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

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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

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

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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

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3 increase of CS rates. We did not restrict search by type of language or publication date. We
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5 searched MEDLINE, Embase, and The Cochrane Library from inception to August 4, 2016,
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7 when the search was last updated. In addition, we manually searched the reference lists of all
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9 included studies and earlier systematic reviews that we identified.
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11 12 13 ***Study selection and outcomes***

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15 To be eligible for inclusion, studies had to report data to allow the calculation of odds ratios
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17 (OR) of CS comparing women covered by private insurance with women covered by public
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19 insurance in a specific health care system. The pre-specified primary outcome was the
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21 adjusted OR of births delivered by CS of women covered with private insurance as compared
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23 with women with public insurance coverage. The pre-specified secondary outcome was the
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25 crude OR of CS of women covered with private insurance as compared with women with
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27 public insurance.
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30 31 32 ***Data extraction***

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34 Two researchers (IH and MB) screened the papers and extracted data independently.
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36 Differences were resolved by consensus. Data from full text articles were extracted onto a
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38 data extraction sheet designed to capture data on study population, study design, data sources,
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40 setting, type of CS analysed, and statistical analysis. We extracted adjusted and/or unadjusted
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42 ORs of CS of women with private insurance as compared with CS of women with public
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44 insurance.
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47 48 49 ***Main analysis***

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51 We used standard inverse-variance random effects meta-analysis to combine overall OR. An
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53 OR above one indicates that CS are more frequently performed in women with private
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55 insurance than in women with public insurance. We calculated the variance estimate τ^2 as a
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57 measure of heterogeneity between studies (23). We pre-specified a τ^2 of 0.04 to represent low
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3 heterogeneity, 0.16 to represent moderate, and 0.36 to represent high heterogeneity between
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5 studies (24). We conducted analyses stratified by study design, period of data collection,
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7 country, type of CS analysed, parity, inclusion of women with previous CS, and pregnancy
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9 risk of included women to investigate potential reasons for between-study heterogeneity and
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11 used chi-square tests to calculate p-values for interaction, or tests for linear trends in cases of
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13 more than two ordered strata. All p-values are two-sided.
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16 17 *Sensitivity analysis*

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19 Five studies (25-29) were excluded from the main analysis, as they had an overlapping
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21 population with a larger study (30) that was included. For this reason, we repeated all
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23 analyses including these five studies (25-29) while excluding the larger one (30). We used
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25 STATA, release 13, for all analyses (Stata-Corp, College Station, Texas).
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28 29 *Patient involvement*

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31 No patients were involved in this study. We used data from published papers only.
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34 35 **Results**

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37 We identified a total of 1490 records with our search strategy (Figure 1): 935 from Medline:
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39 494 from Embase; 38 from the Cochrane Library and 23 from manual search. After removing
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41 duplicates, we screened 1264 records for eligibility, and retained 166 for full text
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43 examination. We excluded another 124 that did not report insurance status of women, 23 that
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45 were otherwise irrelevant and one study that had an overlapping population. Finally, 18
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47 articles describing 21 separate studies in 12.9 million women were included in review and
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49 meta-analysis.
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54 Characteristics of studies are presented in Table 1 and Appendixes 1,2 and 3. Sixteen studies
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56 were cross-sectional, five were retrospective cohort studies. Only one study used surveys, 18
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3 hospital records, seven birth registries, and one census data. All studies were published in
4 English. Most studies were from the United States. Nineteen studies included the entire
5 population of eligible cases, while only two studies selected cases randomly. Case exclusion
6 criteria varied considerably: one study excluded women aged 14 and younger; three excluded
7 multiparas; eight excluded women with previous CS; eight excluded stillbirths and nine
8 multiple births; six excluded cases with specific presentations of the foetus; six studies
9 excluded preterm births, and 13 studies excluded cases due to provider characteristics. Two
10 studies reported ORs of CS for which indication was established before labour (including CS
11 on maternal request) only, three reported CS for which indication was established during
12 labour and 16 reported ORs of any CS irrespective of indication. Eighteen studies adjusted
13 for different characteristics as presented in Appendix 3.

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28 Figure 2 presents the meta-analysis of the 13 studies that reported adjusted ORs (30-40), all
29 of them using public insurance as the reference group. Overall, the odds of receiving CS were
30 1.14 higher for women with private insurance coverage as compared women with public
31 health insurance coverage (95% CI 1.08 to 1.22), with no relevant heterogeneity between
32 studies ($\tau^2 \leq 0.008$). Figure 3 presents results of stratified analyses of adjusted odds ratios.
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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.

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

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

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

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3 also in a position to exploit asymmetry of information between them and patients (48, 49),
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5 which leads to recommendations that are not always aligned with patient needs or preferences
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7 (15). There is also evidence that physicians with higher numbers of privately insured patients
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9 will tend to perform more CS (32, 34); explanations include perceptions that patients with
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11 private insurance have a higher social class, or more prevalent concerns about malpractice
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13 liability in patients with private insurance (50).
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17 The heterogeneity of adjusted estimates across states in the United States (Appendix 4) points
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19 to setting specific factors that will influence the effect of insurance on the odds of CS and are
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21 worth of further investigation. According to Burns et al., the lacking association in Arizona
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23 (OR=1.02) may be due to equal magnitudes of re-imbursements of hospitals for vaginal birth
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25 and CS (32). In Maryland (OR=0.96), the state administration introduced HealthChoice
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27 Program in 1997, that was intended to provide prevention oriented healthcare services, enact
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29 better accountability measures for managed care organizations, and ensure efficient use of
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31 financial resources (36). This program introduced a mandatory managed care system for
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33 Medicaid beneficiaries, which replaced a fee-for-service model. This resulted in more
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35 patients receiving managed care irrespective of their insurance status and, in turn, use of
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37 similar policies in patients with public and private insurance (36). We are unaware of
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39 plausible explanations for the lack of associations observed in Michigan (OR 1.01) and Ohio
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41 (OR 1.00).
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46 47 **Policy and research implications**

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49 Increases in the cost of care and hospital charges have become central issues in policy
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51 discussion in the United States and elsewhere (15, 45). While the public health care costs are
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53 reaching unsustainable levels, hospital charges can have alarming effects on patients (45). In
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3 addition, the potential negative clinical effects of CS on mothers and newborns have raised
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5 concerns among clinicians, academics and policymakers alike (15).
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9 Recent studies and their media coverage and associated increase in public awareness of high
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11 CS rates and changes in reimbursement policy have led to recent decreases of CS rates in
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13 California (18). Our study provides additional evidence to support policy and advocacy
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15 efforts that address escalating CS rates, in particular their association with financial
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17 incentives. Effective policy measures often require context, country or state specific policy
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19 analyses investigating particular insurance programmes. These setting specific analyses are
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21 essential as incentives may differ across health care systems.
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25 As we analyse CS rates relation with health insurance schemes we need to be aware of
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27 complexity of interaction of different determinants and their influence in CS rates. The
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29 published literature has identified a number of determinants of CS rates which operate at
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31 different levels of health care systems (macro, meso, and micro) (15). At the macro level of
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33 national health systems, operate factors such as health financing system, social and political
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35 context, legal regulations, general cultural and social norms and similar. At the meso level are
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37 hospitals and health care facilities. Their ownership status, availability of resources and size
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39 are known to influence CS rates (15, 22). Finally, at the micro level, we have clinical units
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41 that provide care, medical staff and patients, which are characterised with all sorts of features
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43 that can influence the decision for CS. For example, clinical unit staff composition, or
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45 physician education, gender and experience, or mother preference, age and race, are all
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47 known to determine the rates of CS (15).
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51 52 **Conclusion**

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

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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.

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

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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

Peer review only

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

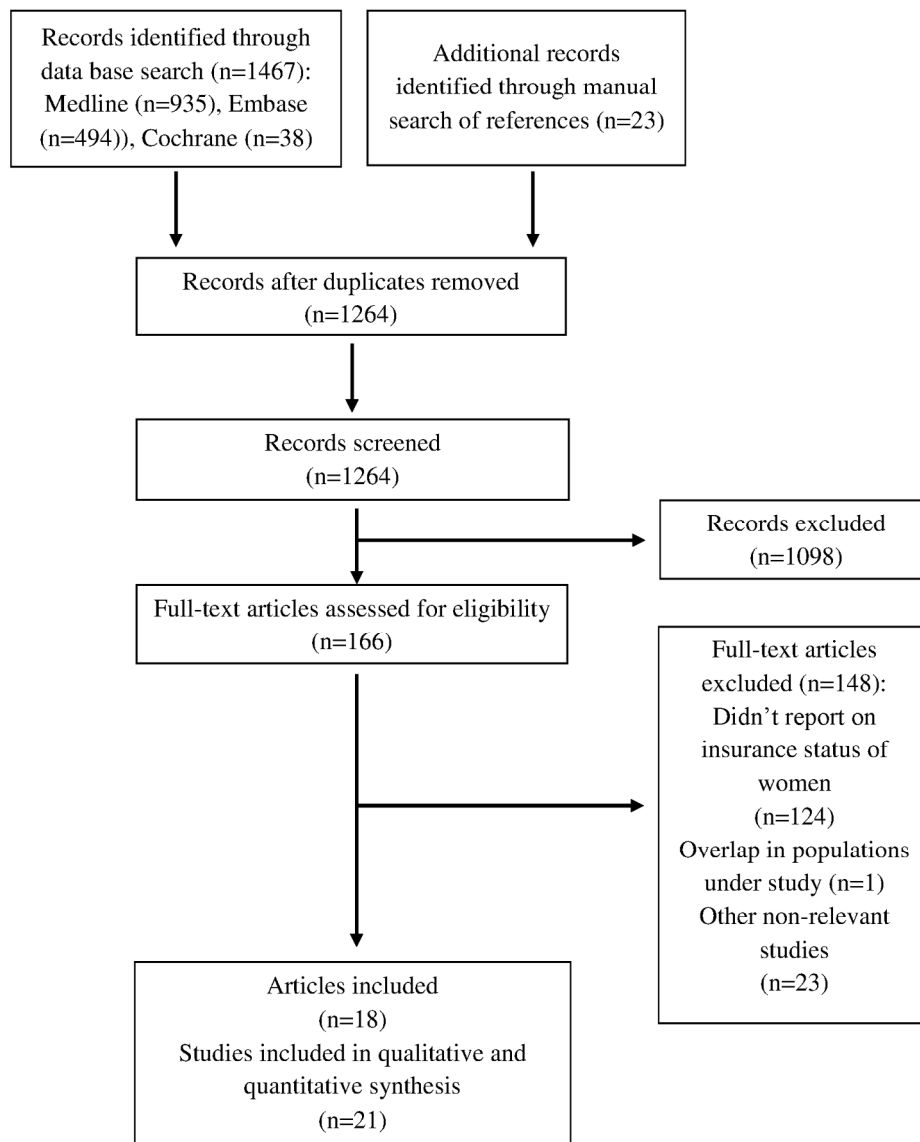


Figure 1. The flow diagram of review

164x201mm (300 x 300 DPI)

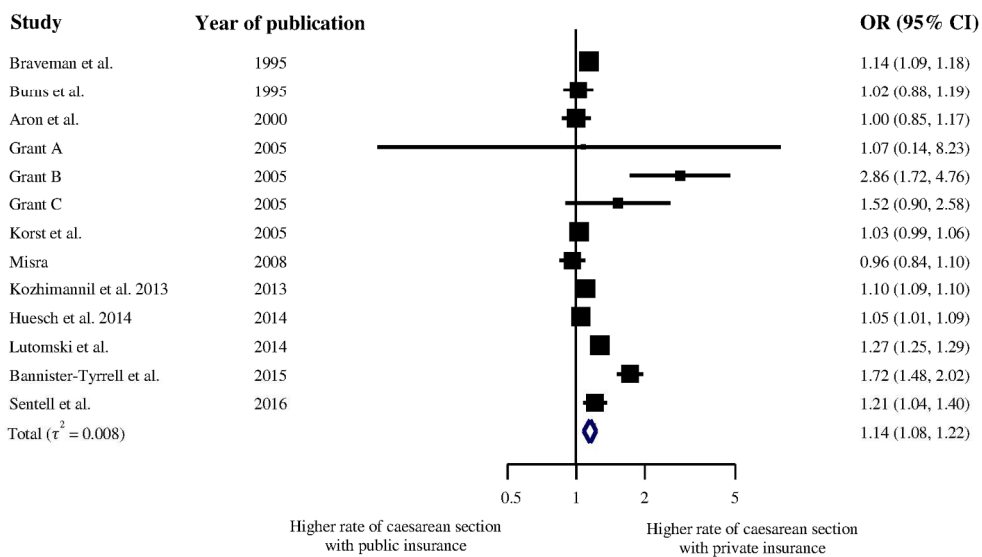


Figure 2. Adjusted odds ratios of caesarean section

171x98mm (300 x 300 DPI)

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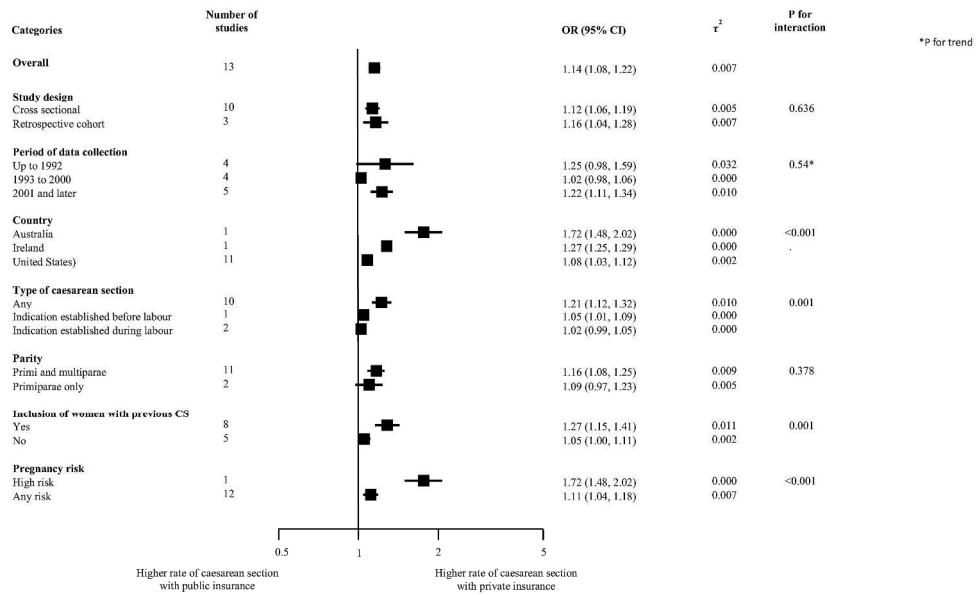


Figure 3. Stratified analyses/Legend: *P for trend

255x158mm (300 x 300 DPI)

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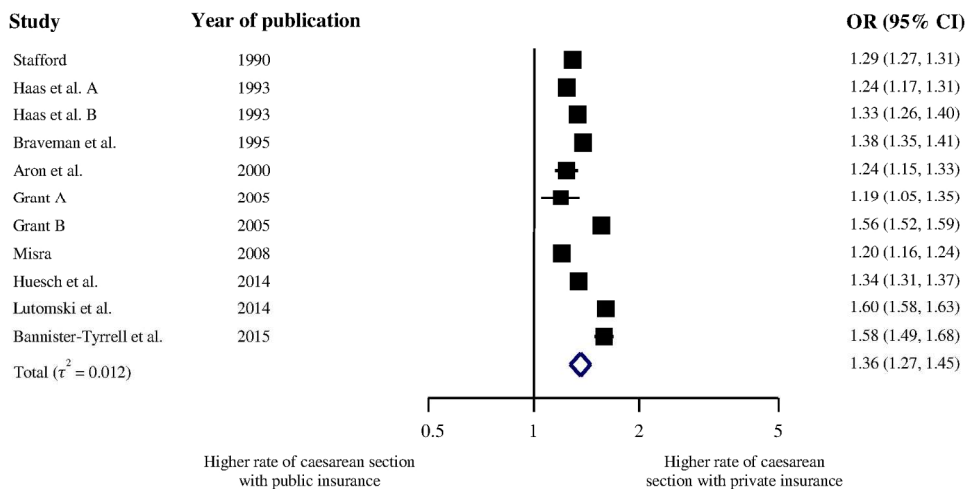


