for distinct subgroups, these were treated as separate studies in the analysis.

A fixed-effects meta-analysis was carried out in RevMan5 (The Cochrane Collaboration) by using the inverse variance method. This was carried out separately for each outcome and for adjusted and unadjusted results. Heterogeneity was assessed by using the chi-square test for Cochrane’s Q statistic (24) and by calculating $I^2$, the proportion of variance due to heterogeneity between studies rather than within-study variation (25). Potential sources of heterogeneity were investigated by comparing study designs and settings. When heterogeneity was present ($P < 0.05$ from the chi-square test) a random-effects meta-analysis was carried out, and studies were reviewed for differences in inclusion and exclusion criteria, outcome measure, and data collection methods that may have contributed to heterogeneity. These differences were explored in subgroup and
sensitivity analyses. In cases in which a random-effects analysis was carried out, the pooled OR was the estimate of the average effect across study populations, because studies were assumed to have different underlying effects. In contrast, for fixed-effects analyses, studies were assumed to have the same underlying effect, which was estimated by the pooled OR.

A meta-regression was performed by using Stata version 11 (StataCorp) to investigate whether association with early breastfeeding differed with type of CD (prelabor or emergency in-labor) and to investigate heterogeneity due to differences in population (maternal parity and preterm birth) and definition of breastfeeding outcome (WHO or non-WHO). Subgroup analysis was performed if meta-regression showed significant differences in the OR. Sensitivity analyses to address recall bias were performed by excluding studies in which breastfeeding data had been collected retrospectively. We considered prospective data collection to include retrospective analysis of data collected at the time of breastfeeding, in particular in clinical notes. If the quality or eligibility of any of the studies was in doubt, the analysis was performed both including and excluding these studies to check the sensitivity of the conclusions. Results were presented using forest plots, and funnel plots were used to investigate publication bias. Because the random-effects result is more affected by publication bias, which makes visual detection difficult, the pooled results from a fixed-effects analysis was used as the reference line (26). If funnel plots showed asymmetry, Egger’s test (27) and trim-and-fill analysis (28) were performed.

RESULTS

The literature search strategy (Figure 1) identified 591 publications. After abstract screening, 107 were reviewed in full text, with a further 3 (1, 29, 30) identified after review of reference lists. Twenty-one publications were not published in English. Attempts were made to contact authors from 39 studies for additional data (6, 7, 10, 31–66); 36 replied, providing data previously unpublished in this form from 245,455 subjects. Six authors could not provide data (47, 48, 57, 59–61) and one author (33) referred us to another publication, but this study was not suitable for inclusion (67). The full text was unobtainable for 3 studies (68–70). Of the remaining 100 studies, 47 were excluded for the following reasons: multiple reports of the same study population (32, 71–74), selective study population (including studies in which all women intended to breastfeed) (32, 40, 58, 64, 75–79), only qualitative data reported (43, 80, 81), or no suitable data on breastfeeding reported (82–110). Two studies (9, 34, 56, 115–118) were available for 9 of 11 studies (1, 9, 34, 56, 63, 115–118) (61,659 subjects).

Full/exclusive breastfeeding at 6 mo

After examining data for all subjects, we found the rate of any breastfeeding to be lower at 6 mo after CD (pooled OR: 0.86; 95% CI: 0.82, 0.91; P < 0.00001; fixed-effects: $I^2 = 38\%$, P = 0.07; 15 studies 84,518 subjects). When the analysis was restricted to women initiating breastfeeding, the pooled OR for any breastfeeding at 6 mo was not significantly different between CD and VD groups (OR: 0.95; 95% CI: 0.89, 1.01; P = 0.08; Figure 4). For comparison, analysis of the rate of any breastfeeding at 6 mo including all women regardless of whether they did or did not initiate breastfeeding for this subgroup of studies resulted in a pooled OR of 0.91 (95% CI: 0.86, 0.97; P = 0.003; fixed-effects: $I^2 = 0\%$, P = 0.65). Data on this outcome were available for 9 of 11 studies (1, 9, 34, 56, 63, 115–118) (61,659 subjects).

