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Caesarean Sections and Private Insurance: Systematic Review and Meta-analysis

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Abstract

Objective - Financial incentives associated with private insurance may encourage health care providers to perform more caesarean sections. We therefore sought to determine the association of private insurance and odds of caesarean section.

Design - Systematic review and meta-analysis.

Data sources - MEDLINE, Embase, and The Cochrane Library from the first year of records through August 2016.

Eligibility criteria – We included studies that reported data to allow the calculation of odds ratios of caesarean section of privately insured as compared to publicly insured women.

Outcomes - The pre-specified primary outcome was the adjusted odds ratio of births delivered by caesarean section of women covered with private insurance as compared with women covered with public insurance. The pre-specified secondary outcome was the crude odds ratio of births delivered by caesarean section of women covered with private insurance as compared with women covered with public insurance.

Results - Eighteen articles describing 21 separate studies in 12.9 million women were included in this study. In a meta-analysis of 13 studies, the adjusted odds of delivery by caesarean section was 1.14 higher among privately insured women as compared with women with public insurance coverage (95% CI 1.08 to 1.22) with no relevant heterogeneity between studies ($\tau^2 \leq 0.008$). The meta-analysis of crude estimates from 11 studies revealed a somewhat more pronounced association (pooled odds ratio 1.36, 95% CI 1.27 to 1.45) with no relevant heterogeneity between studies ($\tau^2 \geq 0.012$).

Conclusions - Caesarean sections are more likely to be performed in privately insured women as compared with women using public health insurance coverage. Although this

effect is small on average and variable in its magnitude, it is present in all analyses we performed.

Strengths and limitations of this study

- ✓ Our meta-analysis includes a broad literature search, screening and data extraction performed in duplicate and an exploration of study characteristics as a potential source of variation between studies and represents major strength of our study.
- ✓ Sensitivity analyses was performed involving studies that required exclusion in main analysis due to overlapping populations.
- ✓ The differences in the characteristics of the study populations, type of data used, types of CS analysed and variables used for adjustment in statistical analyses across studies represent a major limitation of our study.
- ✓ Unadjusted estimates of associations were larger, which suggests the presence of confounding, and we cannot completely rule out residual confounding in adjusted estimates.

Introduction

The global raise of caesarean section (CS) rates during the past decades has raised concerns over appropriateness of usage of the procedure (1, 2). The increase and immense variation among countries' regions and hospitals has been persistent over the years (3-14). Brazil has the highest rate of CS followed by China, Turkey, and Mexico (15). United States and other developed countries are not far behind. Even countries which traditionally have had low CS rates, like Norway or Sweden have seen substantial increase in CS rates (15). This increase has been accompanied with considerable variation within countries (15). In US there was a fourfold difference in CS rates in low and high use areas (15). In England, the rates have varied threefold among National Health Service trusts (15). In British Columbia, Canada, the CS rates varied from 14.7 % to 27.6 % across health service delivery areas (15). The understanding of escalation of CS rates is important as it may prevent negative outcomes on health of mothers and newborns as well as reduce unnecessary costs related to delivery.

Such increase and variation cannot be explained by clinical factors alone (15). Evidence points to many additional, health system related factors, in particular supplier related factors (15). Financial incentives associated with private insurance seem to influence supplier behaviour, be that physician or hospital, affecting this way clinical decision as to whether perform CS or not (14-22). We therefore performed a systematic review and meta-analysis to determine the association of insurance status of women with the odds of delivery by CS.

Materials and methods

Search strategy and data sources

We combined search terms indicating CS, such as 'caesarean section', 'caesarean delivery', 'caesarean', with search terms associated with the study design such as 'small area analysis,' 'medical practice variation,' and search terms associated with determinants of variation and

increase of CS rates. We did not restrict search by type of language or publication date. We searched MEDLINE, Embase, and The Cochrane Library from inception to August 4, 2016, when the search was last updated. In addition, we manually searched the reference lists of all included studies and earlier systematic reviews that we identified.

Study selection and outcomes

To be eligible for inclusion, studies had to report data to allow the calculation of odds ratios (OR) of CS comparing women covered by private insurance with women covered by public insurance in a specific health care system. The pre-specified primary outcome was the adjusted OR of births delivered by CS of women covered with private insurance as compared with women with public insurance coverage. The pre-specified secondary outcome was the crude OR of CS of women covered with private insurance as compared with women with public insurance.

Data extraction

Two researchers (IH and MB) screened the papers and extracted data independently. Differences were resolved by consensus. Data from full text articles were extracted onto a data extraction sheet designed to capture data on study population, study design, data sources, setting, type of CS analysed, and statistical analysis. We extracted adjusted and/or unadjusted ORs of CS of women with private insurance as compared with CS of women with public insurance.

Main analysis

We used standard inverse-variance random effects meta-analysis to combine overall OR. An OR above one indicates that CS are more frequently performed in women with private insurance than in women with public insurance. We calculated the variance estimate τ^2 as a measure of heterogeneity between studies (23). We pre-specified a τ^2 of 0.04 to represent low

heterogeneity, 0.16 to represent moderate, and 0.36 to represent high heterogeneity between studies (24). We conducted analyses stratified by study design, period of data collection, country, type of CS analysed, parity, inclusion of women with previous CS, and pregnancy risk of included women to investigate potential reasons for between-study heterogeneity and used chi-square tests to calculate p-values for interaction, or tests for linear trends in cases of more than two ordered strata. All p-values are two-sided.

Sensitivity analysis

Five studies (25-29) were excluded from the main analysis, as they had an overlapping population with a larger study (30) that was included. For this reason, we repeated all analyses including these five studies (25-29) while excluding the larger one (30). We used STATA, release 13, for all analyses (Stata-Corp, College Station, Texas).

Patient involvement

No patients were involved in this study. We used data from published papers only.

Results

We identified a total of 1490 records with our search strategy (Figure 1): 935 from Medline: 494 from Embase; 38 from the Cochrane Library and 23 from manual search. After removing duplicates, we screened 1264 records for eligibility, and retained 166 for full text examination. We excluded another 124 that did not report insurance status of women, 23 that were otherwise irrelevant and one study that had an overlapping population. Finally, 18 articles describing 21 separate studies in 12.9 million women were included in review and meta-analysis.

Characteristics of studies are presented in Table 1 and Appendixes 1,2 and 3. Sixteen studies were cross-sectional, five were retrospective cohort studies. Only one study used surveys, 18

hospital records, seven birth registries, and one census data. All studies were published in English. Most studies were from the United States. Nineteen studies included the entire population of eligible cases, while only two studies selected cases randomly. Case exclusion criteria varied considerably: one study excluded women aged 14 and younger; three excluded multiparas; eight excluded women with previous CS; eight excluded stillbirths and nine multiple births; six excluded cases with specific presentations of the foetus; six studies excluded preterm births, and 13 studies excluded cases due to provider characteristics. Two studies reported ORs of CS for which indication was established before labour (including CS on maternal request) only, three reported CS for which indication was established during labour and 16 reported ORs of any CS irrespective of indication. Eighteen studies adjusted for different characteristics as presented in Appendix 3.

Figure 2 presents the meta-analysis of the 13 studies that reported adjusted ORs (30-40), all of them using public insurance as the reference group. Overall, the odds of receiving CS were 1.14 higher for women with private insurance coverage as compared women with public health insurance coverage (95% CI 1.08 to 1.22), with no relevant heterogeneity between studies ($\tau 2 \leq 0.008$). Figure 3 presents results of stratified analyses of adjusted odds ratios. Estimates varied between strata, in particular for country (P for interaction<0.001), type of caesarean section (P for interaction=0.001), inclusion of women with previous CS (P for interaction=0.001) and pregnancy risk (P for interaction<0.001). Figure 4 presents the meta-analysis of crude ORs with a slightly stronger average association (pooled OR 1.36, 95% CI 1.27 to 1.45) and no relevant heterogeneity between studies ($\tau^2 \leq 0.012$). Appendix 4 presents adjusted associations for different states in the United States. Adjusted estimates ranged from 0.96 in Maryland to 2.09 in Florida.

Appendixes 5 to 7 report results from sensitivity analyses after inclusion of five smaller studies (25-29) and exclusion of a larger study (30) that had overlapping populations with the five smaller ones. Appendix 5 shows the meta-analysis of the 16 studies (25-28, 31-40) with a pooled adjusted OR of 1.17 (95% CI 1.09 to 1.26) and no evidence for relevant heterogeneity between studies ($\tau 2 \leq 0.017$). Appendix 6 presents results of stratified analyses, with estimates varying between countries (P for interaction<0.001), type of caesarean section (P for interaction=0.003) and pregnancy risks (P for interaction<0.001). Finally, Appendix 7 presents the meta-analysis of crude ORs, again with a stronger association on average (pooled OR 1.35, 95% CI 1.25 to 1.42) and no relevant heterogeneity between studies ($\tau 2 \leq 0.015$).

Discussion

Our systematic review and meta-analysis estimated that the overall odds of receiving a caesarean section are on average 1.14 times higher for privately insured women compared with women covered with public insurance. The increased risk was observed across all subgroups of studies in stratified analyses as well as in sensitivity analysis.

Context

To our knowledge, this is the first meta-analysis to examine the association of CS rates with types of insurance. A recently published meta-analysis found that the odds of delivery by CS was 1.41 higher in for-profit hospitals as compared with non-profit hospitals (95% CI 1.24 to 1.60) (22). These findings were confirmed across subgroups (i.e. such as country, year, or study design) of studies in stratified analyses, indicating financial incentives may play an important role in such outcome (22). We found three other recent meta-analyses that summarized CS studies and found a strong association with obesity (41), Sub-Saharan Africa ethnic origin (42) and labour induction (43). Our estimates of a 14 percent increase are on the lower end of the strength of associations found in earlier studies.

Strengths and limitations

The major strengths of our meta-analysis include a broad literature search, screening and data extraction performed in duplicate, an exploration of study characteristics as a potential source of variation between studies, and sensitivity analyses involving studies that required exclusion due to overlapping populations. Major limitations are differences in the characteristics of the study populations, type of data used, types of CS analysed and variables used for adjustment in statistical analyses across studies. Unadjusted estimates of associations were larger, which suggests the presence of confounding, and we cannot completely rule out residual confounding in adjusted estimates.

Mechanisms

Existing evidence points towards two possible causes for higher odds of CS in women insured privately: payment mechanisms of health insurance bodies and health care providers' responses to these mechanisms. Most insurers pay for higher volume of care through fee-for-service reimbursement (44, 45). Health insurers are known to reimburse hospitals and physicians at higher rates for CS (32) compared with vaginal delivery (34) and they can also differ in rates of reimbursement of CS (34). Multiple studies have shown that hospitals are motivated by and responsive to financial incentives (22, 32, 44, 46), although Grant (34) argues that their impact is small. One example is the financial benefit associated with longer hospital stays associated with CS (46, 47). Hospitals may incentivize physicians (44, 46) to align their clinical decision with institutional strategies, such as patient scheduling policies that steer patients with private insurance to more profit prone physicians (44, 46).

Physicians are known to be motivated by higher fees paid for CS as compared with vaginal delivery (46). They often act as self-interested economic agents according to economic models of physician behaviour, by maximizing income and convenience (32). Physicians are

also in a position to exploit asymmetry of information between them and patients (48, 49), which leads to recommendations that are not always aligned with patient needs or preferences (15). There is also evidence that physicians with higher numbers of privately insured patients will tend to perform more CS (32, 34); explanations include perceptions that patients with private insurance have a higher social class, or more prevalent concerns about malpractice liability in patients with private insurance (50).

The heterogeneity of adjusted estimates across states in the United States (Appendix 4) points to setting specific factors that will influence the effect of insurance on the odds of CS and are worth of further investigation. According to Burns et al., the lacking association in Arizona (OR=1.02) may be due to equal magnitudes of re-imbursements of hospitals for vaginal birth and CS (32). In Maryland (OR=0.96), the state administration introduced HealthChoice Program in 1997, that was intended to provide prevention oriented healthcare services, enact better accountability measures for managed care organizations, and ensure efficient use of financial resources (36). This program introduced a mandatory managed care system for Medicaid beneficiaries, which replaced a fee-for-service model. This resulted in more patients receiving managed care irrespective of their insurance status and, in turn, use of similar policies in patients with public and private insurance (36). We are unaware of plausible explanations for the lack of associations observed in Michigan (OR 1.01) and Ohio (OR 1.00).

Policy and research implications

Increases in the cost of care and hospital charges have become central issues in policy discussion in the United States and elsewhere (15, 45). While the public health care costs are reaching unsustainable levels, hospital charges can have alarming effects on patients (45). In

addition, the potential negative clinical effects of CS on mothers and newborns have raised concerns among clinicians, academics and policymakers alike (15).

Recent studies and their media coverage and associated increase in public awareness of high CS rates and changes in reimbursement policy have led to recent decreases of CS rates in California (18). Our study provides additional evidence to support policy and advocacy efforts that address escalating CS rates, in particular their association with financial incentives. Effective policy measures often require context, country or state specific policy analyses investigating particular insurance programmes. These setting specific analyses are essential as incentives may differ across health care systems.

As we analyse CS rates relation with health insurance schemes we need to be aware of complexity of interaction of different determinants and their influence in CS rates. The published literature has identified a number of determinants of CS rates which operate at different levels of health care systems (macro, meso, and micro) (15). At the macro level of national health systems, operate factors such as health financing system, social and political context, legal regulations, general cultural and social norms and similar. At the meso level are hospitals and health care facilities. Their ownership status, availability of resources and size are known to influence CS rates (15, 22). Finally, at the micro level, we have clinical units that provide care, medical staff and patients, which are characterised with all sorts of features that can influence the decision for CS. For example, clinical unit staff composition, or physician education, gender and experience, or mother preference, age and race, are all known to determine the rates of CS (15).

Conclusion

This systematic review and meta-analysis indicates that CS are more likely to be performed in privately insured women as compared to women with public health insurance coverage.

Although this effect is small and variable across strata, it is present in all performed analysis. Review of setting-specific reimbursement policies will enable an understanding of influencing factors. Reforming reimbursement policies used by private and public insurers may lead to a reduction of CS rates to more appropriate levels (18, 22, 36, 51).

Acknowledgments

Contributorship Statement

IH, LS, DG, PJ conceived and designed the study. IH, LS, MB performed the data extraction and preparation. IH, LS, BdC, PJ analysed the data. IH, DG, PJ wrote the paper, which was critically reviewed and approved by all authors.

Competing interests statement

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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No funding was received to perform this study. All authors, had full access to all of the data (including statistical reports and tables) in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Data sharing statement

No additional unpublished data are available from the study.

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Table 1. Characteristics of included studies

Author	Year	Country	Study design	Number of cases	Number of hospital units	Year of data collection	Population	Sampling	Type of CS analysed
Stafford	1990	United States	Cross sectional	461066	Not reported	1986	Primi- and multiparae; any risk	Consecutive	Any
Haas et al. A	1993	United States	Cross sectional	57257	Not reported	1984	Primi- and multiparae; any risk	Consecutive	Any
Haas et al. B	1993	United States	Cross sectional	64346	Not reported	1987	Primi- and multiparae; any risk	Consecutive	Any
Braveman et al.	1995	United States	Retrospective cohort	213761	Unclear	1991	Primiparae; no previous CS; any risk	Consecutive	Any
Burns et al.	1995	United States	Cross sectional	33233	36	1989	Primi- and multiparae; any risk	Consecutive	Any
Aron et al.	2000	United States	Retrospective cohort	25697	21	1993-1995	Primiparae; no previous CS; any risk	Consecutive	Any
Grant A	2005	United States	Cross sectional	9017	n/a	1988	Primi- and multiparae; any risk	Random	Any
Grant B	2005	United States	Cross sectional	147821	n/a	1992	Primi- and multiparae; any risk	Consecutive	Any
Grant C	2005	United States	Cross sectional	136763	n/a	1995	Primi- and multiparae; any risk	Consecutive	Any
Korst et al.	2005	United States	Cross sectional	327632	288	1995	Primi- and multiparae; no previous CS; any risk	Consecutive	During labour
Misra	2008	United States	Cross sectional	128743	Not reported	1995, 2000	Primi- and multiparae; no previous CS; any risk	Consecutive	During labour
Coonrod et al.	2008	United States	Cross sectional	28863	40	2005	Primiparae; low risk	Consecutive	Any
Huesch	2011	United States	Cross sectional	182108	Not reported	2004-2007	Primi- and multiparae; no previous CS; low risk	Consecutive	Before labour

Movsas et al.	2012	United States	Retrospective cohort	617269	NA	2004-2008	Primi- and multiparae; any risk	Consecutive	Any
Kozhimannil et al.	2013	United States	Cross sectional	6717486	Over 1000	2002-2009	Primi- and multiparae; any risk	Random	Any
Lutomski et al.	2014	Ireland	Retrospective cohort	403642	19	2005-2010	Primi- and multiparae; any risk	Consecutive	Any
Huesch et al.	2014	United States	Cross sectional	408355	254	2010	Primi- and multiparae; no previous CS; any risk	Consecutive	Before labour
Henke et al.	2014	United States	Cross sectional	2516570	Not reported	2009	Primi- and multiparae; no previous CS; low risk	Consecutive	Any
Bannister-Tyrrell et al.	2015	Australia	Cross sectional	20247	51	2007-2011	Primi- and multiparae; high risk	Consecutive	Any
Sebastião et al.	2016	United States	Retrospective cohort	412192	122	2004-2011	Primiparae; no previous CS; low risk	Consecutive	During labour
Sentell et al.	2016	United States	Cross sectional	11419	4	2012	Primi- and multiparae; any risk	Consecutive	Any

CS = caesarean section

Figure legends

Figure 1. The flow diagram of review

Figure 2. Adjusted odds ratios of caesarean section

Figure 3. Stratified analyses/Legend: *P for trend

Figure 4. Crude odds ratios of caesarean section

Supporting information

S1 - Appendix 1. Reported exclusion criteria

S2 - Appendix 2. Characteristics of data used for analysis

S3 - Appendix 3. Covariates used for statistical adjustment

S4 - Appendix 4. Caesarean section rates in United States

S5 - Appendix 5. Sensitivity analysis - Adjusted odds ratios of caesarean section

S6 - Appendix 6. Sensitivity analysis – stratified analyses/Legend: *P for trend

S7 - Appendix 7. Sensitivity analysis - Crude odds ratios of caesarean section

S8 – Appendix 8. Search strategy

S9 – Appendix 9. PRISMA checklist

S10 – Appendix 10. Research Checklist

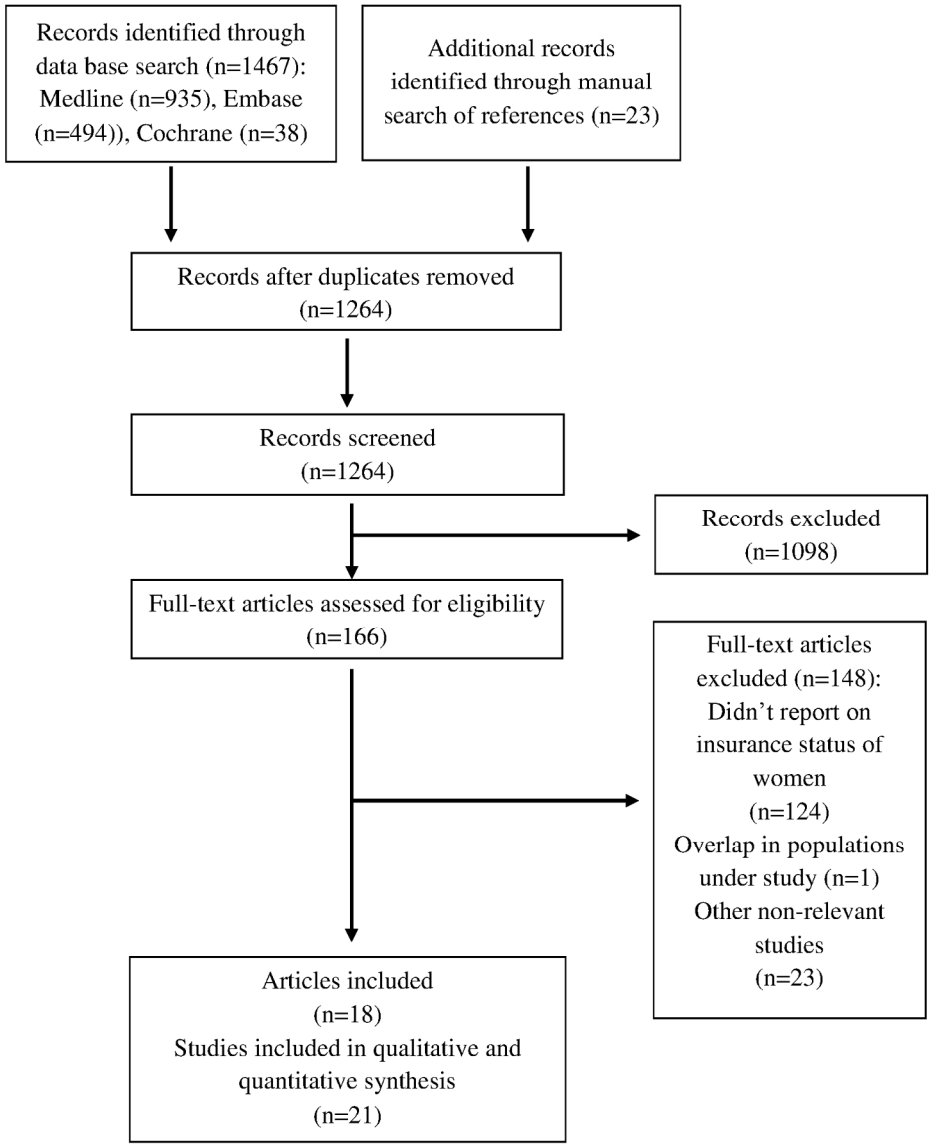


Figure 1. The flow diagram of review

164x201mm (300 x 300 DPI)

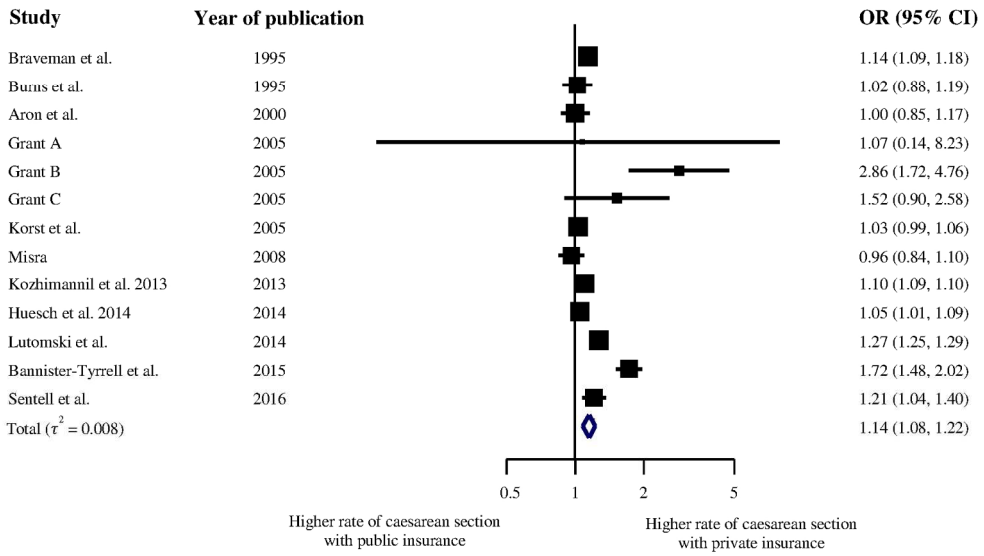


Figure 2. Adjusted odds ratios of caesarean section

171x98mm (300 x 300 DPI)