Figure 4. Crude odds ratios of caesarean section

171x87mm (300 x 300 DPI)

review only

Appendix 2. Characteristics of data used for analysis

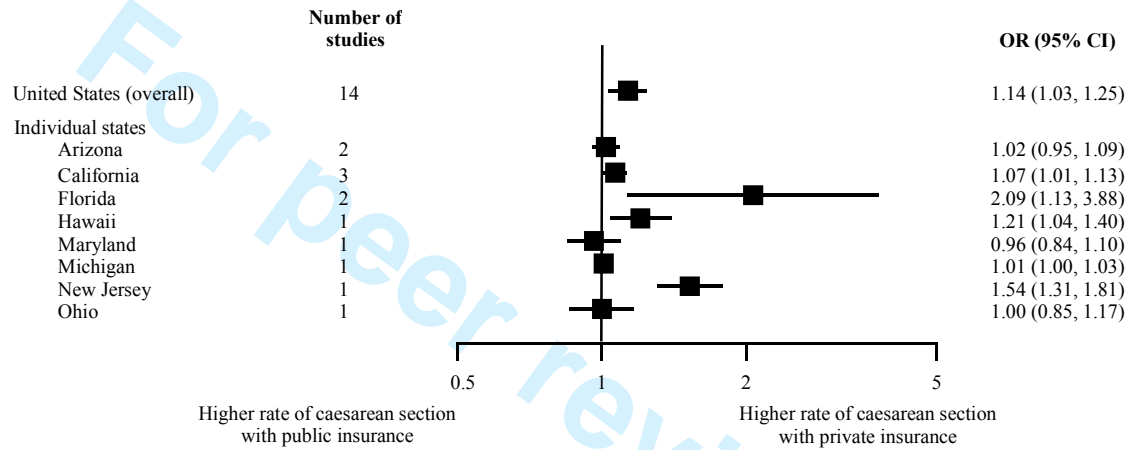
Author	Year	Survey	Hospital records	Birth certificates/registry	Census data
Stafford	1990		+		
Haas et al. A	1993		+	+	
Haas et al. B	1993		+	+	
Braveman et al.	1995			+	+
Burns et al.	1995		+	+	
Aron et al.	2000		+		
Grant A	2005	+			
Grant B	2005		+		
Grant C	2005		+		
Korst et al.	2005		+		
Misra	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

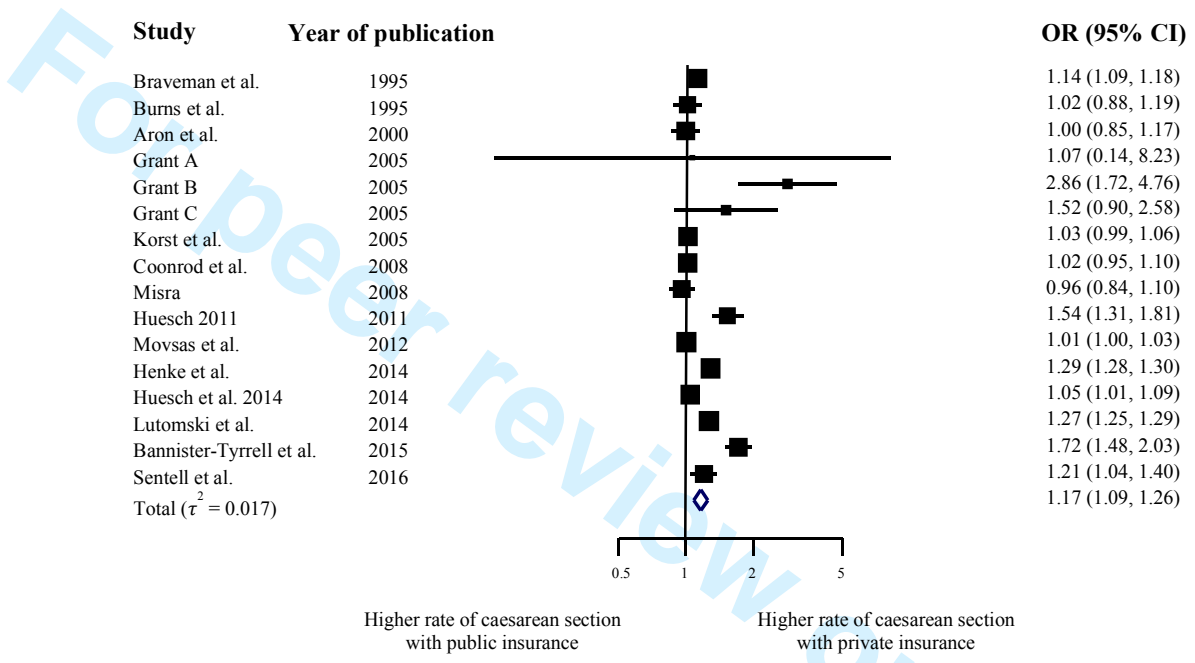
Author	Year	Maternal preconception status							Maternal clinical status				Foetus characteristics				Total number of covariates							
		Ethnicity/Race	Educational level	Marital status	Economic status	Insurances status	Urban status	Weight	Height	Body mass index	Age	Parity	Previous caesarean section	Pre-existing (before pregnancy) conditions	Conditions developed during pregnancy	Gestational age		Birth weight	Other characteristics	Prenatal care	Birth characteristics	Provider characteristics	Other variables	
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.

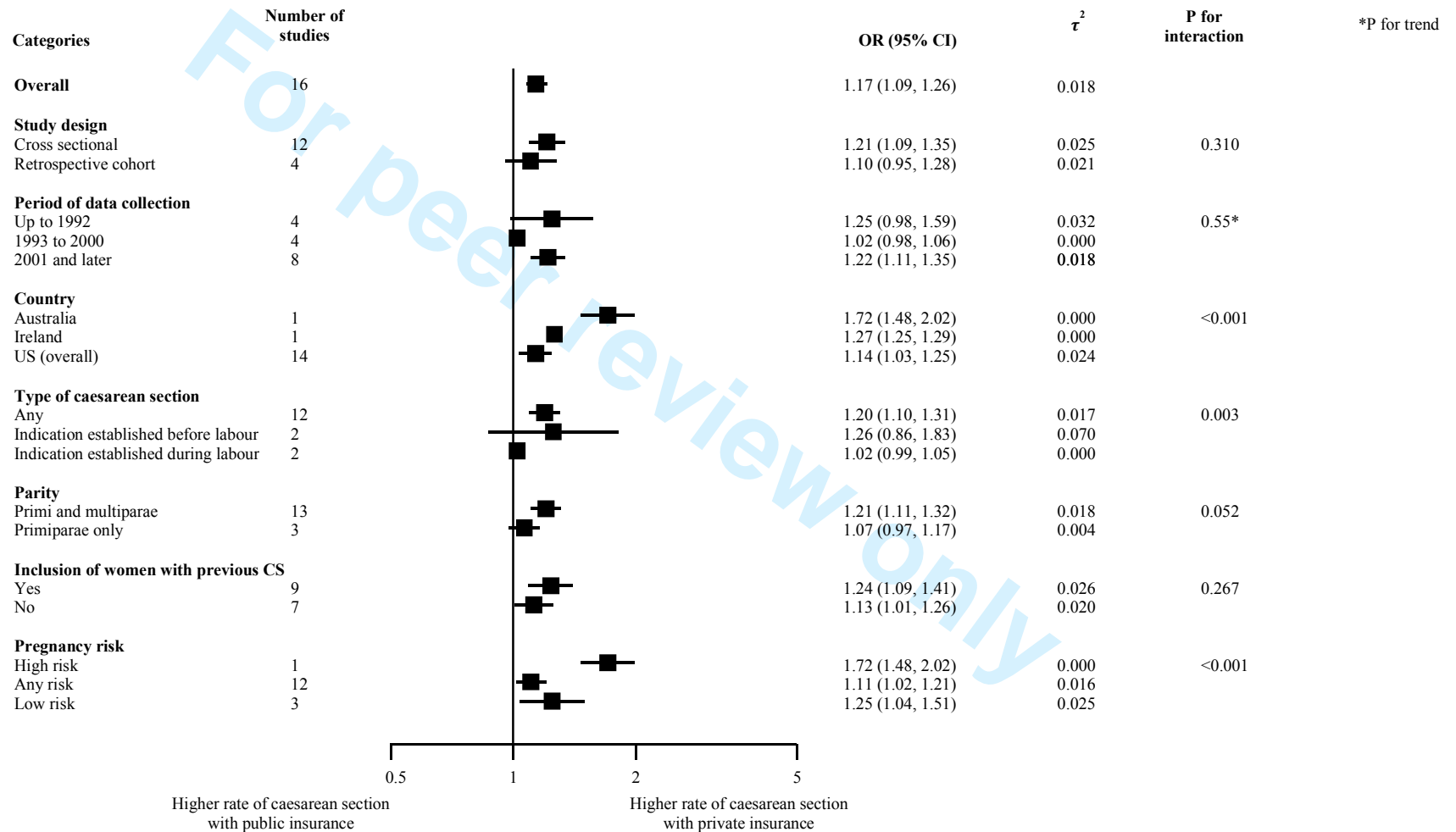
Appendix 4. Caesarean section rates in United States



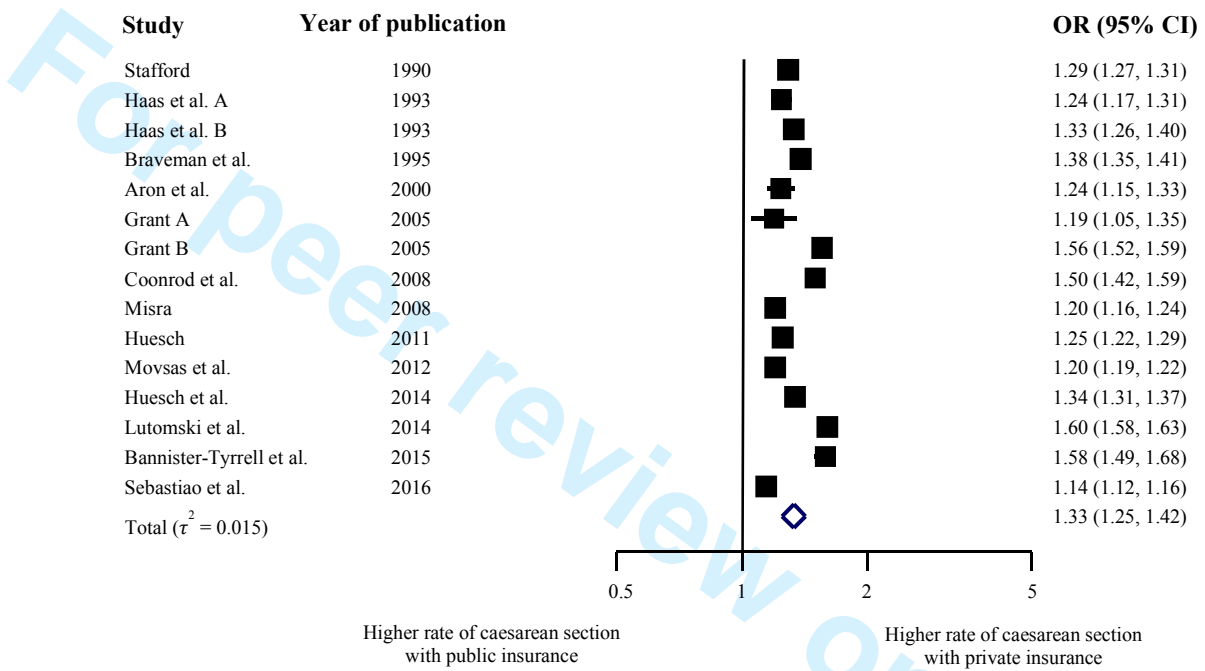
Appendix 5. Sensitivity analysis - Adjusted odds ratios of caesarean section



Appendix 6. Sensitivity analysis – stratified analyses



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



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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 >>
For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml				

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 More »
27	health services research/	27579	Advanced	Display More »
28	geographic distribution/	132846	Advanced	Display More »
29	rural population/	30219	Advanced	Display More »
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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)

1 Documentation of how data were classified and coded (eg, multiple
2 raters, blinding, and interrater reliability) Manuscript (pages 6)

3
4
5
6 Assessment of confounding (eg, comparability of cases and controls
7 in studies where appropriate) Manuscript (page 6-7)
8 Appendix 3

9
10 Assessment of study quality, including blinding of quality assessors;
11 stratification or regression on possible predictors of study results n/a

12
13 Assessment of heterogeneity Manuscript (page 6-7)

14
15 Description of statistical methods (eg, complete description of fixed
16 or random effects models, justification of whether the chosen
17 models account for predictors of study results, dose-response
18 models, or cumulative meta-analysis) in sufficient detail to be
19 replicated Manuscript (page 6-7)

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27
28 Provision of appropriate tables and graphics Manuscript, Table 1, Figure 1-3 and
29 Appendixes 1-7

30 31 32 **Reporting of results should include**

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34
35 Graphic summarizing individual study estimates and overall
36 estimate Figure 2-4

37
38
39 Table giving descriptive information for each study included Table 1

40
41
42 Results of sensitivity testing (eg, subgroup analysis) Figure 2, Appendixes 4-7

43
44 Indication of statistical uncertainty of findings Manuscript, Figure 2-4

45 46 **Reporting of discussion should include**

47
48
49 Quantitative assessment of bias (eg, publication bias) Manuscript (page 8-9)

50
51 Justification for exclusion (eg, exclusion of non—English-language
52 citations) n/a

53
54
55 Assessment of quality of included studies n/a

56 57 **Reporting of conclusions should include**

1	Consideration of alternative explanations for observed results	Manuscript (pages 10-12)
2	Generalization of the conclusions (ie, appropriate for the data	Manuscript (page 12-13)
3	presented and within the domain of the literature review)	
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6	Guidelines for future research	Manuscript (page 12)
7		
8	Disclosure of funding source	Manuscript (page 14)
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Caesarean Sections and Private Insurance: Systematic Review and Meta-analysis

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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 1.13 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 ($\tau^2=0.006$). 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 ($\tau^2=0.011$).