Elective (prelabor) or emergency (in-labor) CD

Eight studies provided data on early breastfeeding by type of CD. A random-effects meta-regression showed that the pooled OR for early breastfeeding comparing elective CD with VD was significantly different from the OR comparing elective CD with VD (OR: 1.21; 95% CI: 1.14, 1.28; P < 0.001), and a subgroup analysis was performed. Elective CD was associated with a significant reduction in early breastfeeding when compared with VD (pooled OR: 0.83; 95% CI: 0.80, 0.86; P < 0.00001; Figure 5), whereas emergency CD had no effect (pooled OR: 1.00; 95% CI: 0.97, 1.04; P = 0.86; Figure 6). This subgroup analysis contained a large cohort study (50) that could potentially bias this result. However, our conclusions remained unchanged when the analysis was repeated after the exclusion of this study (VD compared with elective CD—OR: 0.84; 95% CI: 0.75, 0.94; P = 0.0003; VD compared with emergency CD—OR: 0.96; 95% CI: 0.85, 1.09; P = 0.56).
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<tr>
<td>Al-Sahab, 2010 (119)</td>
<td>Canada; RC; nationwide representative sample Feb–May 2006; BF data: telephone interview between 5–9 mo postpartum (75.2% response rate)</td>
<td>No</td>
<td>VD = 4146 CD (unspecified) = 1456</td>
<td>EBF (WHO) at 6 mo</td>
<td>0.76 (0.64, 0.92)</td>
<td>0.80 (0.65, 0.99)</td>
<td>Marital status, mother's perceived health, smoking, birth setting, admission to NICU, maternal employment, province, maternal education, age at first pregnancy, parity, BMI prepregnancy</td>
<td>Secondary</td>
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<td>Bandusena, 2009 (31)</td>
<td>Sri Lanka, Colombo District; RC; recruited all mothers with infants aged 4–6 mo attending selected hospitals and clinics during the study period (Aug–Dec 2003); BF data: interview at 4–6 mo</td>
<td>Yes</td>
<td>VD = 270 CD (unspecified) = 154</td>
<td>EBF (WHO) at 4 mo</td>
<td>2.00 (1.34, 2.99)</td>
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<td>Secondary</td>
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<td>Baxter, 2009 (34)</td>
<td>Australia; LCS; nationwide random sample as part of the Longitudinal Study of Australian Children, March 2003–Feb 2004; BF data: postal questionnaire of mothers of infants aged 3–24 mo (54% response rate)</td>
<td>Yes</td>
<td>VD = 3572 CD (unspecified) = 1518</td>
<td>Ever BF</td>
<td>0.81 (0.65, 1.00)</td>
<td>0.87 (0.72, 1.06)</td>
<td></td>
<td>Secondary</td>
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<td>Butler, 2004 (10)</td>
<td>New Zealand, Auckland; LCS: part of the Pacific Islands Families Study sample (March–Dec 2000); included 11 pairs of twins; BF data: interview 6 wk postpartum (recruitment rate 87.1%)</td>
<td>Yes</td>
<td>VD = 1062 CD (unspecified) = 185</td>
<td>EBF at discharge</td>
<td>0.54 (0.38, 0.78)</td>
<td>0.57 (0.38, 0.85)</td>
<td>Employed before pregnancy, years in New Zealand, multiple birth, saw midwife during pregnancy, smoked during pregnancy, ethnicity, marital status, age, education, household income, acculturation</td>
<td>Secondary</td>
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<tr>
<td>Calzolari, 1989 (115) (Italian)</td>
<td>Italy, Florence; RC; births Jan 1985–June 1987; BF data: interviews during hospital stay; no response rate given</td>
<td>No</td>
<td>VD = 1209 CD (unspecified) = 155</td>
<td>BF at 1 mo</td>
<td>0.44 (0.31, 0.63)</td>
<td>0.88 (0.58, 1.33)</td>
<td></td>
<td>Secondary</td>
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<td>Ceriani Cernadas, 2010 (120) (Portuguese)</td>
<td>Argentina, Buenos Aires; PC; all healthy, term singleton infants born Dec 2004–July 2006 at one hospital; BF data: clinical data</td>
<td>No</td>
<td>VD = 1120 CD (unspecified) = 901</td>
<td>EBF (WHO) at discharge</td>
<td>0.38 (0.26, 0.55)</td>
<td></td>
<td>Secondary</td>
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<td>Chalmers, 2010 (121)</td>
<td>Canada; RC; random sample of recent births, stratified by province/territory of birth, maternal age, rural/urban area, and other children in the home; drawn from 2006 National Canadian Census; BF data: telephone interview at 5–14 mo (mean: 7.3 mo) postpartum; response rate 75.2%; study included 395 preterm infants</td>
<td>No</td>
<td>VD = 4732 CD (unspecified) = 1689</td>
<td>Any BF initiation EBF (WHO) at 6 mo Any BF at 6 mo</td>
<td>0.92 (0.76, 1.10) 0.80 (0.68, 0.95) 0.81 (0.72, 0.90)</td>
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<td>Secondary</td>
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<td>Chung, 2008 (36)</td>
<td>South Korea; RC; national, cross-sectional survey was conducted in married women aged 15–49 y regarding children born Jan 2001–May 2003; BF: personal interview, answered questions regarding the feeding practices of their youngest infant born during the above period</td>
<td>Yes</td>
<td>VD = 521 CD (unspecified) = 344</td>
<td>Any BF initiation</td>
<td>0.54 (0.39, 0.77)</td>
<td></td>
<td>Secondary</td>
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<td>Chye, 1997 (111)</td>
<td>Malaysia, Kuala Lumpur; RC; single hospital; random selection of 500 mothers with singleton pregnancies who attended with their infants for a 6-wk postnatal check-up from Sep–Nov 1995. BF data: interview 6 wk postpartum</td>
<td>No</td>
<td>VD = 355 CD (unspecified) = 145</td>
<td>EBF (WHO) at 6 wk</td>
<td>0.81 (0.51, 1.28)</td>
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<td>Secondary</td>
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<td>Crost, 1998 (37) (French)</td>
