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REVIEW PAPER

Does Caesarean Section Affect Breastfeeding Practices in China? A Systematic Review and Meta-Analysis

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Abstract *Objectives* To ascertain the association between caesarean delivery and breastfeeding practices in China. *Methods* We conducted a systematic review and meta-analysis following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and Meta-analysis Of Observational Studies in Epidemiology (MOOSE) guidelines. Electronic databases of CNKI, Medline, EMBASE, CINAHL, ProQuest and Science Direct were searched and screened to identify relevant articles from January 1990 to June 2015. Both fixed and random effect meta-analysis techniques were used to estimate the pooled effect size between caesarean delivery and breastfeeding outcomes at different time points. Sensitivity analysis and publication bias test were also conducted. *Results* Forty six studies were eligible for the qualitative synthesis of systematic review; among them, 27 studies were included for the meta-analysis. At the early postpartum period, the odds of exclusive breastfeeding after caesarean section was 47% (pooled OR 0.53, 95% CI 0.41, 0.68) lower than that after vaginal delivery. At 4 months postpartum, the odds of breastfeeding was similarly lower (pooled OR 0.61, 95% CI 0.53, 0.71) for caesarean mothers. Substantial heterogeneity among studies was detected for both breastfeeding outcomes. Subgroup analyses stratified by study design, time points of breastfeeding outcomes and definitions of breastfeeding all confirmed the negative association between caesarean section and breastfeeding prevalence. *Conclusions* In China, breastfeeding practices were affected adversely by caesarean delivery. Therefore, health policy to improve breastfeeding outcomes should take this into consideration.

Keywords Breastfeeding · Caesarean section · Systematic review · Meta-analysis · China

Significance

Caesarean delivery has been identified as one of important factors that adversely affect breastfeeding practices, but the findings remain inconsistent. A systematic review and meta-analysis of worldwide literature confirmed the negative relationship between caesarean section and breastfeeding practices, yet systematic review and meta-analysis of the studies conducted in China published in Chinese or English have never been done. This study is the first study systematically examining the association between caesarean section and breastfeeding practices in China in such a situation that China has been cited as having one of the highest rates of caesarean section globally.

Introduction

Breastfeeding has always been the physiological norm (Berry and Gribble 2008). Non-breastfed or early weaned infants are more likely to get adverse health outcomes as well as their mothers (Eidelman et al. 2012, Ip et al. 2007). However, the rate of breastfeeding, especially exclusive breastfeeding, still remains below the optimal level worldwide (Guo et al. 2013; Merewood et al. 2005; Ryan et al. 2002). Factors affecting breastfeeding have been studied extensively (Harley et al. 2007; Pearce et al. 2012; Scott

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et al. 1999; Senarath et al. 2010). Caesarean delivery has been identified as one of important factors negatively associated with breastfeeding practices; however, the findings remain inconsistent. For example, some studies reported the negative associations between caesarean delivery and breastfeeding outcomes such as breastfeeding initiation, breastfeeding rates at the first week and at 4 months postpartum (Guo et al. 2013; Kohlhuber et al. 2008; Patel et al. 2015), while other studies reported no association between caesarean delivery and breastfeeding rates at 42 days postpartum, and breastfeeding prevalence within 6 months postpartum (Joshi et al. 2014; Patel et al. 2015). A systematic review and meta-analysis on the topic of association between caesarean section and breastfeeding was conducted in 2012 (Prior et al. 2012), in which studies carried out in China and published in the English language were retrieved using the PubMed database. The review concluded that pre-labour caesarean section was associated with early breastfeeding negatively and no statistically significant association was found with the breastfeeding rate at 6 months postpartum (Prior et al. 2012). However, the majority of breastfeeding studies undertaken in China were published in Chinese and hence excluded from this review (Prior et al. 2012). Some degree of bias may have resulted from this omission.

Understanding the relationship between caesarean section and breastfeeding practices accurately in more depth is important to country such as China, where the rate of caesarean section is high at 46.2% in 2007–2008 and 56.1% in 2011, which are nearly double the global rate (Feng et al. 2012; Lumbiganon et al. 2010; Tang et al. 2006). An updated systematic review and meta-analysis based on both English and Chinese literature would reduce such bias and improve the knowledge of the relationship between caesarean delivery and breastfeeding practices in China. Therefore, the aim of the present study is to examine the association between caesarean delivery and breastfeeding practices including 'exclusive breastfeeding during the early postpartum period' and 'breastfeeding at 4 months postpartum'. Specifically, we test the hypothesis that caesarean delivery reduces breastfeeding intensity and prevalence.

Methods

Search Strategy

A systematic electronic search of both Chinese and English language articles on breastfeeding and method of delivery was conducted using the Chinese database China National Knowledge Infrastructure (CNKI) as well as Medline, EMBASE, CINAHL, ProQuest, and Science Direct from January 1990 to June 2015. A two-stage search strategy was adopted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and Meta-analysis Of Observational Studies in Epidemiology (MOOSE) guidelines (Moher et al. 2009; Stroup et al. 2000).

Stage 1: The following Medical Subject Headings (MeSH) terms and key words "breast feeding", "milk human", "breastfeeding duration", "breastfeeding cessation", "human lactation", "infant feed*", "breastfed", "risk factor*", "protective factor*", "determinant*", "socioeconomic factor*", "China", "mainland China", "Chinese" were used.

Stage 2: The following MeSH terms and key words "caesarean delivery", "cesarean delivery", "caesarean section", "cesarean section" and "c-section" were further added to the search process.

Corresponding Chinese terms and key words were used to search in the database of CNKI.

Literature Screening and Selection Criteria

At the initial screening stage, abstracts of eligible publications were retrieved by two independent reviewers (JZ and MRD). Relevant citations were identified after screening the abstracts and their full-texts were then obtained and evaluated. Discrepancies on relevancy were resolved through consensus or referred to a third investigator (YZ) when necessary. Articles were included if they met the following criteria: (i) published in peer-reviewed journals or theses/dissertations; (ii) observational study design; (iii) reported the association between caesarean delivery and breastfeeding quantitatively; (iv) effect size could be obtained directly or calculated from raw tabulated data. The exclusion criteria were as follows: (i) studies that did not specify sample size; (ii) studies that did not report or define time points of breastfeeding outcomes; (iii) studies that reported inappropriate statistical result (statistical error).

Data Extraction

The following information was extracted from each eligible study for qualitative and quantitative synthesis: publication year, name of the first author, study design, location of study, sample size, breastfeeding outcomes (including definitions of breastfeeding, types of breastfeeding, time points of measurements), other factors associated with the breastfeeding outcome, and raw tabulated data or effect size (odds ratios) reported via univariate analysis or multivariate analysis. In cases where the relevant results or raw data were missing, the authors were contacted by email.

Odds ratios (ORs), either crude or adjusted, estimated from logistic regression analysis of 'exclusive breastfeeding during the early postpartum period' and 'breastfeeding at 4 months postpartum' for caesarean section versus vaginal delivery and their corresponding 95% confidence intervals (CIs), were extracted from the eligible studies.

The definitions of breastfeeding used in the data extraction followed the World Health Organization (WHO) definitions (World Health Organization 2003, 2008):

Exclusive breastfeeding: Breastfeeding while giving no other food or liquid, not even water, with the exception of drops or syrups consisting of vitamins, mineral supplements or medicines.