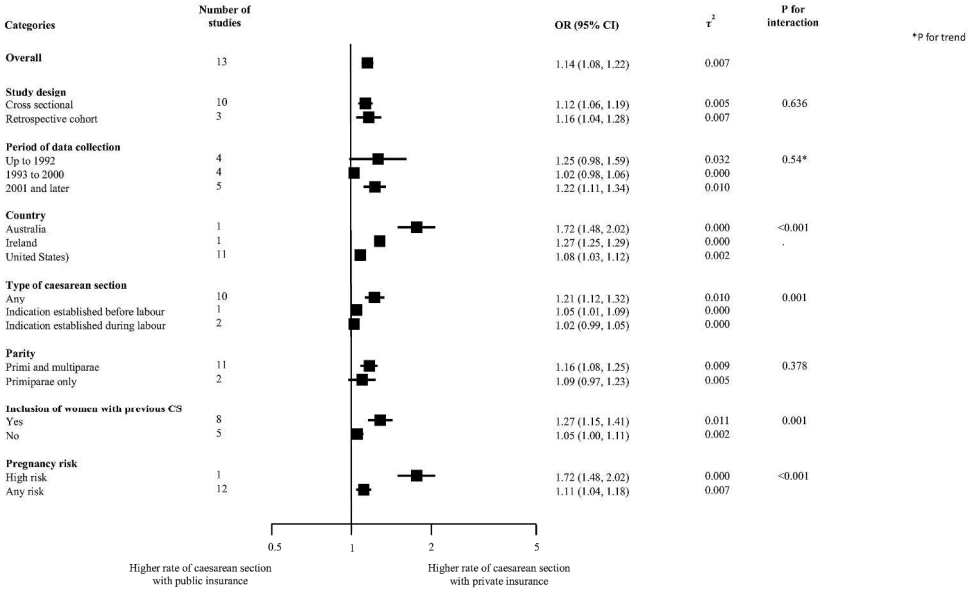


Figure 3. Stratified analyses/Legend: *P for trend

255x158mm (300 x 300 DPI)

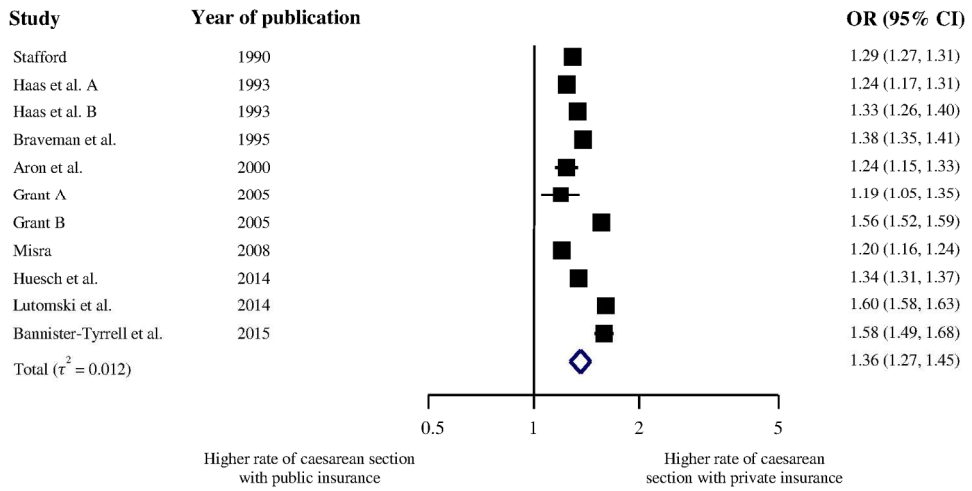


Figure 4. Crude odds ratios of caesarean section

171x87mm (300 x 300 DPI)

Appendix 1. Reported exclusion criteria

			Maternal characteristics						Foetus characteristics										
Authors	Year	Source population	Age ≤14	Racial or ethnic minorities	Multiparae	Previous caesarean section	Other risk factors for caesarean section	Stillbirth	Multiple births (twin or more)	Newborn weighting <500 gr	Breach presentation	Other malpresentation	Preterm birth (less than 37 weeks)	Other risk factors for caesarean section	Not in labour	Cases with missing data	Provider characteristics	Other factors
Stafford	1990	All births in California, United States															+	
Haas et al. A	1993	All births in Massachusetts, United States						+	+	+						+		
Haas et al. B	1993	All births in Massachusetts, United States						+	+	+						+		
Braveman et al.	1995	All births in California, United States			+	+		+	+				+			+		
Burns et al.	1995	All births in Arizona, United States														+	+	
Aron et al.	2000	All births in Cleveland, Ohio, United States				+				+*						+	+	+
Grant A	2005	All births, United States														+		
Grant B	2005	All births in Florida, United States														+	+	+
Grant C	2005	All births in Florida, United States														+	+	+
Korst et al.	2005	All births in California, United States				+	+	+	+		+	+	+	+	+		+	
Misra	2008	All births in Maryland, United States				+									+			
Coonrod et al.	2008	All births in Arizona, United States		+	+			+	+		+	+	+				+	
Huesch	2011	All births in New Jersey, United States				+	+		+		+	+	+	+	+		+	
Movsas et al.	2012	All births in Michigan, United States						+									+	
Kozhimannil et al.	2013	All births in 44 states, United States															+	
Lutomski et al.	2014	All births, Ireland															+	
Huesch et al.	2014	All births in California, United States	+			+								+		+		
Henke et al.	2014	All births in 44 states, United States				+		+	+		+	+	+			+		+
Bannister-Tyrrell et al.	2015	All births in New South Wales, Australia									+	+					+	+
Sebastião et al.	2016	All births in Florida, United States			+	+		+	+		+	+	+		+	+	+	+
Sentell et al.	2016	All births in Hawaii, United States							+							+		+

*500 or less grams

Appendix 2. Characteristics of data used for analysis

Author	Year	Survey	Hospital records	Birth certificates/registry	Census data
Stafford	1990		+		
Haas et al. A	1993		+	+	
Haas et al. B	1993		+	+	
Braveman et al.	1995			+	+
Burns et al.	1995		+	+	
Aron et al.	2000		+		
Grant A	2005	+			
Grant B	2005		+		
Grant C	2005		+		
Korst et al.	2005		+		
Misra	2008		+		
Coonrod et al.	2008			+	
Huesch	2011		+		
Movsas et al.	2012		+	+	
Kozhimannil et al.	2013		+		
Lutomski et al.	2014		+		
Huesch et al.	2014		+		
Henke et al.	2014		+		
Bannister-Tyrrell et al.	2015		+		
Sebastião et al.	2016		+	+	
Sentell et al.	2016		+		

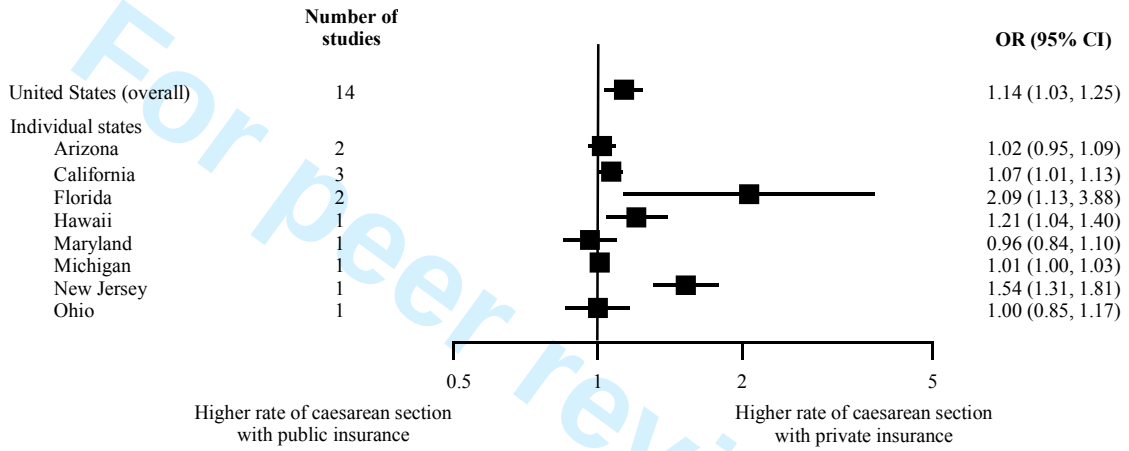
Appendix 3. Covariates used for statistical adjustment

		Maternal preconception status									Maternal clinical status					Foetus characteristics							
Author	Year	Ethnicity/Race	Educational level	Marital status	Economic status	Insurances status	Urban status	Weight	Height	Body mass index	Age	Parity	Previous caesarean section	Pre-existing (before pregnancy) conditions	Conditions developed during pregnancy	Gestational age	Birth weight	Other characteristics	Prenatal care	Birth characteristics	Provider characteristics	Other variables	Total number of covariates
Stafford*	1990																						0
Haas et al. A*	1993																						0
Haas et al. B*	1993																						0
Braveman et al.	1995	+	+	+	+	+					+				+		+	+	+	+	++	+	15
Burns et al.	1995	+	+								+	+	+		++	+	+	++	+		++	++	33
Aron et al.	2000										+	+		++	++	++	+	++					39
Grant A	2005	++	+	+	+		+	+	+		++		+	++	++	+	++	++	++		++	++	68
Grant B	2005	++					+				++		+	++	++	+	++	++	+		++	+	31
Grant C	2005	++					+				++		+	++	++	+	++	++	+		++	+	31
Korst et al.	2005	+									+										++		6
Misra	2008	+									++			++	++			++		+	++	++	30
Coonrod et al.	2008	+	+								+			++	+	+	+	+	+	+	++		20
Huesch	2011	+		+			+				+										+	++	8
Movsas et al.	2012	+									+	+		+		+	+	+				+	9
Kozhimannil et al.	2013	+									+	+	+	++	++	+		++			++		16
Lutomski et al.	2014										+		+	++	+			+					6
Huesch et al.	2014	+			+						+			++	++	+		++	+	++	++	++	124
Henke et al.	2014	+	+		+						+			++	++		+				++	++	28
Bannister-Tyrrell et al.	2015											+	+	++	++	+		+		++	+	+	12
Sebastião et al.	2016	+		+						+	+				+	+				+	++		10
Sentell et al.	2016	+									+	+			+						+	+	6

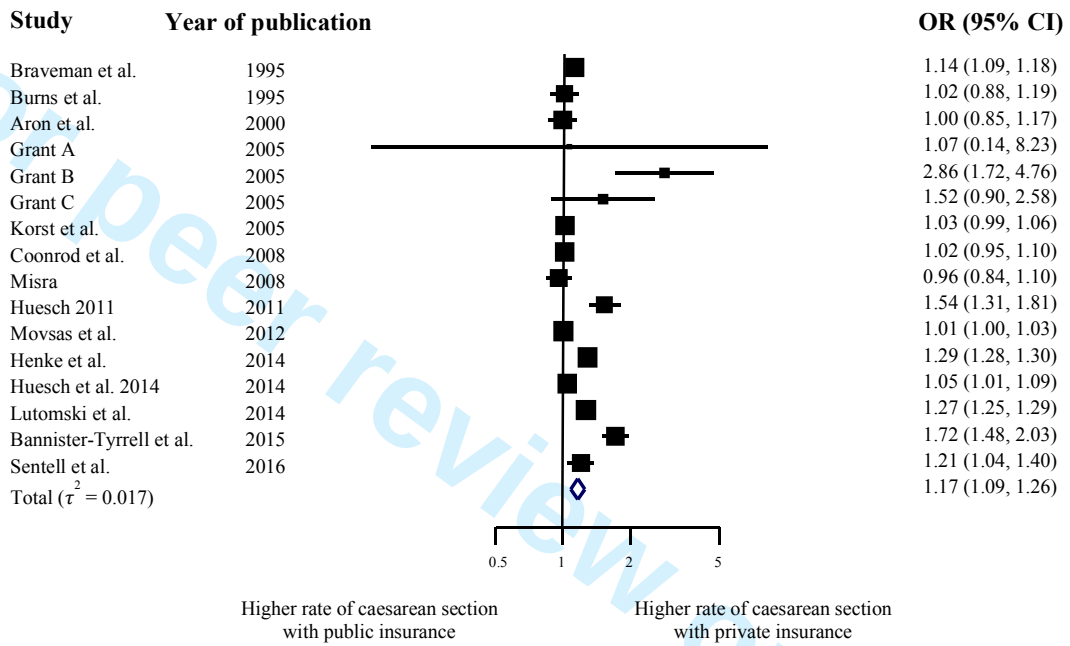
+ One covariate adjusted for ++ Two or more covariates adjusted for

*Stafford and Haas et al. only reported crude estimates.

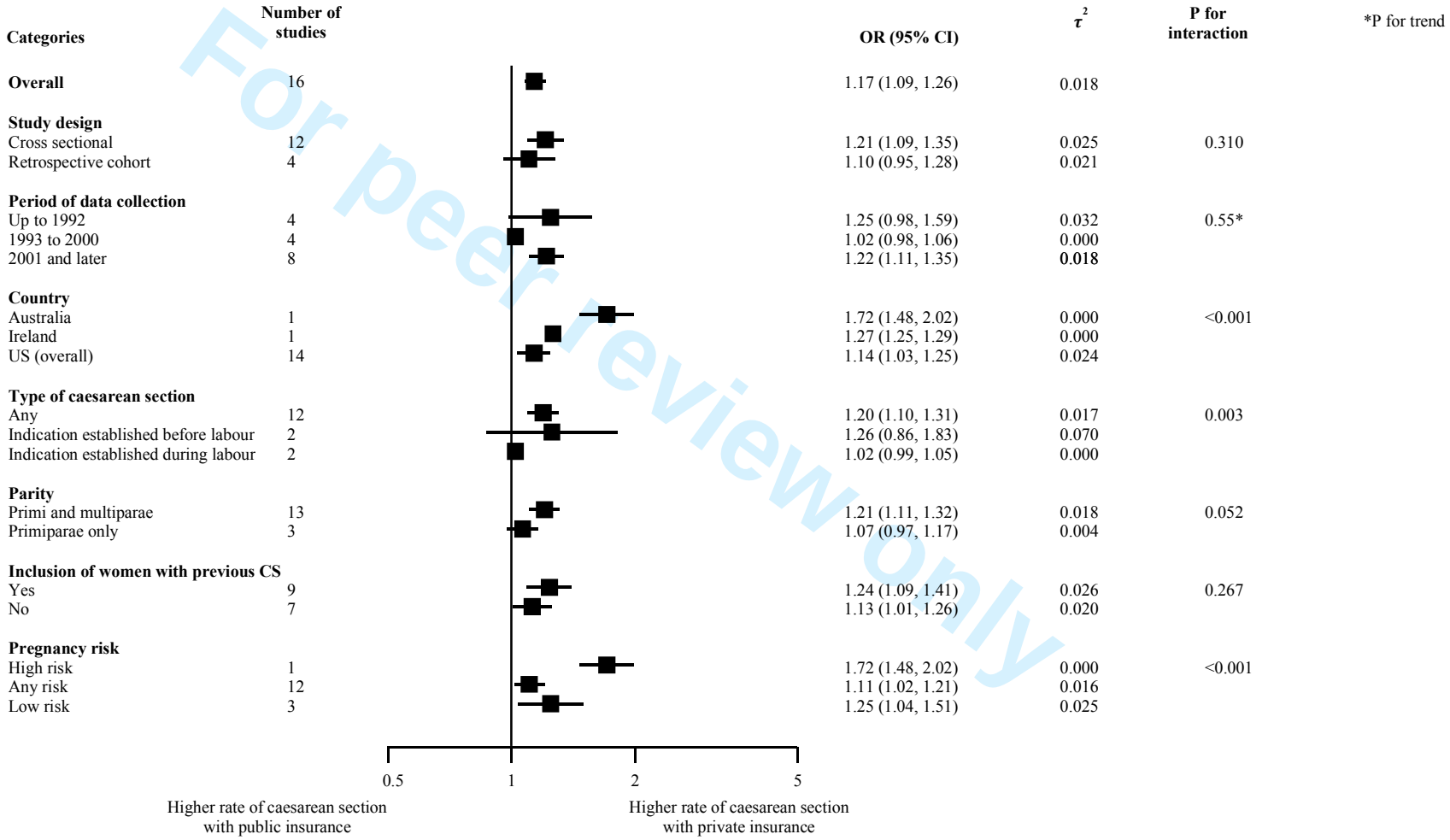
Appendix 4. Caesarean section rates in United States



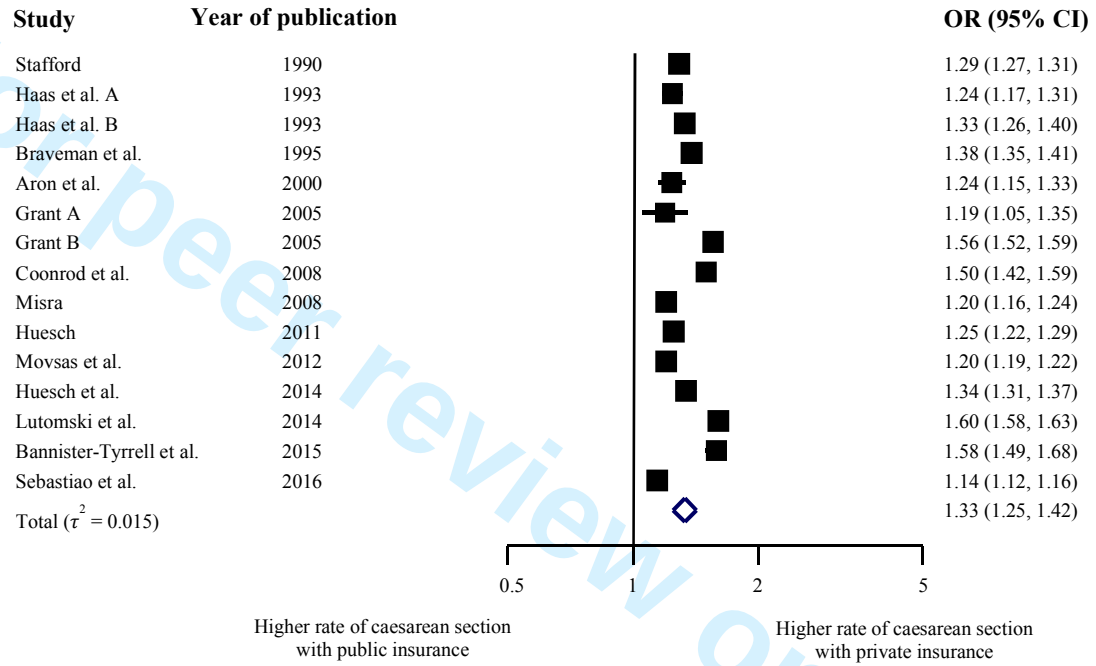
Appendix 5. Sensitivity analysis - Adjusted odds ratios of caesarean section



Appendix 6. Sensitivity analysis – stratified analyses



Appendix 7. Sensitivity analysis - Crude odds ratios of caesarean section



Search Strategy

1. For Medline (PubMed)

(((((((causes OR determinants OR statistics OR rates OR factors OR decision* OR physician* OR socioeconomic OR state medicine OR evidence-based OR hospital OR hospitals OR hospitalization OR hospitalized OR uncertain* OR educational status OR social class OR obstetric* OR gynecolog* OR supply OR distribut* OR utilization OR insurance OR choice OR attitude OR patient OR economics OR maternal OR accessib* OR health service* OR rural population OR urban population[Title/Abstract])) NOT medline[sb])) OR ("Decision Making"[Mesh] OR "Physician's Practice Patterns"[Mesh] OR "Socioeconomic Factors"[Mesh] OR "State Medicine"[Mesh] OR "Evidence-Based Medicine"[Mesh] OR "Hospitals"[Mesh] OR "Uncertainty"[Mesh] OR "Educational Status"[Mesh] OR "Hospital Costs"[Mesh] OR "Physician Incentive Plans"[Mesh] OR "Social Class"[Mesh] OR "Obstetrics and Gynecology Department, Hospital"[Mesh] OR "supply and distribution"[Subheading] OR "utilization"[Subheading] OR "Insurance"[Mesh] OR "Choice Behavior"[Mesh] OR "Attitude to Health"[Mesh] OR "Patient Participation"[Mesh] OR "Physician-Patient Relations"[Mesh] OR "Economics, Hospital"[Mesh] OR "Maternal Health Services"[Mesh] OR "Health Services Accessibility"[Mesh] OR "Health Services Research"[Mesh] OR "Rural Population"[Mesh] OR "Urban Population"[Mesh])))) OR factors OR rates OR statistics OR causes OR determinants AND (((((operative delivery OR caesarean section OR cesarean section OR c-section OR c section OR caesarean OR cesarean OR caesarean delivery OR cesarean delivery OR caesarean rates OR cesarean rates)))) OR cesarean section [MeSH Terms])) AND ((((("Catchment Area (Health)"[Mesh] OR "Small-Area Analysis"[Mesh])))) OR ((((small area analysis OR small area analyses OR medical practice variation OR regions OR geographic variation OR variation)))))

2. Embase (Ovid SP)

	# ▲	Searches	Results	Search Type	Actions
	1	decision making/	134077	Advanced	Display More >>
	2	professional practice/ or group practice/ or health care practice/ or medical practice/	129049	Advanced	Display More >>
	3	socioeconomics/	110558	Advanced	Display More >>
	4	state medicine.mp. or national health service/	54605	Advanced	Display More >>
	5	evidence based medicine/	80825	Advanced	Display More >>
	6	hospital/	216188	Advanced	Display More >>
	7	uncertainty/	6158	Advanced	Display More >>
	8	educational status/	36032	Advanced	Display More >>
	9	"hospital cost"/	13192	Advanced	Display More >>
	10	physician incentive plans.mp. or personnel management/	49572	Advanced	Display More >>
	11	social class/	26291	Advanced	Display More >>
	12	hospital department/	21809	Advanced	Display More >>
	13	obstetrics/	27326	Advanced	Display More >>
	14	gynecology/	29917	Advanced	Display More >>
	15	12 and 13	1423	Advanced	Display More >>