<td>France; PC; all births nationwide during 1 wk in 1995; BF data: collected during postnatal stay by interview and examination of medical records; adjusted analysis compared BF initiation between French and foreign women</td>
<td>Yes</td>
<td>VD = 10,293 Em CD = 803 El CD = 1013</td>
<td>Any BF at hospital discharge</td>
<td>All CD vs VD: 0.91 (0.82, 1.00) Em CD vs VD: 0.99 (0.86, 1.15) El CD vs VD: 0.84 (0.74, 0.96) Em CD vs El CD: 1.18 (0.98, 1.42)</td>
<td>Any BF at hospital discharge: French women: 0.99 (0.87, 1.12) Foreign women: 0.67 (0.45, 1.00)</td>
<td>Age, parity, nationality, marital status, education, employment status, paternal employment status</td>
<td>Secondary</td>
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<td>Dashti, 2010 (122)</td>
<td>Kuwait; PC; random selection from 4 hospitals, over 1 y from Oct 2008; BF data: interview (response rate 85%)</td>
<td>No</td>
<td>VD = 235 CD (unspecified) = 138</td>
<td>Any BF at hospital discharge</td>
<td>Any BF at discharge: 0.55 (0.31, 0.98)</td>
<td>Any BF at discharge: Admissions to SCU, paternal BF preference, country of mother’s birth</td>
<td>Secondary</td>
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<td>Davidson, 2010 (38)</td>
<td>UK; Oxford; PC; analysis of data set from Oxford Record Linkage Study: all NHS births in Oxfordshire and West Berkshire from 1975 to 1989; BF data: collected from maternity records</td>
<td>Yes</td>
<td>VD = 148,544 CD (unspecified) = 13,313</td>
<td>Any BF at hospital discharge</td>
<td>0.71 (0.68, 0.74)</td>
<td>0.60 (0.33, 1.06) EBF (non-WHO) at discharge: 0.15 (0.05, 0.43)</td>
<td>Not stated</td>
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<td>Ever-Hadani, 1994 (11)</td>
<td>Israel, Jerusalem; retrospective cohort; all women in district who delivered between Nov 1974 and Dec 1976, interviewed at birth of next child; BF data: retrospective, interview (4% recruitment rate)</td>
<td>No</td>
<td>VD = 8114 CD (unspecified) = 372</td>
<td>Ever BF (not just in hospital)</td>
<td>0.35 (0.28, 0.43)</td>
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<td>Secondary</td>
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<tr>
<td>Falhammar, 2010 (40)</td>
<td>Australia, Torres Strait Islands; RC; all primiparous deliveries in region over two 1-y time periods (1999 and 2003); BF data from medical records</td>
<td>Yes</td>
<td>1999: VD = 171 Em CD = 12 El CD = 10 2005/2006: VD = 160 Em CD = 12 El CD = 11</td>
<td>Any BF at discharge</td>
<td>All CD vs VD: 0.71 (0.26, 1.95) Em CD vs VD: 0.98 (0.22, 4.38) El CD vs VD: 0.53 (0.15, 1.92) El CD vs Em CD: 1.83 (0.28, 12.19)</td>
<td></td>
<td>Not stated</td>
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<td>Forman, 1991 (41)</td>
<td>Israel, Negev; PC; all live hospital births to Bedouin Arabs (Dec 1981–Dec 1982); BF data: interview during postnatal stay (&lt;3 d after birth) and medical records (response rate 80%)</td>
<td>Yes VD = 1722 CD (unspecified) = 73</td>
<td>EBF (non-WHO)</td>
<td>0.12 (0.07, 0.19)</td>
<td>0.09 (0.05, 0.15)</td>
<td>Birth season, parity, marital status, health during pregnancy, birth weight, infant malformations or illnesses</td>
<td>Secondary</td>
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<tr>
<td>García-López, 2010 (123) (Spanish)</td>
<td>Spain, Cartagena; observational, cross-sectional study; all children born between Nov 2004 and Nov 2005 who attended the Mazarron Health Centre in Cartagena at 15-mo check-up; BF data: interview conducted by a nurse at 15 mo postpartum; included 25 preterm infants</td>
<td>No VD = 158 CD (unspecified) = 54</td>
<td>EBF (WHO) initiation</td>
<td>0.34 (0.17, 0.67)</td>
<td>EBF at 6 mo</td>
<td>0.54 (0.23, 1.31)</td>
<td>EBF at 6 mo (continuation)</td>
<td>0.76 (0.30, 1.91)</td>
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<tr>
<td>Gathwala, 1992 (124)</td>
<td>India, New Delhi; PC; single hospital, primiparous women only; recruitment methods and date of study not stated; BF data: questionnaire, clinical observation, and follow-up visit at 1 mo</td>
<td>No VD = 26 CD (unspecified) = 26</td>
<td>EBF (non-WHO) initiation</td>
<td>1.70 (0.53, 5.48); no difference (all mothers in study had someBF)</td>
<td>Any BF initiation</td>
<td>0.64 (0.10, 4.18); no difference (all mothers in study had someBF)</td>
<td>Any BF 1 mo</td>
<td>1.13 (0.90, 1.42)</td>
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<td>Häggkvist, 2010 (116)</td>
<td>Norway; PC; recruitment at all routine antenatal ultrasound scans in Norway (1999–2008); BF data: questionnaire at 6 mo postpartum (43% response rate)</td>
<td>No VD = 25,696 CD (unspecified) = 3925</td>
<td>Any BF initiation</td>
<td>0.36 (0.29, 0.45)</td>
<td>Fully BF (including water) at 1 mo</td>
<td>0.51 (0.47, 0.55)</td>
<td>Fully BF at 6 mo (continuation)</td>
<td>0.78 (0.73, 0.83)</td>
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<td>Fully BF (including water) at 3 mo</td>
<td>1.11 (0.88, 1.40)</td>
<td>BF at 6 mo</td>
<td>1.13 (0.90, 1.42)</td>
<td>BF at 6 mo (continuation)</td>
<td>1.13 (0.90, 1.42)</td>
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<td>Hauck, 2010 (6)</td>
<td>Australia, Western Australia; RC; women recruited via Western Australia's database of all births; BF data: postal questionnaires sent out over 5-mo period (Feb–June 2005) at 8 wk postpartum (response rate 48%, which represented 9.5% of the Western Australia birthing population in 2006)</td>
<td>Yes</td>
<td>VD = 1693 EI CD = 582 Em CD = 300</td>