Full breastfeeding: Exclusive breastfeeding or predominant breastfeeding (or almost exclusive breastfeeding). Breastmilk is the only source of milk given to the infant regardless of supplementation with other fluids such as water and orange juice.

Any breastfeeding: The child has received breastmilk (direct from the breast or expressed) with or without other drink, formula or other infant food.

Quality Assessment

To assess methodological quality of the selected studies, we developed a checklist based on the criteria proposed in Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) (von Elm et al. 2007) and the previous checklist proposed by Tooth et al. (2005). The possible score of our checklist ranges from 0 to 18, with scores above 14, between 11 and 14, and below 11 indicating high, medium and low quality, respectively (see Appendix).

Statistical Analysis

The odds ratios of 'exclusive breastfeeding during the early postpartum period' (defined as initiation of breastfeeding or exclusive breastfeeding before discharge or exclusive breastfeeding at 42 days post birth) and 'breastfeeding (including exclusive breastfeeding, full breastfeeding and any breastfeeding) at 4 months postpartum', for caesarean section versus vaginal delivery, were the primary outcomes of interest. A meta-analysis was performed to determine the pooled effect size of caesarean delivery on these two breastfeeding outcomes separately. Based on the raw data extraction from the selected studies, the natural logarithmic transformed ORs were used in the meta-analysis.

Fixed-effect [inverse variance (I-V) method of fixed-effect model] meta-analysis was performed initially and heterogeneity across studies was assessed by the I-square statistic (Higgins and Thompson 2002; Higgins et al. 2003). A random-effect model [DerSimonian and Laird (D + L) method of random-effect model] was further utilised and presented when the heterogeneity was confirmed statistically significant (DerSimonian and Laird 1986). A meta-regression was then performed to investigate potential sources contributing to the heterogeneity. Subgroup analysis was undertaken to assess the magnitude of effect on the outcome variables of interest under different stratifications.

To test the dependence of effect size reported in each study, sensitivity analysis using the jackknife approach was performed to assess the robustness of the results (Miller 1974). Such sensitivity analysis was repeated multiple times with one study removed per cycle.

In order to ascertain publication bias and small sample size bias among the studies, Begg's funnel plot/test and Egger's test were applied (Egger et al. 1997). All calculations and statistical analyses were performed using the Stata package version 14.1 (StataCorp LP, College Station, USA). A p value less than 0.05 was considered as statistically significant.

Results

Systematic Review

As shown in Fig. 1, a total of 1061 records were identified from both English and Chinese databases, and five more records were obtained from other sources. After removal of duplicates, 1054 articles were screened by manually reading titles and abstracts. As a result 197 articles were deemed eligible for full-text review. After formal review, 151 of them were excluded (86 qualitative studies, 54 not suitable for analysis, 4 full-text Chinese publications incomplete, 1 sample size not specified, 3 with statistical errors, 3 duplicated the same study). One author was contacted to obtain additional data to calculate the rate of exclusive breastfeeding initiation (Xu 2008). Finally, 46 articles (38 published in Chinese and 8 published in English, respectively) were included for the qualitative synthesis of systematic review (Table 1), among which 13 were suitable for meta-analysis of the association between caesarean delivery and 'exclusive breastfeeding during the early postpartum period', and 14 were appropriate for meta-analysis of the effect of caesarean delivery on 'breastfeeding at 4 months postpartum' (Chen et al. 2010; Fang et al. 1996; Gan et al. 2007; Guo et al. 2013; He et al. 1994; Huang and Lu 2010; Jiang 2000; Jiang and Li 2008; Kang et al. 2013; Leng 2014; Li 2014; Liu 2008; Liu and Xing 1998; Liu et al. 2014, 2012; Liu and Shao 2009; Ma et al. 2009; Qin and Hua 2013; Qiu 2008; Ruan et al. 2012; Tang 2013, 2014; Tian et al. 2008; Wang et al. 2006, 2005, 2009, 1995, 2013; Wang 2010; Wei and Li 2009; Xu 2008; Xu and Yu 2009; Xue et al. 2012; Yang and Feng 2014; Ye 2008; Yin et al. 2012; Yu 2013; Zhang and Wang 2000; Zhang and Shi 2013; Zhang and Wu 1999; Zhang et al. 2006, 2013; Zhang 2012; Zheng et al. 2008; Zhu et al. 2013, 2014). Among these 46 articles 20 of them were assessed to be high scientific quality, 24 medium quality

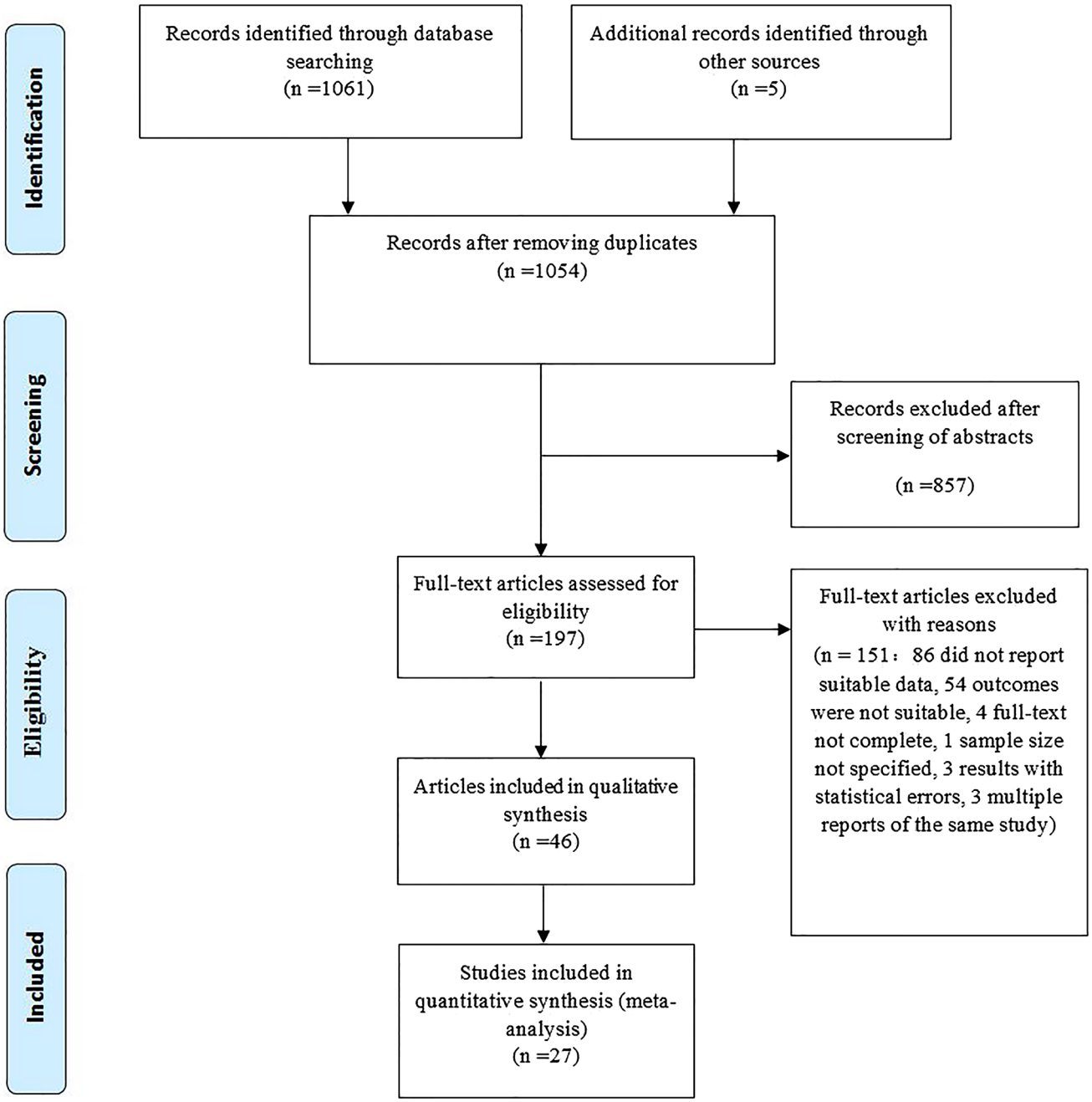

Fig. 1 PRISMA flow chart of the systematic review process

and 2 low quality, according to the methodological quality checklist scores in Appendix.