☐	16	12 and 15	413	Advanced	Display More ≫
☐	17	health care distribution/	2333	Advanced	Display More ≫
☐	18	health care utilization/	36879	Advanced	Display More ≫
☐	19	insurance/	33934	Advanced	Display More ≫
☐	20	choice behavior.mp.	765	Advanced	Display More ≫
☐	21	attitude to health/	81021	Advanced	Display More ≫
☐	22	patient participation/	16400	Advanced	Display More ≫
☐	23	doctor patient relation/	81043	Advanced	Display More ≫
☐	24	health economics/	33098	Advanced	Display More ≫
☐	25	obstetric procedure/	550	Advanced	Display More ≫
☐	26	health care access/	34433	Advanced	Display
☐	27	health services research/	27579	Advanced	Display More ≫
☐	28	geographic distribution/	132846	Advanced	Display More ≫
☐	29	rural population/	30219	Advanced	Display More ≫
☐	30	urban population/	35323	Advanced	Display More ≫
☐	31	causes/	0	Advanced	Delete More ≫
☐	32	determinants/	1	Advanced	Display More ≫
☐	33	statistics/	301146	Advanced	Display More ≫
☐	34	rates/	0	Advanced	Delete More ≫
☐	35	factors/	0	Advanced	Delete More ≫
☐	36	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 29 or 30 or 32 or 33	1340916	Advanced	Display More ≫
☐	37	cesarean section/	59755	Advanced	Display More ≫
☐	38	(caesarean section or cesarean section or c-section or c section or caesarean or cesarean or caesarean delivery or cesarean delivery or caesarean rates or cesarean rates or operative delivery).ti,ab,tw.	53950	Advanced	Display Delete More ≫
☐	39	37 or 38	73014	Advanced	Display More ≫
☐	40	(small area analysis or small area analyses or small aeraor medical practice variation or regions or geographic variation or variation or variations).ti,ab,tw.	964890	Advanced	Display More ≫
☐	41	28 or 40	1082827	Advanced	Display More ≫
☐	**42**	**36 and 39 and 41**	**357**	**Advanced**	Display More ≫

3. Cochrane Library

Caesarean section and insurance

Appendix 9 - PRISMA checklist

TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 1, 2
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Page 2,3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Page 4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Page 4,5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No published protocol or registration
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Page 4,5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Page 4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	S8 Appendix
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Page 6, Fig 1

Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Page 5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Page 4, 5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Appendix 1, 2, 3
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Page 4, 5
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	Page 5
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Appendix 1, 2, 3
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	Page 5
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Page 5, 6, Fig 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 1, Appendix 1, 2, 3
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Appendix 1, 2, 3
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Fig 1, Appendix 5
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Page 6, 7, Fig 1, Fig 3, Appendix 5, Appendix 7

Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Appendix 1, 2, 3
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Page 6, 7, Fig 2, Fig 5, Appendix 6,
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Page 7
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Page 8
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Page 8, 9
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	In submitting system

Research Checklist

According to MOOSE statement for meta-analyses of observational studies

Reporting of background should include	**Where to find in manuscript**
Problem definition	Manuscript (page 5)
Hypothesis statement	Manuscript (page 5)
Description of study outcome(s)	Manuscript (page 6)
Type of exposure or intervention used	Manuscript (page 6)
Type of study designs used	Manuscript (page 6)
Study population	Manuscript (page 6)
Reporting of search strategy should include	
Qualifications of searchers (eg, librarians and investigators)	Manuscript (page 6)
Search strategy, including time period included in the synthesis and keywords	Manuscript (pages 5), Appendix 8
Effort to include all available studies, including contact with authors	Manuscript (page 5-6)
Databases and registries searched	Manuscript (page 6)
Search software used, name and version, including special features used (eg, explosion)	Manuscript (page 6)
Use of hand searching (eg, reference lists of obtained articles)	Manuscript (page 6)
List of citations located and those excluded, including justification	Appendix 1
Method of addressing articles published in languages other than English	n/a
Method of handling abstracts and unpublished studies	Manuscript (page 6)
Description of any contact with authors	No contact made
Reporting of methods should include	
Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	Manuscript (page 6)
Rationale for the selection and coding of data (eg, sound clinical	Manuscript (page 6)

principles or convenience)	
Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	Manuscript (pages 6)
Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	Manuscript (page 6-7) Appendix 3
Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	n/a
Assessment of heterogeneity	Manuscript (page 6-7)
Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	Manuscript (page 6-7)
Provision of appropriate tables and graphics	Manuscript, Table 1, Figure 1-3 and Appendixes 1-7
Reporting of results should include	
Graphic summarizing individual study estimates and overall estimate	Figure 2-4
Table giving descriptive information for each study included	Table 1
Results of sensitivity testing (eg, subgroup analysis)	Figure 2, Appendixes 4-7
Indication of statistical uncertainty of findings	Manuscript, Figure 2-4
Reporting of discussion should include	
Quantitative assessment of bias (eg, publication bias)	Manuscript (page 8-9)
Justification for exclusion (eg, exclusion of non—English-language citations)	n/a
Assessment of quality of included studies	n/a
Reporting of conclusions should include	

Consideration of alternative explanations for observed results	Manuscript (pages 10-12)
Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	Manuscript (page 12-13)
Guidelines for future research	Manuscript (page 12)
Disclosure of funding source	Manuscript (page 14)

BMJ Open

Caesarean Sections and Private Insurance: Systematic Review and Meta-analysis

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016600.R1
Article Type:	Research
Date Submitted by the Author:	16-May-2017
Complete List of Authors:	Hoxha, Ilir; Universitat Bern Institut fur Sozial- und Praventivmedizin, Health Services Research Syrogiannouli, Lamprini; Universität Bern, Berner Institut für Hausarztmedizin (BIHAM) Braha, Medina; International Business College Mitrovica, Department of Managment and Marketing Goodman, David C; Dartmouth College Geisel School of Medicine da Costa, Bruno; Universität Bern, Berner Institut für Hausarztmedizin (BIHAM) Jüni, Peter; Applied Health Research Centre (AHRC), Li Ka Shing Knowledge Institute of St. Michael's Hospital, Department of Medicine, University of Toronto
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health economics, Health policy, Health services research, Obstetrics and gynaecology
Keywords:	caesarean section, health insurance, private insurance, financial incentives, medical practice variation, health services

Caesarean Sections and Private Insurance: Systematic Review and Meta-analysis

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Key words

caesarean section, health insurance, private insurance, financial incentives, medical practice variation, health services

Word count

2683 words excluding title page, abstract, references, figures and tables.

Abstract

Objective - Financial incentives associated with private insurance may encourage health care providers to perform more caesarean sections. We therefore sought to determine the association of private insurance and odds of caesarean section.

Design - Systematic review and meta-analysis.

Data sources - MEDLINE, Embase, and The Cochrane Library from the first year of records through August 2016.

Eligibility criteria – We included studies that reported data to allow the calculation of odds ratios of caesarean section of privately insured as compared to publicly insured women.

Outcomes - The pre-specified primary outcome was the adjusted odds ratio of births delivered by caesarean section of women covered with private insurance as compared with women covered with public insurance. The pre-specified secondary outcome was the crude odds ratio of births delivered by caesarean section of women covered with private insurance as compared with women covered with public insurance.

Results - Eighteen articles describing 21 separate studies in 12.9 million women were included in this study. In a meta-analysis of 13 studies, the adjusted odds of delivery by caesarean section was 1.13 higher among privately insured women as compared with women with public insurance coverage (95% CI 1.07 to 1.18) with no relevant heterogeneity between studies (τ^2=0.006). The meta-analysis of crude estimates from 12 studies revealed a somewhat more pronounced association (pooled odds ratio 1.35, 95% CI 1.27 to 1.44) with no relevant heterogeneity between studies (τ^2=0.011).

Conclusions - Caesarean sections are more likely to be performed in privately insured women as compared with women using public health insurance coverage. Although this

effect is small on average and variable in its magnitude, it is present in all analyses we performed.

Strengths and limitations of this study

- ✓ Our meta-analysis includes a broad literature search, screening and data extraction performed in duplicate and an exploration of study characteristics as a potential source of variation between studies and represents major strength of our study.
- ✓ Sensitivity analyses was performed involving studies that required exclusion in main analysis due to overlapping populations.
- ✓ The differences in the characteristics of the study populations, type of data used, types of CS analysed and variables used for adjustment in statistical analyses across studies represent a major limitation of our study.
- ✓ Unadjusted estimates of associations were larger, which suggests the presence of confounding, and we cannot completely rule out residual confounding in adjusted estimates.

Introduction

The global raise of caesarean section (CS) rates during the past decades has raised concerns over appropriateness of usage of the procedure (1, 2). The increase and immense variation among countries' regions and hospitals has been persistent over the years (3-14). Brazil has the highest rate of CS followed by China, Turkey, and Mexico (15). United States and other developed countries are not far behind. Even countries which traditionally have had low CS rates, like Norway or Sweden have seen substantial increase in CS rates (15). This increase has been accompanied with considerable variation within countries (15). In the United States, there was a fourfold difference in CS rates in low and high use areas (15). In England, the rates have varied threefold among National Health Service trusts (15). In British Columbia, Canada, the CS rates varied from 14.7 % to 27.6 % across health service delivery areas (15). The understanding of escalation of CS rates is important as it may prevent negative outcomes on health of mothers and newborns as well as reduce unnecessary costs related to delivery.

Such increase and variation cannot be explained by clinical factors alone (15). Evidence points to many additional, health system related factors, in particular supplier related factors (15). Financial incentives associated with private insurance seem to influence supplier behaviour, be that physician or hospital, affecting this way clinical decision as to whether perform CS or not (14-22). We therefore performed a systematic review and meta-analysis to determine the association of insurance status of women with the odds of delivery by CS.

Materials and methods

Search strategy and data sources

We combined search terms indicating CS, such as 'caesarean section', 'caesarean delivery', 'caesarean', with search terms associated with the study design such as 'small area analysis,' 'medical practice variation,' and search terms associated with determinants of variation and

increase of CS rates. We did not restrict search by type of language or publication date. We searched MEDLINE, Embase, and The Cochrane Library from inception to August 4, 2016, when the search was last updated. In addition, we manually searched the reference lists of all included studies and earlier systematic reviews that we identified.

Study selection and outcomes

To be eligible for inclusion, studies had to report data to allow the calculation of odds ratios (OR) of CS comparing women covered by private insurance with women covered by public insurance in a specific health care system. The pre-specified primary outcome was the adjusted OR of births delivered by CS of women covered with private insurance as compared with women with public insurance coverage. The pre-specified secondary outcome was the crude OR of CS of women covered with private insurance as compared with women with public insurance.

Data extraction

Two researchers (IH and MB) screened the papers and extracted data independently. Data from full text articles were extracted onto a data extraction sheet designed to capture data on study population, study design, data sources, setting, type of CS analysed, and statistical analysis. We extracted adjusted and/or unadjusted ORs of CS of women with private insurance as compared with CS of women with public insurance. Differences among researchers with regards to study inclusion and data extraction procedure were resolved by consensus and consultation with other authors.

Main analysis

We used standard inverse-variance random effects meta-analysis to estimate the pooled OR. An OR above one indicates that CS are more frequently performed in women with private insurance than in women with public insurance. We calculated the variance estimate τ^2 as a

measure of heterogeneity between studies (23). We pre-specified a τ^2 of 0.04 to represent low heterogeneity, 0.16 to represent moderate, and 0.36 to represent high heterogeneity between studies (24). We conducted analyses stratified by study design, period of data collection, country, type of CS analysed, parity, inclusion of women with previous CS, and pregnancy risk of included women to investigate potential reasons for between-study heterogeneity and used chi-square tests to calculate p-values for interaction, or tests for linear trends in cases of more than two ordered strata. All p-values are two-sided.

Sensitivity analyses

Five studies (25-29) were excluded from the main analysis, as they had an overlapping population with a larger study (30) that was included. For this reason, we repeated all analyses including these five studies (25-29) while excluding the larger one (30). Finally, we visually inspected a funnel plot of adjusted ORs against their standard errors to address potential small study effects (31). We used STATA, release 13, for all analyses (Stata-Corp, College Station, Texas).

Patient involvement

No patients were involved in this study. We used data from published papers only.

Results

We identified a total of 1490 records with our search strategy (Figure 1): 935 from Medline: 494 from Embase; 38 from the Cochrane Library and 23 from manual search. After removing duplicates, we screened 1264 records for eligibility, and retained 166 for full text examination. We excluded another 124 that did not report insurance status of women, 23 that were otherwise irrelevant and one study that had an overlapping population. Finally, 18 articles describing 21 separate studies in 12.9 million women were included in review and meta-analysis.

Characteristics of studies are presented in Table 1 and Appendixes 1,2 and 3. Sixteen studies were cross-sectional, five were retrospective cohort studies. Only one study used surveys, 18 hospital records, seven birth registries, and one census data. All studies were published in English. Most studies were from the United States. Nineteen studies included the entire population of eligible cases, while only two studies selected cases randomly. Case exclusion criteria varied considerably: one study excluded women aged 14 and younger; three excluded multiparas; eight excluded women with previous CS; eight excluded stillbirths and nine multiple births; six excluded cases with specific presentations of the foetus; six studies excluded preterm births, and 13 studies excluded cases due to provider characteristics. Two studies reported ORs of CS for which indication was established before labour (including CS on maternal request) only, three reported CS for which indication was established during labour and 16 reported ORs of any CS irrespective of indication. Eighteen studies adjusted for different characteristics as presented in Appendix 3.

Figure 2 presents the meta-analysis of the 13 studies that reported adjusted ORs (30, 32-41), all of them using public insurance as the reference group. Overall, the odds of receiving CS were 1.13 higher for women with private insurance coverage as compared women with public health insurance coverage (95% CI 1.07 to 1.18), with no relevant heterogeneity between studies ($\tau 2=0.006$). Figure 3 presents results of stratified analyses of adjusted odds ratios. Estimates varied between strata, in particular for country (P for interaction<0.001), type of caesarean section (P for interaction=0.001), inclusion of women with previous CS (P for interaction=0.001) and pregnancy risk (P for interaction<0.001). Appendix 4 shows a funnel plot of adjusted ORs against their standard errors on a log scale; there was no evidence for small study effects. Figure 4 presents the meta-analysis of crude ORs with a slightly stronger average association (pooled OR 1.35, 95% CI 1.27 to 1.44) and no relevant heterogeneity

between studies (τ^2=0.011). Appendix 5 presents adjusted associations for different states in the United States. Adjusted estimates ranged from 0.96 in Maryland to 1.54 in New Jersey.

Appendixes 6 to 8 report results from sensitivity analyses after inclusion of five smaller studies (25-29) and exclusion of a larger study (30) that had overlapping populations with the five smaller ones. Appendix 6 shows the meta-analysis of the 16 studies (25-28, 32-41) with a pooled adjusted OR of 1.14 (95% CI 1.07 to 1.22) and no evidence for relevant heterogeneity between studies (τ2=0.015). Appendix 7 presents results of stratified analyses, with estimates varying between countries (P for interaction<0.001), type of caesarean section (P for interaction=0.007) and pregnancy risks (P for interaction<0.001). Finally, Appendix 8 presents the meta-analysis of crude ORs, again with a stronger association on average (pooled OR 1.33, 95% CI 1.25 to 1.41) and no relevant heterogeneity between studies (τ2=0.014).

Discussion

Our systematic review and meta-analysis estimated that the overall odds of receiving a caesarean section are on average 1.13 times higher for privately insured women compared with women covered with public insurance. The increased risk was observed across all subgroups of studies in stratified analyses as well as in sensitivity analysis.

Context

To our knowledge, this is the first meta-analysis to examine the association of CS rates with types of insurance. A recently published meta-analysis found that the odds of delivery by CS was 1.41 higher in for-profit hospitals as compared with non-profit hospitals (95% CI 1.24 to 1.60) (22). These findings were confirmed across subgroups (i.e. such as country, year, or study design) of studies in stratified analyses, indicating financial incentives may play an important role in such outcome (22). We found three other recent meta-analyses that

summarized CS studies and found a strong association with obesity (42), Sub-Saharan Africa ethnic origin (43) and labour induction (44). Our estimates of a 14 percent increase are on the lower end of the strength of associations found in earlier studies.

Strengths and limitations

The major strengths of our meta-analysis include a broad literature search, screening and data extraction performed in duplicate, an exploration of study characteristics as a potential source of variation between studies, and sensitivity analyses involving studies that required exclusion due to overlapping populations. Major limitations are differences in the characteristics of the study populations, type of data used, types of CS analysed and variables used for adjustment in statistical analyses across studies. Unadjusted estimates of associations were larger, which suggests the presence of confounding, and we cannot completely rule out residual confounding in adjusted estimates.

Mechanisms

Existing evidence suggests that possible causes for higher odds of CS in women insured privately lie in the differences in payment for CS and reimbursement arrangements among insurers as well as providers' responses to these arrangements. In the countries included in our analysis, private health insurers generally reimburse hospitals at higher fees for providing a CS compared to the public insurers (35). This incentive is heightened when public insurance funds hospital care through a budget (e.g. Australia and Ireland) rather than fee-for-service, which is common in private insurance (45, 46). Similar incentives are present in physician payment.

Multiple studies have shown that hospitals are motivated by and responsive to financial incentives (22, 33, 47, 48), although Grant (35) argues that their impact is small. One example is the financial benefit associated with longer hospital stays associated with CS (47, 49). Hospitals may incentivize physicians (47, 48) to align their clinical decision with

institutional strategies, such as patient scheduling policies that steer patients with private insurance to more profit prone physicians (47, 48). Physicians are known to be motivated by higher fees paid for CS as compared with vaginal delivery (47). They often act as self-interested economic agents according to economic models of physician behaviour, by maximizing income and convenience (33). Physicians are also in a position to exploit asymmetry of information between them and patients (50, 51), which leads to recommendations that are not always aligned with patient needs or preferences (15). There is also evidence that physicians with higher numbers of privately insured patients will tend to perform more CS (33, 35); explanations include perceptions that patients with private insurance have a higher social class, or more prevalent concerns about malpractice liability in patients with private insurance (52).

Comparing 'public insurance' and 'private insurance' across countries is not a straightforward exercise as the meaning of such distinction can vary substantially across countries. In the United States 'public insurance' is insurance assigned to specific categories of population (by age, disability, poverty or military service) and 'private insurance' is insurance mainly organized through employment. In general, private insurance offers higher reimbursement rates for surgical procedures, and this may incentivize CS. The heterogeneity of adjusted estimates across states in the United States (Appendix 5) points to setting specific factors that will influence the effect of insurance on the odds of CS and are worth of further investigation. According to Burns et al., the lacking association in Arizona (OR=1.02) may be due to equal magnitudes of re-imbursements of hospitals for vaginal birth and CS (33). In Maryland (OR=0.96), the state administration introduced HealthChoice Program in 1997, that was intended to provide prevention oriented healthcare services, enact better accountability measures for managed care organizations, and ensure efficient use of financial resources (37). This program introduced a mandatory managed care system for Medicaid beneficiaries,

which replaced a fee-for-service model. This resulted in more patients receiving managed care irrespective of their insurance status and, in turn, use of similar policies in patients with public and private insurance (37). We are unaware of plausible explanations for the lack of associations observed in Michigan (OR 1.01) and Ohio (OR 1.00). This analysis shows that variation in CS rates among insurers within the United States can be explained by differences in reimbursement arrangements nested within public and private insurance.

For the other two countries, Ireland and Australia, included in the adjusted analysis, 'private health insurance' status differs in character from the United States but offers similarly higher payment levels for procedures. In Australia, women of childbearing age with private insurance, would have increased the use of private obstetricians, leading to higher rates of CS (53). In Ireland, the financial incentives in private insurance are similar, and are associated with striking inequities in care (54).

Policy and research implications

Increases in the cost of care and hospital charges have become central issues in policy discussion in the United States and elsewhere (15, 55). While the public health care costs are reaching unsustainable levels, hospital charges can have alarming effects on patients (55). In addition, the potential negative clinical effects of CS on mothers and newborns have raised concerns among clinicians, academics and policymakers alike (15).

Recent studies and their media coverage and associated increase in public awareness of high CS rates and changes in reimbursement policy have led to recent decreases of CS rates (18). Our study provides additional evidence to support policy and advocacy efforts that address escalating CS rates, in particular their association with financial incentives. Effective policy measures often require context, country or state specific policy analyses investigating particular insurance schemes. These setting specific analyses are essential as incentives and

reimbursement arrangements within health insurance schemes may differ across health care systems. We recognize that while categories 'public insurance' and 'private insurance' are useful markers of higher reimbursement rates, other aspects of insurance reimbursement may also influence the odds of CS.

As we analyse CS rates relation with health insurance schemes we need also to be aware of complexity of interaction of different determinants and their influence in CS rates. The published literature has identified a number of determinants of CS rates which operate at different levels of health care systems (macro, meso, and micro) (15). At the macro level of national health systems, operate factors such as health financing system, social and political context, legal regulations, general cultural and social norms and similar. At the meso level are hospitals and health care facilities. Their ownership status, availability of resources and size are known to influence CS rates (15, 22). Finally, at the micro level, we have clinical units that provide care, medical staff and patients, which are characterised with all sorts of features that can influence the decision for CS. For example, clinical unit staff composition, or physician education, gender and experience, or mother preference, age and race, are all known to determine the rates of CS (15).

Conclusion

This systematic review and meta-analysis indicates that CS are more likely to be performed in privately insured women as compared to women with public health insurance coverage. Although this effect is small and variable across strata, it is present in all performed analysis. Review of setting-specific payment levels and reimbursement arrangements within health insurance schemes will enable a better understanding of influencing factors. Efforts to address payment levels for delivery procedures and reform of reimbursement arrangements may lead to a reduction of CS rates to more appropriate levels (18, 22, 37, 56).

Acknowledgments

Contributorship Statement

IH, LS, DG, PJ conceived and designed the study. IH, LS, MB performed the data extraction and preparation. IH, LS, BdC, PJ analysed the data. IH, DG, PJ wrote the paper, which was critically reviewed and approved by all authors.

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Competing interests statement

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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No funding was received to perform this study. All authors, had full access to all of the data (including statistical reports and tables) in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Data sharing statement

No additional unpublished data are available from the study.