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

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

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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

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3 increase of CS rates. We did not restrict search by type of language or publication date. We
4
5 searched MEDLINE, Embase, and The Cochrane Library from inception to August 4, 2016,
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7 when the search was last updated. In addition, we manually searched the reference lists of all
8
9 included studies and earlier systematic reviews that we identified.
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12 ***Study selection and outcomes***

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14 To be eligible for inclusion, studies had to report data to allow the calculation of odds ratios
15
16 (OR) of CS comparing women covered by private insurance with women covered by public
17
18 insurance in a specific health care system. The pre-specified primary outcome was the
19
20 adjusted OR of births delivered by CS of women covered with private insurance as compared
21
22 with women with public insurance coverage. The pre-specified secondary outcome was the
23
24 crude OR of CS of women covered with private insurance as compared with women with
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26 public insurance.
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31 ***Data extraction***

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33 Two researchers (IH and MB) screened the papers and extracted data independently. Data
34
35 from full text articles were extracted onto a data extraction sheet designed to capture data on
36
37 study population, study design, data sources, setting, type of CS analysed, and statistical
38
39 analysis. We extracted adjusted and/or unadjusted ORs of CS of women with private
40
41 insurance as compared with CS of women with public insurance. Differences among
42
43 researchers with regards to study inclusion and data extraction procedure were resolved by
44
45 consensus and consultation with other authors.
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50 ***Main analysis***

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52 We used standard inverse-variance random effects meta-analysis to estimate the pooled OR.
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54 An OR above one indicates that CS are more frequently performed in women with private
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56 insurance than in women with public insurance. We calculated the variance estimate τ^2 as a
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3 measure of heterogeneity between studies (23). We pre-specified a τ^2 of 0.04 to represent low
4 heterogeneity, 0.16 to represent moderate, and 0.36 to represent high heterogeneity between
5 studies (24). We conducted analyses stratified by study design, period of data collection,
6 country, type of CS analysed, parity, inclusion of women with previous CS, and pregnancy
7 risk of included women to investigate potential reasons for between-study heterogeneity and
8 used chi-square tests to calculate p-values for interaction, or tests for linear trends in cases of
9 more than two ordered strata. All p-values are two-sided.
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19 *Sensitivity analyses*

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

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38 No patients were involved in this study. We used data from published papers only.
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42 **Results**

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44 We identified a total of 1490 records with our search strategy (Figure 1): 935 from Medline:
45 494 from Embase; 38 from the Cochrane Library and 23 from manual search. After removing
46 duplicates, we screened 1264 records for eligibility, and retained 166 for full text
47 examination. We excluded another 124 that did not report insurance status of women, 23 that
48 were otherwise irrelevant and one study that had an overlapping population. Finally, 18
49 articles describing 21 separate studies in 12.9 million women were included in review and
50 meta-analysis.
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3 Characteristics of studies are presented in Table 1 and Appendixes 1,2 and 3. Sixteen studies
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5 were cross-sectional, five were retrospective cohort studies. Only one study used surveys, 18
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7 hospital records, seven birth registries, and one census data. All studies were published in
8
9 English. Most studies were from the United States. Nineteen studies included the entire
10
11 population of eligible cases, while only two studies selected cases randomly. Case exclusion
12
13 criteria varied considerably: one study excluded women aged 14 and younger; three excluded
14
15 multiparas; eight excluded women with previous CS; eight excluded stillbirths and nine
16
17 multiple births; six excluded cases with specific presentations of the foetus; six studies
18
19 excluded preterm births, and 13 studies excluded cases due to provider characteristics. Two
20
21 studies reported ORs of CS for which indication was established before labour (including CS
22
23 on maternal request) only, three reported CS for which indication was established during
24
25 labour and 16 reported ORs of any CS irrespective of indication. Eighteen studies adjusted
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27 for different characteristics as presented in Appendix 3.
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33 Figure 2 presents the meta-analysis of the 13 studies that reported adjusted ORs (30, 32-41),
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35 all of them using public insurance as the reference group. Overall, the odds of receiving CS
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37 were 1.13 higher for women with private insurance coverage as compared women with public
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39 health insurance coverage (95% CI 1.07 to 1.18), with no relevant heterogeneity between
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41 studies ($\tau^2=0.006$). Figure 3 presents results of stratified analyses of adjusted odds ratios.
42
43 Estimates varied between strata, in particular for country (P for interaction<0.001), type of
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45 caesarean section (P for interaction=0.001), inclusion of women with previous CS (P for
46
47 interaction=0.001) and pregnancy risk (P for interaction<0.001). Appendix 4 shows a funnel
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49 plot of adjusted ORs against their standard errors on a log scale; there was no evidence for
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51 small study effects. Figure 4 presents the meta-analysis of crude ORs with a slightly stronger
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53 average association (pooled OR 1.35, 95% CI 1.27 to 1.44) and no relevant heterogeneity
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3 between studies ($\tau^2=0.011$). Appendix 5 presents adjusted associations for different states in
4
5 the United States. Adjusted estimates ranged from 0.96 in Maryland to 1.54 in New Jersey.
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9 Appendixes 6 to 8 report results from sensitivity analyses after inclusion of five smaller
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11 studies (25-29) and exclusion of a larger study (30) that had overlapping populations with the
12
13 five smaller ones. Appendix 6 shows the meta-analysis of the 16 studies (25-28, 32-41) with
14
15 a pooled adjusted OR of 1.14 (95% CI 1.07 to 1.22) and no evidence for relevant
16
17 heterogeneity between studies ($\tau^2=0.015$). Appendix 7 presents results of stratified analyses,
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19 with estimates varying between countries (P for interaction <0.001), type of caesarean section
20
21 (P for interaction $=0.007$) and pregnancy risks (P for interaction <0.001). Finally, Appendix 8
22
23 presents the meta-analysis of crude ORs, again with a stronger association on average (pooled
24
25 OR 1.33, 95% CI 1.25 to 1.41) and no relevant heterogeneity between studies ($\tau^2=0.014$).
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30 **Discussion**

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32 Our systematic review and meta-analysis estimated that the overall odds of receiving a
33
34 caesarean section are on average 1.13 times higher for privately insured women compared
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36 with women covered with public insurance. The increased risk was observed across all
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38 subgroups of studies in stratified analyses as well as in sensitivity analysis.
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42 **Context**

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44 To our knowledge, this is the first meta-analysis to examine the association of CS rates with
45
46 types of insurance. A recently published meta-analysis found that the odds of delivery by CS
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48 was 1.41 higher in for-profit hospitals as compared with non-profit hospitals (95% CI 1.24 to
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50 1.60) (22). These findings were confirmed across subgroups (i.e. such as country, year, or
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52 study design) of studies in stratified analyses, indicating financial incentives may play an
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54 important role in such outcome (22). We found three other recent meta-analyses that
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3 summarized CS studies and found a strong association with obesity (42), Sub-Saharan Africa
4 ethnic origin (43) and labour induction (44). Our estimates of a 14 percent increase are on the
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6 lower end of the strength of associations found in earlier studies.
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9 10 11 ***Strengths and limitations***

12 The major strengths of our meta-analysis include a broad literature search, screening and data
13 extraction performed in duplicate, an exploration of study characteristics as a potential source
14 of variation between studies, and sensitivity analyses involving studies that required
15 exclusion due to overlapping populations. Major limitations are differences in the
16 characteristics of the study populations, type of data used, types of CS analysed and variables
17 used for adjustment in statistical analyses across studies. Unadjusted estimates of associations
18 were larger, which suggests the presence of confounding, and we cannot completely rule out
19 residual confounding in adjusted estimates.
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30 31 32 ***Mechanisms***

33 Existing evidence suggests that possible causes for higher odds of CS in women insured privately lie
34 in the differences in payment for CS and reimbursement arrangements among insurers as well as
35 providers' responses to these arrangements. In the countries included in our analysis, private health
36 insurers generally reimburse hospitals at higher fees for providing a CS compared to the public
37 insurers (35). This incentive is heightened when public insurance funds hospital care through
38 a budget (e.g. Australia and Ireland) rather than fee-for-service, which is common in private
39 insurance (45, 46). Similar incentives are present in physician payment.
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49 Multiple studies have shown that hospitals are motivated by and responsive to financial
50 incentives (22, 33, 47, 48), although Grant (35) argues that their impact is small. One
51 example is the financial benefit associated with longer hospital stays associated with CS (47,
52 49). Hospitals may incentivize physicians (47, 48) to align their clinical decision with
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3 institutional strategies, such as patient scheduling policies that steer patients with private
4 insurance to more profit prone physicians (47, 48). Physicians are known to be motivated by
5 higher fees paid for CS as compared with vaginal delivery (47). They often act as self-
6 interested economic agents according to economic models of physician behaviour, by
7 maximizing income and convenience (33). Physicians are also in a position to exploit
8 asymmetry of information between them and patients (50, 51), which leads to
9 recommendations that are not always aligned with patient needs or preferences (15). There is
10 also evidence that physicians with higher numbers of privately insured patients will tend to
11 perform more CS (33, 35); explanations include perceptions that patients with private
12 insurance have a higher social class, or more prevalent concerns about malpractice liability in
13 patients with private insurance (52).

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28 Comparing 'public insurance' and 'private insurance' across countries is not a
29 straightforward exercise as the meaning of such distinction can vary substantially across
30 countries. In the United States 'public insurance' is insurance assigned to specific categories
31 of population (by age, disability, poverty or military service) and 'private insurance' is
32 insurance mainly organized through employment. In general, private insurance offers higher
33 reimbursement rates for surgical procedures, and this may incentivize CS. The heterogeneity
34 of adjusted estimates across states in the United States (Appendix 5) points to setting specific
35 factors that will influence the effect of insurance on the odds of CS and are worth of further
36 investigation. According to Burns et al., the lacking association in Arizona (OR=1.02) may
37 be due to equal magnitudes of re-imbursements of hospitals for vaginal birth and CS (33). In
38 Maryland (OR=0.96), the state administration introduced HealthChoice Program in 1997, that
39 was intended to provide prevention oriented healthcare services, enact better accountability
40 measures for managed care organizations, and ensure efficient use of financial resources (37).
41 This program introduced a mandatory managed care system for Medicaid beneficiaries,
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3 which replaced a fee-for-service model. This resulted in more patients receiving managed
4 care irrespective of their insurance status and, in turn, use of similar policies in patients with
5 public and private insurance (37). We are unaware of plausible explanations for the lack of
6 associations observed in Michigan (OR 1.01) and Ohio (OR 1.00). This analysis shows that
7 variation in CS rates among insurers within the United States can be explained by differences
8 in reimbursement arrangements nested within public and private insurance.
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17 For the other two countries, Ireland and Australia, included in the adjusted analysis, 'private health
18 insurance' status differs in character from the United States but offers similarly higher payment levels
19 for procedures. In Australia, women of childbearing age with private insurance, would have increased
20 the use of private obstetricians, leading to higher rates of CS (53). In Ireland, the financial
21 incentives in private insurance are similar, and are associated with striking inequities in care
22 (54).
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31 **Policy and research implications**

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33 Increases in the cost of care and hospital charges have become central issues in policy
34 discussion in the United States and elsewhere (15, 55). While the public health care costs are
35 reaching unsustainable levels, hospital charges can have alarming effects on patients (55). In
36 addition, the potential negative clinical effects of CS on mothers and newborns have raised
37 concerns among clinicians, academics and policymakers alike (15).
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45 Recent studies and their media coverage and associated increase in public awareness of high
46 CS rates and changes in reimbursement policy have led to recent decreases of CS rates (18).
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49 Our study provides additional evidence to support policy and advocacy efforts that address
50 escalating CS rates, in particular their association with financial incentives. Effective policy
51 measures often require context, country or state specific policy analyses investigating
52 particular insurance schemes. These setting specific analyses are essential as incentives and
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3 reimbursement arrangements within health insurance schemes may differ across health care
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5 systems. We recognize that while categories 'public insurance' and 'private insurance' are useful
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7 markers of higher reimbursement rates, other aspects of insurance reimbursement may also influence
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9 the odds of CS.
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12 As we analyse CS rates relation with health insurance schemes we need also to be aware of
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14 complexity of interaction of different determinants and their influence in CS rates. The
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16 published literature has identified a number of determinants of CS rates which operate at
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18 different levels of health care systems (macro, meso, and micro) (15). At the macro level of
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20 national health systems, operate factors such as health financing system, social and political
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22 context, legal regulations, general cultural and social norms and similar. At the meso level are
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24 hospitals and health care facilities. Their ownership status, availability of resources and size
25
26 are known to influence CS rates (15, 22). Finally, at the micro level, we have clinical units
27
28 that provide care, medical staff and patients, which are characterised with all sorts of features
29
30 that can influence the decision for CS. For example, clinical unit staff composition, or
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32 physician education, gender and experience, or mother preference, age and race, are all
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34 known to determine the rates of CS (15).
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40 ***Conclusion***

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42 This systematic review and meta-analysis indicates that CS are more likely to be performed
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44 in privately insured women as compared to women with public health insurance coverage.
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46 Although this effect is small and variable across strata, it is present in all performed analysis.
47
48 Review of setting-specific payment levels and reimbursement arrangements within health
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50 insurance schemes will enable a better understanding of influencing factors. Efforts to
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52 address payment levels for delivery procedures and reform of reimbursement arrangements
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54 may lead to a reduction of CS rates to more appropriate levels (18, 22, 37, 56).
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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

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2
3 *All authors have completed the ICMJE uniform disclosure form at*
4
5 *www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the*
6
7 *submitted work; no financial relationships with any organisations that might have an interest*
8
9 *in the submitted work in the previous three years; no other relationships or activities that*
10
11 *could appear to have influenced the submitted work.*

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15
16 ***Funding statement***

17
18 *No funding was received to perform this study. All authors, had full access to all of the data*
19
20 *(including statistical reports and tables) in the study and take responsibility for the integrity*
21
22 *of the data and the accuracy of the data analysis.*

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26 ***Data sharing statement***

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28 *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

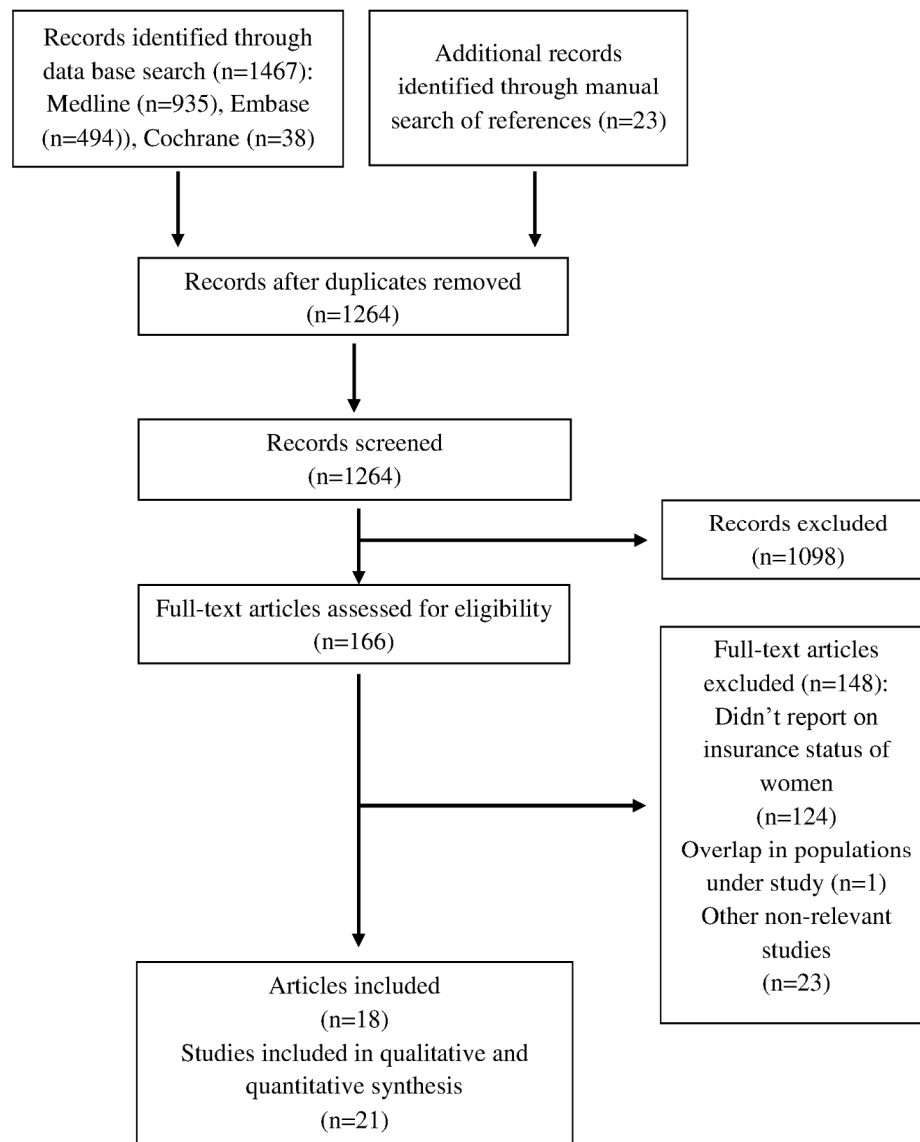


Figure 1. The flow diagram of review

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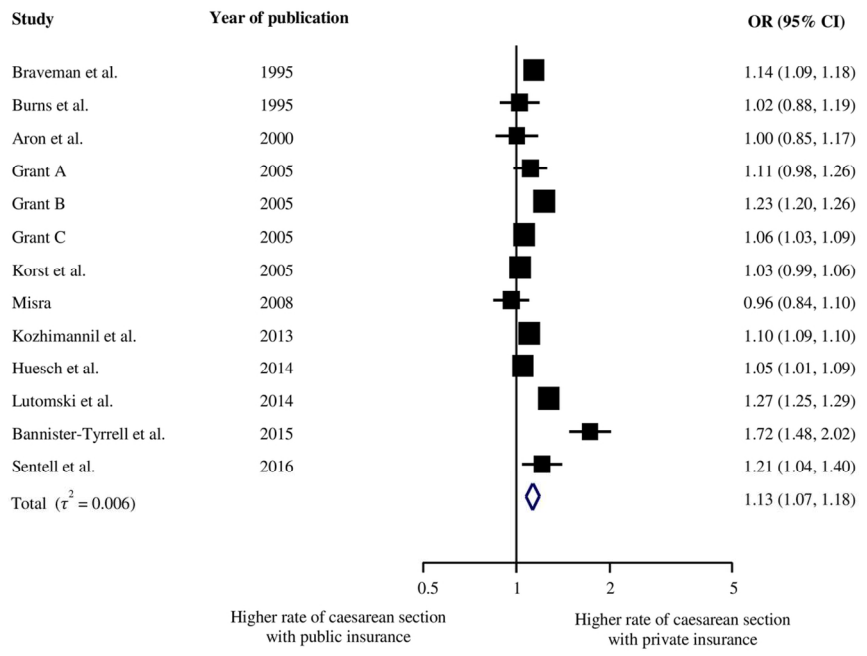