Effect of Caesarean Delivery on 'Exclusive Breastfeeding During The Early Postpartum Period'

The random-effect model meta-analysis of the 13 studies (441,044 subjects: 27,152 in the caesarean delivery group and 413,892 in the vaginal delivery group) showed that the odds of 'exclusive breastfeeding during the early postpartum period' was 47% (pooled OR 0.53, 95% CI 0.41, 0.68) lower in the caesarean delivery group than the vaginal delivery group (Fig. 2), with a significant heterogeneity in effect sizes evident across the studies ($I^2 = 90.6\%$, $p < 0.001$).

The stepwise meta-regression analysis revealed no clear main sources for heterogeneity, which may be due to the small number of studies included in this meta-analysis

Table 1 Characteristics of studies assessing the association between caesarean delivery and breastfeeding in China

Published year	First author	Study design	Location	Sample size	Other factors associated with breastfeeding outcomes	Breastfeeding outcome measured	Definition	Score
1994	HE,H.L	Cross-sectional	Fuzhou	216	Initiation time, milk bottle using, sleep, alcohol drinking	Breastfeeding at 1 month postpartum	Non-WHO	13
1995	WANG,S	Cross-sectional	Beijing	439	BFHI, maternal age, infant gender, gestational reaction	FB at 4 months postpartum	Reclassified with WHO definition	13
1996	FANG,L.L	Cross-sectional	Beijing	60	Initiation time	EBF at 42 days/4 months postpartum	WHO	13
1998	LIU,J	Cross-sectional	Inner Mongolia	374	Maternal health condition, complication, nutrition condition, appetite after delivery, maternal education, initiation time	Breastfeeding 0–90 days postpartum	Non-WHO	11
1999	ZHANG,S.J	Prospective cohort	Hebei	207	Knowledge of breastfeeding, confidence of breastfeeding, initiation time, breast milk substitute	Breastfeeding at 1 month postpartum	Non-WHO	15
2000	ZHANG,G.D	Prospective cohort	Chongqing	627	Postpartum hemorrhage	Breastfeeding 28 days/4 months postpartum	Non-WHO	11
2000	JIANG,G.F	Cross-sectional	Liuhe	736	Maternal education, rooming-in	EBF within 6 months postpartum	WHO	15
2005	WANG,C.X	Retrospective cohort	Jinan	853	Maternal education, health education, milk powder promotion, initiation time	EBF at 4 months postpartum	Non-WHO	16
2006	WANG,B.S	Prospective cohort	Shanghai	602	NA	FB at 1,6,12 months postpartum	Reclassified with WHO definition	13
2006	ZHANG,W.K	Prospective cohort	Beijing	802	Maternal age, early touch time, perception of breastfeeding during gestation, living space	FB 2–5 days, 42 days postpartum	Reclassified with WHO definition	16
2007	GAN,W.L	Cross-sectional	Chongqing	375	Maternal age, maternal education, occupation, maternal mood, postpartum home visit, monthly income	EBF at 4 months postpartum	Non-WHO	12
2008	XU,F.L	Prospective cohort	Xinjiang	1064	Giving breastmilk as the first feed, feeding on demand, maternal perception of the breastfeeding information received, minority ethnic group, giving birth in spring or summer, medical staff not recommending formula to parents, prelacteal feeds of water or formula	AF initiation/EBF initiation	WHO	18

Table 1 (continued)

Published year	First author	Study design	Location	Sample size	Other factors associated with breastfeeding outcomes	Breastfeeding outcome measured	Definition	Score
2008	LIU,F.L	Retrospective cohort	Xinxiang	288 392 415 376	NA	AF at 4 months postpartum in year 2000, 2002, 2004 and 2006 separately	Non-WHO	13
2008	ZHENG,K.Y	Cross-sectional	Hangzhou	628	Neonatal disease, initiation time, early feeding	AF before discharge	Reclassified with WHO definition	16
2008	TIAN,J.Z	Cross-sectional	Zhejiang	253	Neonate disease, early sucking, initiation time, breastfeeding confidence, maternal education	FB before discharge	Reclassified with WHO definition	14
2008	YE,C.E	Cross-sectional	Ninghai	931	Maternal education, health education	EBF at 4 months postpartum	Non-WHO	16
2008	JIANG,Z.H	Retrospective cohort	Herbin	310	Initiation time, maternal education	EBF at 42 days postpartum	Non-WHO	14
2008	QIU,L.Q	Prospective cohort	Zhejiang	917	Living in the suburb or rural areas, maternal age, mother decides to breastfeed until after birth, prelacteal feeding	EBF initiation/at discharge	WHO	18
2009	LIU,X.Q	Cross-sectional	Beijing	123	Health education, initiation time	Breastfeeding at 42 days postpartum	Non-WHO	11
2009	XU,T	Retrospective cohort	Shenyang	1025	Maternal age, family income	FB at 6 months postpartum	Reclassified with WHO definition	17
2009	WEI,X.J	Retrospective cohort	Zhengzhou	501 445 458 503 541 399 340 223 347 284 250 246	NA	FB 42 days postpartum in year 1996–2007 separately	Reclassified with WHO definition	16
2009	WANG,R	Cross-sectional	Kunming	1328	NA	EBF initiation, at 4 months postpartum	Non-WHO	15

Table 1 (continued)