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Table 1. Characteristics of included studies

Author	Year	Country	Study design	Number of cases	Number of hospital units	Year of data collection	Population	Sampling	Type of CS analysed
Stafford	1990	United States	Cross sectional	461066	Not reported	1986	Primi- and multiparae; any risk	Consecutive	Any
Haas et al. A	1993	United States	Cross sectional	57257	Not reported	1984	Primi- and multiparae; any risk	Consecutive	Any
Haas et al. B	1993	United States	Cross sectional	64346	Not reported	1987	Primi- and multiparae; any risk	Consecutive	Any
Braveman et al.	1995	United States	Retrospective cohort	213761	Unclear	1991	Primiparae; no previous CS; any risk	Consecutive	Any
Burns et al.	1995	United States	Cross sectional	33233	36	1989	Primi- and multiparae; any risk	Consecutive	Any
Aron et al.	2000	United States	Retrospective cohort	25697	21	1993-1995	Primiparae; no previous CS; any risk	Consecutive	Any
Grant A	2005	United States	Cross sectional	9017	n/a	1988	Primi- and multiparae; any risk	Random	Any
Grant B	2005	United States	Cross sectional	147821	n/a	1992	Primi- and multiparae; any risk	Consecutive	Any
Grant C	2005	United States	Cross sectional	136763	n/a	1995	Primi- and multiparae; any risk	Consecutive	Any
Korst et al.	2005	United States	Cross sectional	327632	288	1995	Primi- and multiparae; no previous CS; any risk	Consecutive	Emergency
Misra	2008	United States	Cross sectional	128743	Not reported	1995, 2000	Primi- and multiparae; no previous CS; any risk	Consecutive	Emergency
Coonrod et al.	2008	United States	Cross sectional	28863	40	2005	Primiparae; low risk	Consecutive	Any
Huesch	2011	United States	Cross sectional	182108	Not reported	2004-2007	Primi- and multiparae; no previous CS; low risk	Consecutive	Planned

Movsas et al.	2012	United States	Retrospective cohort	617269	NA	2004-2008	Primi- and multiparae; any risk	Consecutive	Any
Kozhimannil et al.	2013	United States	Cross sectional	6717486	Over 1000	2002-2009	Primi- and multiparae; any risk	Random	Any
Lutomski et al.	2014	Ireland	Retrospective cohort	403642	19	2005-2010	Primi- and multiparae; any risk	Consecutive	Any
Huesch et al.	2014	United States	Cross sectional	408355	254	2010	Primi- and multiparae; no previous CS; any risk	Consecutive	Planned
Henke et al.	2014	United States	Cross sectional	2516570	Not reported	2009	Primi- and multiparae; no previous CS; low risk	Consecutive	Any
Bannister-Tyrrell et al.	2015	Australia	Cross sectional	20247	51	2007-2011	Primi- and multiparae; high risk	Consecutive	Any
Sebastião et al.	2016	United States	Retrospective cohort	412192	122	2004-2011	Primiparae; no previous CS; low risk	Consecutive	Emergency
Sentell et al.	2016	United States	Cross sectional	11419	4	2012	Primi- and multiparae; any risk	Consecutive	Any

CS = caesarean section

Figure legends

Figure 1. The flow diagram of review

Figure 2. Adjusted odds ratios of caesarean section

Figure 3. Stratified analyses/Legend: *P for trend

Figure 4. Crude odds ratios of caesarean section

Supporting information

S1 - Appendix 1. Reported exclusion criteria

S2 - Appendix 2. Characteristics of data used for analysis

S3 - Appendix 3. Covariates used for statistical adjustment

S4 - Appendix 4. Funnel plot of adjusted ORs against their standard errors on a log scale

S5 - Appendix 5. Caesarean section rates in United States

S6 - Appendix 6. Sensitivity analysis - Adjusted odds ratios of caesarean section

S7 - Appendix 7. Sensitivity analysis – stratified analyses/Legend: *P for trend

S8 - Appendix 8. Sensitivity analysis - Crude odds ratios of caesarean section

S9 – Appendix 9. Search strategy

S10 – Appendix 10. PRISMA checklist

S11 – Appendix 11. Research Checklist

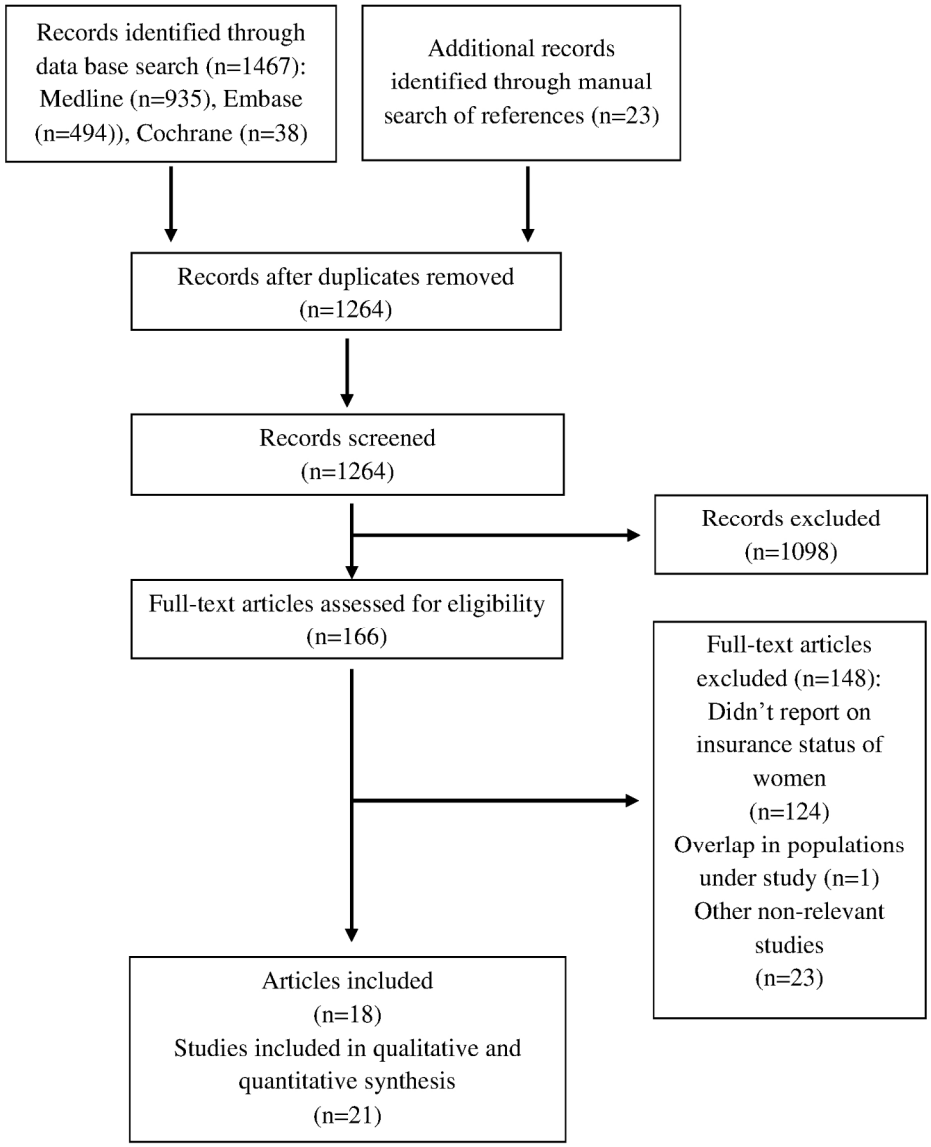


Figure 1. The flow diagram of review

164x201mm (300 x 300 DPI)

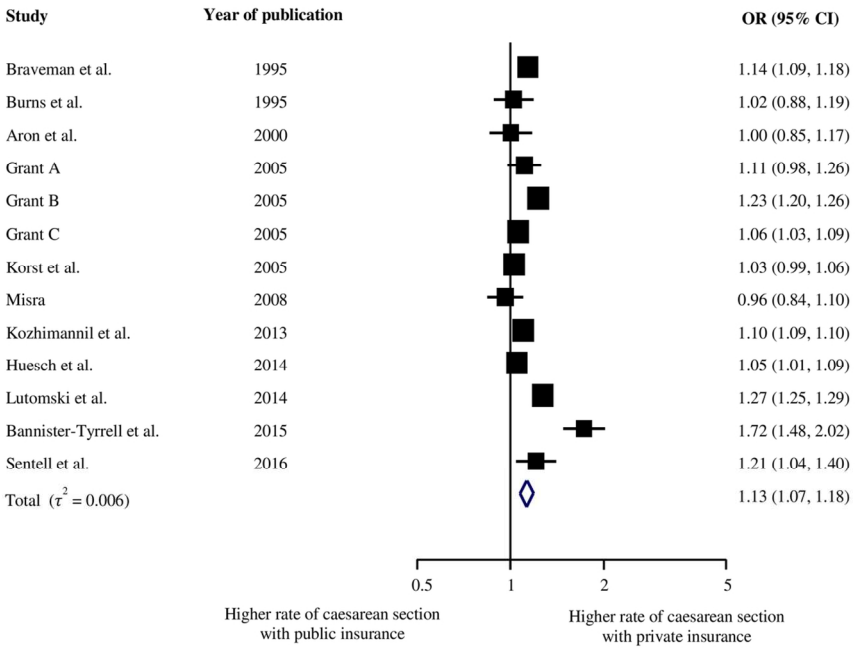


Figure 2. Adjusted odds ratios of caesarean section

118x83mm (300 x 300 DPI)

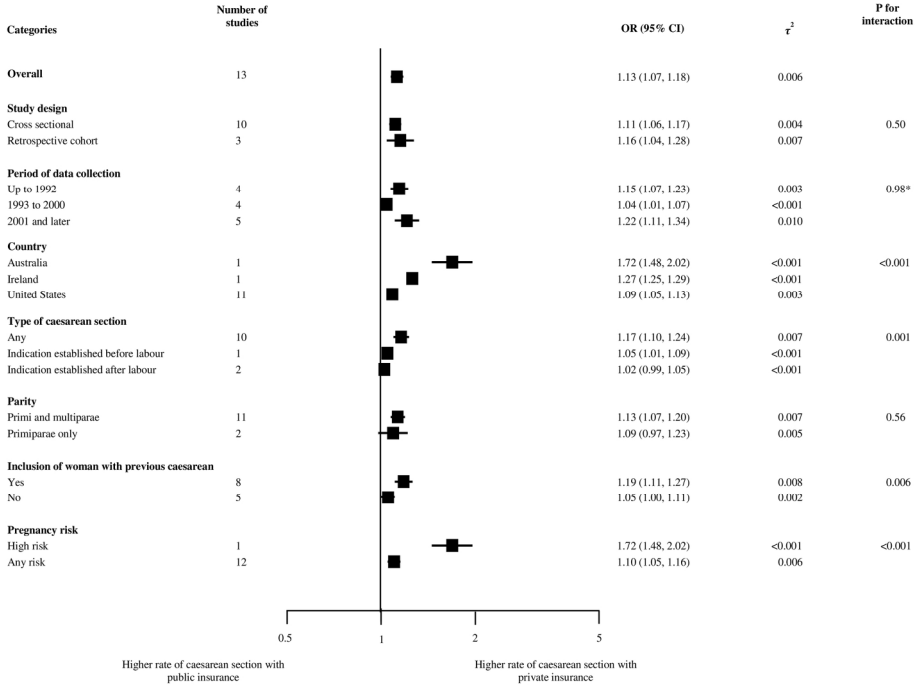


Figure 3. Stratified analyses/Legend: *P for trend

182x129mm (300 x 300 DPI)

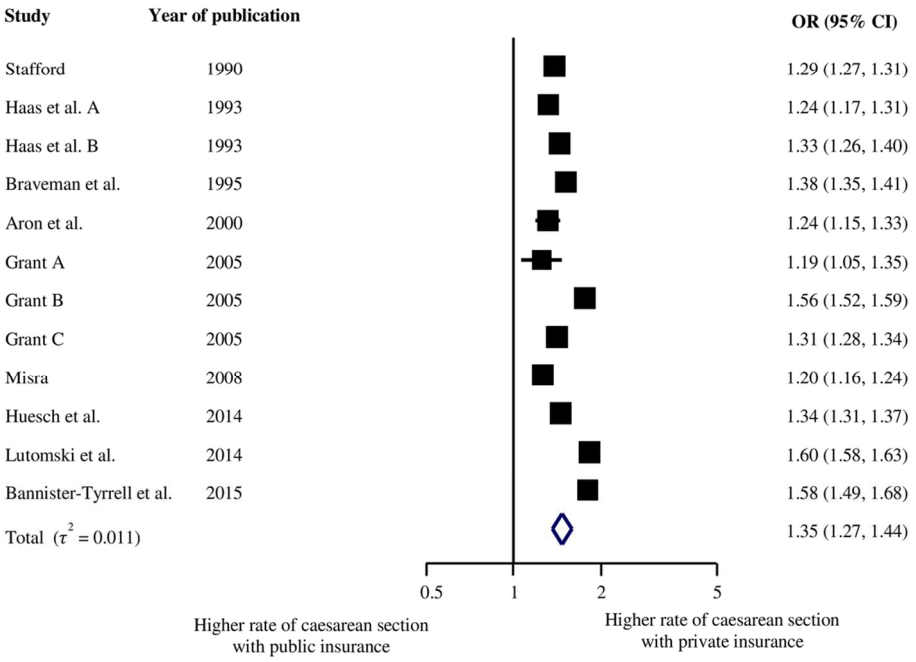


Figure 4. Crude odds ratios of caesarean section

108x76mm (300 x 300 DPI)

Appendix 1. Reported exclusion criteria

			Maternal characteristics						Foetus characteristics										
Authors	**Year**	**Source population**	**Age ≤14**	**Racial or ethnic minorities**	**Multiparae**	**Previous caesarean section**	**Other risk factors for caesarean section**	**Stillbirth**	**Multiple births (twin or more)**	**Newborn weighting <500 gr**	**Breach presentation**	**Other malpresentation**	**Preterm birth (less than 37 weeks)**	**Other risk factors for caesarean section**	**Not in labour**	**Cases with missing data**	**Provider characteristics**	**Other factors**
Stafford	1990	All births in California, United States															+	
Haas et al. A	1993	All births in Massachusetts, United States						+	+	+						+		
Haas et al. B	1993	All births in Massachusetts, United States						+	+	+						+		
Braveman et al.	1995	All births in California, United States			+	+		+	+				+			+		
Burns et al.	1995	All births in Arizona, United States														+	+	
Aron et al.	2000	All births in Cleveland, Ohio, United States				+				+*						+	+	+
Grant A	2005	All births, United States														+		
Grant B	2005	All births in Florida, United States														+	+	+
Grant C	2005	All births in Florida, United States														+	+	+
Korst et al.	2005	All births in California, United States				+	+	+	+		+	+	+	+	+		+	
Misra	2008	All births in Maryland, United States				+									+			
Coonrod et al.	2008	All births in Arizona, United States		+	+			+	+		+	+	+				+	
Huesch	2011	All births in New Jersey, United States				+	+		+		+	+	+	+	+		+	
Movsas et al.	2012	All births in Michigan, United States						+									+	
Kozhimannil et al.	2013	All births in 44 states, United States															+	
Lutomski et al.	2014	All births, Ireland															+	
Huesch et al.	2014	All births in California, United States	+			+								+		+		
Henke et al.	2014	All births in 44 states, United States				+		+	+		+	+	+			+		+
Bannister-Tyrrell et al.	2015	All births in New South Wales, Australia									+	+					+	+
Sebastião et al.	2016	All births in Florida, United States			+	+		+	+		+	+	+		+	+	+	+
Sentell et al.	2016	All births in Hawaii, United States							+							+		+

*500 or less grams

Appendix 2. Characteristics of data used for analysis

Author	Year	Survey	Hospital records	Birth certificates/registry	Census data
Stafford	1990		+		
Haas et al. A	1993		+	+	
Haas et al. B	1993		+	+	
Braveman et al.	1995			+	+
Burns et al.	1995		+	+	
Aron et al.	2000		+		
Grant A	2005	+			
Grant B	2005		+		
Grant C	2005		+		
Korst et al.	2005		+		
Misra	2008		+		
Coonrod et al.	2008			+	
Huesch	2011		+		
Movsas et al.	2012		+	+	
Kozhimannil et al.	2013		+		
Lutomski et al.	2014		+		
Huesch et al.	2014		+		
Henke et al.	2014		+		
Bannister-Tyrrell et al.	2015		+		
Sebastião et al.	2016		+	+	
Sentell et al.	2016		+		

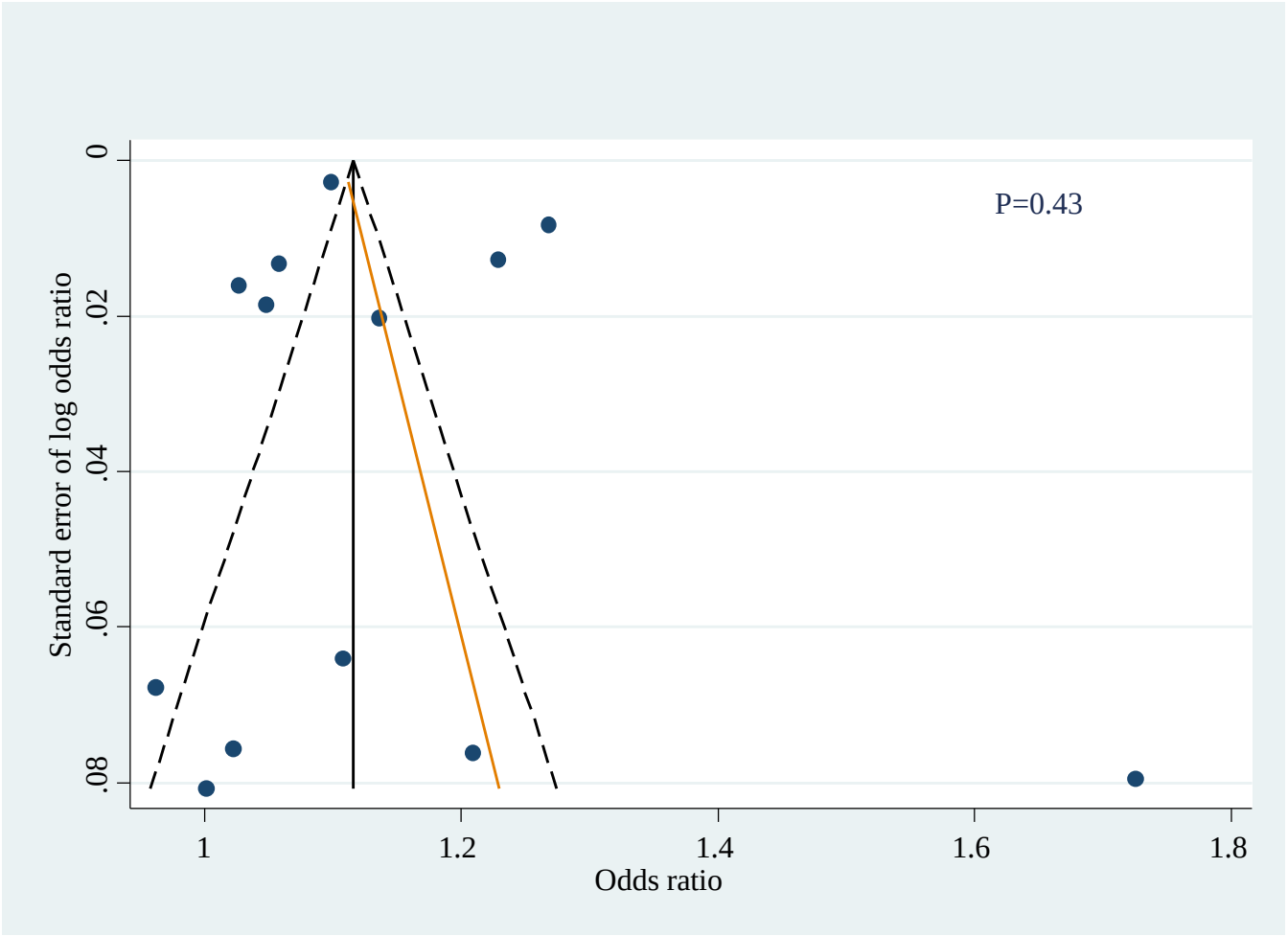
Appendix 3. Covariates used for statistical adjustment

		Maternal preconception status									Maternal clinical status					Foetus characteristics							
Author	Year	Ethnicity/Race	Educational level	Marital status	Economic status	Insurances status	Urban status	Weight	Height	Body mass index	Age	Parity	Previous caesarean section	Pre-existing (before pregnancy) conditions	Conditions developed during pregnancy	Gestational age	Birth weight	Other characteristics	Prenatal care	Birth characteristics	Provider characteristics	Other variables	Total number of covariates
Stafford*	1990																						0
Haas et al. A*	1993																						0
Haas et al. B*	1993																						0
Braveman et al.	1995	+	+	+	+	+					+			+			+	+	+	+	++	+	15
Burns et al.	1995	+	+								+	+	+		++	+	+	++	+		++	++	33
Aron et al.	2000										+	+		++	++	++	+	++					39
Grant A	2005	++	+	+	+		+	+	+		++		+	++	++	+	++	++	++		++	++	68
Grant B	2005	++					+				++		+	++	++	+	++	++	+		++	+	31
Grant C	2005	++					+				++		+	++	++	+	++	++	+		++	+	31
Korst et al.	2005	+									+										++		6
Misra	2008	+									++			++	++			++		+	++	++	30
Coonrod et al.	2008	+	+								+			++	+	+	+	+	+	+	++		20
Huesch	2011	+		+			+				+										+	++	8
Movsas et al.	2012	+									+	+		+		+	+	+				+	9
Kozhimannil et al.	2013	+									+	+	+	++	++	+		++			++		16
Lutomski et al.	2014										+		+	++	+			+					6
Huesch et al.	2014	+			+						+			++	++	+		++	+	++	++	++	124
Henke et al.	2014	+	+		+						+			++	++		+				++	++	28
Bannister-Tyrrell et al.	2015											+	+	++	++	+		+		++	+	+	12
Sebastião et al.	2016	+		+						+	+			+		+				+	++		10
Sentell et al.	2016	+									+	+		+							+	+	6

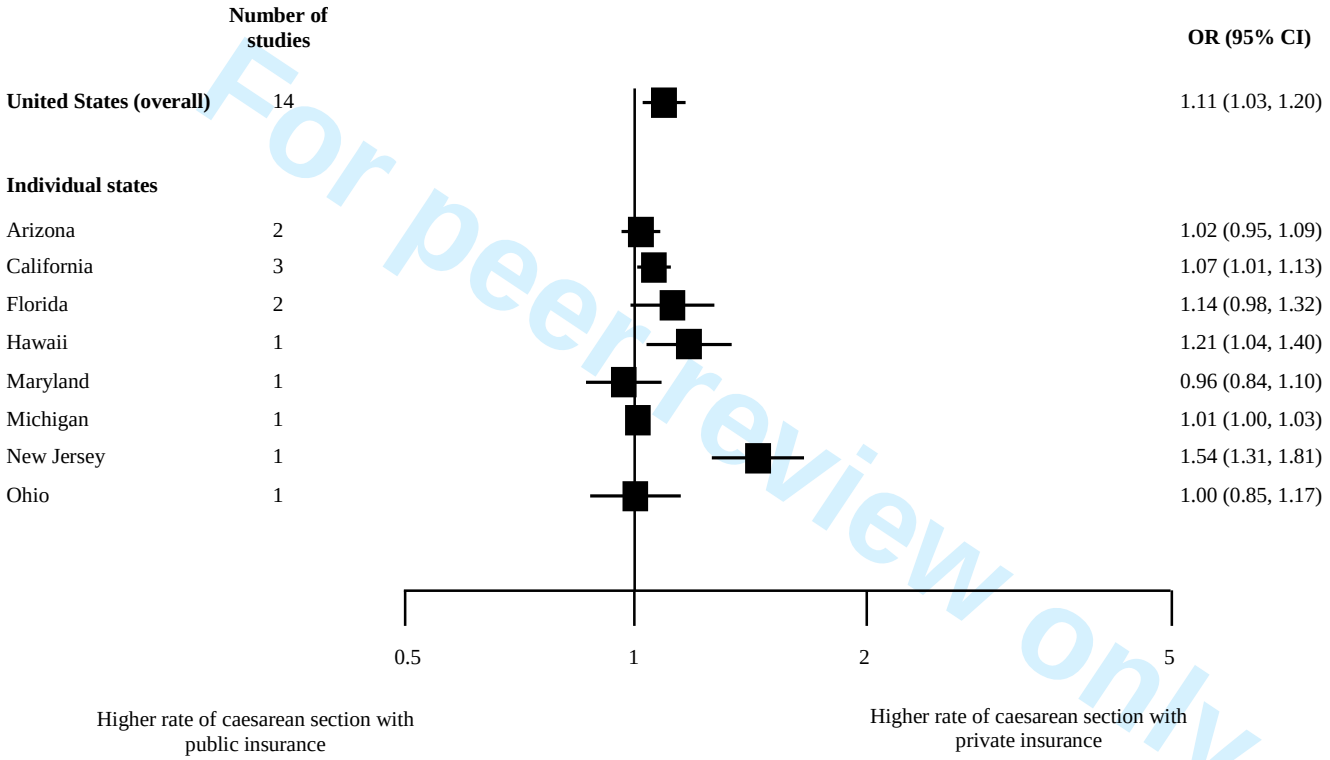
+ One covariate adjusted for ++ Two or more covariates adjusted for

*Stafford and Haas et al. only reported crude estimates.