Figure 2. Adjusted odds ratios of caesarean section

118x83mm (300 x 300 DPI)

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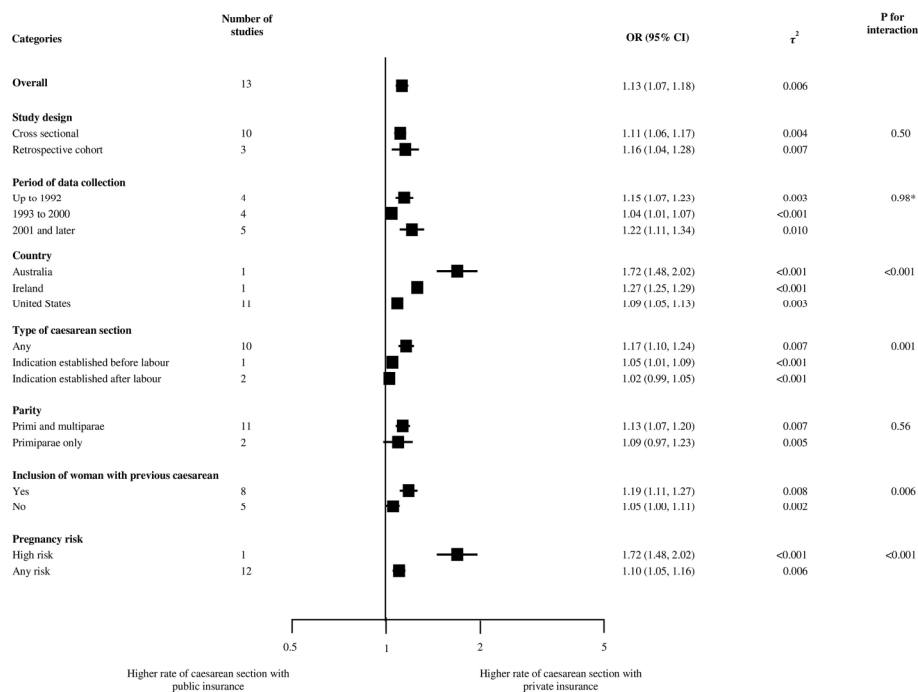


Figure 3. Stratified analyses/Legend: *P for trend

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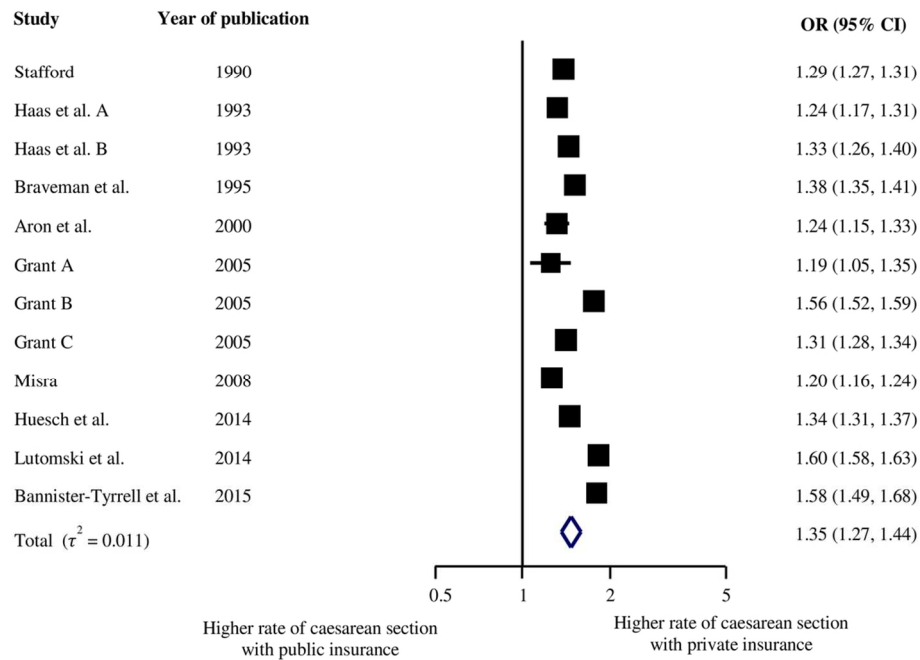


Figure 4. Crude odds ratios of caesarean section

108x76mm (300 x 300 DPI)

Appendix 1. Reported exclusion criteria

Authors	Year	Source population	Maternal characteristics					Fetus characteristics					Cases with missing data	Provider characteristics	Other factors		
			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
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		+		

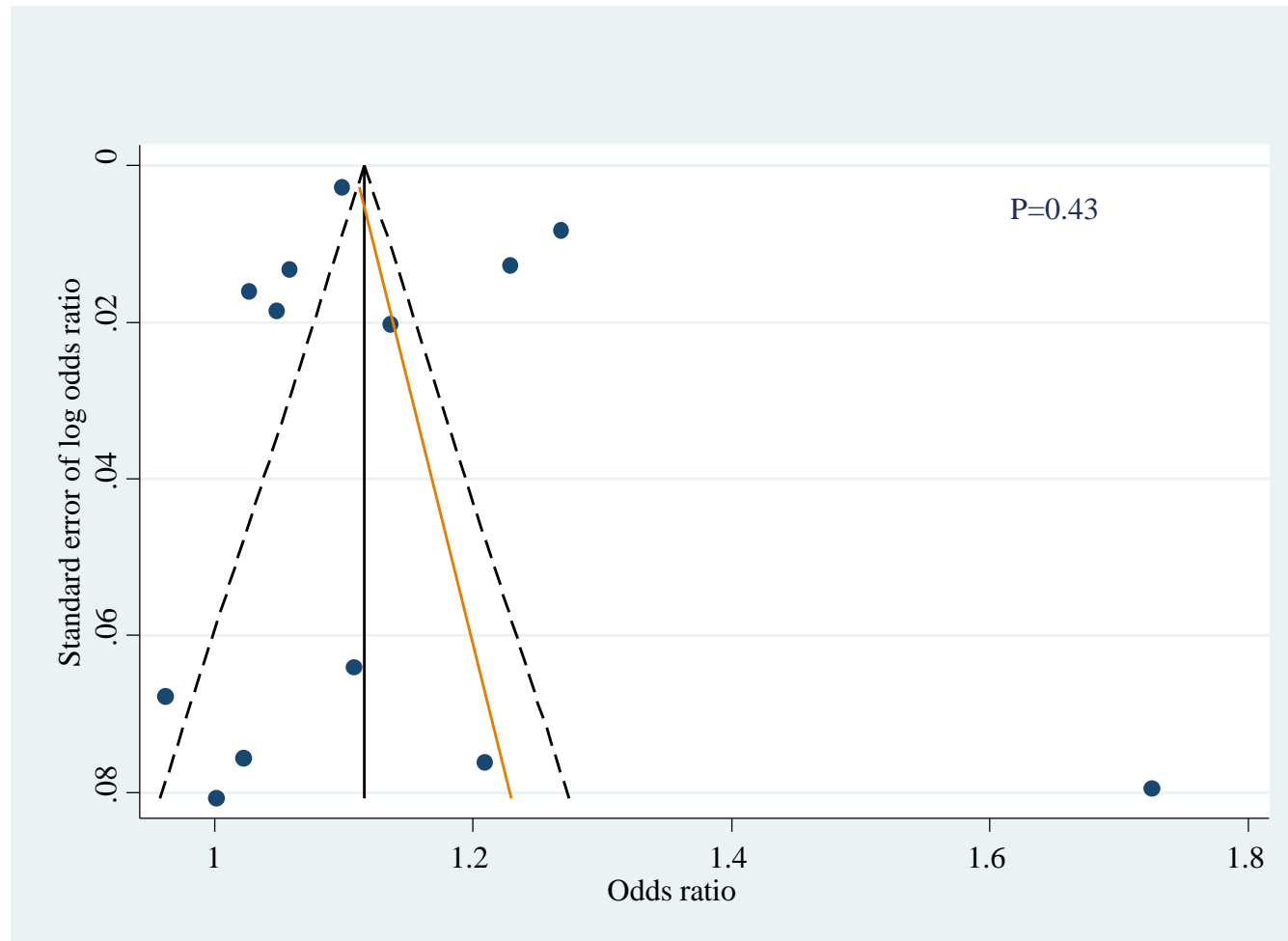
Appendix 3. Covariates used for statistical adjustment

Author	Year	Maternal preconception status							Maternal clinical status				Foetus characteristics			Prenatal care	Birth characteristics	Provider characteristics	Other variables	Total number of covariates		
		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
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	

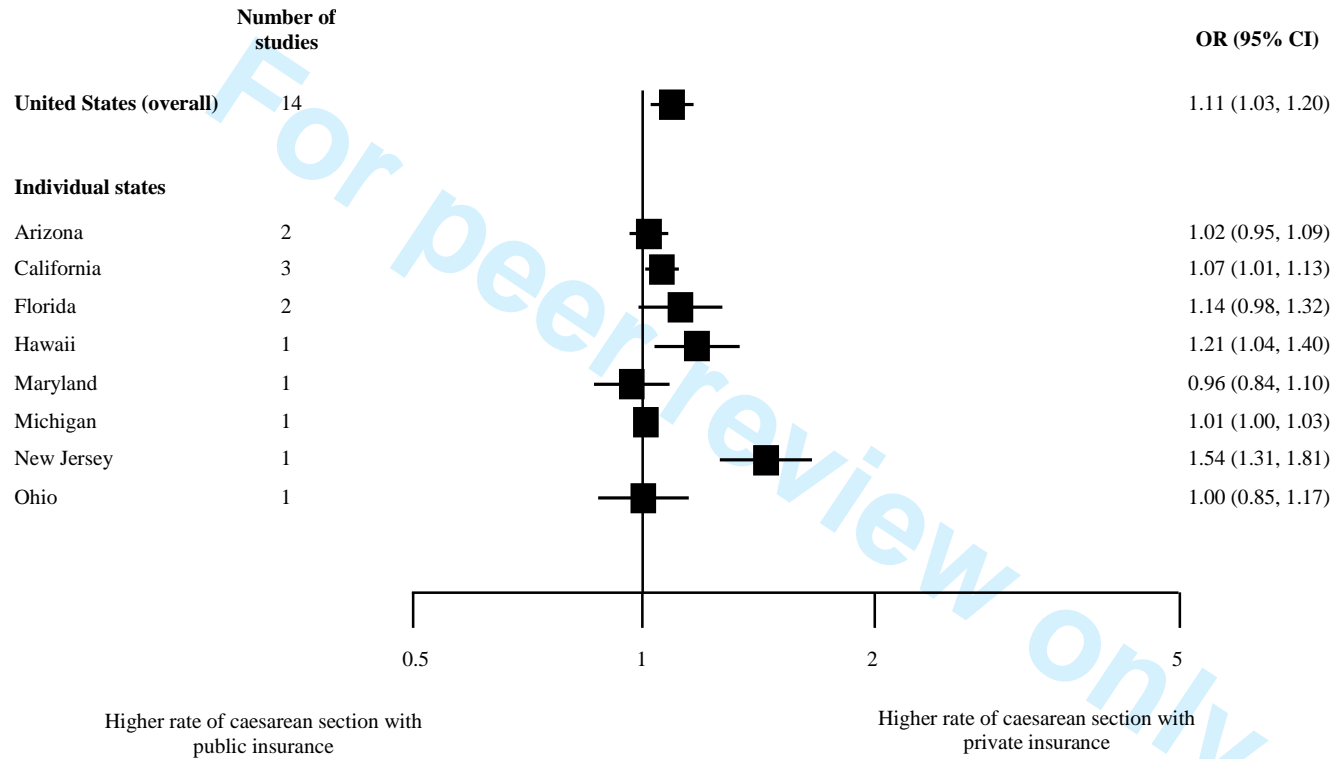
+ One covariate adjusted for ++ Two or more covariates adjusted for