Published year	First author	Study design	Location	Sample size	Other factors associated with breastfeeding outcomes	Breastfeeding outcome measured	Definition	Score
2009	MA,X	Prospective cohort	Shaanxi	605	Initiation time, perception of breastfeeding, supplementary feeding, confidence of breastfeeding, milk bottle using	EBF before discharge and 1 month postpartum	Non-WHO	13
2010	CHEN,Y.F	Cross-sectional	Wuhan	445	Prenatal preparation, initiation time, right feeding method, feeding confidence, maternal nutrition, feeding setting	Breastfeeding within 4–6 months postpartum	Non-WHO	13
2010	WANG,H.Z	Cross-sectional	Changli	1296	Health education, maternal education	EBF at 6 months postpartum	WHO	13
2010	HUANG,Q.J	Cross-sectional	Shanghai	350	Early feeding, milk bottle using	EBF before discharge	WHO	13
2012	RUAN,M.J	Cross-sectional	Beijing	103	Maternal education, fixed term job, maternal age	EBF at 4 months postpartum	Non-WHO	13
2012	ZHANG,Y.M	Prospective cohort	Chengdu	268	NA	EBF at discharge	Non-WHO	15
2012	XUE,F	Cross-sectional	Changshu	126	Area (rural or urban)	EBF at 4 months postpartum	Non-WHO	13
2012	YIN,X.G	Prospective cohort	Hefei	2522	Maternal education, family income, preterm birth	AF at 2 months, 4 months postpartum	Reclassified with WHO definition	18
2012	LIU,X	Retrospective cohort	27 sites	431,704	NA	EBF before discharge	WHO	17
2013	ZHANG,Q.J	Cross-sectional	Zhengzhou	612	NA	EBF 24 hours before discharge	Non-WHO	8
2013	ZHANG,Y.X	Cross-sectional	Danyang	3057	First child breastfeeding duration, perception of breastmilk amount, psychosocial factors	FB before discharge and after discharge	WHO	15
2013	KANG,Y	Cross-sectional	Chongqing	939	Infant gender, maternal education, monthly income, birth weight, duration of maternity leave, perception of breastmilk amount, prelacteal feeding	Breastfeeding at 6 months	Non-WHO	14
2013	WANG,Z	Cross-sectional	Zhejiang	528	Infant age, infant gender, early feeding, perception of breastmilk amount	EBF within 6 months postpartum	WHO	16
2013	GUO,S.F	Cross-sectional	26 counties	2293	Maternal antenatal clinic visit, infant age	EBF initiation /within 6 months postpartum	WHO	14
2013	ZHU,P	Prospective cohort	Hefei	1602	Preterm birth, breastfeeding frequency on Day 1, life events in the third trimester, onset of lactation	AF at 2 month postpartum	Reclassified with WHO definition	14
2013	QIN,L.L	Retrospective cohort	Suzhou	1212	Maternal occupation, maternal age, birth region, breastfeeding professional instruction	EBF at 4 months postpartum	WHO	17

Table 1 (continued)

Published year	First author	Study design	Location	Sample size	Other factors associated with breastfeeding outcomes	Breastfeeding outcome measured	Definition	Score
2013	TANG,L	Prospective cohort	Jiangyou	693	Father's attitude towards breastfeeding, early breastfeeding initiation	EBF initiation within 1 hour post birth/AF at discharge/FB at discharge	WHO	18
2013	YU,C	Prospective cohort	Chengdu	845	Maternal occupation, paternal education, intention of going back to work, first feeding, mothers' friends breastfeed their babies, paternal occupation, staff encouragement, father's attitude, maternal grandmother's breastfeeding history	AF within 15 days postpartum/FB within 15 days postpartum	WHO	18
2014	TANG,Z.J	Cross-sectional	Guangzhou	315	NA	BF at 6 months postpartum	Reclassified with WHO definition	13
2014	LIU,L.F	Cross-sectional	Lishui	675	Family monthly income, early initiation, health education, neonatal disease	EBF within 6 months	WHO	16
2014	LENG,X.L	Cross-sectional	Shenzhen	1200	Maternal age, initiation time	FB within 6 months postpartum	Reclassified with WHO definition	13
2014	YANG,Y.L	Cross-sectional	Wuhan	513	Health education, maternal education, prenatal risk factors	EBF within 6 months postpartum	Non-WHO	8
2014	LI,R	Cross-sectional	Shenzhen	840	Initiation time, nipples condition	EBF before discharge	Non-WHO	13
2014	ZHU,X	Cross-sectional	3 cities	151	Occupation status, initiation time, frequency of lactation per day	EBF at 6 months postpartum	Non-WHO	14

BFHI Baby friendly hospital initiative, *FB* full breastfeeding, *EBF* exclusive breastfeeding *AF* any breastfeeding

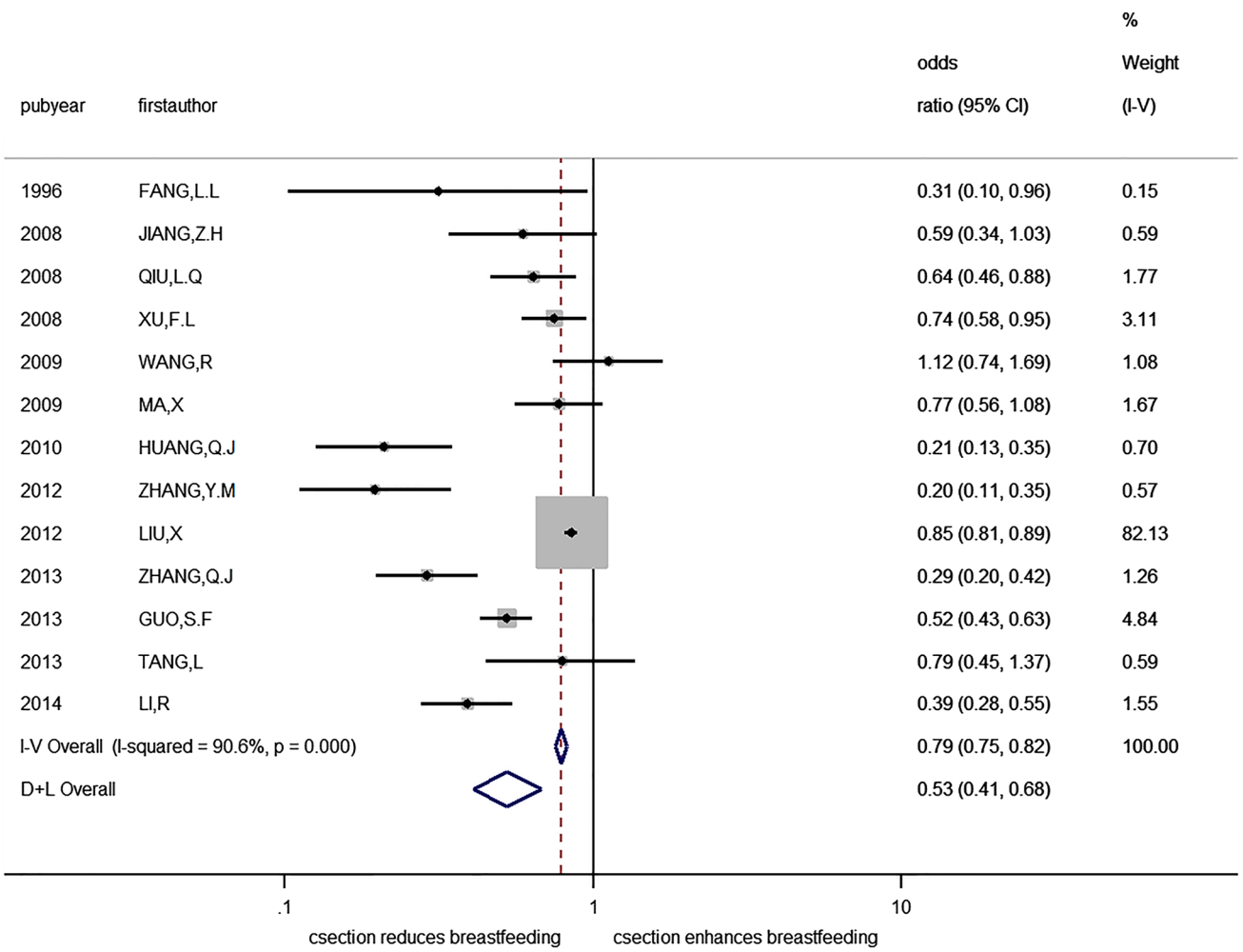

Fig. 2 Forest plot showing the fixed-effect and random-effect meta-analysis for the exclusive breastfeeding during the early postpartum period

(Higgins and Green 2011). Exploratory subgroup analyses were further conducted with regard to study design (cross-sectional, prospective cohort and retrospective cohort), exclusive breastfeeding time points (initiation, before discharge and at 42 days after birth) and definitions of breastfeeding (WHO and non-WHO).