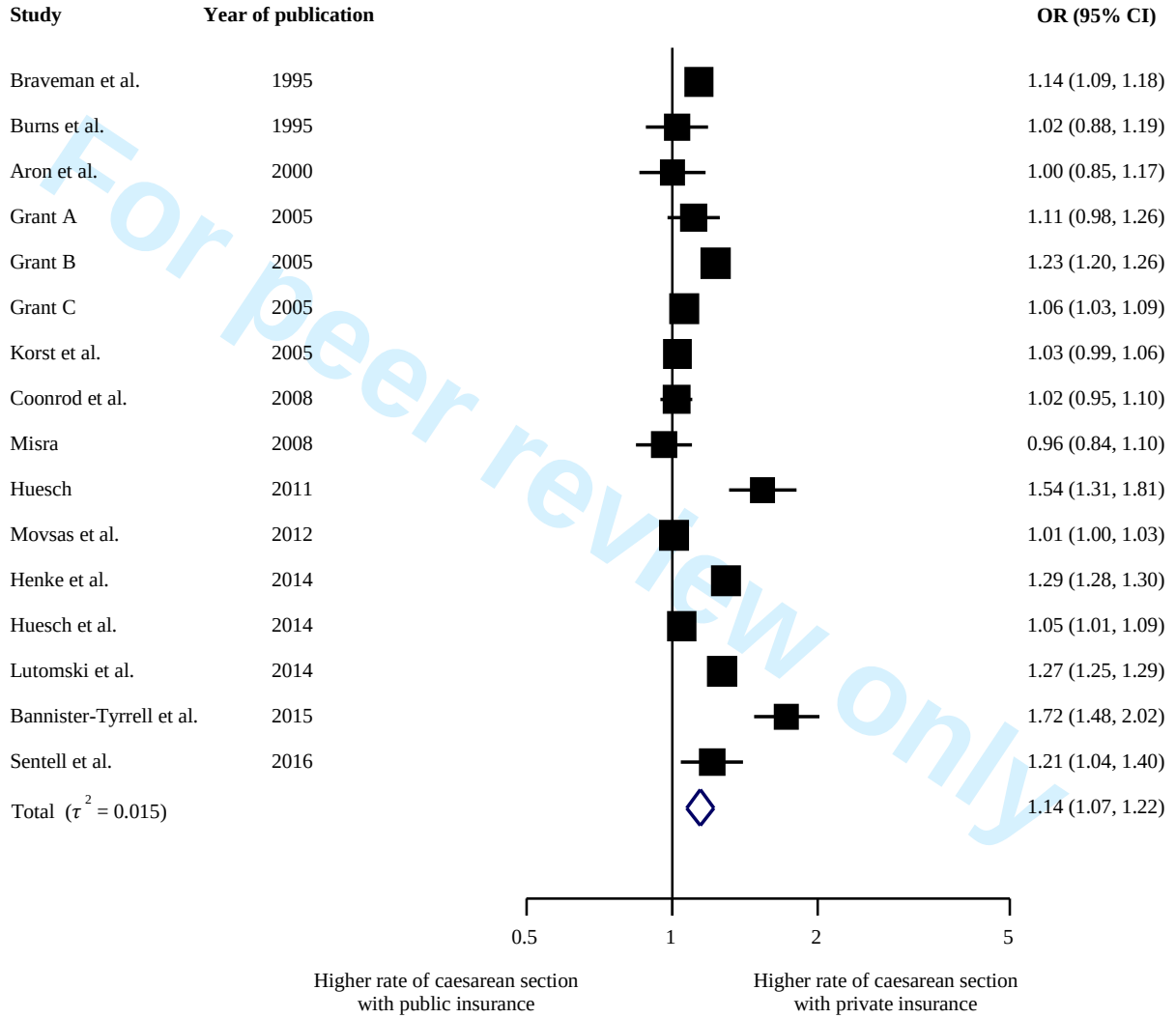
Appendix 4. Funnel plot of adjusted ORs against their standard errors on a log scale



Appendix 5. Caesarean section rates in United States

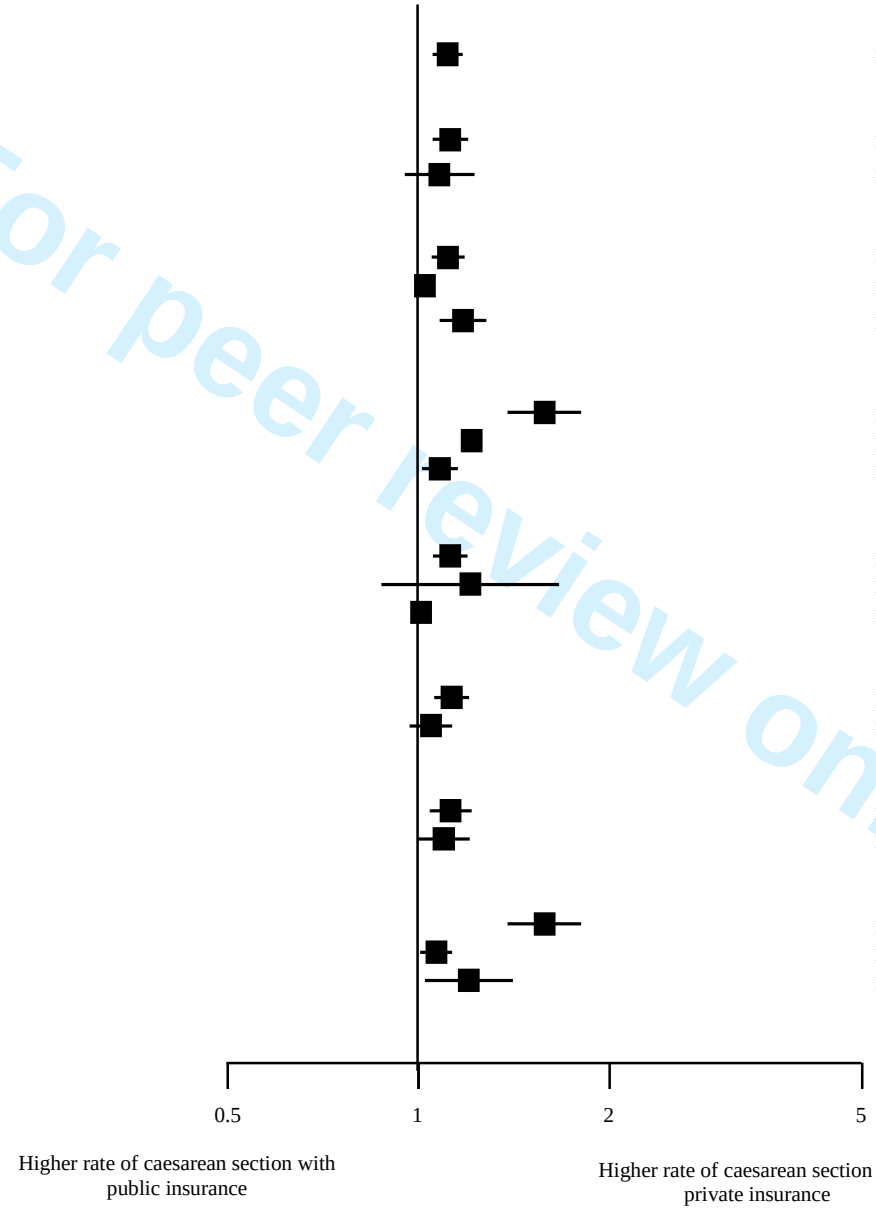


Appendix 6. Sensitivity analysis - Adjusted odds ratios of caesarean section

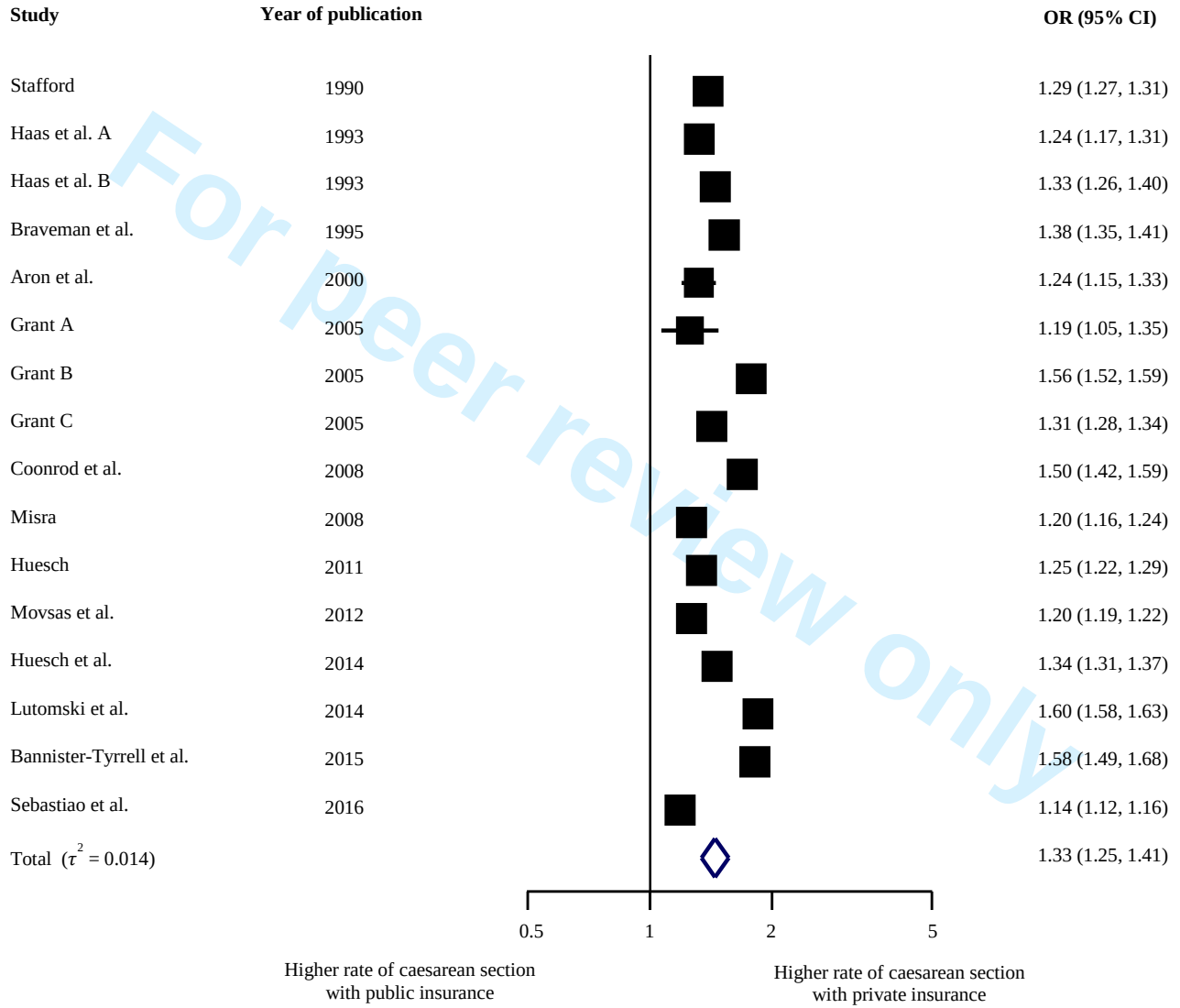


Appendix 7. Sensitivity analysis – stratified analyses

Categories	Number of studies	OR (95% CI)	τ^2	P for interaction
Overall	16	1.14 (1.07, 1.22)	0.015	
Study design				
Cross sectional	12	1.16 (1.07, 1.25)	0.016	0.587
Retrospective cohort	4	1.10 (0.95, 1.28)	0.021	
Period of data collection				
Up to 1992	4	1.15 (1.07, 1.23)	0.003	0.96*
1993 to 2000	4	1.04 (1.01, 1.07)	<0.001	
2001 and later	8	1.22 (1.11, 1.35)	0.018	
Country				
Australia	1	1.72 (1.48, 2.02)	<0.001	<0.001
Ireland	1	1.27 (1.25, 1.29)	<0.001	
United States	14	1.11 (1.03, 1.20)	0.019	
Type of caesarean section				
Any	12	1.16 (1.07, 1.24)	0.015	0.007
Indication established before labour	2	1.26 (0.86, 1.83)	0.070	
Indication established during labour	2	1.02 (0.99, 1.05)	<0.001	
Parity				
Primi and multiparae	13	1.16 (1.08, 1.25)	0.016	0.138
Primiparae only	3	1.07 (0.97, 1.17)	0.004	
Inclusion of woman with previous caesarean				
Yes	9	1.16 (1.06, 1.26)	0.016	0.703
No	7	1.13 (1.01, 1.26)	0.020	
Pregnancy risk				
High risk	1	1.72 (1.48, 2.02)	<0.001	<0.001
Any risk	12	1.09 (1.02, 1.17)	0.012	
Low risk	3	1.25 (1.04, 1.51)	0.025	



Appendix 8. Sensitivity analysis - Crude odds ratios of caesarean section



Appendix 9. Search Strategy

1. For Medline (PubMed)

(((((((causes OR determinants OR statistics OR rates OR factors OR decision* OR physician* OR socioeconomic OR state medicine OR evidence-based OR hospital OR hospitals OR hospitalization OR hospitalized OR uncertain* OR educational status OR social class OR obstetric* OR gynecolog* OR supply OR distribut* OR utilization OR insurance OR choice OR attitude OR patient OR economics OR maternal OR accessib* OR health service* OR rural population OR urban population[Title/Abstract])) NOT medline[sb])) OR ("Decision Making"[Mesh] OR "Physician's Practice Patterns"[Mesh] OR "Socioeconomic Factors"[Mesh] OR "State Medicine"[Mesh] OR "Evidence-Based Medicine"[Mesh] OR "Hospitals"[Mesh] OR "Uncertainty"[Mesh] OR "Educational Status"[Mesh] OR "Hospital Costs"[Mesh] OR "Physician Incentive Plans"[Mesh] OR "Social Class"[Mesh] OR "Obstetrics and Gynecology Department, Hospital"[Mesh] OR "supply and distribution"[Subheading] OR "utilization"[Subheading] OR "Insurance"[Mesh] OR "Choice Behavior"[Mesh] OR "Attitude to Health"[Mesh] OR "Patient Participation"[Mesh] OR "Physician-Patient Relations"[Mesh] OR "Economics, Hospital"[Mesh] OR "Maternal Health Services"[Mesh] OR "Health Services Accessibility"[Mesh] OR "Health Services Research"[Mesh] OR "Rural Population"[Mesh] OR "Urban Population"[Mesh])))) OR factors OR rates OR statistics OR causes OR determinants AND (((((operative delivery OR caesarean section OR cesarean section OR c-section OR c section OR caesarean OR cesarean OR caesarean delivery OR cesarean delivery OR caesarean rates OR cesarean rates)))) OR cesarean section [MeSH Terms])) AND ((((("Catchment Area (Health)"[Mesh] OR "Small-Area Analysis"[Mesh])))) OR ((((small area analysis OR small area analyses OR medical practice variation OR regions OR geographic variation OR variation)))))

2. Embase (Ovid SP)

	# ▲	Searches	Results	Search Type	Actions
	1	decision making/	134077	Advanced	Display More ≫
	2	professional practice/ or group practice/ or health care practice/ or medical practice/	129049	Advanced	Display More ≫
	3	socioeconomics/	110558	Advanced	Display More ≫
	4	state medicine.mp. or national health service/	54605	Advanced	Display More ≫
	5	evidence based medicine/	80825	Advanced	Display More ≫
	6	hospital/	216188	Advanced	Display More ≫
	7	uncertainty/	6158	Advanced	Display More ≫
	8	educational status/	36032	Advanced	Display More ≫
	9	"hospital cost"/	13192	Advanced	Display More ≫
	10	physician incentive plans.mp. or personnel management/	49572	Advanced	Display More ≫
	11	social class/	26291	Advanced	Display More ≫
	12	hospital department/	21809	Advanced	Display More ≫
	13	obstetrics/	27326	Advanced	Display More ≫
	14	gynecology/	29917	Advanced	Display More ≫
	15	(obstetr*	28126	Advanced	Display More ≫

	16	12 and 15	413	Advanced	Display More ≫
	17	health care distribution/	2333	Advanced	Display More ≫
	18	health care utilization/	36879	Advanced	Display More ≫
	19	insurance/	33934	Advanced	Display More ≫
	20	choice behavior.mp.	765	Advanced	Display More ≫
	21	attitude to health/	81021	Advanced	Display More ≫
	22	patient participation/	16400	Advanced	Display More ≫
	23	doctor patient relation/	81043	Advanced	Display More ≫
	24	health economics/	33098	Advanced	Display More ≫
	25	obstetric procedure/	550	Advanced	Display More ≫
	26	health care access/	34433	Advanced	Display
	27	health services research/	27579	Advanced	Display More ≫
	28	geographic distribution/	132846	Advanced	Display More ≫
	29	rural population/	30219	Advanced	Display More ≫
	30	urban population/	35323	Advanced	Display More ≫
	31	causes/	0	Advanced	Delete More ≫
	32	determinants/	1	Advanced	Display More ≫
	33	statistics/	301146	Advanced	Display More ≫
	34	rates/	0	Advanced	Delete More ≫
	35	factors/	0	Advanced	Delete More ≫
	36	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 29 or 30 or 32 or 33	1340916	Advanced	Display More ≫
	37	cesarean section/	59755	Advanced	Display More ≫
	38	(caesarean section or cesarean section or c-section or c section or caesarean or cesarean or caesarean delivery or cesarean delivery or caesarean rates or cesarean rates or operative delivery).ti,ab,tw.	53950	Advanced	Display Delete More ≫
	39	37 or 38	73014	Advanced	Display More ≫
	40	(small area analysis or small area analyses or small aera or medical practice variation or regions or geographic variation or variation or variations).ti,ab,tw.	964890	Advanced	Display More ≫
	41	28 or 40	1082827	Advanced	Display More ≫
	42	**36 and 39 and 41**	**357**	**Advanced**	Display More ≫

3. Cochrane Library

Caesarean section and insurance

Appendix 10 - PRISMA checklist

TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 1, 2
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Page 2,3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Page 4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Page 4,5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No published protocol or registration
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Page 4,5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Page 4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	S8 Appendix
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Page 6, Fig 1

Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Page 5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Page 4, 5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Appendix 1, 2, 3
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Page 4, 5
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	Page 5
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Appendix 1, 2, 3
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	Page 5
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Page 5, 6, Fig 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 1, Appendix 1, 2, 3
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Appendix 1, 2, 3
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Fig 1, Appendix 5
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Page 6, 7, Fig 1, Fig 3, Appendix 5, Appendix 7

Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Appendix 1, 2, 3
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Page 6, 7, Fig 2, Fig 5, Appendix 6,
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Page 7
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Page 8
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Page 8, 9
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	In submitting system

Research Checklist

According to MOOSE statement for meta-analyses of observational studies

Reporting of background should include	**Where to find in manuscript**
Problem definition	Manuscript (page 5)
Hypothesis statement	Manuscript (page 5)
Description of study outcome(s)	Manuscript (page 6)
Type of exposure or intervention used	Manuscript (page 6)
Type of study designs used	Manuscript (page 6)
Study population	Manuscript (page 6)
Reporting of search strategy should include	
Qualifications of searchers (eg, librarians and investigators)	Manuscript (page 6)
Search strategy, including time period included in the synthesis and keywords	Manuscript (pages 5), Appendix 9
Effort to include all available studies, including contact with authors	Manuscript (page 5-6)
Databases and registries searched	Manuscript (page 6)
Search software used, name and version, including special features used (eg, explosion)	Manuscript (page 6)
Use of hand searching (eg, reference lists of obtained articles)	Manuscript (page 6)
List of citations located and those excluded, including justification	Appendix 1
Method of addressing articles published in languages other than English	n/a
Method of handling abstracts and unpublished studies	Manuscript (page 6)
Description of any contact with authors	No contact made
Reporting of methods should include	
Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	Manuscript (page 6)

Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	Manuscript (page 6)
Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	Manuscript (pages 6)
Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	Manuscript (page 6-7) Appendix 3
Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	n/a
Assessment of heterogeneity	Manuscript (page 6-7)
Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	Manuscript (page 6-7)
Provision of appropriate tables and graphics	Manuscript, Table 1, Figure 1-3 and Appendixes 1-8
Reporting of results should include	
Graphic summarizing individual study estimates and overall estimate	Figure 2-4
Table giving descriptive information for each study included	Table 1
Results of sensitivity testing (eg, subgroup analysis)	Figure 2, Appendixes 5-8
Indication of statistical uncertainty of findings	Manuscript, Figure 2-4
Reporting of discussion should include	
Quantitative assessment of bias (eg, publication bias)	Manuscript (page 8-9)
Justification for exclusion (eg, exclusion of non—English-language citations)	n/a
Assessment of quality of included studies	n/a

Reporting of conclusions should include	
Consideration of alternative explanations for observed results	Manuscript (pages 10-12)
Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	Manuscript (page 12-13)
Guidelines for future research	Manuscript (page 12)
Disclosure of funding source	Manuscript (page 14)

BMJ Open

Caesarean Sections and Private Insurance: Systematic Review and Meta-analysis

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016600.R2
Article Type:	Research
Date Submitted by the Author:	07-Jul-2017
Complete List of Authors:	Hoxha, Ilir; Universitat Bern Institut fur Sozial- und Praventivmedizin, Health Services Research Syrogiannouli, Lamprini; Universität Bern, Berner Institut für Hausarztmedizin (BIHAM) Braha, Medina; International Business College Mitrovica, Department of Managment and Marketing Goodman, David C; Dartmouth College Geisel School of Medicine da Costa, Bruno; Universität Bern, Berner Institut für Hausarztmedizin (BIHAM) Jüni, Peter; Applied Health Research Centre (AHRC), Li Ka Shing Knowledge Institute of St. Michael's Hospital, Department of Medicine, University of Toronto
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health economics, Health policy, Health services research, Obstetrics and gynaecology
Keywords:	caesarean section, health insurance, private insurance, financial incentives, medical practice variation, health services

Caesarean Sections and Private Insurance: Systematic Review and Meta-analysis

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Key words

caesarean section, health insurance, private insurance, financial incentives, medical practice variation, health services

Word count

2939 words excluding title page, abstract, references, figures and tables.