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

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

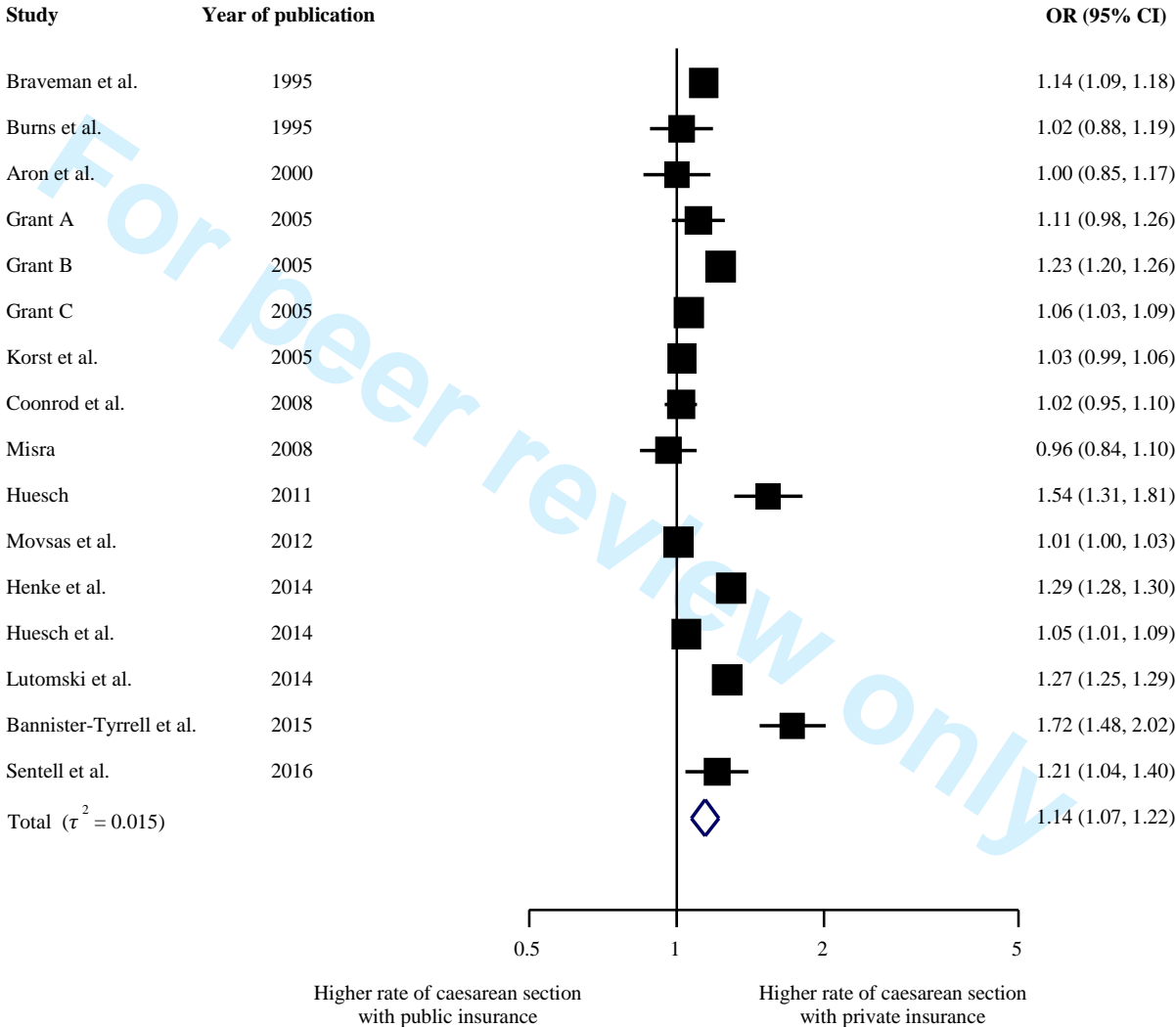


Appendix 5. Caesarean section rates in United States

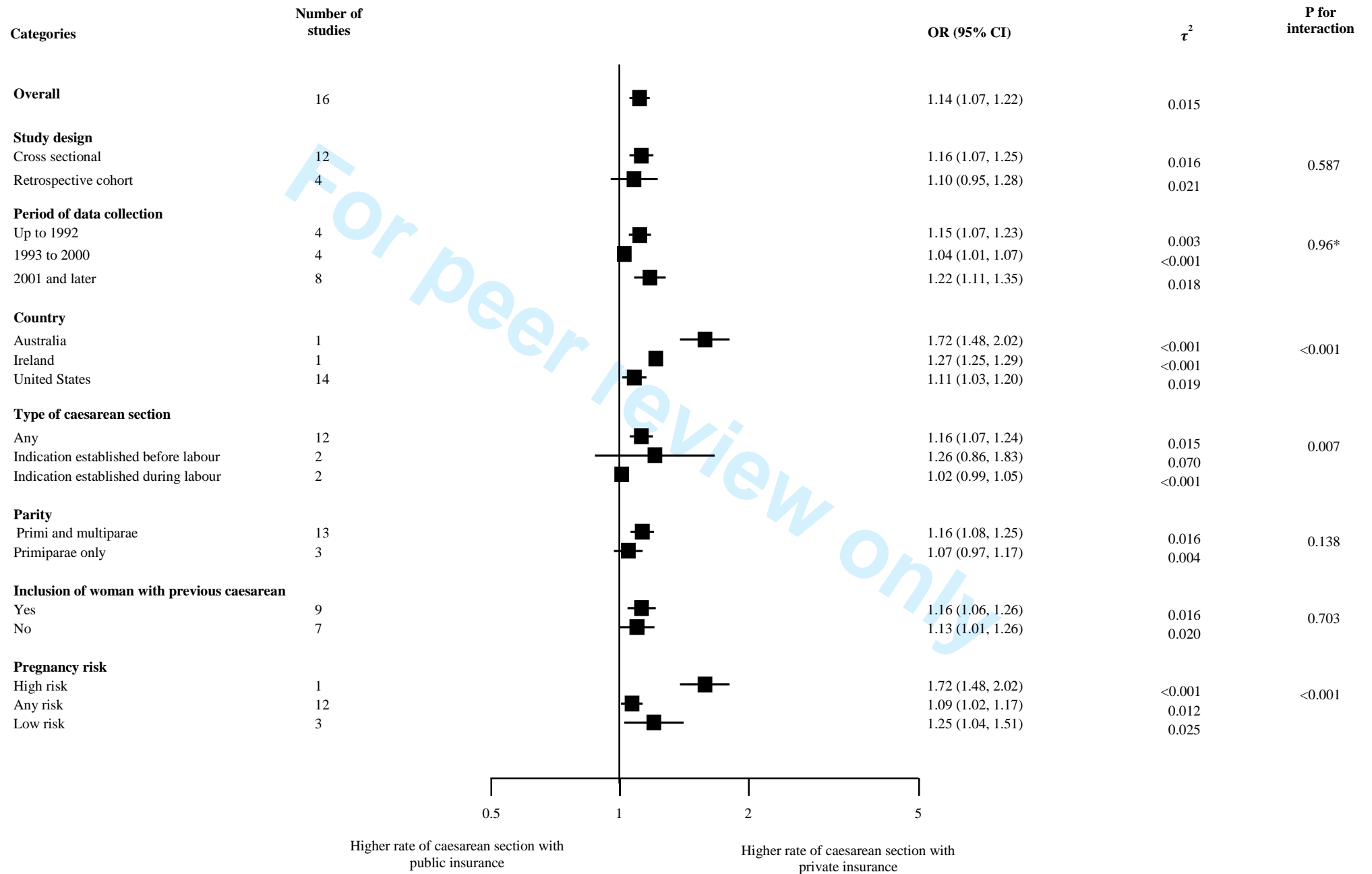


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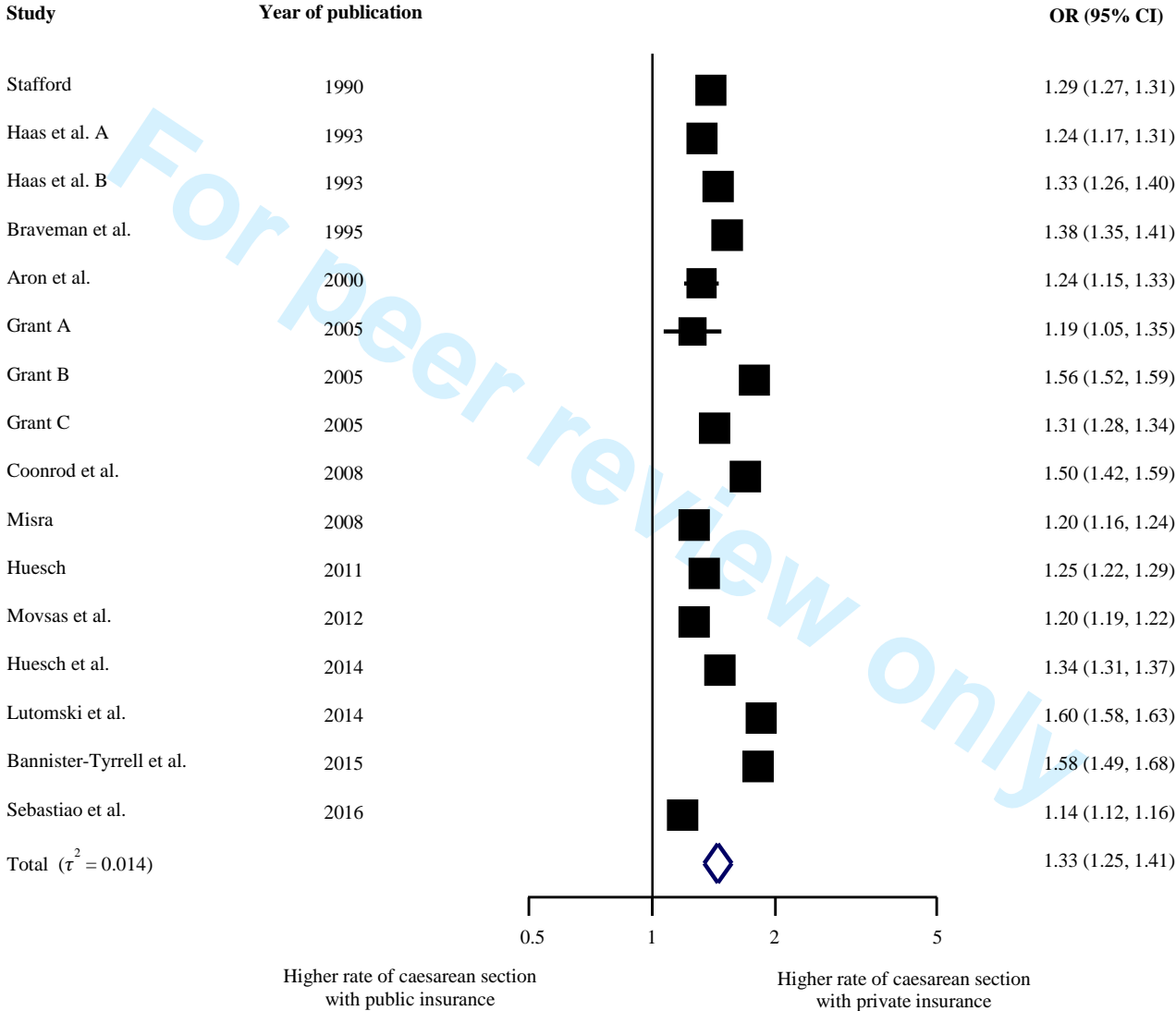
Appendix 6. Sensitivity analysis - Adjusted odds ratios of caesarean section



Appendix 7. Sensitivity analysis – stratified analyses



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	For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml		Advanced	Display More >>

1	16	12 and 15	413	Advanced	Display More >>
2	17	health care distribution/	2333	Advanced	Display More >>
3	18	health care utilization/	36879	Advanced	Display More >>
4	19	insurance/	33934	Advanced	Display More >>
5	20	choice behavior.mp.	765	Advanced	Display More >>
6	21	attitude to health/	81021	Advanced	Display More >>
7	22	patient participation/	16400	Advanced	Display More >>
8	23	doctor patient relation/	81043	Advanced	Display More >>
9	24	health economics/	33098	Advanced	Display More >>
10	25	obstetric procedure/	550	Advanced	Display More >>
11	26	health care access/	34433	Advanced	Display
12	27	health services research/	27579	Advanced	Display More >>
13	28	geographic distribution/	132846	Advanced	Display More >>
14	29	rural population/	30219	Advanced	Display More >>
15	30	urban population/	35323	Advanced	Display More >>
16	31	causes/	0	Advanced	Delete More >>
17	32	determinants/	1	Advanced	Display More >>
18	33	statistics/	301146	Advanced	Display More >>
19	34	rates/	0	Advanced	Delete More >>
20	35	factors/	0	Advanced	Delete More >>
21	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 >>
22	37	cesarean section/	59755	Advanced	Display More >>
23	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 >>
24	39	37 or 38	73014	Advanced	Display More >>
25	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 >>
26	41	28 or 40	1082827	Advanced	Display More >>
27	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

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
2				
3				
4	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
5				
6				
7	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
8				
9				
10	Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Page 4, 5
11				
12	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
13				
14	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
15				
16				
17	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
18				
19				
20				
21	RESULTS			
22				
23	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
24				
25				
26	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
27				
28				
29				
30	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
31				
32				
33	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
34				
35				
36	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
37				
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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

1
2 According to MOOSE statement for meta-analyses of observational studies
3
4
5

Reporting of background should include**Where to find in manuscript**

6
7
8 Problem definition

Manuscript (page 5)

9
10 Hypothesis statement

Manuscript (page 5)

11
12 Description of study outcome(s)

Manuscript (page 6)

13
14 Type of exposure or intervention used

Manuscript (page 6)

15
16 Type of study designs used

Manuscript (page 6)

17
18 Study population

Manuscript (page 6)

Reporting of search strategy should include

19
20 Qualifications of searchers (eg, librarians and investigators)

Manuscript (page 6)

21
22 Search strategy, including time period included in the synthesis and

Manuscript (pages 5), Appendix 9

23
24 keywords

25
26 Effort to include all available studies, including contact with authors

Manuscript (page 5-6)

27
28 Databases and registries searched

Manuscript (page 6)

29
30 Search software used, name and version, including special features

Manuscript (page 6)

31
32 used (eg, explosion)

33
34 Use of hand searching (eg, reference lists of obtained articles)

Manuscript (page 6)

35
36 List of citations located and those excluded, including justification

Appendix 1

37
38 Method of addressing articles published in languages other than

n/a

39
40 English

41
42 Method of handling abstracts and unpublished studies

Manuscript (page 6)

43
44 Description of any contact with authors

No contact made

Reporting of methods should include

45
46 Description of relevance or appropriateness of studies assembled for

Manuscript (page 6)

47
48 assessing the hypothesis to be tested

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	Manuscript (page 6)
38	Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	Manuscript (pages 6)
39	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	Manuscript (page 6-7) Appendix 3
40	Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	n/a
41	Assessment of heterogeneity	Manuscript (page 6-7)
42	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)
43	Provision of appropriate tables and graphics	Manuscript, Table 1, Figure 1-3 and Appendixes 1-8
44	Reporting of results should include	
45	Graphic summarizing individual study estimates and overall estimate	Figure 2-4
46	Table giving descriptive information for each study included	Table 1
47	Results of sensitivity testing (eg, subgroup analysis)	Figure 2, Appendixes 5-8
48	Indication of statistical uncertainty of findings	Manuscript, Figure 2-4
49	Reporting of discussion should include	
50	Quantitative assessment of bias (eg, publication bias)	Manuscript (page 8-9)
51	Justification for exclusion (eg, exclusion of non—English-language citations)	n/a
52	Assessment of quality of included studies	n/a

Reporting of conclusions should include

1		
2	Consideration of alternative explanations for observed results	Manuscript (pages 10-12)
3		
4	Generalization of the conclusions (ie, appropriate for the data	Manuscript (page 12-13)
5		
6	presented and within the domain of the literature review)	
7		
8		
9	Guidelines for future research	Manuscript (page 12)
10		
11	Disclosure of funding source	Manuscript (page 14)
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For peer review only

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-016600.R2
Article Type:	Research
Date Submitted by the Author:	07-Jul-2017
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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

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Manuscripts

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 ($\tau^2=0.006$). 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 ($\tau^2=0.011$).