Study Design

Of the 13 studies, six adopted a cross-sectional design, two used retrospective design and five were prospective cohort studies. Considerable heterogeneity remained present in both cross-sectional and prospective cohort subgroups ($I^2 = 86.1\%$, $p < 0.001$ and $I^2 = 79.9\%$, $p = 0.001$, respectively) whereas no significant heterogeneity was observed in the retrospective cohort subgroup ($I^2 = 38.5\%$, $p = 0.202$). Meta-analysis stratified by the study design (Fig. 3) showed that the adverse effect of caesarean delivery remained on the exclusive breastfeeding prevalence during the early postpartum period for the three study designs (cross-sectional: pooled OR 0.42, 95% CI 0.27, 0.64; retrospective: pooled OR 0.85, 95% CI 0.81, 0.89; prospective: pooled OR 0.59, 95% CI 0.41, 0.85).

Exclusive Breastfeeding Time Points

Figure 4 presents the subgroup analysis stratified by time points (initiation, before discharge and at 42 days post birth) of exclusive breastfeeding outcomes measured. Again, the negative association between caesarean delivery and the exclusive breastfeeding prevalence during the early postpartum period remained persistent (initiation: pooled OR 0.71, 95% CI 0.55, 0.91; before discharge: pooled OR 0.39, 95% CI 0.23, 0.67; at 42 days post birth:

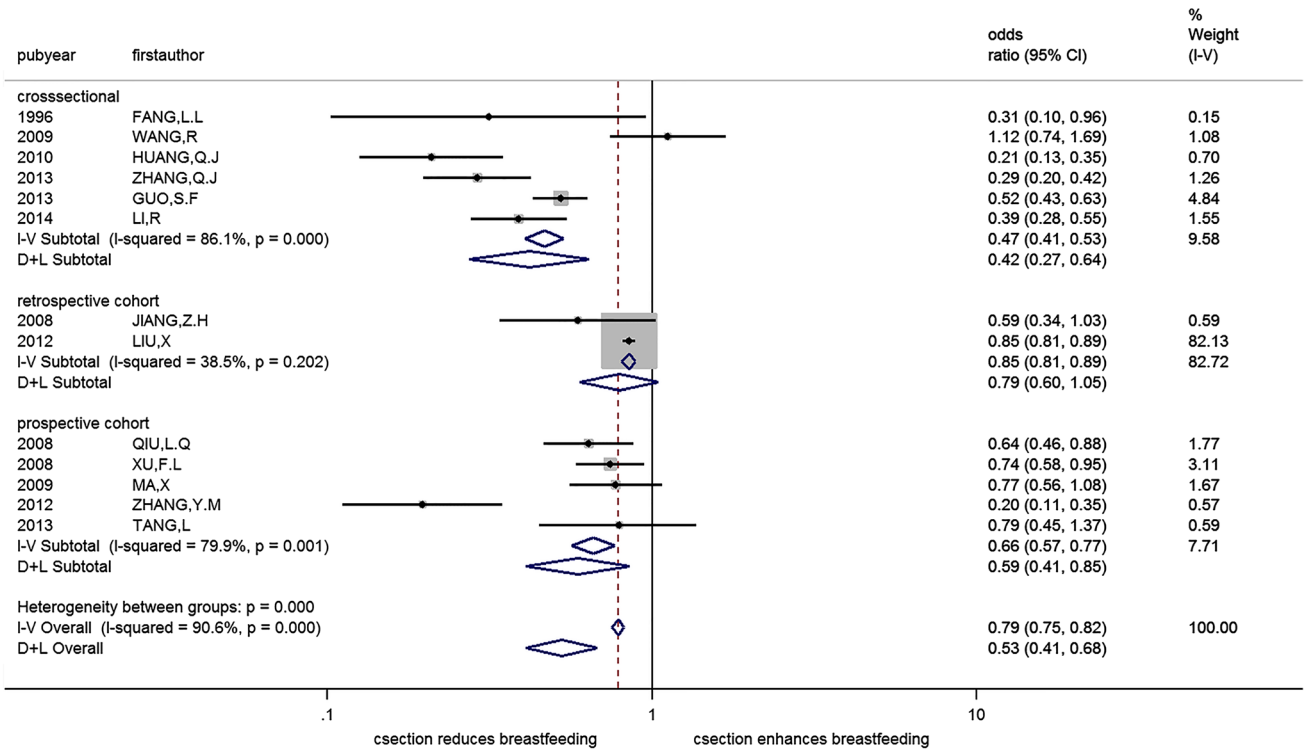

Fig. 3 Subgroup analysis for exclusive breastfeeding during the early postpartum period stratified by study design

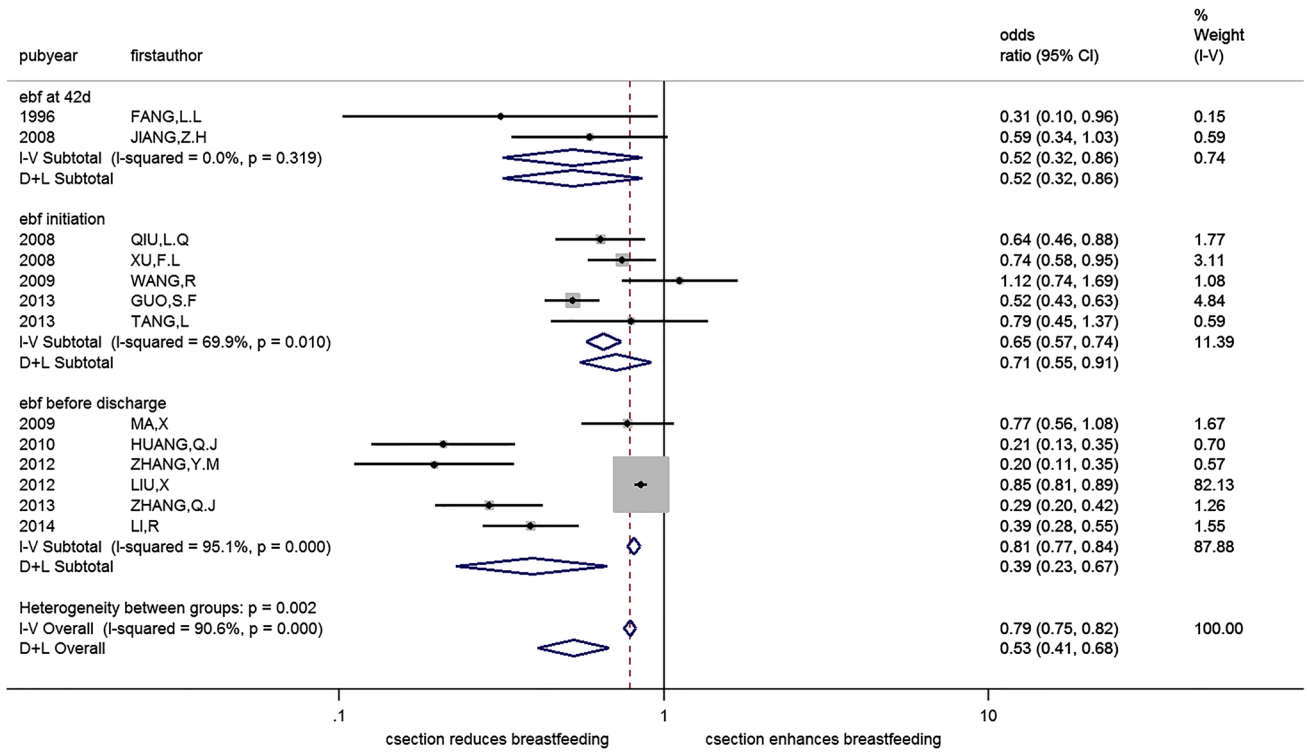

Fig. 4 Subgroup analysis for exclusive breastfeeding during the early postpartum period stratified by time points of breastfeeding outcomes measured