<td>BF initiation in hospital BF cessation by 9 wk after birth</td>
<td>1.53 (1.2, 1.95)</td>
<td>Maternal age, parity, location, public or private hospital, maternal education, feeding method in hospital</td>
<td>Secondary</td>
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<tr>
<td>Heck, 2003 (44)</td>
<td>USA, California; retrospective, stratified, random-sample survey, sample, weighted to represent all childbearing women in California, 1999–2001. BF data: postal questionnaire sent out at 2 mo postpartum; nonrespondents followed up with telephone contacts (70–71% response rate each year)</td>
<td>Yes</td>
<td>VD = 7602 CD = 2179</td>
<td>EBF initiation</td>
<td>0.77 (0.68, 0.88)</td>
<td>Not stated</td>
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<tr>
<td>Janke, 1988 (112)</td>
<td>USA; Alaska (metropolitan district); PC; women recruited on the postnatal unit of single hospital (May–Aug 1986); BF data: telephone questionnaire at 6 wk (response rate 6.3%)</td>
<td>No</td>
<td>VD = 148 CD (unspecified) = 67</td>
<td>BF success at 6 wk (non-WHO)</td>
<td>0.78 (0.43, 1.43)</td>
<td>Primary</td>
<td></td>
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<td>Jordan, 2005 (45)</td>
<td>UK, Swansea; RC; random sample of primiparous women were selected from the maternity unit of a district general hospital during 2000; BF data: review of joint obstetric/nursing midwife case notes</td>
<td>Yes</td>
<td>VD = 325 EI CD = 28 Em CD = 72</td>
<td>BF on discharge</td>
<td>0.25 (0.13, 0.47)</td>
<td>Drugs administered, mother’s occupation, feeding intention, maternal age, length of labor and hospital stay</td>
<td>Secondary</td>
<td></td>
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<td>Khassawneh, 2006 (46)</td>
<td>Jordan; RC; random national sample in clustered locations (5 villages) across Jordan for births between 2000 and 2003; BF data: married women were interviewed at 6 mo to 3 y postpartum</td>
<td>Yes</td>
<td>VD = 296; CD (unspecified) = 46</td>
<td>Full BF (non-WHO) at 6 mo</td>
<td>0.37 (0.19, 0.70)</td>
<td>Does not specify</td>
<td>Secondary</td>
<td></td>
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<tr>
<td>Kohlhuber, 2008 (7)</td>
<td>Germany; Bavaria, PC; all women in hospital/clinics/at home in April 2005; BF data: questionnaire between 2-6 d and 2 and 4 mo after birth; 141 of 146 birth clinics in Bavaria participated (45% response rate); mothers of twins were told to answer the questionnaire for the firstborn only</td>
<td>Yes</td>
<td>Initial numbers: VD = 2086; CD (unspecified) = 106</td>
<td>BF initiation at 2 d postpartum</td>
<td>0.79 (0.61, 1.03)</td>
<td>2.36 (1.17, 4.78)</td>
<td>Secondary</td>
<td></td>
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<tr>
<td>Kramer, 2001 (1)</td>
<td>Belarus; nationwide, prospective cluster-randomized controlled trial; June 1996–Dec 1997; BF data: prospective interview at 1, 2, 3, 6, 9, and 12 mo at well-child clinics</td>
<td>Yes</td>
<td>VD = 14,677; CD (unspecified) = 1920</td>
<td>Any BF (WHO) at 6 mo</td>
<td>0.92 (0.83, 1.01)</td>
<td>0.92 (0.83, 1.01)</td>
<td>Intervention (calculated based on data from author)</td>
<td>Not stated</td>
</tr>
<tr>
<td>Leung, 2002 (125)</td>
<td>Hong Kong; RC; multicenter, covering 92% of all births in Hong Kong; article presents comparison of 1997 and 1987 birth cohorts; BF data: mix of personal and telephone interviews and self-administered questionnaires (response rates: 1987 = 99.4%, 1997 = 95%)</td>
<td>Yes</td>
<td>Raw data available from the 1997 cohort only: VD = 5593; CD (unspecified) = 2084</td>
<td>BF initiation</td>
<td>1997 cohort only: 0.67 (0.54, 0.84)</td>
<td>Pooled 1987 and 1997 cohorts: 0.62 (0.56, 0.69)</td>
<td>Birth cohort, maternal age, smoking, maternal education, maternal employment, sex of infant, birth weight, birth order</td>
<td>Not stated</td>
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<td>Liston, 2008 (50)</td>
<td>Canada, Nova Scotia; RC; 15-y population-based cohort study using Nova Scotia Atlee database: all births in Nova Scotia between 1988 and 2002; BF data: standardized patient care records entered into the database after collection by health records personnel; singleton infants only</td>
<td>Yes</td>
<td>VD = 115,666&lt;br&gt;El CD = 10,755&lt;br&gt;Em CD = 16,508</td>
<td>BF at discharge</td>
<td>All CD vs VD: 0.93 (0.91, 0.96)&lt;br&gt;Em CD vs VD: 1.01 (0.98, 1.04)&lt;br&gt;El CD vs VD: 0.83 (0.79, 0.86)&lt;br&gt;Em CD vs El CD: 1.22 (1.16, 1.28)</td>
<td>0.79 (0.77, 0.83)</td>
<td>Year of delivery, maternal age, parity, smoking, maternal weight, hypertension, diabetes, previous CD, regional anesthesia, induction of labor, gestational age, large/small for gestational age</td>
<td>Not stated</td>
</tr>
<tr>
<td>Mansbach, 1991 (12)</td>
<td>Israel, Jerusalem; RC; random sample of primiparous mothers attending maternal and child health clinics run by the Jerusalem municipality (80% of births in Jerusalem); Feb–Aug 1988; BF data: personal interview at 6 mo postpartum</td>
<td>No</td>
<td>VD = 165&lt;br&gt;CD (unspecified) = 24</td>
<td>Any BF initiation</td>
<td>0.26 (0.09, 0.76)</td>
<td>Primary</td>
<td></td>
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<tr>
<td>Mihirshahi, 2010 (29)</td>
<td>Bangladesh; retrospective nationwide population health survey (Bangladesh Demographic and Health Survey 2004); survey sample is a stratified, multistage, cluster sample of 2480 children aged 0–23 mo; BF data: personal interview, restricted to the last-born child aged &lt;24 mo living with the respondent</td>