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

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

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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

1
2
3 increase of CS rates. We did not restrict search by type of language or publication date. We
4
5 searched MEDLINE, Embase, and The Cochrane Library from inception to August 4, 2016,
6
7 when the search was last updated. In addition, we manually searched the reference lists of all
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9 included studies and earlier systematic reviews that we identified.
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12 ***Study selection and outcomes***

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14 To be eligible for inclusion, studies had to report data to allow the calculation of odds ratios
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16 (OR) of CS comparing women covered by private insurance with women covered by public
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18 insurance in a specific health care system. The pre-specified primary outcome was the
19
20 adjusted OR of births delivered by CS of women covered with private insurance as compared
21
22 with women with public insurance coverage. The pre-specified secondary outcome was the
23
24 crude OR of CS of women covered with private insurance as compared with women with
25
26 public insurance.
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30 ***Data extraction***

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32 Two researchers (IH and MB) screened the papers and extracted data independently. Data
33
34 from full text articles were extracted onto a data extraction sheet designed to capture data on
35
36 study population, study design, data sources, setting, type of CS analysed, and statistical
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38 analysis. We extracted adjusted and/or unadjusted ORs of CS of women with private
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40 insurance as compared with CS of women with public insurance. Differences among
41
42 researchers with regards to study inclusion and data extraction procedure were resolved by
43
44 consensus and consultation with other authors.
45
46
47
48

49 ***Quality assessment***

50
51 Quality assessment was performed using the Quality In Prognostic Studies (QUIPS) tool
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53 (23). The QUIPS is used to assess bias in prognostic studies across six domains including:
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55 selection bias; attrition bias, measurement bias of prognostic factor and outcome,
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3 confounding; and bias related to the statistical analysis and presentation of results (23). We
4
5 decided to use QUIPS tool as it seemed the most appropriate to perform quality assessment of
6
7 the studies under investigation. Only minor adjustment of the original tool was performed,
8
9 i.e. we added the option “not applicable” in rating of issues assessed for judging domains of
10
11 bias. Each study was read in full and evaluated independently by two researchers (IH and
12
13 MB). We used three levels of rating, i.e. “high”, “moderate”, or “low” to assess the risk of
14
15 bias for all domains (23). Any assessment differences were discussed and a single rating was
16
17 assigned to each study. A study was judged with a high or a moderate risk of bias in case only
18
19 one of the domains was assessed with a high or a moderate risk of bias. A study was judged
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21 with a low risk of bias in case all the six domains were rated with a low risk of bias.
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26 *Main analysis*

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28 We used standard inverse-variance random effects meta-analysis to estimate the pooled OR.
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30 An OR above one indicates that CS are more frequently performed in women with private
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32 insurance than in women with public insurance. We calculated the variance estimate τ^2 as a
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34 measure of heterogeneity between studies (24). We pre-specified a τ^2 of 0.04 to represent low
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36 heterogeneity, 0.16 to represent moderate, and 0.36 to represent high heterogeneity between
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38 studies (25). We conducted analyses stratified by study design, period of data collection,
39
40 country, type of CS analysed, parity, inclusion of women with previous CS, pregnancy risk of
41
42 included women and QUIPS risk of bias to investigate potential reasons for between-study
43
44 heterogeneity and used chi-square tests to calculate p-values for interaction, or tests for linear
45
46 trends in cases of more than two ordered strata. All p-values are two-sided.
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51 *Sensitivity analyses*

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53 Five studies (26-30) were excluded from the main analysis, as they had an overlapping
54
55 population with a larger study (31) that was included. For this reason, we repeated all
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3 analyses including these five studies (26-30) while excluding the larger one (31). Finally, we
4
5 visually inspected a funnel plot of adjusted ORs against their standard errors to address
6
7 potential small study effects (32). We used STATA, release 13, for all analyses (Stata-Corp,
8
9 College Station, Texas).

10 11 12 ***Patient involvement***

13
14 No patients were involved in this study. We used data from published papers only.
15
16
17

18 19 **Results**

20
21 We identified a total of 1490 records with our search strategy (Figure 1): 935 from Medline:
22
23 494 from Embase; 38 from the Cochrane Library and 23 from manual search. After removing
24
25 duplicates, we screened 1264 records for eligibility, and retained 166 for full text
26
27 examination. We excluded another 124 that did not report insurance status of women, 23 that
28
29 were otherwise irrelevant and one study that had an overlapping population. Finally, 18
30
31 articles describing 21 separate studies in 12.9 million women were included in review and
32
33 meta-analysis.
34
35

36
37 Characteristics of studies are presented in Table 1 and Appendixes 1,2 and 3. Sixteen studies
38
39 were cross-sectional, five were retrospective cohort studies. Only one study used surveys, 18
40
41 hospital records, seven birth registries, and one census data. All studies were published in
42
43 English. Most studies were from the United States. Nineteen studies included the entire
44
45 population of eligible cases, while only two studies selected cases randomly. Case exclusion
46
47 criteria varied considerably: one study excluded women aged 14 and younger; three excluded
48
49 multiparas; eight excluded women with previous CS; eight excluded stillbirths and nine
50
51 multiple births; six excluded cases with specific presentations of the foetus; six studies
52
53 excluded preterm births, and 13 studies excluded cases due to provider characteristics. Two
54
55 studies reported ORs of CS for which indication was established before labour (including CS
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3 on maternal request) only, three reported CS for which indication was established during
4 labour and 16 reported ORs of any CS irrespective of indication. Seventeen studies adjusted
5 for different characteristics as presented in Appendix 3. Quality assessment is presented in
6 Appendix 4 and 5. No studies were excluded due to quality assessment result. Five studies
7 were rated with high risk of bias, ten studies with moderate risk of bias and six studies with
8 low risk of bias.

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

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47 Appendixes 8 to 10 report results from sensitivity analyses after inclusion of five smaller
48 studies (26-30) and exclusion of a larger study (31) that had overlapping populations with the
49 five smaller ones. Appendix 8 shows the meta-analysis of the 16 studies (26-29, 33-42) with
50 a pooled adjusted OR of 1.14 (95% CI 1.07 to 1.22) and no evidence for relevant
51 heterogeneity between studies ($\tau^2=0.015$). Appendix 9 presents results of stratified analyses,
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3 with estimates varying between countries (P for interaction<0.001), type of caesarean section
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5 (P for interaction=0.007) and pregnancy risks (P for interaction<0.001). Finally, Appendix 10
6
7 presents the meta-analysis of crude ORs, again with a stronger association on average (pooled
8
9 OR 1.33, 95% CI 1.25 to 1.41) and no relevant heterogeneity between studies ($\tau^2=0.014$).
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12 13 **Discussion**

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15 Our systematic review and meta-analysis estimated that the overall odds of receiving a
16
17 caesarean section are on average 1.13 times higher for privately insured women compared
18
19 with women covered with public insurance. The increased risk was observed across all
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21 subgroups of studies in stratified analyses as well as in sensitivity analysis.
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25 26 **Context**

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28 To our knowledge, this is the first meta-analysis to examine the association of CS rates with
29
30 types of insurance. A recently published meta-analysis found that the odds of delivery by CS
31
32 was 1.41 higher in for-profit hospitals as compared with non-profit hospitals (95% CI 1.24 to
33
34 1.60) (22). These findings were confirmed across subgroups (i.e. such as country, year, or
35
36 study design) of studies in stratified analyses, indicating financial incentives may play an
37
38 important role in such outcome (22). We found three other recent meta-analyses that
39
40 summarized CS studies and found a strong association with obesity (43), Sub-Saharan Africa
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42 ethnic origin (44) and labour induction (45). Our estimates of a 14 percent increase are on the
43
44 lower end of the strength of associations found in earlier studies.
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49 50 **Strengths and limitations**

51
52 The major strengths of our meta-analysis include a broad literature search (Appendix 11),
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54 screening and data extraction performed in duplicate, an exploration of study characteristics
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56 as a potential source of variation between studies, sensitivity analyses involving studies that
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3 required exclusion due to overlapping populations and firm quality assessment using QUIPS
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5 tool. Major limitations are differences in the characteristics of the study populations, type of
6
7 data used, types of CS analysed and variables used for adjustment in statistical analyses
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9 across studies. Unadjusted estimates of associations were larger, which suggests the presence
10
11 of confounding, and we cannot completely rule out residual confounding in adjusted
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13 estimates.
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16 17 *Mechanisms*

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19 Existing evidence suggests that possible causes for higher odds of CS in women insured privately lie
20
21 in the differences in payment for CS and reimbursement arrangements among insurers as well as
22
23 providers' responses to these arrangements. In the countries included in our analysis, private health
24
25 insurers generally reimburse hospitals at higher fees for providing a CS compared to the public
26
27 insurers (36). This incentive is heightened when public insurance funds hospital care through
28
29 a budget (e.g. Australia and Ireland) rather than fee-for-service, which is common in private
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31 insurance (46, 47). Similar incentives are present in physician payment.
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35 Multiple studies have shown that hospitals are motivated by and responsive to financial
36
37 incentives (22, 34, 48, 49), although Grant (36) argues that their impact is small. One
38
39 example is the financial benefit associated with longer hospital stays associated with CS (48,
40
41 50). Hospitals may incentivize physicians (48, 49) to align their clinical decision with
42
43 institutional strategies, such as patient scheduling policies that steer patients with private
44
45 insurance to more profit prone physicians (48, 49). Physicians are known to be motivated by
46
47 higher fees paid for CS as compared with vaginal delivery (48). They often act as self-
48
49 interested economic agents according to economic models of physician behaviour, by
50
51 maximizing income and convenience (34). Physicians are also in a position to exploit
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53 asymmetry of information between them and patients (51, 52), which leads to
54
55 recommendations that are not always aligned with patient needs or preferences (15). There is
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3 also evidence that physicians with higher numbers of privately insured patients will tend to
4
5 perform more CS (34, 36); explanations include perceptions that patients with private
6
7 insurance have a higher social class, or more prevalent concerns about malpractice liability in
8
9 patients with private insurance (53).
10

11
12 Comparing 'public insurance' and 'private insurance' across countries is not a
13
14 straightforward exercise as the meaning of such distinction can vary substantially across
15
16 countries. In the United States 'public insurance' is insurance assigned to specific categories
17
18 of population (by age, disability, poverty or military service) and 'private insurance' is
19
20 insurance mainly organized through employment. In general, private insurance offers higher
21
22 reimbursement rates for surgical procedures, and this may incentivize CS. The heterogeneity
23
24 of adjusted estimates across states in the United States (Appendix 7) points to setting specific
25
26 factors that will influence the effect of insurance on the odds of CS and are worth of further
27
28 investigation. According to Burns et al., the lacking association in Arizona (OR=1.02) may
29
30 be due to equal magnitudes of re-imbursments of hospitals for vaginal birth and CS (34). In
31
32 Maryland (OR=0.96), the state administration introduced HealthChoice Program in 1997, that
33
34 was intended to provide prevention oriented healthcare services, enact better accountability
35
36 measures for managed care organizations, and ensure efficient use of financial resources (38).
37
38 This program introduced a mandatory managed care system for Medicaid beneficiaries,
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40 which replaced a fee-for-service model. This resulted in more patients receiving managed
41
42 care irrespective of their insurance status and, in turn, use of similar policies in patients with
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44 public and private insurance (38). We are unaware of plausible explanations for the lack of
45
46 associations observed in Michigan (OR 1.01) and Ohio (OR 1.00). This analysis shows that
47
48 variation in CS rates among insurers within the United States can be explained by differences
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50 in reimbursement arrangements nested within public and private insurance.
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3 For the other two countries, Ireland and Australia, included in the adjusted analysis, 'private health
4 insurance' status differs in character from the United States but offers similarly higher payment levels
5 for procedures. In Australia, women of childbearing age with private insurance, would have increased
6 the use of private obstetricians, leading to higher rates of CS (54). In Ireland, the financial
7 incentives in private insurance are similar, and are associated with striking inequities in care
8 (55).

17 **Policy and research implications**

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

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

54 As we analyse CS rates relation with health insurance schemes we need also to be aware of
55 complexity of interaction of different determinants and their influence in CS rates. The
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3 published literature has identified a number of determinants of CS rates which operate at
4
5 different levels of health care systems (macro, meso, and micro) (15). At the macro level of
6
7 national health systems, operate factors such as health financing system, social and political
8
9 context, legal regulations, general cultural and social norms and similar. At the meso level are
10
11 hospitals and health care facilities. Their ownership status, availability of resources and size
12
13 are known to influence CS rates (15, 22). Finally, at the micro level, we have clinical units
14
15 that provide care, medical staff and patients, which are characterised with all sorts of features
16
17 that can influence the decision for CS. For example, clinical unit staff composition, or
18
19 physician education, gender and experience, or mother preference, age and race, are all
20
21 known to determine the rates of CS (15).
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26 ***Conclusion***

27
28 This systematic review and meta-analysis indicates that CS are more likely to be performed
29
30 in privately insured women as compared to women with public health insurance coverage.
31
32 Although this effect is small and variable across strata, it is present in all performed analysis.
33
34 Review of setting-specific payment levels and reimbursement arrangements within health
35
36 insurance schemes will enable a better understanding of influencing factors. Efforts to
37
38 address payment levels for delivery procedures and reform of reimbursement arrangements
39
40 may lead to a reduction of CS rates to more appropriate levels (18, 22, 38, 57).
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20 21 22 **Contributorship Statement**

23
24 *IH, LS, DG, PJ conceived and designed the study. IH, LS, MB performed the data extraction*
25 *and preparation. IH, LS, Bdc, PJ analysed the data. IH, DG, PJ wrote the paper, which was*
26 *critically reviewed and approved by all authors.*
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33 *execution of search strategy, Andre Busato and Xhylyjeta Luta for support in study design and*
34 *data extraction and Dr. Karmit Zysman for editorial contribution.*
35
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40 41 **Competing interests statement**

42
43 *All authors have completed the ICMJE uniform disclosure form at*
44 www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the
45 submitted work; no financial relationships with any organisations that might have an interest
46 in the submitted work in the previous three years; no other relationships or activities that
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2
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5 *of the data and the accuracy of the data analysis.*
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10 ***Data sharing statement***

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12 *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

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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

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Appendix 5. QUIPS risk of bias (chart)

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

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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

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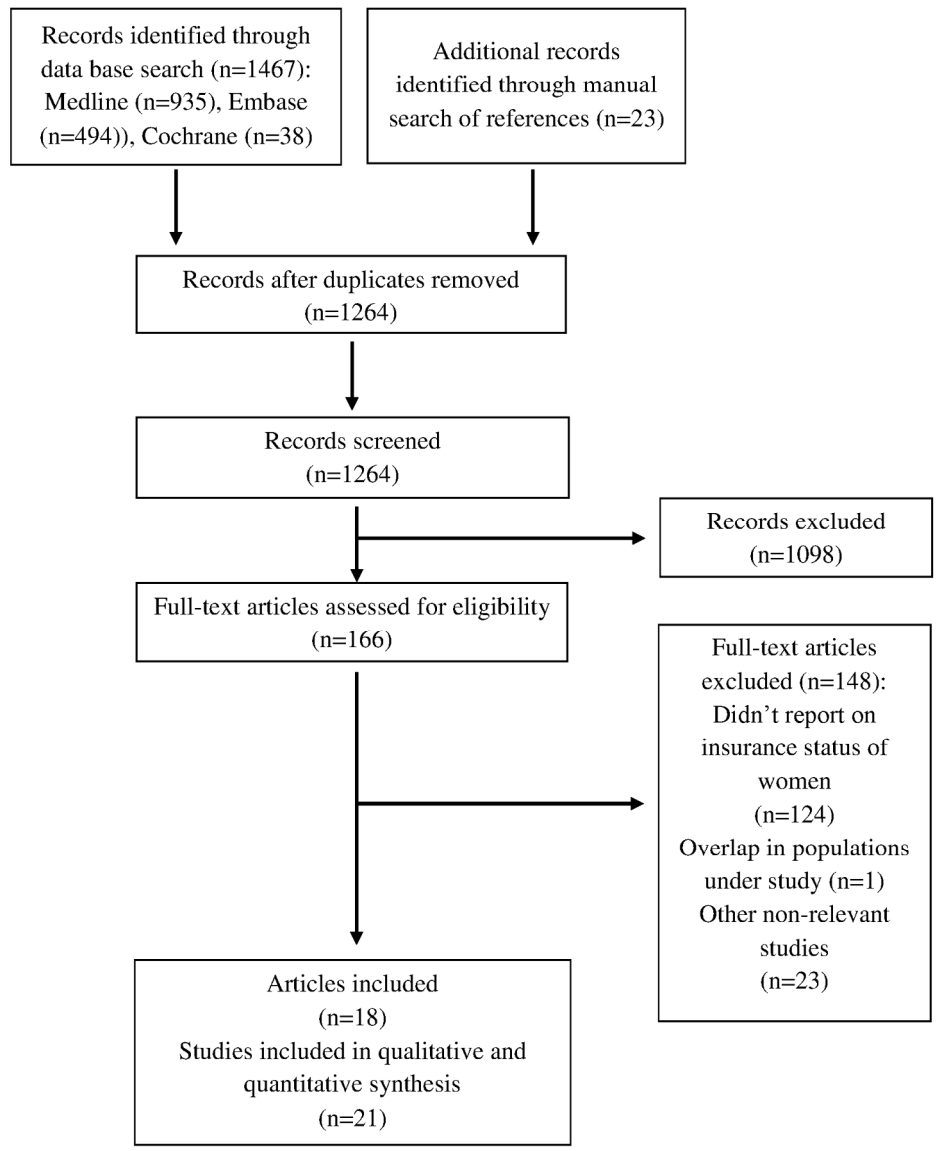