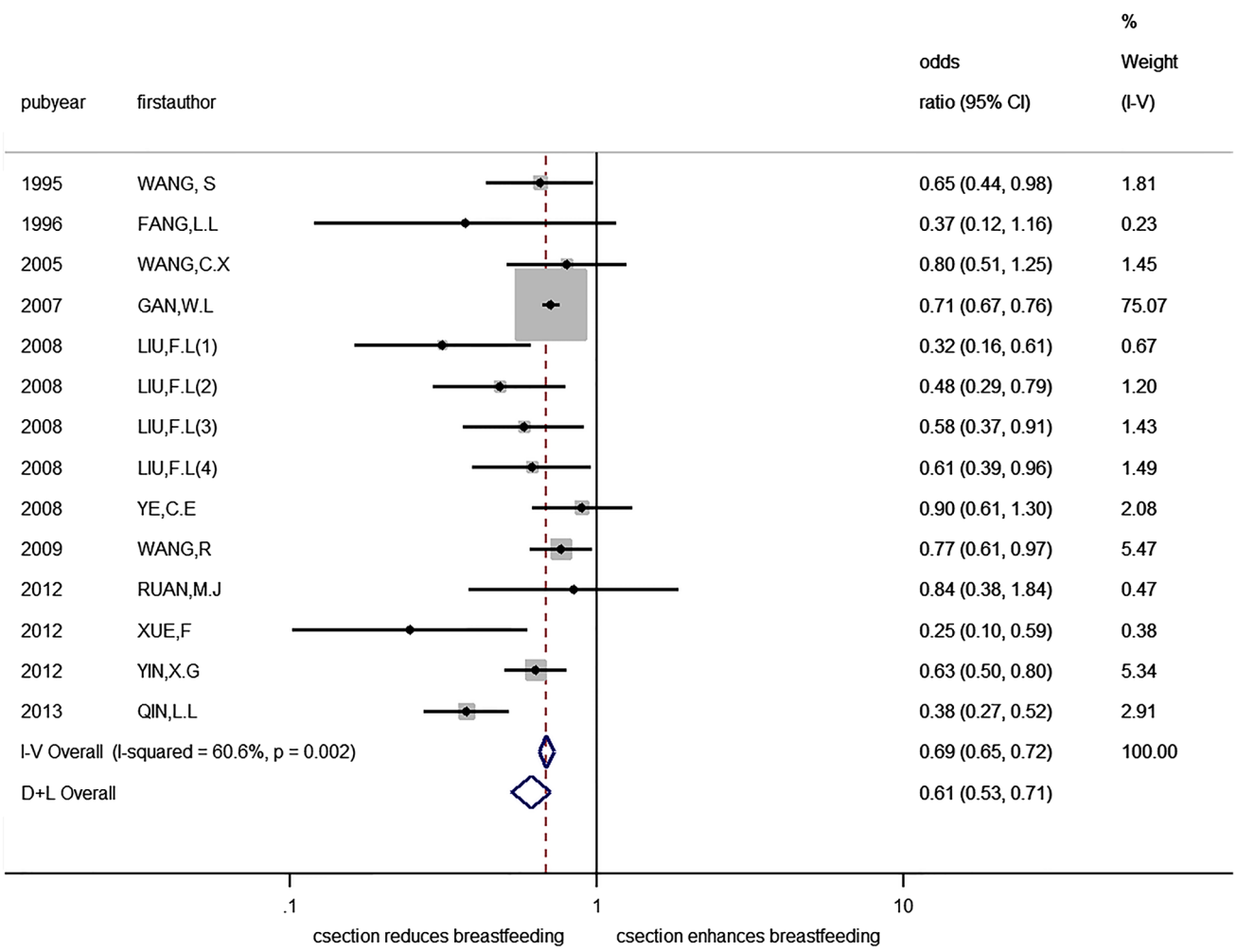

Fig. 5 Forest plot showing the fixed-effect and random-effect meta-analysis for breastfeeding at 4 months postpartum

pooled OR 0.52, 95% CI 0.32, 0.86). Except the third subgroup ($I^2 = 0.0\%$, $p = 0.319$), significant heterogeneity was evident for the first two subgroups (initiation: $I^2 = 69.9\%$, $p = 0.010$ and before discharge: $I^2 = 95.1\%$, $p < 0.001$, respectively).

Definitions of Breastfeeding

Figure 6 in Appendix presents the result of subgroup analysis stratified by the definitions of breastfeeding (WHO and non-WHO). The adverse effect of caesarean delivery on the exclusive breastfeeding prevalence during the early postpartum period was confirmed significant for both subgroups (WHO: pooled OR 0.58, 95% CI 0.43, 0.77; non-WHO: pooled OR 0.48, 95% CI 0.29, 0.78). Significant heterogeneity was detected as well (WHO: $I^2 = 89.3\%$, $p < 0.001$; non-WHO: $I^2 = 88.2\%$, $p < 0.001$).

Effect of Caesarean Delivery on 'Breastfeeding at 4 Months Postpartum'

Fourteen studies were included for this meta-analysis, among which one study (Liu 2008) had four sub-studies carried out independently in four different periods and consequently these sub-studies were regarded as separate studies in the meta-analysis. Figure 5 shows that the prevalence of breastfeeding at 4 months postpartum was significantly lower after caesarean section (pooled OR = 0.61, 95% CI 0.53, 0.71). Significant heterogeneity ($I^2 = 60.6\%$, $p = 0.002$) was found.

Among the 14 studies, four used the WHO definitions. For the subgroup of studies using WHO definitions, the odds of breastfeeding at 4 months postpartum reduced by 48% (pooled OR 0.52, 95% CI 0.38, 0.72) when compared with that using non-WHO definitions (pooled OR 0.66, 95% CI 0.56, 0.77), as indicated in Figure 7 in Appendix.

Heterogeneity was found marginally significant in both subgroups (WHO: $I^2 = 62.0\%$, p = 0.048; non-WHO: $I^2 = 47.0\%$, p = 0.049).

Sensitivity Analysis

The results of sensitivity analysis for both breastfeeding outcomes showed that the pooled ORs remained significant when one study was omitted at a time during recalculation of the pooled ORs, suggesting the pooled ORs were not substantially influenced by any individual study, so that the results of meta-analysis were robust.

Publication Bias

The distribution of 13 studies involved in the meta-analysis of 'exclusive breastfeeding during the early postpartum period' showed in the funnel plot (Fig. 8 in Appendix) was considered asymmetric, however the Begg's test was not significant (p = 0.502), while some evidence of publication bias or small sample size effect was detected by the Egger's test (p = 0.007).

For the meta-analysis of 'breastfeeding at 4 months postpartum', the funnel plot (Fig. 9 in Appendix) appeared symmetric (p = 0.049 for Begg's test and p = 0.059 for Egger's test), suggesting little publication bias or small sample size effect was present.