<td>No</td>
<td>VD = 2359&lt;br&gt;CD (unspecified) = 121</td>
<td>Ever BF</td>
<td>0.02 (0.00, 0.42)</td>
<td>Secondary</td>
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<td>Mikiel-Kostyra, 2005 (51)</td>
<td>Poland; PC; countrywide; independent cross-sectional surveys: Jan 1995; 427 maternity wards (all governmental hospitals in Poland); BF data: clinical notes</td>
<td>Yes</td>
<td>VD (all) = 9785 CD (unspecified) = 1637</td>
<td>EBF (WHO) at discharge/during stay</td>
<td>0.20 (0.18, 0.22)</td>
<td>Secondary</td>
<td></td>
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<tr>
<td>Nakao, 2008 (53)</td>
<td>Japan, Nagasaki; RC; all primiparous mothers of 4-mo-old infants were recruited from a single hospital between Sep and Dec 2003; BF data: self-administered questionnaire at 4 mo postpartum (response rate of 81%)</td>
<td>Yes</td>
<td>VD = 263 CD (unspecified) = 55</td>
<td>EBF at 4 mo (WHO)</td>
<td>0.56 (0.31, 1.02)</td>
<td>Secondary</td>
<td></td>
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<tr>
<td>Nissen, 1996 (52)</td>
<td>Sweden, Stockholm; PC; all mothers recruited from the maternity ward of a single hospital. BF data: questionnaires distributed at 2 mo postpartum, which women were asked to complete at the end of their BF period (response rate not provided); all mothers initiated BF, so only continuation rates available</td>
<td>Yes</td>
<td>VD = 20 Em CD = 17</td>
<td>EBF (WHO) at 6 wk (continuation rates) EBF (WHO) at 4 mo Any BF at 6 mo (continuation rates)</td>
<td>1.08 (0.24, 4.90) 1.65 (0.44, 6.20) 0.77 (0.20, 2.92)</td>
<td>Secondary</td>
<td></td>
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<tr>
<td>Pai, 1999 (113)</td>
<td>India, Chennai; RC; survey carried out in an urban, educated, middle/upper-class population as part of a wider study examining vaccine coverage; July–Sep 1997; BF data: interview at 12–36 mo postpartum</td>
<td>No</td>
<td>VD = 115 CD (unspecified) = 95</td>
<td>EBF at 4 mo</td>
<td>0.75 (0.43, 1.29)</td>
<td>Primary</td>
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<td>Pandey, 2010 (126)</td>
<td>Nepal; retrospective nationwide population health survey (Nepal Demographic and Health Survey 2006) in children aged 0–23 mo; BF data: obtained via personal interview</td>
<td>No</td>
<td>VD = 1843</td>
<td>Ever BF</td>
<td>0.66 (0.04, 11.42)</td>
<td></td>
<td></td>
<td>Secondary</td>
</tr>
<tr>
<td>Patel, 2010 (30)</td>
<td>India; retrospective nationwide population health survey (secondary data analysis of National Family Health Survey 2005–2006); random sample of children aged 0–23 mo; BF data collected via personal interview</td>
<td>No</td>
<td>VD = 18,208</td>
<td>Ever BF</td>
<td>0.52 (0.34, 0.81)</td>
<td></td>
<td></td>
<td>Secondary</td>
</tr>
<tr>
<td>Patel, 2003 (8)</td>
<td>UK, Bristol; PC; women who fulfilled inclusion criteria (term, singleton, cephalic pregnancy) were identified from the obstetric records at 2 hospitals Feb 1999–Feb 2000; BF data: prospectively by personal interview before discharge and postal questionnaires at 6 wk and 1 y postpartum (response rates: 6 wk, 90%; 1 y, not stated)</td>
<td>No</td>
<td>VD (all assisted instrumental) = 184 Em CD (during 2nd stage of labor) = 209</td>
<td>EBF (WHO) at hospital discharge EBF (WHO) at 6 wk</td>
<td>1.15 (0.75, 1.76) 0.75 (0.49, 1.14)</td>
<td>0.84 (0.50, 1.41)</td>
<td>Maternal age, social class, smoking, parity, duration of second stage of labor, opiate analgesia, admission to SCU, intention to breastfeed</td>
<td>Primary</td>
</tr>
<tr>
<td>Pechlivani, 2005 (127)</td>
<td>Greece, Athens; PC; cross-sectional study across 5 main maternity hospitals (representing 87% of all births in Athens during Oct 2001); participants were selected from hospital case notes; BF data: questionnaire on day of discharge</td>
<td>No</td>
<td>VD = 974 (excluded assisted instrumental delivery) Em CD (unspecified) = 608</td>
<td>BF initiation</td>
<td>0.13 (0.08, 0.20)</td>
<td></td>
<td></td>
<td>Secondary</td>
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<td>Pérez-Escamilla, 1996 (117)</td>
<td>Mexico; RC; part of the Mexican Demographic and Health Survey (1987): multistage cluster design based on a nationally representative sampling framework; women whose delivery of their last-born child (aged ≤5 y) was attended by a physician; BF data: questionnaire up to 5 y postpartum (response rate 96%)</td>
<td>No</td>
<td>VD = 1973 CD (unspecified) = 514</td>
<td>BF initiation</td>
<td>0.55 (0.44, 0.69)</td>
<td>0.82 (0.66, 1.02)</td>
<td>BF by mode of delivery: primary, secondary, or not stated outcome</td>
<td>Primary</td>
</tr>
<tr>
<td>Pérez-Escamilla, 1999 (54)</td>
<td>Peru; retrospective; women whose last child was born within 5 y of the Peruvian Demographic Health Survey (1991–1992); BF data: personal interview</td>
<td>Yes</td>
<td>VD = 5684 CD (unspecified) = 612</td>
<td>BF initiation</td>
<td>0.41 (0.29, 0.58)</td>
<td>Not stated</td>
<td>Maternal age, education, marital status, work status, participation in nutritional program during pregnancy, BF persistence, BF aid, artificial formula promotion</td>
<td>Primary</td>
</tr>
<tr>
<td>Pérez-Rios, 2008 (128)</td>
<td>Puerto Rico; population-based cross-sectional study, part of the Puerto Rico Reproductive Health Survey; nationwide representative sample of all women aged 15–45 y; interviewed in 1995–1996; BF data: information on feeding of last-born child aged &lt;6 y</td>
<td>No</td>
<td>VD = 1097 CD (unspecified) = 598</td>