Figure 1. The flow diagram of review

164x201mm (300 x 300 DPI)

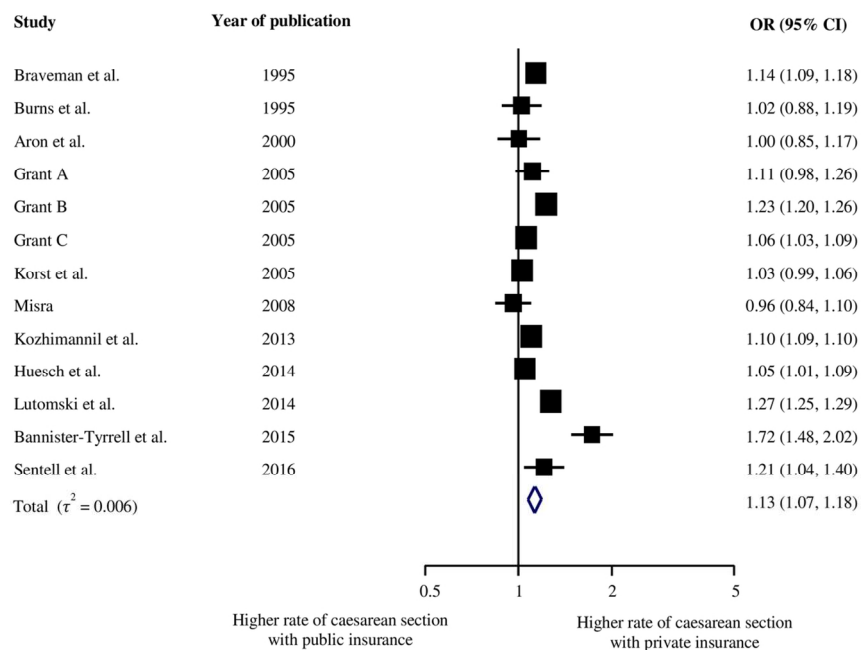


Figure 2. Adjusted odds ratios of caesarean section

118x83mm (300 x 300 DPI)

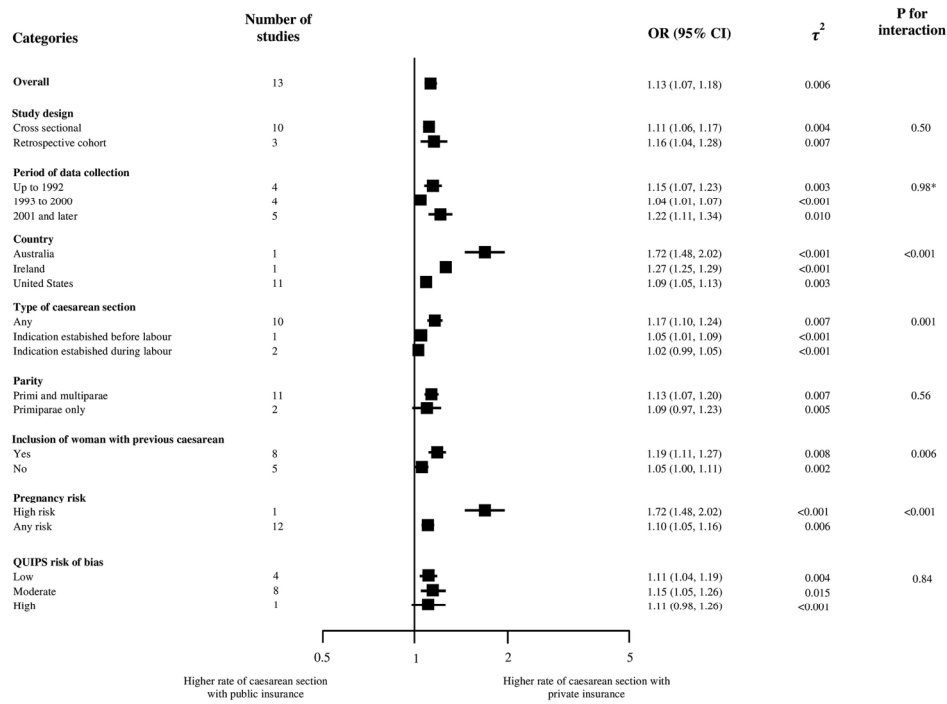


Figure 3. Stratified analyses/Legend: *P for trend

155x109mm (300 x 300 DPI)

Review only

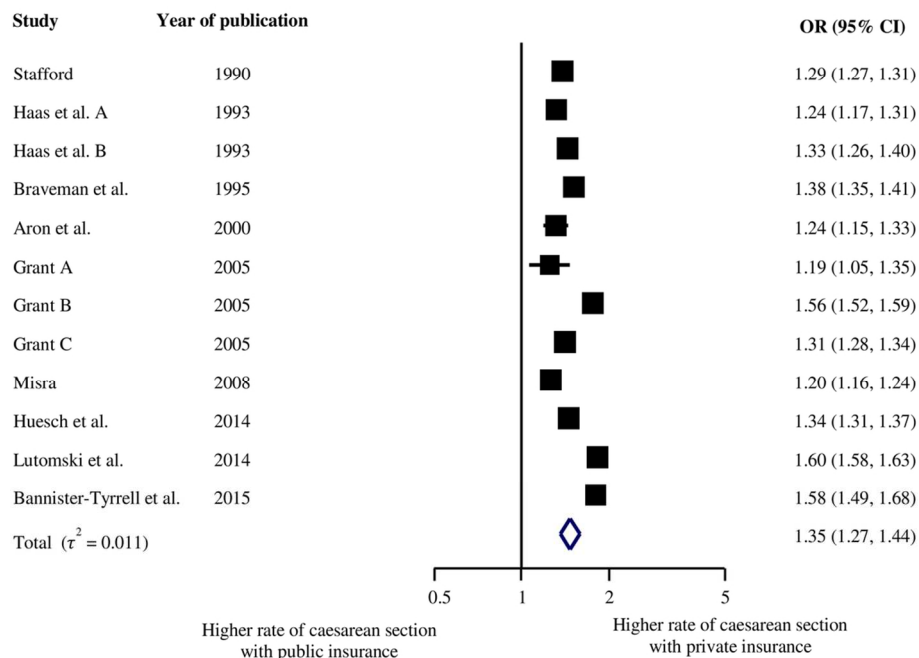


Figure 4. Crude odds ratios of caesarean section

108x76mm (300 x 300 DPI)

ew only

Appendix 1. Reported exclusion criteria

Authors	Year	Source population	Maternal characteristics					Fetus characteristics										
			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

Author	Year	Maternal preconception status									Maternal clinical status				Foetus characteristics					Total number of covariates				
		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	
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

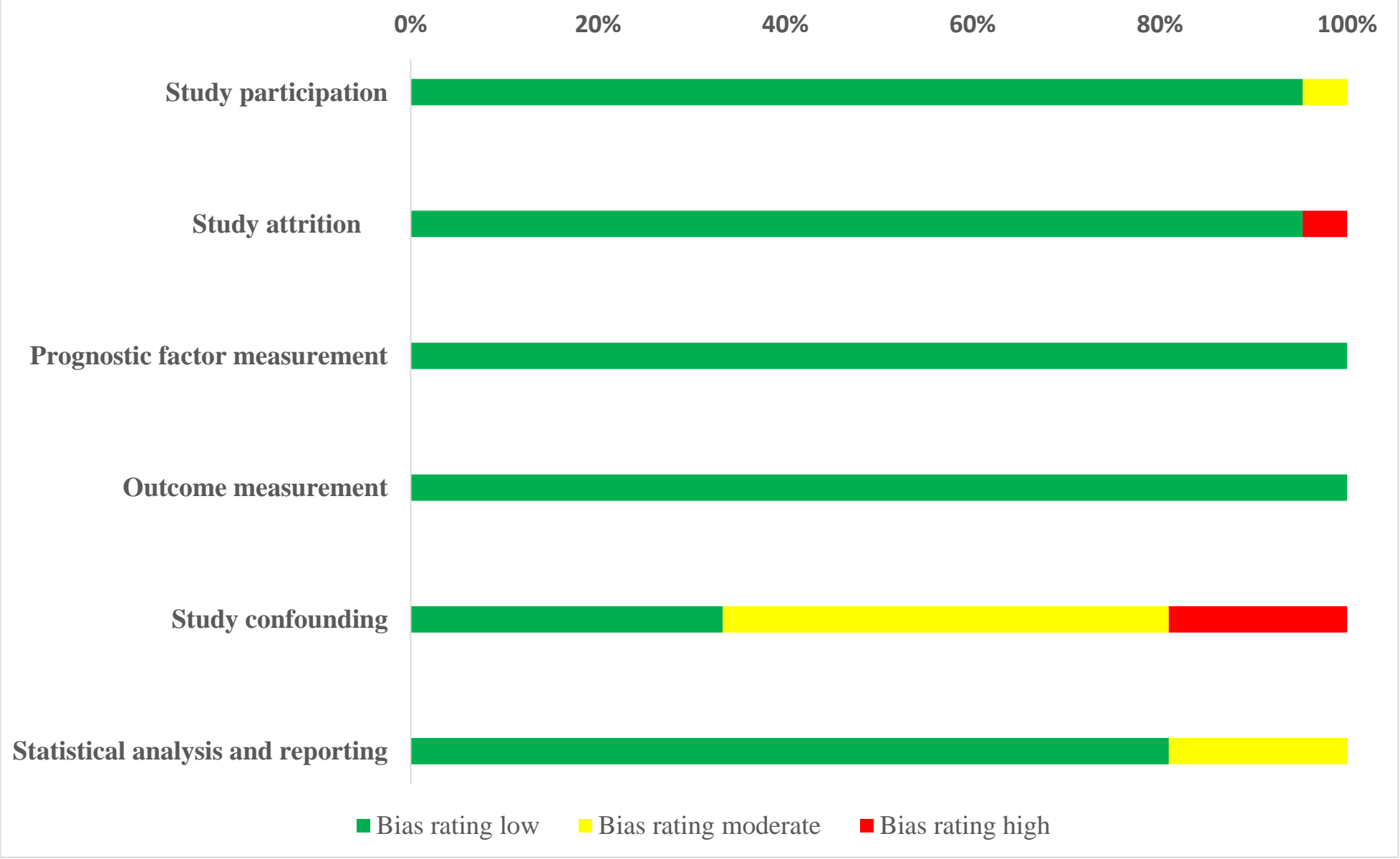
+ One covariate adjusted for ++ Two or more covariates adjusted for