Discussion

The present systematic review incorporated 46 studies to assess the association between caesarean delivery and breastfeeding practices in China. The meta-analysis comprised of 13 studies (441,044 subjects) on 'exclusive breastfeeding during the early postpartum period' and 14 studies (8771 subjects) on 'breastfeeding at 4 months postpartum' to estimate the pooled relationship between caesarean delivery and breastfeeding outcomes. Based on our findings, caesarean delivery was found to have an adverse effect on the breastfeeding outcomes. More specifically, compared with vaginal birth, the likelihood of mothers exclusively breastfeeding their babies during the early postpartum period was reduced by 47% (pooled OR 0.53) and 39% (pooled OR 0.61) reduction was found for the odds of breastfeeding at 4 months postpartum after caesarean section. Our finding of 'exclusive breastfeeding during the early postpartum period' (pooled OR 0.53; 95% CI 0.41, 0.68) appears to be consistent with a previous review (pooled OR 0.57, 95% CI 0.50, 0.64) (Prior et al. 2012). However, our finding of significant impact of caesarean section on 'breastfeeding at 4 months postpartum' (pooled OR 0.61, 95% CI 0.53, 0.71) is different from the non-significant result on any breastfeeding at 6 months postpartum in that same review (pooled OR 0.95, 95% CI 0.89, 1.01) (Prior et al. 2012). The current knowledge of surgery consequences suggests that postsurgical pain, haemorrhage, infections as well as some hormone issues (like prolactin level postpartum) affect breastfeeding, however these effects lessen in strength over time, indicating the impact of caesarean delivery on breastfeeding may attenuate over time (Chapman and Perez-Escamilla 1999; Liu et al. 2012; Marcus et al. 2015; Mkontwana and Novikova 2015; Prior et al. 2012; Wang et al. 2006). Previous studies showed that caesarean section remained an important barrier to early initiation of breastfeeding as well as to the implementation of hospital practices such as delayed skin-to-skin contact between mother-infant pairs (Bramson et al. 2010; Rowe-Murray and Fisher 2002). Given the negative association between caesarean section and breastfeeding outcomes revealed in the present analysis, it suggests that early initiation of breastfeeding may play a role of mediator variable between caesarean section and premature cessation of exclusive breastfeeding or any breastfeeding.

It is well known that China has a high caesarean section rate where nearly half of the babies born were delivered by caesarean section in 2010 (Hellerstein et al. 2015). The reasons for such a high rate mainly include three important factors: the obstetric care system in China (in hospital births, urbanisation, highly covered New Co-operative Medical Scheme that reduces patient costs and increases revenues for doctors and hospitals for caesarean than for vaginal deliveries, and high volume of deliveries), health care provider factors (insufficient nurses/midwives, some doctors do recommend caesarean section to avoid possible lawsuits in view of the medical malpractice environment), and cultural aspects of patient preference (demand for perfect baby, fear of pain, increasing numbers of macrosomia, increasing pregnancies in older women and delivery date choosing because of luck and belief) (Hellerstein et al. 2015; Long et al. 2012; Mi and Liu 2014). Although the association between caesarean section on maternal request and breastfeeding has been investigated in China (Liu et al. 2012), there is a gap in research on the different impacts of caesarean section on breastfeeding outcomes with respect to medical indication and maternal request (Liu et al. 2015; Tang et al. 2006).

The findings of this study suggest that practices or interventions after caesarean delivery are of benefits to improve breastfeeding behaviours. The practice of maternal-infant skin to skin contact after birth has been increasingly considered as an efficient way to promote

breastfeeding status postpartum especially breastfeeding initiation (Moore et al. 2016). The feasibility of an intervention of skin to skin contact after caesarean delivery in the operating room to improve breastfeeding as well as maternal satisfaction and pain perception outcomes was described and evaluated in previous studies (Hung and Berg 2011; Sundin and Mazac 2015). However, to our best knowledge, there is no intervention described to improve breastfeeding practice following caesarean section available in the literature. Future intervention studies to promote breastfeeding after caesarean delivery are warranted.

A major strength of this study was the extensive searches conducted in both Chinese and English literature to ensure all relevant articles have been included to reduce reporting bias. In addition, several studies without clarification of valid time-point for the breastfeeding outcomes had been excluded to enhance the quality of our evaluation. However, publication bias was still detected in the meta-analyses for early postpartum exclusive breastfeeding using the Egger's test (Higgins and Green 2011). Six months postpartum is the recommended period for exclusive breastfeeding by the WHO and it would be more comparable with other studies if the impact of caesarean section on 'breastfeeding at 6 months postpartum' could be examined in our study, however most of available reports in the present systematic review comprised the breastfeeding outcomes only for within 6 months postpartum. In view of the small number of studies addressing breastfeeding outcomes at 6 months postpartum, the corresponding quantitative synthesis was not performed. Another limitation concerns that the pooled weighted effect size was estimated based on both crude and adjusted ORs due to the limited number of eligible studies available. Ideally, extraction of data and analysis should be performed for adjusted ORs, as consequence the impact of caesarean section on breastfeeding practice could be assessed under the controlling for possible confounding effects. Since most of all studies retrieved were cross-sectional in this systematic review, a causal relationship between caesarean section and breastfeeding rates could not be concluded.

In conclusion, the present study confirmed that the likelihood of breastfeeding, including 'exclusive breastfeeding during the early postpartum period' and 'breastfeeding at 4 months postpartum', was significantly lower after caesarean section in China. Therefore, health policy and measures to improve breastfeeding outcomes should target the reduction of caesarean rate and health intervention after caesarean delivery in China.

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Appendix

Quality Assessment Checklist

1 Design of study	Score
Prospective	2
Retrospective	1
Cross-sectional	0
2 Loss to follow up /incompleteness of record	
<20%	2
≥20% or no information	0
3. Sample size	
≥100	2
<100	0
4. Description of period of recruitment	
Yes	2
No	0
5. Participants selection	
Representative of the general perinatal population	2
No	0
6. Exposure	
Define clearly	2
No	0
7. Outcomes	
Define clearly	2
No	0
8. Statistical analysis	
Proper statistical analysis with controlling confounders	2
Proper statistical analysis without controlling confounders	1
Otherwise	0
9. Result report	
Summarize key results with reference to study objectives	2
No	0

High: >14; Medium: 11-14; Low: <11

See Figs. 6, 7, 8, 9.