Abstract

Objective - Financial incentives associated with private insurance may encourage health care providers to perform more caesarean sections. We therefore sought to determine the association of private insurance and odds of caesarean section.

Design - Systematic review and meta-analysis.

Data sources - MEDLINE, Embase, and The Cochrane Library from the first year of records through August 2016.

Eligibility criteria – We included studies that reported data to allow the calculation of odds ratios of caesarean section of privately insured as compared to publicly insured women.

Outcomes - The pre-specified primary outcome was the adjusted odds ratio of births delivered by caesarean section of women covered with private insurance as compared with women covered with public insurance. The pre-specified secondary outcome was the crude odds ratio of births delivered by caesarean section of women covered with private insurance as compared with women covered with public insurance.

Results - Eighteen articles describing 21 separate studies in 12.9 million women were included in this study. In a meta-analysis of 13 studies, the adjusted odds of delivery by caesarean section was 1.13 higher among privately insured women as compared with women with public insurance coverage (95% CI 1.07 to 1.18) with no relevant heterogeneity between studies (τ^2=0.006). The meta-analysis of crude estimates from 12 studies revealed a somewhat more pronounced association (pooled odds ratio 1.35, 95% CI 1.27 to 1.44) with no relevant heterogeneity between studies (τ^2=0.011).

Conclusions - Caesarean sections are more likely to be performed in privately insured women as compared with women using public health insurance coverage. Although this

effect is small on average and variable in its magnitude, it is present in all analyses we performed.

Strengths and limitations of this study

- ✓ Our meta-analysis includes a broad literature search, screening and data extraction performed in duplicate, an exploration of study characteristics as a potential source of variation between studies and firm quality assessment and represents major strength of our study.
- ✓ Sensitivity analyses was performed involving studies that required exclusion in main analysis due to overlapping populations.
- ✓ The differences in the characteristics of the study populations, type of data used, types of CS analysed and variables used for adjustment in statistical analyses across studies represent a major limitation of our study.
- ✓ Unadjusted estimates of associations were larger, which suggests the presence of confounding, and we cannot completely rule out residual confounding in adjusted estimates.

Introduction

The global raise of caesarean section (CS) rates during the past decades has raised concerns over appropriateness of usage of the procedure (1, 2). The increase and immense variation among countries' regions and hospitals has been persistent over the years (3-14). Brazil has the highest rate of CS followed by China, Turkey, and Mexico (15). United States and other developed countries are not far behind. Even countries which traditionally have had low CS rates, like Norway or Sweden have seen substantial increase in CS rates (15). This increase has been accompanied with considerable variation within countries (15). In the United States, there was a fourfold difference in CS rates in low and high use areas (15). In England, the rates have varied threefold among National Health Service trusts (15). In British Columbia, Canada, the CS rates varied from 14.7 % to 27.6 % across health service delivery areas (15). The understanding of escalation of CS rates is important as it may prevent negative outcomes on health of mothers and newborns as well as reduce unnecessary costs related to delivery.

Such increase and variation cannot be explained by clinical factors alone (15). Evidence points to many additional, health system related factors, in particular supplier related factors (15). Financial incentives associated with private insurance seem to influence supplier behaviour, be that physician or hospital, affecting this way clinical decision as to whether perform CS or not (14-22). We therefore performed a systematic review and meta-analysis to determine the association of insurance status of women with the odds of delivery by CS.

Materials and methods

Search strategy and data sources

We combined search terms indicating CS, such as 'caesarean section', 'caesarean delivery', 'caesarean', with search terms associated with the study design such as 'small area analysis,' 'medical practice variation,' and search terms associated with determinants of variation and

increase of CS rates. We did not restrict search by type of language or publication date. We searched MEDLINE, Embase, and The Cochrane Library from inception to August 4, 2016, when the search was last updated. In addition, we manually searched the reference lists of all included studies and earlier systematic reviews that we identified.

Study selection and outcomes

To be eligible for inclusion, studies had to report data to allow the calculation of odds ratios (OR) of CS comparing women covered by private insurance with women covered by public insurance in a specific health care system. The pre-specified primary outcome was the adjusted OR of births delivered by CS of women covered with private insurance as compared with women with public insurance coverage. The pre-specified secondary outcome was the crude OR of CS of women covered with private insurance as compared with women with public insurance.

Data extraction

Two researchers (IH and MB) screened the papers and extracted data independently. Data from full text articles were extracted onto a data extraction sheet designed to capture data on study population, study design, data sources, setting, type of CS analysed, and statistical analysis. We extracted adjusted and/or unadjusted ORs of CS of women with private insurance as compared with CS of women with public insurance. Differences among researchers with regards to study inclusion and data extraction procedure were resolved by consensus and consultation with other authors.

Quality assessment

Quality assessment was performed using the Quality In Prognostic Studies (QUIPS) tool (23). The QUIPS is used to assess bias in prognostic studies across six domains including: selection bias; attrition bias, measurement bias of prognostic factor and outcome,

confounding; and bias related to the statistical analysis and presentation of results (23). We decided to use QUIPS tool as it seemed the most appropriate to perform quality assessment of the studies under investigation. Only minor adjustment of the original tool was performed, i.e. we added the option "not applicable" in rating of issues assessed for judging domains of bias. Each study was read in full and evaluated independently by two researchers (IH and MB). We used three levels of rating, i.e. "high", "moderate", or "low" to assess the risk of bias for all domains (23). Any assessment differences were discussed and a single rating was assigned to each study. A study was judged with a high or a moderate risk of bias in case only one of the domains was assessed with a high or a moderate risk of bias. A study was judged with a low risk of bias in case all the six domains where rated with a low risk of bias.

Main analysis

We used standard inverse-variance random effects meta-analysis to estimate the pooled OR. An OR above one indicates that CS are more frequently performed in women with private insurance than in women with public insurance. We calculated the variance estimate τ^2 as a measure of heterogeneity between studies (24). We pre-specified a τ^2 of 0.04 to represent low heterogeneity, 0.16 to represent moderate, and 0.36 to represent high heterogeneity between studies (25). We conducted analyses stratified by study design, period of data collection, country, type of CS analysed, parity, inclusion of women with previous CS, pregnancy risk of included women and QUIPS risk of bias to investigate potential reasons for between-study heterogeneity and used chi-square tests to calculate p-values for interaction, or tests for linear trends in cases of more than two ordered strata. All p-values are two-sided.

Sensitivity analyses

Five studies (26-30) were excluded from the main analysis, as they had an overlapping population with a larger study (31) that was included. For this reason, we repeated all

analyses including these five studies (26-30) while excluding the larger one (31). Finally, we visually inspected a funnel plot of adjusted ORs against their standard errors to address potential small study effects (32). We used STATA, release 13, for all analyses (Stata-Corp, College Station, Texas).

Patient involvement

No patients were involved in this study. We used data from published papers only.

Results

We identified a total of 1490 records with our search strategy (Figure 1): 935 from Medline: 494 from Embase; 38 from the Cochrane Library and 23 from manual search. After removing duplicates, we screened 1264 records for eligibility, and retained 166 for full text examination. We excluded another 124 that did not report insurance status of women, 23 that were otherwise irrelevant and one study that had an overlapping population. Finally, 18 articles describing 21 separate studies in 12.9 million women were included in review and meta-analysis.

Characteristics of studies are presented in Table 1 and Appendixes 1,2 and 3. Sixteen studies were cross-sectional, five were retrospective cohort studies. Only one study used surveys, 18 hospital records, seven birth registries, and one census data. All studies were published in English. Most studies were from the United States. Nineteen studies included the entire population of eligible cases, while only two studies selected cases randomly. Case exclusion criteria varied considerably: one study excluded women aged 14 and younger; three excluded multiparas; eight excluded women with previous CS; eight excluded stillbirths and nine multiple births; six excluded cases with specific presentations of the foetus; six studies excluded preterm births, and 13 studies excluded cases due to provider characteristics. Two studies reported ORs of CS for which indication was established before labour (including CS

on maternal request) only, three reported CS for which indication was established during labour and 16 reported ORs of any CS irrespective of indication. Seventeen studies adjusted for different characteristics as presented in Appendix 3. Quality assessment is presented in Appendix 4 and 5. No studies were excluded due to quality assessment result. Five studies were rated with high risk of bias, ten studies with moderate risk of bias and six studies with low risk of bias.

Figure 2 presents the meta-analysis of the 13 studies that reported adjusted ORs (31, 33-42), all of them using public insurance as the reference group. Overall, the odds of receiving CS were 1.13 higher for women with private insurance coverage as compared women with public health insurance coverage (95% CI 1.07 to 1.18), with no relevant heterogeneity between studies ($\tau 2=0.006$). Figure 3 presents results of stratified analyses of adjusted odds ratios. Estimates varied between strata, in particular for country (P for interaction<0.001), type of caesarean section (P for interaction=0.001), inclusion of women with previous CS (P for interaction=0.001) and pregnancy risk (P for interaction<0.001). Appendix 6 shows a funnel plot of adjusted ORs against their standard errors on a log scale; there was no evidence for small study effects. Figure 4 presents the meta-analysis of crude ORs with a slightly stronger average association (pooled OR 1.35, 95% CI 1.27 to 1.44) and no relevant heterogeneity between studies ($\tau^2=0.011$). Appendix 7 presents adjusted associations for different states in the United States. Adjusted estimates ranged from 0.96 in Maryland to 1.54 in New Jersey.

Appendixes 8 to 10 report results from sensitivity analyses after inclusion of five smaller studies (26-30) and exclusion of a larger study (31) that had overlapping populations with the five smaller ones. Appendix 8 shows the meta-analysis of the 16 studies (26-29, 33-42) with a pooled adjusted OR of 1.14 (95% CI 1.07 to 1.22) and no evidence for relevant heterogeneity between studies ($\tau 2=0.015$). Appendix 9 presents results of stratified analyses,

with estimates varying between countries (P for interaction<0.001), type of caesarean section (P for interaction=0.007) and pregnancy risks (P for interaction<0.001). Finally, Appendix 10 presents the meta-analysis of crude ORs, again with a stronger association on average (pooled OR 1.33, 95% CI 1.25 to 1.41) and no relevant heterogeneity between studies ($\tau 2$=0.014).

Discussion

Our systematic review and meta-analysis estimated that the overall odds of receiving a caesarean section are on average 1.13 times higher for privately insured women compared with women covered with public insurance. The increased risk was observed across all subgroups of studies in stratified analyses as well as in sensitivity analysis.

Context

To our knowledge, this is the first meta-analysis to examine the association of CS rates with types of insurance. A recently published meta-analysis found that the odds of delivery by CS was 1.41 higher in for-profit hospitals as compared with non-profit hospitals (95% CI 1.24 to 1.60) (22). These findings were confirmed across subgroups (i.e. such as country, year, or study design) of studies in stratified analyses, indicating financial incentives may play an important role in such outcome (22). We found three other recent meta-analyses that summarized CS studies and found a strong association with obesity (43), Sub-Saharan Africa ethnic origin (44) and labour induction (45). Our estimates of a 14 percent increase are on the lower end of the strength of associations found in earlier studies.

Strengths and limitations

The major strengths of our meta-analysis include a broad literature search (Appendix 11), screening and data extraction performed in duplicate, an exploration of study characteristics as a potential source of variation between studies, sensitivity analyses involving studies that

required exclusion due to overlapping populations and firm quality assessment using QUIPS tool. Major limitations are differences in the characteristics of the study populations, type of data used, types of CS analysed and variables used for adjustment in statistical analyses across studies. Unadjusted estimates of associations were larger, which suggests the presence of confounding, and we cannot completely rule out residual confounding in adjusted estimates.

Mechanisms

Existing evidence suggests that possible causes for higher odds of CS in women insured privately lie in the differences in payment for CS and reimbursement arrangements among insurers as well as providers' responses to these arrangements. In the countries included in our analysis, private health insurers generally reimburse hospitals at higher fees for providing a CS compared to the public insurers (36). This incentive is heightened when public insurance funds hospital care through a budget (e.g. Australia and Ireland) rather than fee-for-service, which is common in private insurance (46, 47). Similar incentives are present in physician payment.

Multiple studies have shown that hospitals are motivated by and responsive to financial incentives (22, 34, 48, 49), although Grant (36) argues that their impact is small. One example is the financial benefit associated with longer hospital stays associated with CS (48, 50). Hospitals may incentivize physicians (48, 49) to align their clinical decision with institutional strategies, such as patient scheduling policies that steer patients with private insurance to more profit prone physicians (48, 49). Physicians are known to be motivated by higher fees paid for CS as compared with vaginal delivery (48). They often act as self-interested economic agents according to economic models of physician behaviour, by maximizing income and convenience (34). Physicians are also in a position to exploit asymmetry of information between them and patients (51, 52), which leads to recommendations that are not always aligned with patient needs or preferences (15). There is

also evidence that physicians with higher numbers of privately insured patients will tend to perform more CS (34, 36); explanations include perceptions that patients with private insurance have a higher social class, or more prevalent concerns about malpractice liability in patients with private insurance (53).

Comparing 'public insurance' and 'private insurance' across countries is not a straightforward exercise as the meaning of such distinction can vary substantially across countries. In the United States 'public insurance' is insurance assigned to specific categories of population (by age, disability, poverty or military service) and 'private insurance' is insurance mainly organized through employment. In general, private insurance offers higher reimbursement rates for surgical procedures, and this may incentivize CS. The heterogeneity of adjusted estimates across states in the United States (Appendix 7) points to setting specific factors that will influence the effect of insurance on the odds of CS and are worth of further investigation. According to Burns et al., the lacking association in Arizona (OR=1.02) may be due to equal magnitudes of re-imbursements of hospitals for vaginal birth and CS (34). In Maryland (OR=0.96), the state administration introduced HealthChoice Program in 1997, that was intended to provide prevention oriented healthcare services, enact better accountability measures for managed care organizations, and ensure efficient use of financial resources (38). This program introduced a mandatory managed care system for Medicaid beneficiaries, which replaced a fee-for-service model. This resulted in more patients receiving managed care irrespective of their insurance status and, in turn, use of similar policies in patients with public and private insurance (38). We are unaware of plausible explanations for the lack of associations observed in Michigan (OR 1.01) and Ohio (OR 1.00). This analysis shows that variation in CS rates among insurers within the United States can be explained by differences in reimbursement arrangements nested within public and private insurance.

For the other two countries, Ireland and Australia, included in the adjusted analysis, 'private health insurance' status differs in character from the United States but offers similarly higher payment levels for procedures. In Australia, women of childbearing age with private insurance, would have increased the use of private obstetricians, leading to higher rates of CS (54). In Ireland, the financial incentives in private insurance are similar, and are associated with striking inequities in care (55).

Policy and research implications

Increases in the cost of care and hospital charges have become central issues in policy discussion in the United States and elsewhere (15, 56). While the public health care costs are reaching unsustainable levels, hospital charges can have alarming effects on patients (56). In addition, the potential negative clinical effects of CS on mothers and newborns have raised concerns among clinicians, academics and policymakers alike (15).

Recent studies and their media coverage and associated increase in public awareness of high CS rates and changes in reimbursement policy have led to recent decreases of CS rates (18). Our study provides additional evidence to support policy and advocacy efforts that address escalating CS rates, in particular their association with financial incentives. Effective policy measures often require context, country or state specific policy analyses investigating particular insurance schemes. These setting specific analyses are essential as incentives and reimbursement arrangements within health insurance schemes may differ across health care systems. We recognize that while categories 'public insurance' and 'private insurance' are useful markers of higher reimbursement rates, other aspects of insurance reimbursement may also influence the odds of CS.

As we analyse CS rates relation with health insurance schemes we need also to be aware of complexity of interaction of different determinants and their influence in CS rates. The

published literature has identified a number of determinants of CS rates which operate at different levels of health care systems (macro, meso, and micro) (15). At the macro level of national health systems, operate factors such as health financing system, social and political context, legal regulations, general cultural and social norms and similar. At the meso level are hospitals and health care facilities. Their ownership status, availability of resources and size are known to influence CS rates (15, 22). Finally, at the micro level, we have clinical units that provide care, medical staff and patients, which are characterised with all sorts of features that can influence the decision for CS. For example, clinical unit staff composition, or physician education, gender and experience, or mother preference, age and race, are all known to determine the rates of CS (15).

Conclusion

This systematic review and meta-analysis indicates that CS are more likely to be performed in privately insured women as compared to women with public health insurance coverage. Although this effect is small and variable across strata, it is present in all performed analysis. Review of setting-specific payment levels and reimbursement arrangements within health insurance schemes will enable a better understanding of influencing factors. Efforts to address payment levels for delivery procedures and reform of reimbursement arrangements may lead to a reduction of CS rates to more appropriate levels (18, 22, 38, 57).

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Contributorship Statement

IH, LS, DG, PJ conceived and designed the study. IH, LS, MB performed the data extraction and preparation. IH, LS, BdC, PJ analysed the data. IH, DG, PJ wrote the paper, which was critically reviewed and approved by all authors.

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Competing interests statement

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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No funding was received to perform this study. All authors, had full access to all of the data (including statistical reports and tables) in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Data sharing statement

No additional unpublished data are available from the study.

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Table 1. Characteristics of included studies

Author	Year	Country	Study design	Number of cases	Number of hospital units	Year of data collection	Population	Sampling	Type of CS analysed
Stafford	1990	United States	Cross sectional	461066	Not reported	1986	Primi- and multiparae; any risk	Consecutive	Any
Haas et al. A	1993	United States	Cross sectional	57257	Not reported	1984	Primi- and multiparae; any risk	Consecutive	Any
Haas et al. B	1993	United States	Cross sectional	64346	Not reported	1987	Primi- and multiparae; any risk	Consecutive	Any
Braveman et al.	1995	United States	Retrospective cohort	213761	Unclear	1991	Primiparae; no previous CS; any risk	Consecutive	Any
Burns et al.	1995	United States	Cross sectional	33233	36	1989	Primi- and multiparae; any risk	Consecutive	Any
Aron et al.	2000	United States	Retrospective cohort	25697	21	1993-1995	Primiparae; no previous CS; any risk	Consecutive	Any
Grant A	2005	United States	Cross sectional	9017	n/a	1988	Primi- and multiparae; any risk	Random	Any
Grant B	2005	United States	Cross sectional	147821	n/a	1992	Primi- and multiparae; any risk	Consecutive	Any
Grant C	2005	United States	Cross sectional	136763	n/a	1995	Primi- and multiparae; any risk	Consecutive	Any
Korst et al.	2005	United States	Cross sectional	327632	288	1995	Primi- and multiparae; no previous CS; any risk	Consecutive	Emergency
Misra	2008	United States	Cross sectional	128743	Not reported	1995, 2000	Primi- and multiparae; no previous CS; any risk	Consecutive	Emergency
Coonrod et al.	2008	United States	Cross sectional	28863	40	2005	Primiparae; low risk	Consecutive	Any
Huesch	2011	United States	Cross sectional	182108	Not reported	2004-2007	Primi- and multiparae; no previous CS; low risk	Consecutive	Planned

Movsas et al.	2012	United States	Retrospective cohort	617269	NA	2004-2008	Primi- and multiparae; any risk	Consecutive	Any
Kozhimannil et al.	2013	United States	Cross sectional	6717486	Over 1000	2002-2009	Primi- and multiparae; any risk	Random	Any
Lutomski et al.	2014	Ireland	Retrospective cohort	403642	19	2005-2010	Primi- and multiparae; any risk	Consecutive	Any
Huesch et al.	2014	United States	Cross sectional	408355	254	2010	Primi- and multiparae; no previous CS; any risk	Consecutive	Planned
Henke et al.	2014	United States	Cross sectional	2516570	Not reported	2009	Primi- and multiparae; no previous CS; low risk	Consecutive	Any
Bannister-Tyrrell et al.	2015	Australia	Cross sectional	20247	51	2007-2011	Primi- and multiparae; high risk	Consecutive	Any
Sebastião et al.	2016	United States	Retrospective cohort	412192	122	2004-2011	Primiparae; no previous CS; low risk	Consecutive	Emergency
Sentell et al.	2016	United States	Cross sectional	11419	4	2012	Primi- and multiparae; any risk	Consecutive	Any

CS = caesarean section

Figure legends

Figure 1. The flow diagram of review

Figure 2. Adjusted odds ratios of caesarean section

Figure 3. Stratified analyses/Legend: *P for trend

Figure 4. Crude odds ratios of caesarean section

Supporting information

Appendix 1. Reported exclusion criteria

Appendix 2. Characteristics of data used for analysis

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Appendix 4. QUIPS risk of bias (table)

Appendix 5. QUIPS risk of bias (chart)

Appendix 6. Funnel plot of adjusted ORs against their standard errors on a log scale