<td>Any BF initiation</td>
<td>0.81 (0.66, 1.00)</td>
<td>0.64 (0.51, 0.81)</td>
<td>Maternal age, education, marital status, work status, participation in nutritional program during pregnancy, BF persistence, BF aid, artificial formula promotion</td>
<td>Primary</td>
</tr>
<tr>
<td>Procianoy, 1984 (114)</td>
<td>Brazil, Porto Alegre; PC; mothers delivering in a single hospital; date not stated; BF data: interview at hospital discharge and at 2 mo discharge</td>
<td>No</td>
<td>VD = 73 CD (unspecified) = 22</td>
<td>EBF at 2 mo (nons- WHO)</td>
<td>0.36 (0.14, 0.95)</td>
<td>Primary</td>
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<td>Qiu, 2007 (129)</td>
<td>China, Hangzhou; PC; single hospital; BF data: interviewer-administered questionnaires before discharge until infants were age 6 mo, during 2005 (response rate 96%)</td>
<td>Yes</td>
<td>VD = 155 CD (unspecified) = 483</td>
<td>EBF initiation</td>
<td>0.67 (0.54, 0.84)</td>
<td>Secondary</td>
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<td>Rowe-Murray, 2002 (56)</td>
<td>Australia, Melbourne; PC; consecutive primiparous mothers identified through birth registers at 4 hospitals, Dec 1996–Oct 1997; BF data: interviewed 2 d postpartum and postal questionnaire 8 mo postpartum (response rate 80%)</td>
<td>Yes</td>
<td>VD = 155</td>
<td>BF initiation</td>
<td>0.76 (0.23, 2.54)</td>
<td>0.67 (0.32, 1.41)</td>
<td>BF by mode of delivery: primary, secondary, or not stated outcome</td>
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<tr>
<td>Tamminen, 1983 (118)</td>
<td>Finland, Tampere; prospective cohort of mothers giving birth in single hospital between Oct 1978 and March 1979; BF data: postal questionnaire at 6–8 mo postpartum with a response rate of 94.4%</td>
<td>No</td>
<td>VD = 1465</td>
<td>BF initiation</td>
<td>0.19 (0.09, 0.42)</td>
<td>1.06 (0.74, 1.52)</td>
<td>Secondary</td>
<td></td>
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<tr>
<td>Taylor, 2010 (130)</td>
<td>Australia, NSW; BF data: clinical data obtained from the Midwives data collection for 2007 covering all births in NSW in 2007; included preterm infants</td>
<td>No</td>
<td>VD = 65,824</td>
<td>BF initiation</td>
<td>0.77 (0.74, 0.80)</td>
<td></td>
<td>Season of birth, socioeconomic status, maternal age and education, paternal age and education, BMI, smoking, miscarriage, in vitro fertilization</td>
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<tr>
<td>Theofilogiannakou, 2006 (62)</td>
<td>Greece, Central Athens; PC; women were recruited consecutively in 1 public and 3 private hospitals as part of an epidemiologic survey in Athens Sep 2003–Feb 2004; BF data: interview before discharge and telephoned at 40 d postpartum; those still BF at 40 d were contacted again at 6 mo</td>
<td>Yes, but not able to provide data on BF at 6 mo</td>
<td>VD = 193</td>
<td>BF initiation</td>
<td>0.24 (0.11, 0.49)</td>
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<td>Vestermark, 1991 (63)</td>
<td>Denmark; PC; all mothers who delivered between April and June 1986, single hospital; BF data: interview on discharge and at 3 and 6 mo postpartum</td>
<td>Yes</td>
<td>VD = 268 CD (unspecified) = 102</td>
<td>BF initiation Any BF at 6 mo</td>
<td>0.24 (0.07, 0.88) 0.77 (0.49, 1.22)</td>
<td></td>
<td></td>
<td>Primary</td>
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<tr>
<td>Victoria, 1990 (9)</td>
<td>Brazil, Pelotas; RC, &gt;99% infants delivered in the city in 1982; singleton births; BF data: personal interviews at 12–27 mo postpartum</td>
<td>No</td>
<td>VD = 3559 El CD = 398 Em CD = 955</td>
<td>BF initiation BF at 6 mo (out of total sample size)</td>
<td>1.05 (0.83, 1.32) 0.93 (0.80, 1.07)</td>
<td>IBF at 6 mo (El CD): 0.78 (0.66, 0.92) IBF at 6 mo (Em CD): 0.97 (0.77, 1.22)</td>
<td>Household income, maternal age and education, number of antenatal attendances, gestational age, gestational risk, birth weight</td>
<td>Primary</td>
</tr>
<tr>
<td>Wang, 2006 (131) (Chinese)</td>
<td>China, Shanghai; PC; multiparous mothers choosing to deliver at one hospital in Shanghai during 2001–2002. BF data: interviewed 1, 6, and 12 mo postpartum</td>
<td>No</td>
<td>VD = 301 CD (unspecified) = 301</td>
<td>Any BF at 6 mo</td>
<td>0.68 (0.49, 0.94)</td>
<td></td>
<td></td>
<td>Primary</td>
</tr>
<tr>
<td>Weiderpass, 1998 (132) (Portuguese)</td>
<td>Brazil, Pelotas; PC; population-based cohort of children born in 1993; BF data: interview at birth and at 1 and 3 mo postpartum; this study included 48 preterm infants</td>
<td>No</td>
<td>VD = 468 Em CD = 135 El CD = 52</td>
<td>BF initiation</td>
<td>All CD vs VD: 0.59 (0.21, 1.60) Em CD vs VD: 0.86 (0.23, 3.23) El CD vs El CD: 0.32 (0.08, 1.22) Em CD vs El CD: 2.69 (0.53, 13.80)</td>
<td></td>
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<td>Primary</td>
</tr>
<tr>
<td>Wiklund, 2007 (133)</td>
<td>Sweden; PC; primiparous mothers recruited at a single hospital Jan 2003–June 2005; BF data: questionnaire issued at 2 d postpartum</td>
<td>No</td>
<td>VD = 237 CD (unspecified) = 91</td>
<td>BF initiation</td>
<td>0.55 (0.34, 0.9)</td>
<td></td>
<td></td>
<td>Primary</td>
</tr>
<tr>
<td>Zuppa, 1984 (65) (Italian)</td>
<td>Italy, Rome; PC; single hospital, March–April 1981; 57% of all live births during period; included only healthy term infants, of normal birth weight; BF data: clinical data</td>
<td>Yes</td>
<td>VD = 291 El CD = 54 Em CD = 11</td>
<td>Any BF at discharge</td>
<td>0.61 (0.25, 0.74)</td>
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Parity