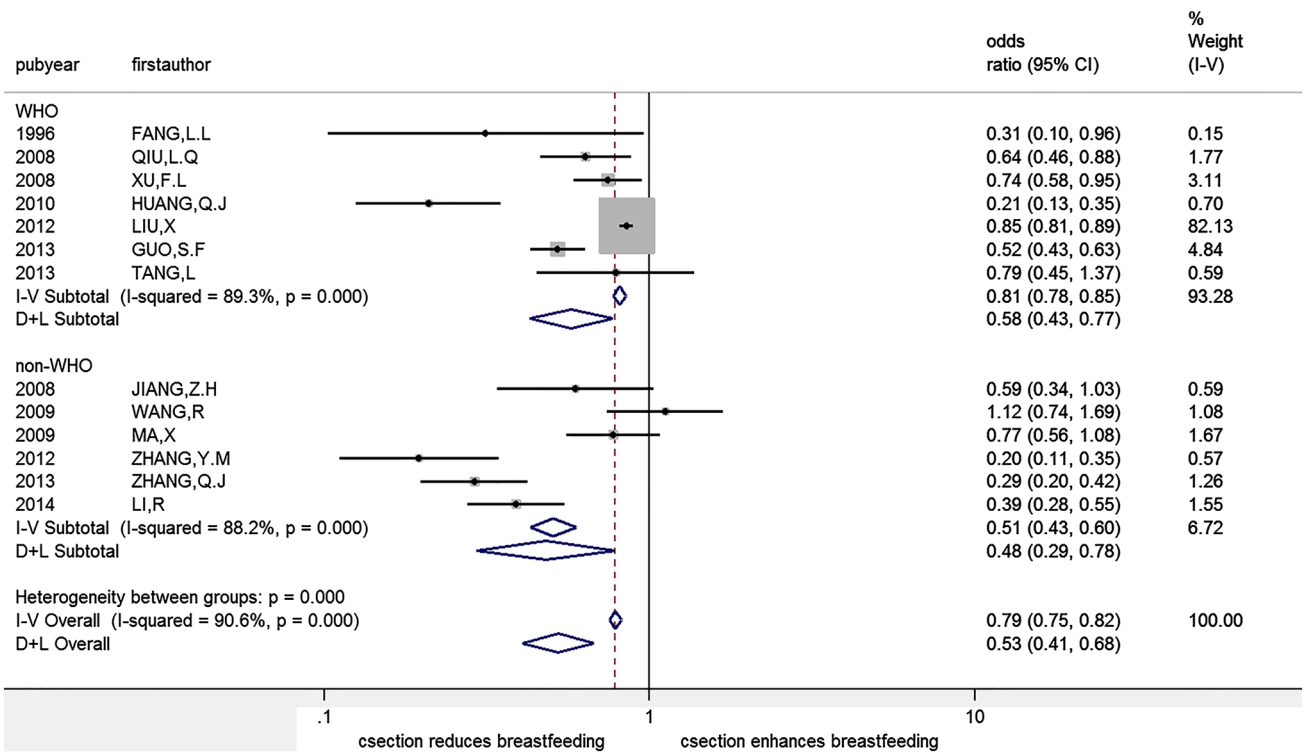

Fig. 6 Subgroup analysis for exclusive breastfeeding during the early postpartum period stratified by definitions

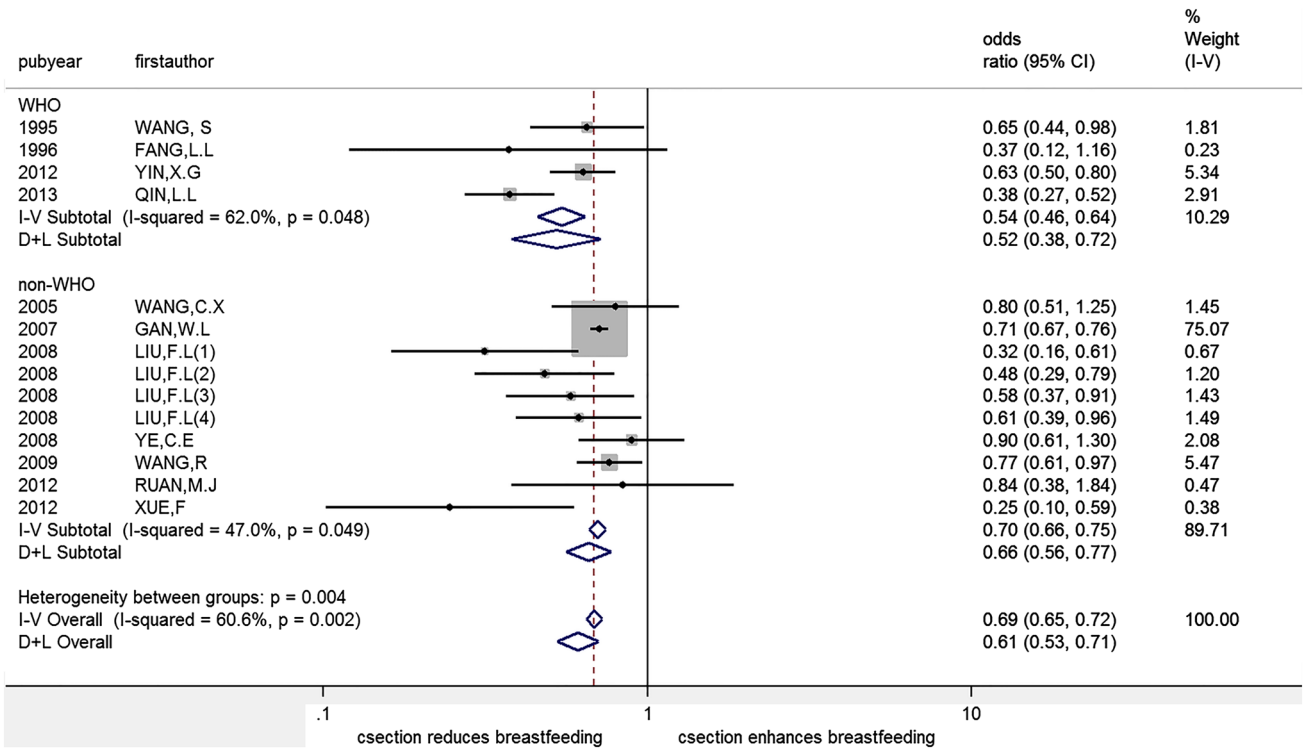

Fig. 7 Subgroup analysis for breastfeeding at 4 months postpartum stratified by definitions

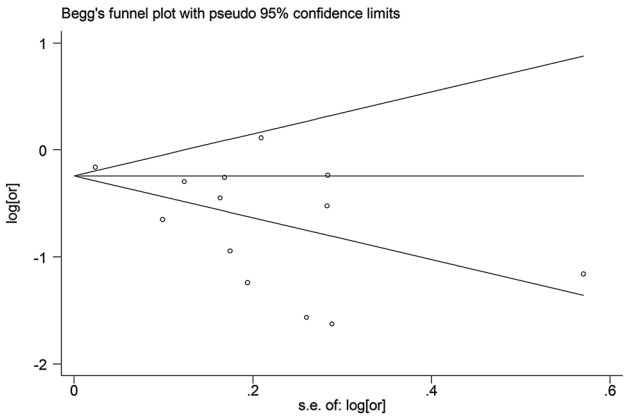

Fig. 8 Funnel plot exploring publication bias in exclusive breastfeeding during the early postpartum period

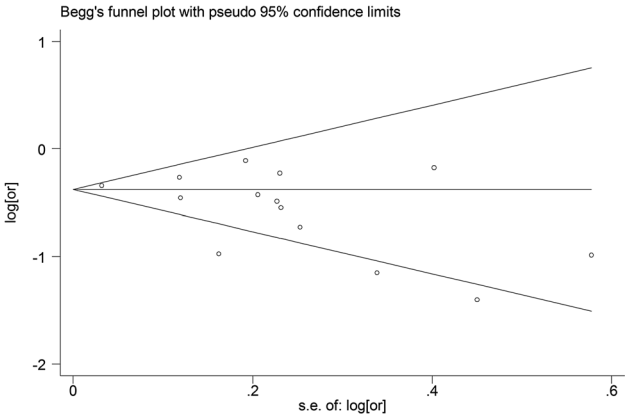

Fig. 9 Funnel plot exploring publication bias in breastfeeding at 4 months postpartum

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