Appendix 7. Caesarean section rates in the United States

Appendix 8. Sensitivity analysis - Adjusted odds ratios of caesarean section

Appendix 9. Sensitivity analysis – Stratified analyses/Legend: *P for trend

Appendix 10. Sensitivity analysis - Crude odds ratios of caesarean section

Appendix 11. Search strategy

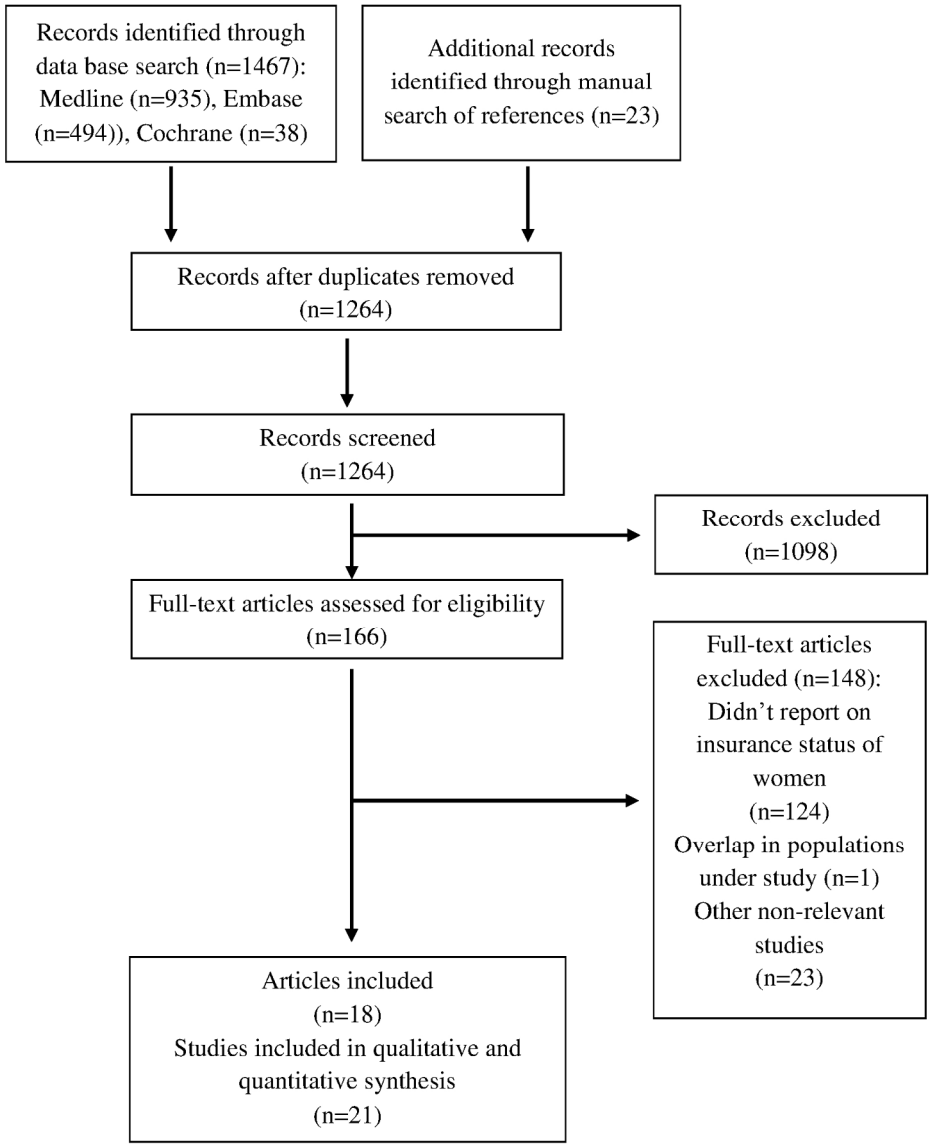


Figure 1. The flow diagram of review

164x201mm (300 x 300 DPI)

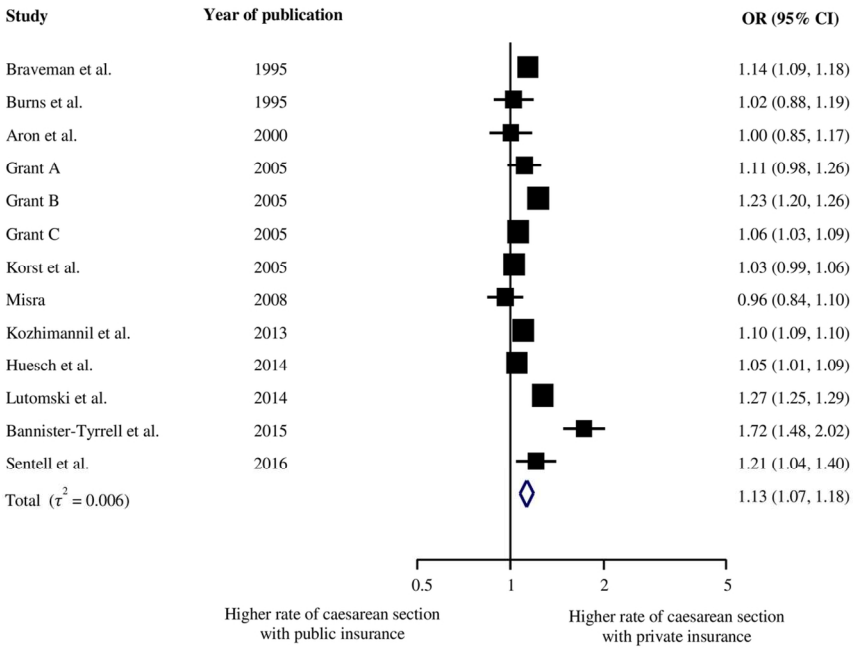


Figure 2. Adjusted odds ratios of caesarean section

118x83mm (300 x 300 DPI)

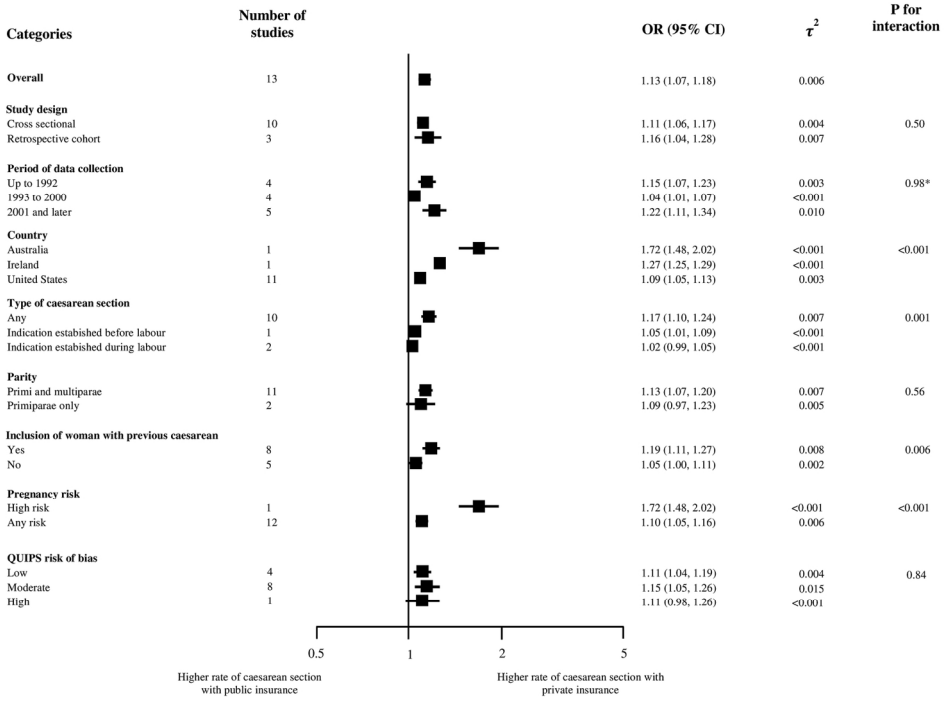


Figure 3. Stratified analyses/Legend: *P for trend

155x109mm (300 x 300 DPI)

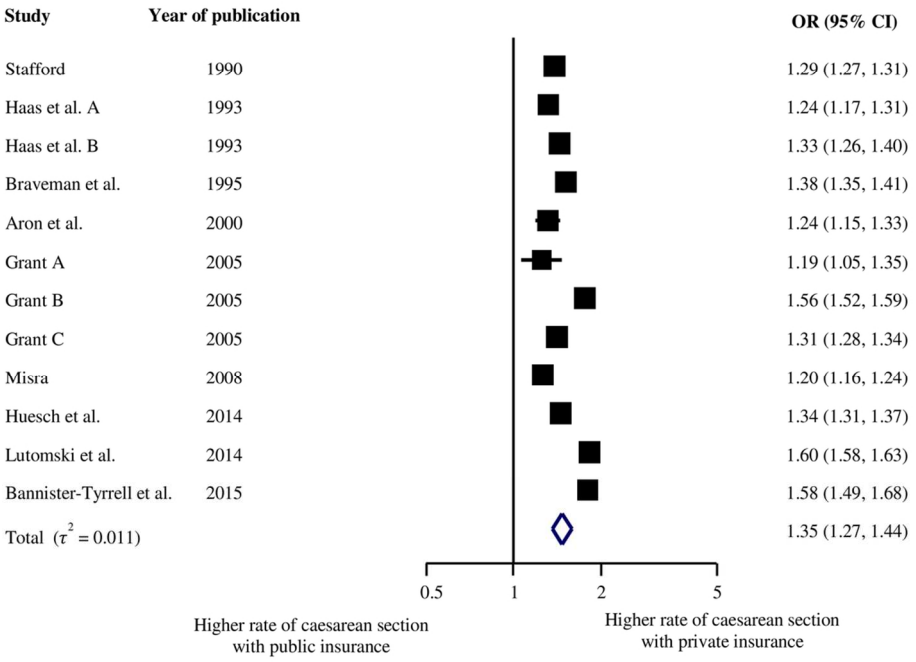


Figure 4. Crude odds ratios of caesarean section

108x76mm (300 x 300 DPI)

Appendix 1. Reported exclusion criteria

			Maternal characteristics						Foetus characteristics									
Authors	**Year**	**Source population**	**Age ≤14**	**Racial or ethnic minorities**	**Multiparae**	**Previous caesarean section**	**Other risk factors for caesarean section**	**Stillbirth**	**Multiple births (twin or more)**	**Newborn weighting <500 gr**	**Breach presentation**	**Other malpresentation**	**Preterm birth (less than 37 weeks)**	**Other risk factors for caesarean section**	**Not in labour**	**Cases with missing data**	**Provider characteristics**	**Other factors**
Stafford	1990	All births in California, United States															+	
Haas et al. A	1993	All births in Massachusetts, United States						+	+	+						+		
Haas et al. B	1993	All births in Massachusetts, United States						+	+	+						+		
Braveman et al.	1995	All births in California, United States			+	+		+	+				+			+		
Burns et al.	1995	All births in Arizona, United States														+	+	
Aron et al.	2000	All births in Cleveland, Ohio, United States				+				+*						+	+	+
Grant A	2005	All births, United States														+		
Grant B	2005	All births in Florida, United States														+	+	+
Grant C	2005	All births in Florida, United States														+	+	+
Korst et al.	2005	All births in California, United States				+	+	+	+		+	+	+	+	+		+	
Misra	2008	All births in Maryland, United States				+									+			
Coonrod et al.	2008	All births in Arizona, United States		+	+			+	+		+	+	+				+	
Huesch	2011	All births in New Jersey, United States				+	+		+		+	+	+	+	+		+	
Movsas et al.	2012	All births in Michigan, United States						+									+	
Kozhimannil et al.	2013	All births in 44 states, United States															+	
Lutomski et al.	2014	All births, Ireland															+	
Huesch et al.	2014	All births in California, United States	+			+								+		+		
Henke et al.	2014	All births in 44 states, United States				+		+	+		+	+	+			+		+
Bannister-Tyrrell et al.	2015	All births in New South Wales, Australia									+	+					+	+
Sebastião et al.	2016	All births in Florida, United States			+	+		+	+		+	+	+		+	+	+	+
Sentell et al.	2016	All births in Hawaii, United States							+							+		+

*500 or less grams

Appendix 2. Characteristics of data used for analysis

Author	Year	Survey	Hospital records	Birth certificates/registry	Census data
Stafford	1990		+		
Haas et al. A	1993		+	+	
Haas et al. B	1993		+	+	
Braveman et al.	1995			+	+
Burns et al.	1995		+	+	
Aron et al.	2000		+		
Grant A	2005	+			
Grant B	2005		+		
Grant C	2005		+		
Korst et al.	2005		+		
Misra	2008		+		
Coonrod et al.	2008			+	
Huesch	2011		+		
Movsas et al.	2012		+	+	
Kozhimannil et al.	2013		+		
Lutomski et al.	2014		+		
Huesch et al.	2014		+		
Henke et al.	2014		+		
Bannister-Tyrrell et al.	2015		+		
Sebastião et al.	2016		+	+	
Sentell et al.	2016		+		

Appendix 3. Covariates used for statistical adjustment

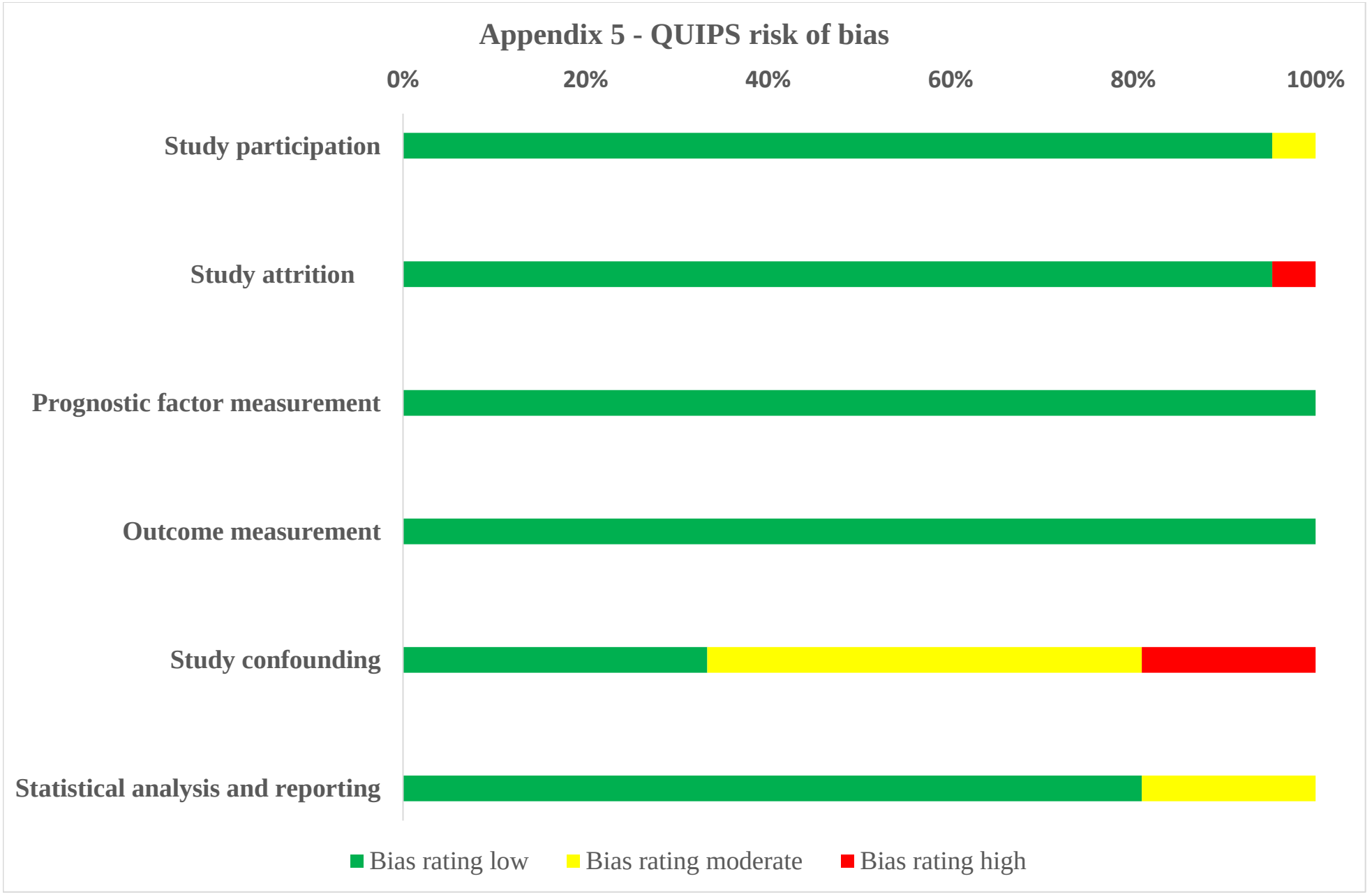
		Maternal preconception status									Maternal clinical status						Foetus characteristics						
Author	Year	Ethnicity/Race	Educational level	Marital status	Economic status	Insurances status	Urban status	Weight	Height	Body mass index	Age	Parity	Previous caesarean section	Pre-existing (before pregnancy) conditions	Conditions developed during pregnancy	Gestational age	Birth weight	Other characteristics	Prenatal care	Birth characteristics	Provider characteristics	Other variables	Total number of covariates
Stafford*	1990																						0
Haas et al. A*	1993																						0
Haas et al. B*	1993																						0
Braveman et al.	1995	+	+	+	+	+					+			+			+	+	+	+	++	+	15
Burns et al.	1995	+	+								+	+	+		++	+	+	++	+		++	++	33
Aron et al.	2000										+	+		++	++	++	+	++					39
Grant A	2005	++	+	+	+		+	+	+		++		+	++	++	+	++	++	++		++	++	68
Grant B	2005	++					+				++		+	++	++	+	++	++	+		++	+	31
Grant C	2005	++					+				++		+	++	++	+	++	++	+		++	+	31
Korst et al.	2005	+									+										++		6
Misra	2008	+									++			++	++			++		+	++	++	30
Coonrod et al.	2008	+	+								+			++	+	+	+	+	+	+	++		20
Huesch	2011	+		+			+				+										+	++	8
Movsas et al.	2012	+									+	+		+		+	+	+				+	9
Kozhimannil et al.	2013	+									+	+	+	++	++	+		++			++		16
Lutomski et al.	2014										+		+	++	+			+					6
Huesch et al.	2014	+			+						+			++	++	+		++	+	++	++	++	124
Henke et al.	2014	+	+		+						+			++	++		+				++	++	28
Bannister-Tyrrell et al.	2015											+	+	++	++	+		+		++	+	+	12
Sebastião et al.	2016																						0
Sentell et al. *	2016	+									+	+			+						+	+	6

+ One covariate adjusted for ++ Two or more covariates adjusted for

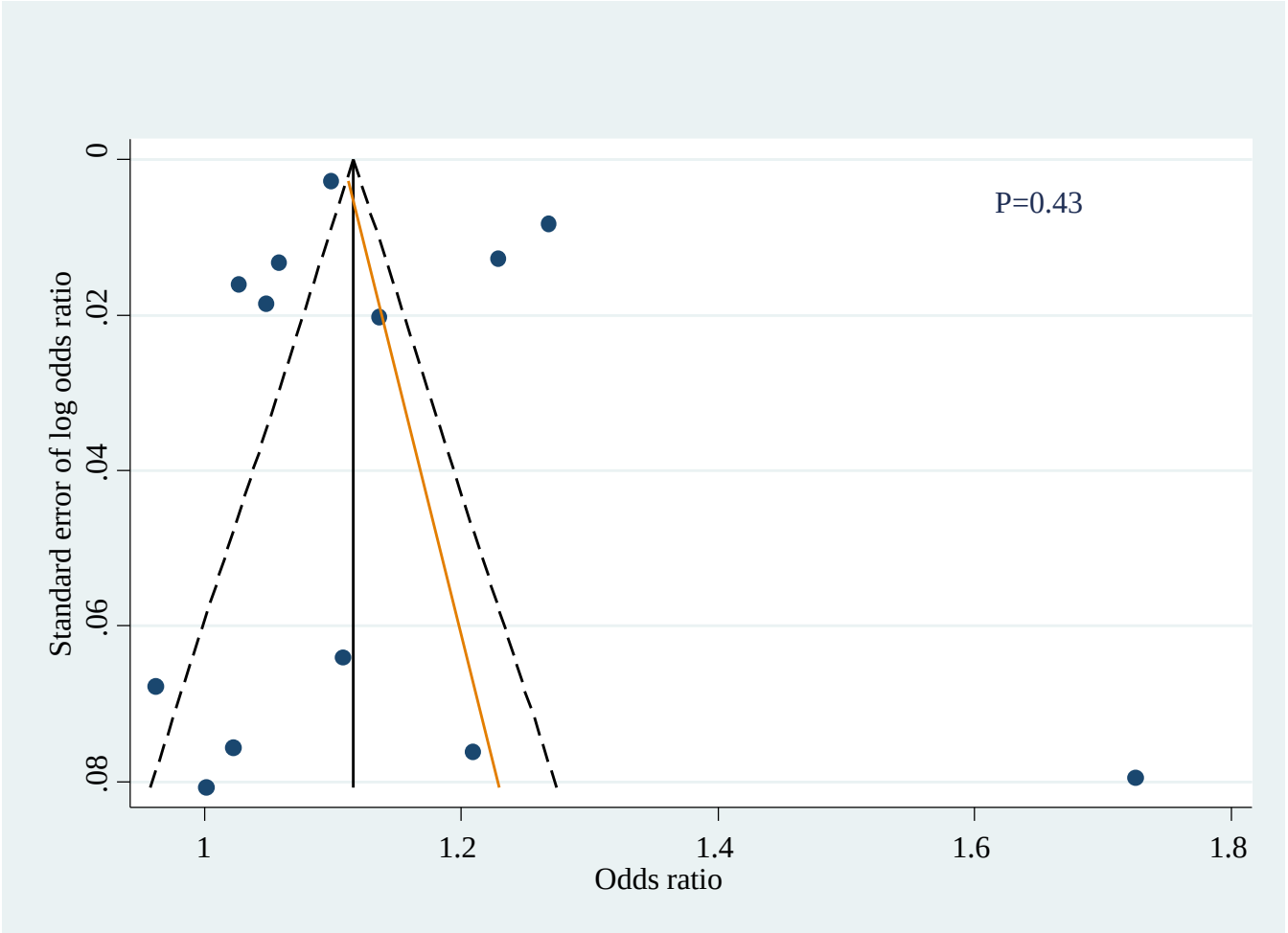
*Stafford, Haas et al. and Sebastião et al. only reported crude estimates.