Six studies (12, 40, 45, 56, 124, 133) included only primiparous women. A random-effects meta-regression showed that the OR for early breastfeeding in these studies was not significantly different from the OR for studies that included all women (OR: 1.14; 95% CI: 0.65, 1.99; \( P = 0.64 \)).

Full-term birth

Six studies (7, 36, 40, 121, 123, 130) included only infants born at term. A random-effects meta-regression showed that the OR for early breastfeeding in these studies was not significantly different from the OR for studies not limited to term infants (OR: 1.25; 95% CI: 0.79, 1.97; \( P = 0.34 \)).

Sensitivity analyses

Prospective collection of breastfeeding data

When the analysis was limited to studies in which data were collected prospectively, (21 of 41 studies; 437,385 of 554,568 subjects), the OR for early breastfeeding after CD in comparison to VD was 0.56 (95% CI: 0.47, 0.67; \( P \), 0.00001; random-effects: \( I^2 = 98\% \), \( P \), 0.00001), an effect that was almost identical to the analysis that included all studies.

WHO definition of exclusive breastfeeding

In comparison to the pooled OR for full/exclusive breastfeeding at 6 mo (0.81; 95% CI: 0.67, 0.98), when the analysis was restricted to studies that used the WHO definition of “exclusive breastfeeding;,” a similar magnitude of effect was seen (pooled OR: 0.84; 95% CI: 0.74, 0.94; \( P < 0.003 \); random-effects: \( I^2 = 42\% \), \( P = 0.16 \); 4 studies, 28,832 subjects) (1, 119, 121, 123).

Funnel plots

The funnel plot for early breastfeeding (Figure 7) showed strong visual evidence of publication bias. This was confirmed by Egger’s test (\( P = 0.007 \)). However, the trim-and-fill analysis resulted in an identical OR of 0.57 (95% CI: 0.50, 0.64). The funnel plot for any breastfeeding at 6 mo (limited to mothers who initiated breastfeeding; Figure 8) showed some visual evidence of publication bias, but the \( P \) value from Egger’s test was not significant (\( P = 0.7 \)), and the trim-and-fill analysis provided identical results (OR: 0.95; 95% CI: 0.90, 1.01). There was no evidence of publication bias for the other analyses, although the small number of studies made this difficult to evaluate.

DISCUSSION

Our meta-analysis, which comprised data from more than half a million women in 31 countries, provided strong support for the conclusion that CD has a significant adverse association with early breastfeeding. Crucially, once initiated, breastfeeding at 6 mo does not appear to be affected. The adverse association between CD and breastfeeding appears limited to elective, prelabor CD. With both CD (15, 134) and elective CD (135) increasing worldwide, this is of international public health importance. This question has been addressed by previous studies, notably that of Liston et al (50). Conclusions similar to our own have been reached by some authors, such as Pérez-Escamilla et al (117), but
these have generally been from smaller studies (<10,000 subjects) and confined to single geographic regions. By combining data from all eligible studies in our meta-analysis, we provided conclusions that represent effects in an internationally representative population, thereby strengthening generalization to different health care settings. Because of the large size of our

FIGURE 2. Forest plot shows the random-effects meta-analysis of the unadjusted ORs for reports of early breastfeeding comparing all types of CD with VD. BF, breastfeeding; CD, cesarean delivery; inc, including; M-H, Mantel-Haenszel; VD, vaginal delivery.

FIGURE 3. Forest plot shows the random-effects meta-analysis of the adjusted ORs for reports of early breastfeeding comparing all types of CD with VD. BF, breastfeeding; CD, cesarean delivery; IV, inverse variance; VD, vaginal delivery.
analysis we were able to perform subgroup analyses of the separate effects of emergency and prelabor CD and also to investigate potential sources of heterogeneity. Furthermore, we included additional data from 25 peer-reviewed studies, including data from 161,857 subjects in the UK-based Oxford Record Linkage study (38). The inclusion of this large body of additional data strengthened the validity of our findings.

Due to the large size of our meta-analysis, we could address several important biases inherent in breastfeeding studies (136). To reduce reporting bias we included studies in all languages, excluded multiple examinations of the same cohort, and contacted authors to obtain unpublished data. Nevertheless, funnel plots for some analyses did suggest reporting bias. This may have led to an overestimation of the effect size, a point that must be considered, despite the biological plausibility of our results. However, the relation between breastfeeding and mode of delivery was not a primary outcome in 74% (39 of 53) of included studies, reducing the likelihood of true publication bias, nor did the trim-and-fill analyses alter the conclusions. To examine the effect of recall bias, we performed a sensitivity analysis of studies in which breastfeeding outcome data were collected prospectively. The use of nonstandard definitions for breastfeeding outcomes also has the potential to introduce bias (137); therefore, we undertook a sensitivity analysis of studies in which “exclusive breastfeeding” was recorded at 6 mo in accordance with rigorous WHO criteria. Both analyses showed an effect on breastfeeding similar in magnitude and direction. To address the potential effects of confounders shown to affect breastfeeding, we performed an analysis of studies that reported adjusted results. We also performed meta-regressions to evaluate the effect of parity and prematurity. All of these analyses were in keeping with our primary results and showed similar effect sizes. Given the presence of high between-study variability, we acknowledge uncertainties in the interpretation of results. The possibility remains that, whereas the adverse effect we find exists on average, it may not be present in all settings (138). A high level of heterogeneity was perhaps unsurprising given the wide range of health care systems and populations included in our study.

The meta-analysis of studies in which adjustment for major confounders was made still showed heterogeneity (see Table 1 for list of adjustments). Of note, there was no heterogeneity in the limited subgroup analysis of type of CD, suggesting that the mix of elective and emergency CD in studies is a major cause of the heterogeneity observed overall. A further source of possible heterogeneity is the lack of clarity on how breastfeeding was measured because few studies included details of how this was defined. Finally, it is possible that the reasons that determine why some women express a preference for CD are closely linked with a decision not to breastfeed. However, to examine this relation requires knowledge of breastfeeding intent, which was collected in only 3 studies (8, 45, 129); because only 2 of these studies adjusted their results for breastfeeding intention (8, 45), we did not perform a subgroup analysis. Overall, it was disappointing that data on potential confounders were collected in so few studies. Breastfeeding engenders strong views, emphasizing the need for rigorous design, preregistration of study

![FIGURE 4](https://academic.oup.com/ajcn/article-abstract/95/5/1113/4576793/fig4)