Appendix 4. QUIPS risk of bias

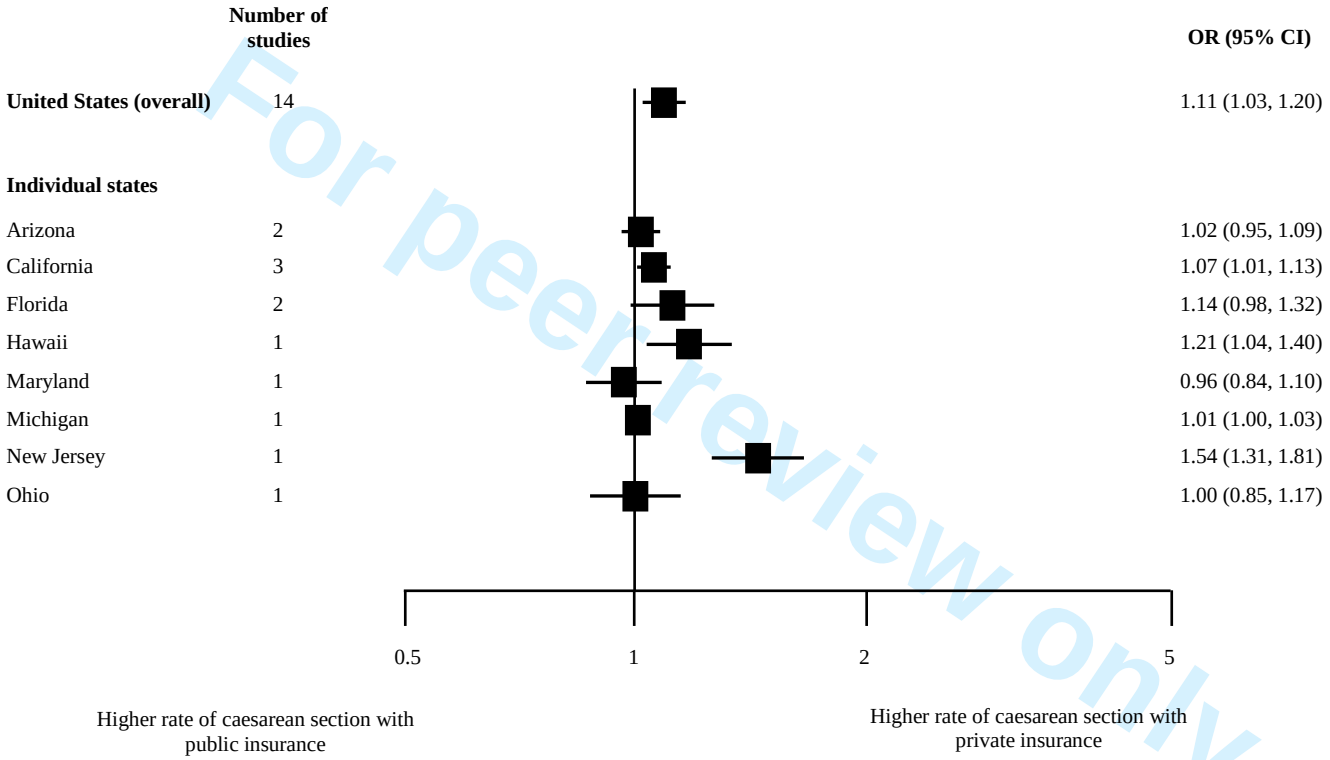
Author	Year	Study participation	Study attrition	Prognostic factor measurement	Outcome measurement	Study confounding	Statistical analysis and reporting	Overall rating
Stafford	1990	low	low	low	low	high	moderate	high
Haas et al. A	1993	low	low	low	low	high	moderate	high
Haas et al. B	1993	low	low	low	low	high	moderate	high
Braveman et al.	1995	low	low	low	low	moderate	low	moderate
Burns et al.	1995	low	low	low	low	moderate	low	moderate
Aron et al.	2000	low	low	low	low	low	low	low
Grant A	2005	moderate	high	low	low	low	low	high
Grant B	2005	low	low	low	low	low	low	low
Grant C	2005	low	low	low	low	low	low	low
Korst et al.	2005	low	low	low	low	moderate	low	moderate
Misra	2008	low	low	low	low	moderate	low	moderate
Coonrod et al.	2008	low	low	low	low	low	low	low
Huesch	2011	low	low	low	low	low	low	low
Movsas et al.	2012	low	low	low	low	moderate	low	moderate
Kozhimannil et al.	2013	low	low	low	low	low	low	low
Lutomski et al.	2014	low	low	low	low	moderate	low	moderate
Huesch et al.	2014	low	low	low	low	moderate	low	moderate
Henke et al.	2014	low	low	low	low	moderate	low	moderate
Bannister-Tyrrell et al.	2015	low	low	low	low	moderate	low	moderate
Sebastião et al.	2016	low	low	low	low	high	moderate	high
Sentell et al.	2016	low	low	low	low	moderate	low	moderate


Appendix 5 - QUIPS risk of bias
0%
20%
40%
60%
80%
100%
Study participation
Study attrition
Prognostic factor measurement
Outcome measurement
Study confounding
Statistical analysis and reporting
Bias rating low
Bias rating moderate
Bias rating high

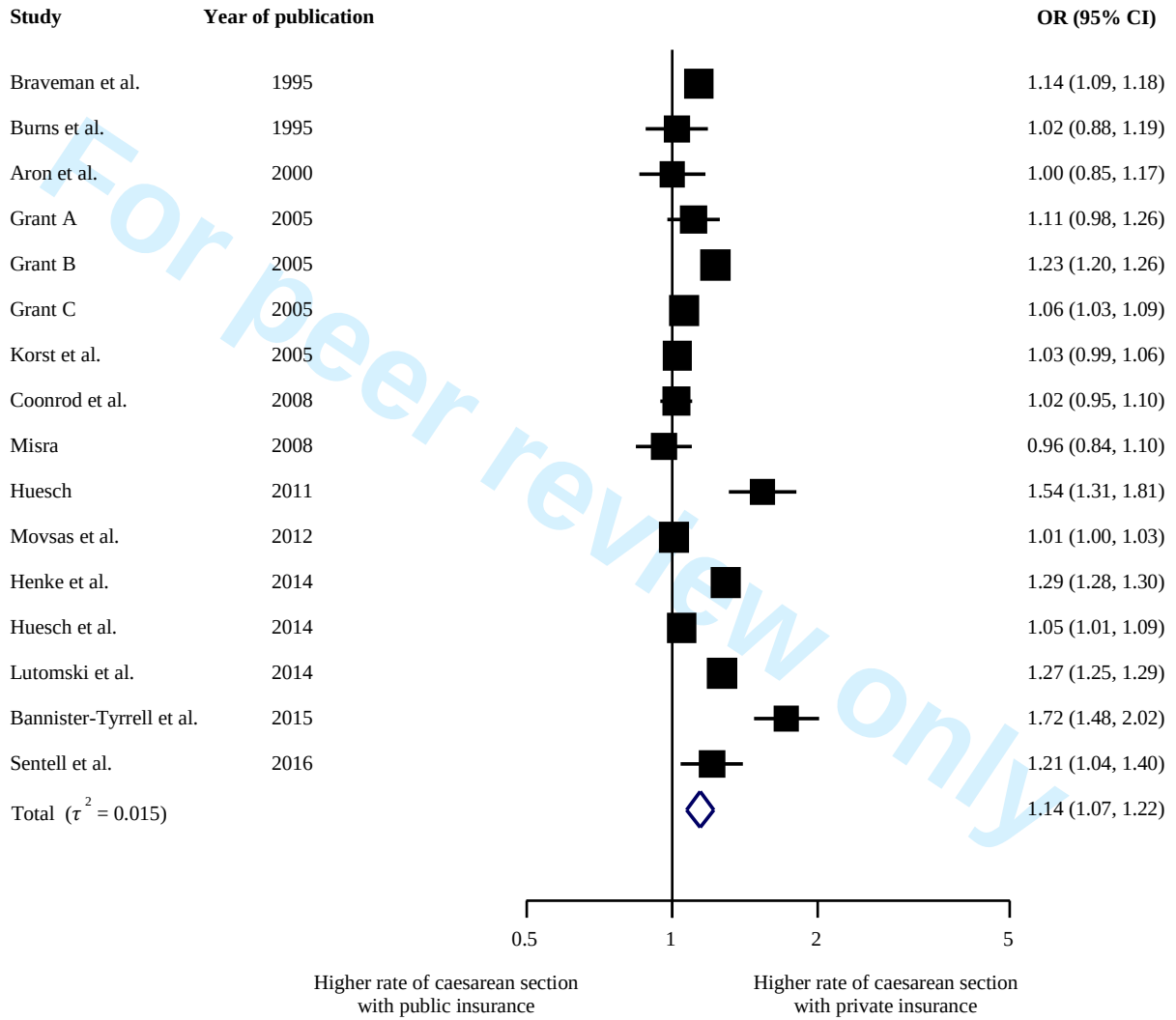
Appendix 6. Funnel plot of adjusted ORs against their standard errors on a log scale



Appendix 7. Caesarean section rates in the United States



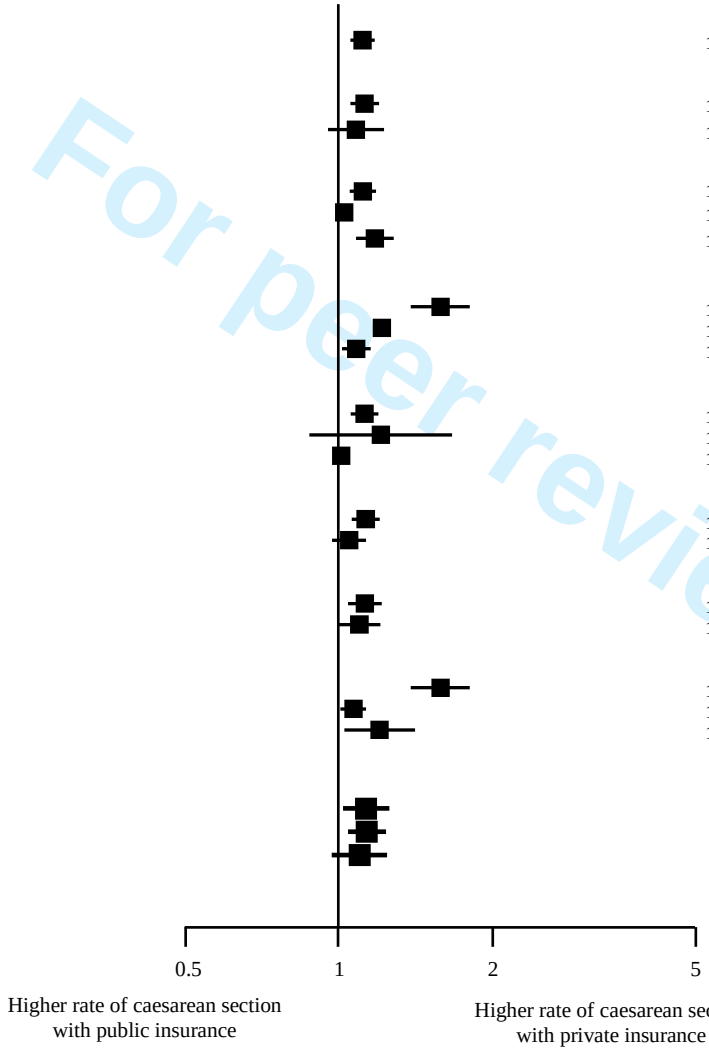
Appendix 8. Sensitivity analysis - Adjusted odds ratios of caesarean section



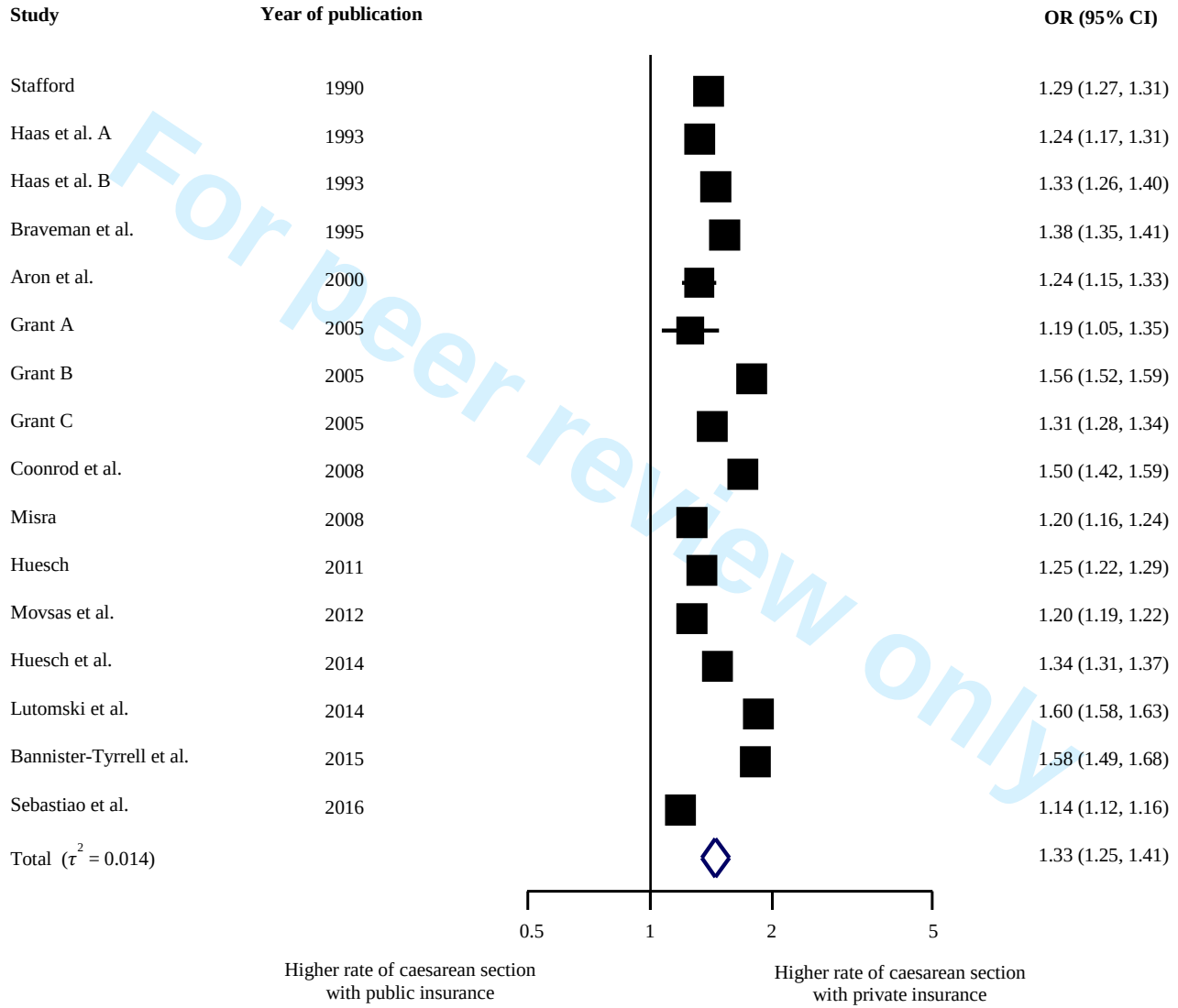
Appendix 9. Sensitivity analysis – Stratified analyses

Categories	Number of studies	OR (95% CI)	τ^2	P for interaction
Overall	16	1.14 (1.07, 1.22)	0.015	
Study design				
Cross sectional	12	1.16 (1.07, 1.25)	0.016	0.587
Retrospective cohort	4	1.10 (0.95, 1.28)	0.021	
Period of data collection				
Up to 1992	4	1.15 (1.07, 1.23)	0.003	0.96*
1993 to 2000	4	1.04 (1.01, 1.07)	<0.001	
2001 and later	8	1.22 (1.11, 1.35)	0.018	
Country				
Australia	1	1.72 (1.48, 2.02)	<0.001	<0.001
Ireland	1	1.27 (1.25, 1.29)	<0.001	
United States	14	1.11 (1.03, 1.20)	0.019	
Type of ceasarean section				
Any	12	1.16 (1.07, 1.24)	0.015	0.007
Indication estabished before labour	2	1.26 (0.86, 1.83)	0.070	
Indication estabished during labour	2	1.02 (0.99, 1.05)	<0.001	
Parity				
Primi and multiparae	13	1.16 (1.08, 1.25)	0.016	0.138
Primiparae only	3	1.07 (0.97, 1.17)	0.004	
Inclusion of woman with previous caesarean				
Yes	9	1.16 (1.06, 1.26)	0.016	0.703
No	7	1.13 (1.01, 1.26)	0.020	
Pregnancy risk				
High risk	1	1.72 (1.48, 2.02)	<0.001	<0.001
Any risk	12	1.09 (1.02, 1.17)	0.012	
Low risk	3	1.25 (1.04, 1.51)	0.025	
QUIPS risk of bias				
Low	5	1.14 (1.03, 1.27)	0.012	0.90
Moderate	10	1.15 (1.05, 1.25)	0.017	
High	1	1.11 (0.98, 1.26)	<0.001	

*P for trend



Appendix 10. Sensitivity analysis - Crude odds ratios of caesarean section



Appendix 11. Search Strategy

1. For Medline (PubMed)

(((((((causes OR determinants OR statistics OR rates OR factors OR decision* OR physician* OR socioeconomic OR state medicine OR evidence-based OR hospital OR hospitals OR hospitalization OR hospitalized OR uncertain* OR educational status OR social class OR obstetric* OR gynecolog* OR supply OR distribut* OR utilization OR insurance OR choice OR attitude OR patient OR economics OR maternal OR accessib* OR health service* OR rural population OR urban population[Title/Abstract])) NOT medline[sb])) OR ("Decision Making"[Mesh] OR "Physician's Practice Patterns"[Mesh] OR "Socioeconomic Factors"[Mesh] OR "State Medicine"[Mesh] OR "Evidence-Based Medicine"[Mesh] OR "Hospitals"[Mesh] OR "Uncertainty"[Mesh] OR "Educational Status"[Mesh] OR "Hospital Costs"[Mesh] OR "Physician Incentive Plans"[Mesh] OR "Social Class"[Mesh] OR "Obstetrics and Gynecology Department, Hospital"[Mesh] OR "supply and distribution"[Subheading] OR "utilization"[Subheading] OR "Insurance"[Mesh] OR "Choice Behavior"[Mesh] OR "Attitude to Health"[Mesh] OR "Patient Participation"[Mesh] OR "Physician-Patient Relations"[Mesh] OR "Economics, Hospital"[Mesh] OR "Maternal Health Services"[Mesh] OR "Health Services Accessibility"[Mesh] OR "Health Services Research"[Mesh] OR "Rural Population"[Mesh] OR "Urban Population"[Mesh])))) OR factors OR rates OR statistics OR causes OR determinants AND (((((operative delivery OR caesarean section OR cesarean section OR c-section OR c section OR caesarean OR cesarean OR caesarean delivery OR cesarean delivery OR caesarean rates OR cesarean rates)))) OR cesarean section [MeSH Terms])) AND ((((("Catchment Area (Health)"[Mesh] OR "Small-Area Analysis"[Mesh])))) OR ((((small area analysis OR small area analyses OR medical practice variation OR regions OR geographic variation OR variation)))))

2. Embase (Ovid SP)

##	# ▲	Searches	Results	Search Type	Actions
##	1	decision making/	134077	Advanced	Display More ≫
##	2	professional practice/ or group practice/ or health care practice/ or medical practice/	129049	Advanced	Display More ≫
##	3	socioeconomics/	110558	Advanced	Display More ≫
##	4	state medicine.mp. or national health service/	54605	Advanced	Display More ≫
##	5	evidence based medicine/	80825	Advanced	Display More ≫
##	6	hospital/	216188	Advanced	Display More ≫
##	7	uncertainty/	6158	Advanced	Display More ≫
##	8	educational status/	36032	Advanced	Display More ≫
##	9	"hospital cost"/	13192	Advanced	Display More ≫
##	10	physician incentive plans.mp. or personnel management/	49572	Advanced	Display More ≫
##	11	social class/	26291	Advanced	Display More ≫
##	12	hospital department/	21809	Advanced	Display More ≫
##	13	obstetrics/	27326	Advanced	Display More ≫
##	14	gynecology/	29917	Advanced	Display More ≫
##	15	(8 or 9)	22126	Advanced	Display More ≫

#16	16	12 and 15	413	Advanced	Display More »
#17	17	health care distribution/	2333	Advanced	Display More »
#18	18	health care utilization/	36879	Advanced	Display More »
#19	19	insurance/	33934	Advanced	Display More »
#20	20	choice behavior.mp.	765	Advanced	Display More »
#21	21	attitude to health/	81021	Advanced	Display More »
#22	22	patient participation/	16400	Advanced	Display More »
#23	23	doctor patient relation/	81043	Advanced	Display More »
#24	24	health economics/	33098	Advanced	Display More »
#25	25	obstetric procedure/	550	Advanced	Display More »
#26	26	health care access/	34433	Advanced	Display
#27	27	health services research/	27579	Advanced	Display More »
#28	28	geographic distribution/	132846	Advanced	Display More »
#29	29	rural population/	30219	Advanced	Display More »
#30	30	urban population/	35323	Advanced	Display More »
#31	31	causes/	0	Advanced	Delete More »
#32	32	determinants/	1	Advanced	Display More »
#33	33	statistics/	301146	Advanced	Display More »
#34	34	rates/	0	Advanced	Delete More »
#35	35	factors/	0	Advanced	Delete More »
#36	36	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 29 or 30 or 32 or 33	1340916	Advanced	Display More »
#37	37	cesarean section/	59755	Advanced	Display More »
#38	38	(caesarean section or cesarean section or c-section or c section or caesarean or cesarean or caesarean delivery or cesarean delivery or caesarean rates or cesarean rates or operative delivery).ti,ab,tw.	53950	Advanced	Display Delete More »
#39	39	37 or 38	73014	Advanced	Display More »
#40	40	(small area analysis or small area analyses or small aera or medical practice variation or regions or geographic variation or variation or variations).ti,ab,tw.	964890	Advanced	Display More »
#41	41	28 or 40	1082827	Advanced	Display More »
#42	**42**	**36 and 39 and 41**	**357**	**Advanced**	Display More »

3. Cochrane Library

Caesarean section and insurance

Research Checklist

According to MOOSE statement for meta-analyses of observational studies

Reporting of background should include	**Where to find in manuscript**
Problem definition	Manuscript (page 5)
Hypothesis statement	Manuscript (page 5)
Description of study outcome(s)	Manuscript (page 6)
Type of exposure or intervention used	Manuscript (page 6)
Type of study designs used	Manuscript (Table 1)
Study population	Manuscript (Table 1, Appendix 1)
Reporting of search strategy should include	
Qualifications of searchers (eg, librarians and investigators)	Manuscript (page 6)
Search strategy, including time period included in the synthesis and keywords	Manuscript (page 5, 6), Appendix 11
Effort to include all available studies, including contact with authors	Manuscript (page 5-6)
Databases and registries searched	Manuscript (page 6)
Search software used, name and version, including special features used (eg, explosion)	Manuscript (page 6)
Use of hand searching (eg, reference lists of obtained articles)	Manuscript (page 6)
List of citations located and those excluded, including justification	Figure 1
Method of addressing articles published in languages other than English	n/a
Method of handling abstracts and unpublished studies	Manuscript (page 6)
Description of any contact with authors	No contact made
Reporting of methods should include	
Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	Manuscript (page 6)

Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	Manuscript (page 6)
Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	Manuscript (pages 6)
Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	Manuscript (page 6-7) Appendix 3, 4, 5
Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	Page 7, Appendix 4, 5
Assessment of heterogeneity	Manuscript (page 6-7)
Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	Manuscript (page 6-7)
Provision of appropriate tables and graphics	Manuscript, Table 1, Figure 1-3 and Appendixes 1-10
Reporting of results should include	
Graphic summarizing individual study estimates and overall estimate	Figure 2, 4
Table giving descriptive information for each study included	Table 1
Results of sensitivity testing (eg, subgroup analysis)	Figure 3, Appendixes 6, 8, 9, 10
Indication of statistical uncertainty of findings	Manuscript, Figure 2-4
Reporting of discussion should include	
Quantitative assessment of bias (eg, publication bias)	Manuscript (page 8-9)
Justification for exclusion (eg, exclusion of non—English-language citations)	11
Assessment of quality of included studies	Page 11

Reporting of conclusions should include	
Consideration of alternative explanations for observed results	Manuscript (pages 11-13)
Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	Manuscript (page 14)
Guidelines for future research	Manuscript (page 14)
Disclosure of funding source	Manuscript (page 16)

PRISMA checklist

TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 1, 2
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Page 2,3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Page 5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Page 5,6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No published protocol or registration
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Page 6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Page 5, 6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 11
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Page 6, Fig 1

Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Page 6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Page 6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Page 6, 7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Page 6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	Page 7, 8
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Page 7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	Page 7, 8
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Page 8, Fig 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 1, Appendix 1, 2, 3
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Page 9, Appendix 4, 5
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Fig 2, 4, Appendix 8, 10
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Page 9, Fig 2, 4,

			Appendix 8, 10
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Appendix 4, 5
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Page 9, 10, Fig 3, Appendix 6, 7, 9
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Page 10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Page 10, 11
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Page 11, 12, 13
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	In submitting system