**FIGURE 4.** Forest plot shows the fixed-effects meta-analysis of the unadjusted ORs for reports of continuation of any breastfeeding at 6 mo comparing all types of CD with VD for mothers who initiated breastfeeding. BF, breastfeeding; CD, cesarean delivery; inc, including; M-H, Mantel-Haenszel; VD, vaginal delivery.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>CD Events</th>
<th>Total</th>
<th>CD inc (assisted) Events</th>
<th>Total</th>
<th>Weight</th>
<th>Odds Ratio</th>
<th>M-H, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innesen 1996 [53]</td>
<td>10</td>
<td>17</td>
<td>13</td>
<td>20</td>
<td>0.2%</td>
<td>0.77 [0.20, 2.92]</td>
<td></td>
</tr>
<tr>
<td>Prez-Escamilla 1996 [117]</td>
<td>188</td>
<td>375</td>
<td>760</td>
<td>1639</td>
<td>6.5%</td>
<td>1.16 [0.93, 1.45]</td>
<td></td>
</tr>
<tr>
<td>Roawe-Murray 2002 [50]</td>
<td>17</td>
<td>36</td>
<td>67</td>
<td>117</td>
<td>0.8%</td>
<td>0.57 [0.32, 1.41]</td>
<td></td>
</tr>
<tr>
<td>Tammiminen 1993 [119]</td>
<td>81</td>
<td>127</td>
<td>670</td>
<td>1437</td>
<td>2.8%</td>
<td>0.97 [0.54, 1.73]</td>
<td></td>
</tr>
<tr>
<td>Westerman 1991 [63]</td>
<td>47</td>
<td>86</td>
<td>141</td>
<td>284</td>
<td>1.9%</td>
<td>0.84 [0.52, 1.34]</td>
<td></td>
</tr>
<tr>
<td>Victoria 1980 [9]</td>
<td>331</td>
<td>1249</td>
<td>920</td>
<td>3274</td>
<td>17.3%</td>
<td>0.92 [0.80, 1.07]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>9145</td>
<td>5326</td>
<td>100.0%</td>
<td>0.95 [0.89, 1.01]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![FIGURE 5](https://academic.oup.com/ajcn/article-abstract/95/5/1113/4576793/fig5)

**FIGURE 5.** Forest plot shows the fixed-effects meta-analysis of the unadjusted ORs for reports of early breastfeeding comparing El CD and VD. BF, breastfeeding; CD, cesarean delivery; El CD, elective, prelabor cesarean delivery; M-H, Mantel-Haenszel; VD, vaginal delivery.
protocols, use of accepted breastfeeding definitions, and recording of potential confounders.

Any effect of CD on early breastfeeding might be mediated through processes that delay the onset of lactation, disrupt mother-infant interaction, or inhibit infant suckling. The first postnatal hours are crucial for establishing mother-infant interaction and breastfeeding success (139–142); timing of the first feeding is a key determinant (53, 143). Postoperative care routines after CD interrupt bonding (67, 144), delay mothers holding their infants (52, 53, 89, 145), and reduce early breastfeeding (146), which all are potential mechanisms that reduce breastfeeding. CD is carried out for a variety of reasons, including maternal illness and fetal compromise, which may also reduce breastfeeding success (50). These factors all have greater association with emergency CD than with prelabor CD. Consequently they seem unlikely explanations for our results; subgroup analysis showed that early breastfeeding was no different in women who had an emergency CD compared with those who delivered vaginally. Although our study was possibly underpowered to detect a difference between emergency CD and VD, the 95% CI for the OR was fairly narrow (0.97, 1.04), so any difference is likely to be small. Because emergency CD usually takes place after the onset of labor, this observation supports the contention that it is the metabolic or endocrine milieu of labor that is paramount to initiating lactation (147). The magnitude of oxytocin and prolactin responses, which play important mediating roles in milk ejection and in establishing mother-infant interaction (148–150), differs in mothers delivering by CD and vaginally (52). Differences have also been shown in blood concentrations of appetite-regulating hormones in infants born by CD and VD (151–153). Rat pups that undergo simulated VD by drawing them through a rubber ring in utero before CD show earlier suckling than pups from the same litters delivered by CD without simulated VD (154).

Our findings raise the important question of whether early breastfeeding after CD can be improved through increased support. An examination of this question would require the randomized assignment of breastfeeding support, which was carried out in the PROBIT (Promotion of Breastfeeding Intervention Trial); however, in this trial all infants initiated breastfeeding (155), precluding any evaluation of the effect of breastfeeding support on breastfeeding initiation after CD. No other study in our review was conducted solely in “baby friendly” hospitals. Other evidence to date is not reassuring, and encouraging breastfeeding in all mothers does not appear to be sufficient to harmonize initiation rates (145). Carefully planned intervention studies of breastfeeding support after CD need to be performed.

In summary, we showed that, globally, there is an association between elective CD and lower rates of breastfeeding. The rise in elective prelabor CD is thus particularly concerning. In the United States, the number of elective CDs increased by 53% between 1996 and 2007 (157), whereas in England there was a 250% increase between 1980 and 2010, and currently 40% of all CDs are prelabor (158). The contribution of maternal choice to the increasing elective CD rate is important. In the United Kingdom, 6–8% of pregnant women express a preference for CD (18), whereas in Australia, an increase in elective CD has not been accompanied by increases in potentially explanatory health-related factors (159). However, maternal choice is not the only reason for elective CD, and there are a wide range of medical reasons that obstetricians recommend a prelabor CD (160). The association between lower breastfeeding rates after elective CD, together with a number of adverse short- and long-term clinical outcomes in offspring born by prelabor CD (147, 161), indicates

FIGURE 6. Forest plot shows the fixed-effects meta-analysis of the unadjusted ORs for reports of early breastfeeding comparing Em CD and VD. BF, breastfeeding; CD, cesarean delivery; Em CD, emergency, in-labor cesarean delivery; M-H, Mantel-Haenszel; VD, vaginal delivery.

FIGURE 7. Funnel plot of log ORs for reports of early breastfeeding comparing all types of cesarean delivery with vaginal delivery, against SEs of the log ORs, with 95% pseudo-confidence limits (dashed lines) around the pooled result from the fixed-effects analysis (solid line).
that the continuing increase in elective CD requires urgent scrutiny worldwide.

At present, all mothers, regardless of mode of delivery, should be supported and encouraged to initiate breastfeeding promptly, and all prospective mothers and health workers should be informed about the negative association between prelabour CD and breastfeeding and the implications for infant well-being.

We thank all of the authors listed in Table 1 who kindly supplied additional unpublished data for inclusion in this meta-analysis.

The authors’ responsibilities were as follows—MJH and NM: designed the research; EP and LHP: conducted the literature search; MJH: contacted the authors for further data when required; EP and CG: extracted the data; SS and MJH: checked the data; EP, MJH, and SS: performed the statistical analyses; and NM: had primary responsibility for the final content. All authors contributed to first, interim, and final drafts and reviewed and approved the final draft of the manuscript. CG has received support from Pfizer Nutrition to attend an educational conference; she declared no other conflicts of interest.

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