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

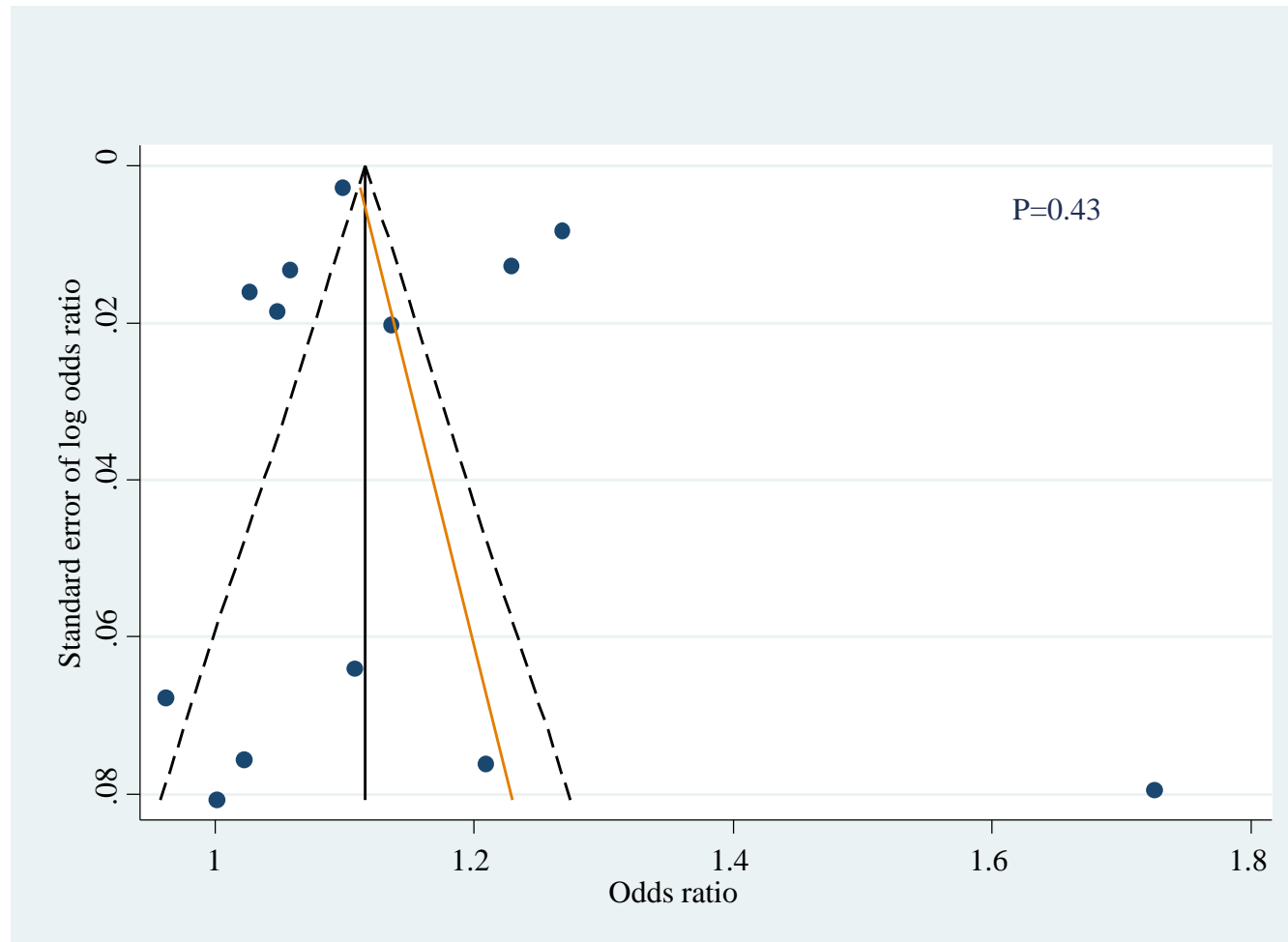
Appendix 4. QUIPS risk of bias

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

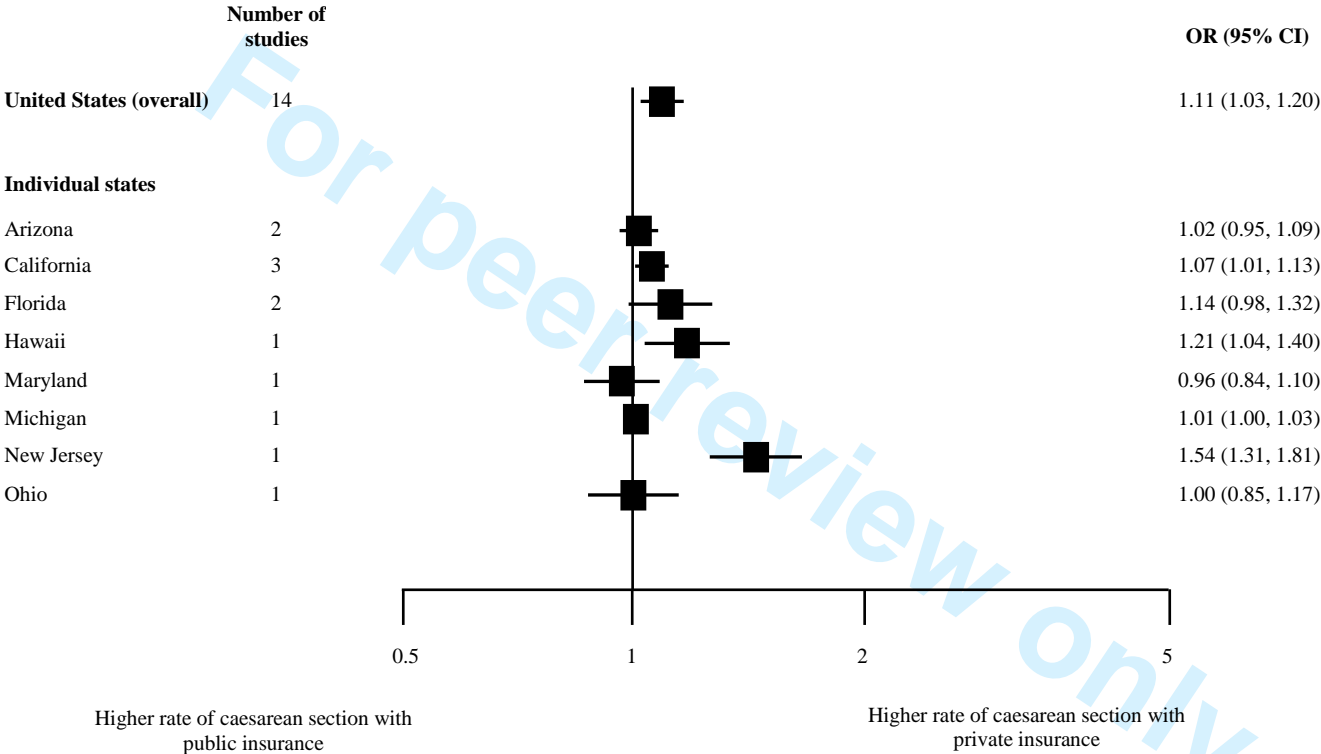
Appendix 5 - QUIPS risk of bias



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

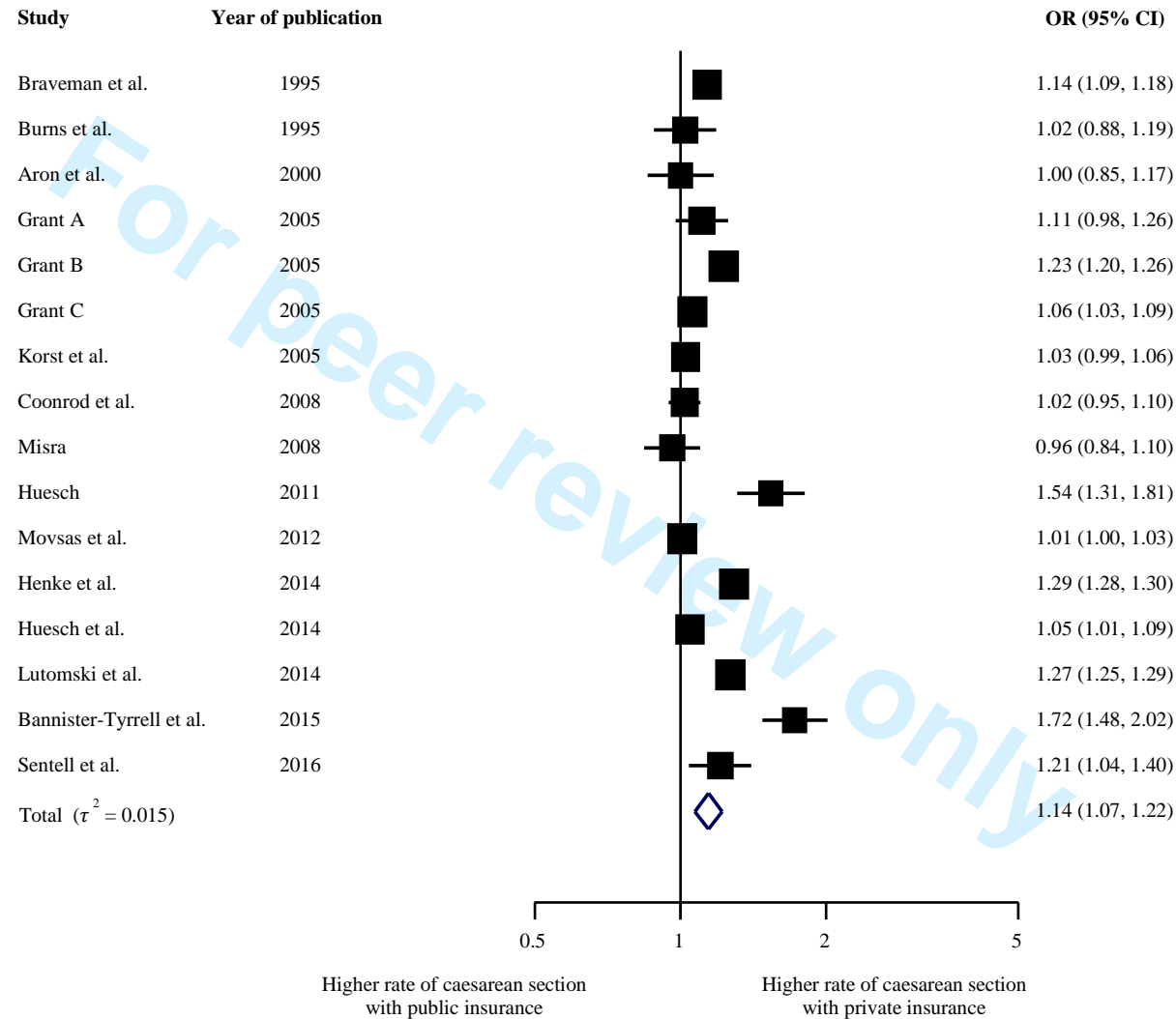


Appendix 7. Caesarean section rates in the United States



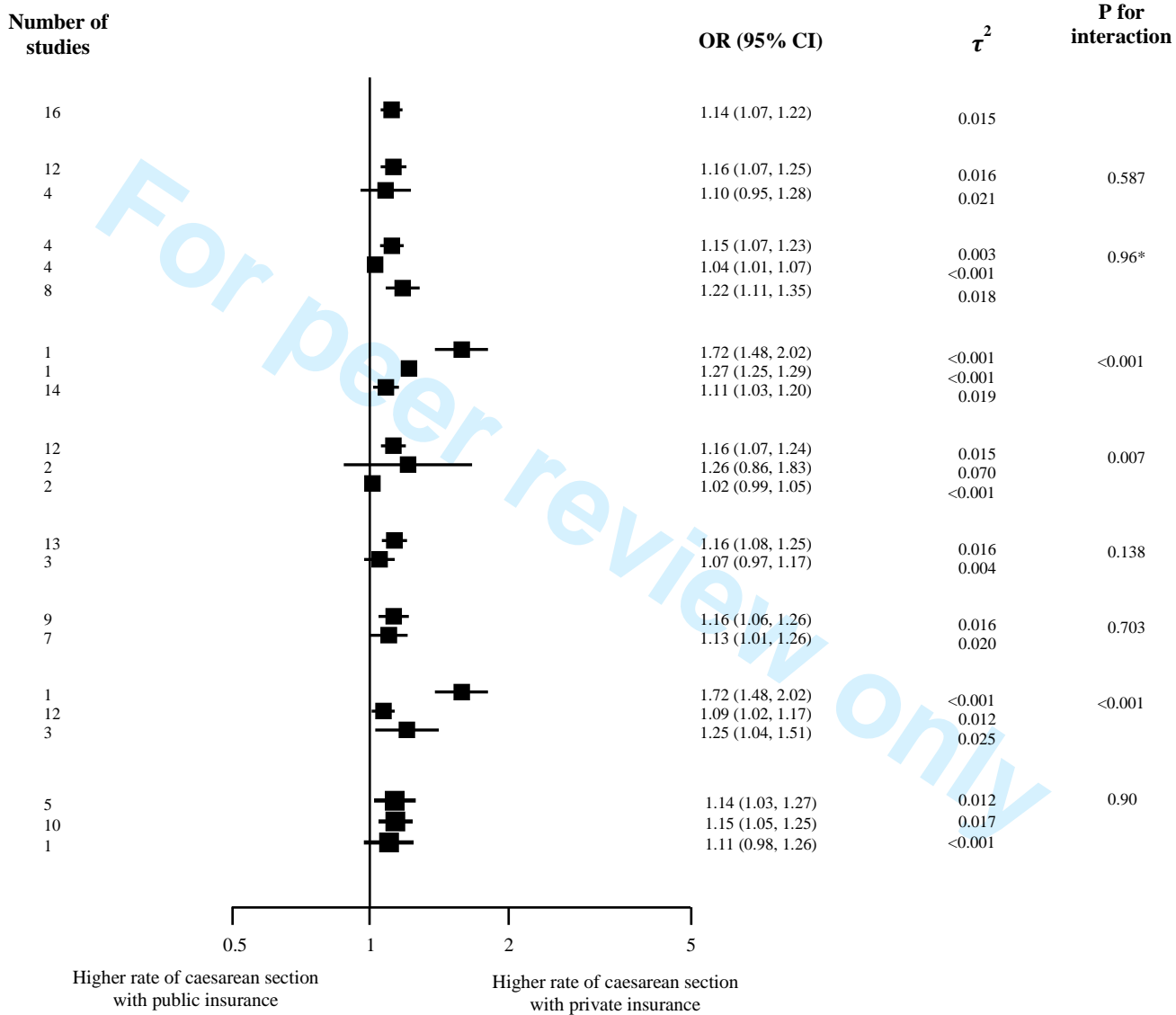
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Appendix 8. Sensitivity analysis - Adjusted odds ratios of caesarean section



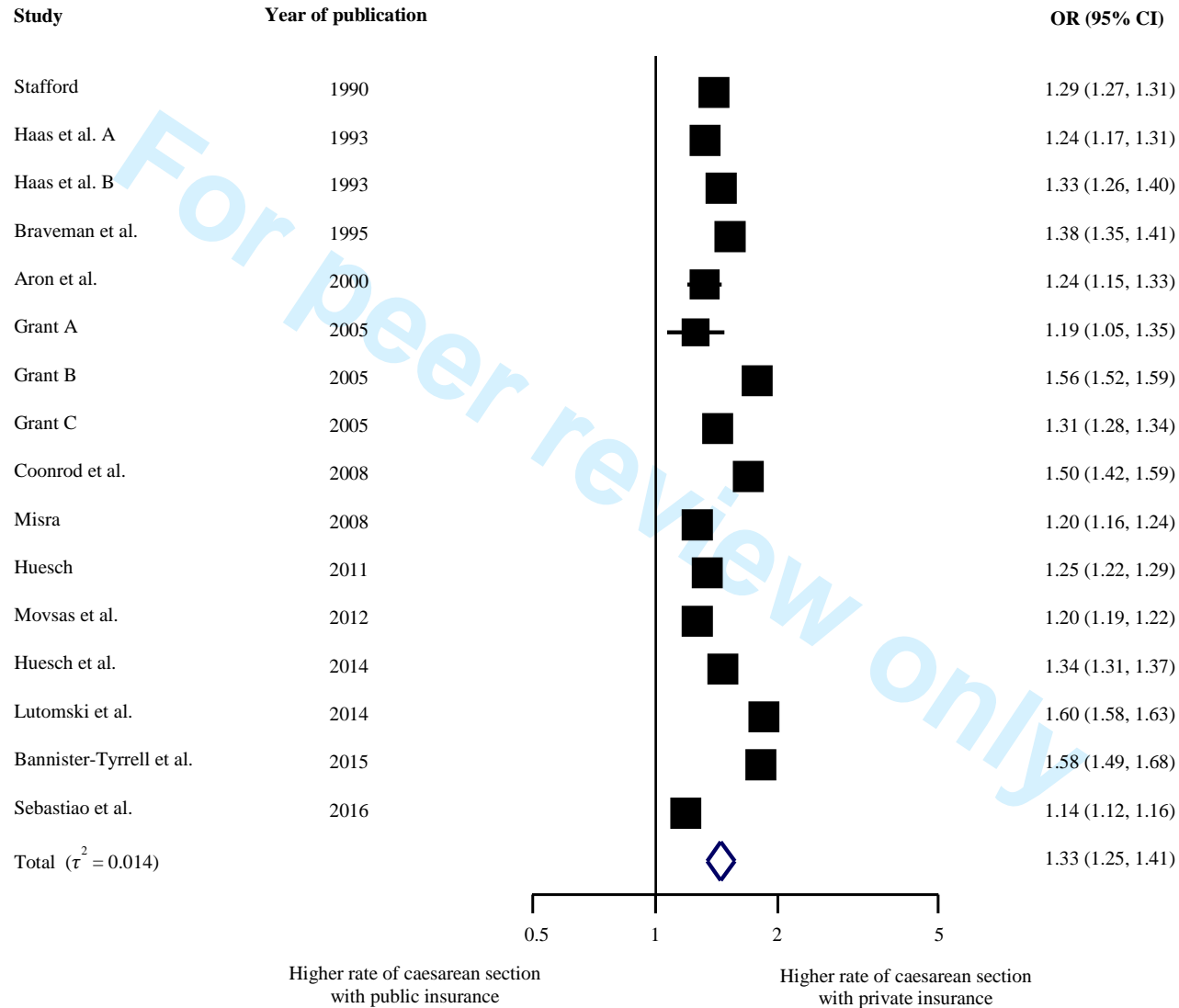
Appendix 9. Sensitivity analysis – Stratified analyses

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*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)

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

HF	16	12 and 15	413	Advanced	Display More >>
HF	17	health care distribution/	2333	Advanced	Display More >>
HF	18	health care utilization/	36879	Advanced	Display More >>
HF	19	insurance/	33934	Advanced	Display More >>
HF	20	choice behavior.mp.	765	Advanced	Display More >>
HF	21	attitude to health/	81021	Advanced	Display More >>
HF	22	patient participation/	16400	Advanced	Display More >>
HF	23	doctor patient relation/	81043	Advanced	Display More >>
HF	24	health economics/	33098	Advanced	Display More >>
HF	25	obstetric procedure/	550	Advanced	Display More >>
HF	26	health care access/	34433	Advanced	Display
HF	27	health services research/	27579	Advanced	Display More >>
HF	28	geographic distribution/	132846	Advanced	Display More >>
HF	29	rural population/	30219	Advanced	Display More >>
HF	30	urban population/	35323	Advanced	Display More >>
HF	31	causes/	0	Advanced	Delete More >>
HF	32	determinants/	1	Advanced	Display More >>
HF	33	statistics/	301146	Advanced	Display More >>
HF	34	rates/	0	Advanced	Delete More >>
HF	35	factors/	0	Advanced	Delete More >>
HF	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 >>
HF	37	cesarean section/	59755	Advanced	Display More >>
HF	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 >>
HF	39	37 or 38	73014	Advanced	Display More >>
HF	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 >>
HF	41	28 or 40	1082827	Advanced	Display More >>
HF	42	36 and 39 and 41	357	Advanced	Display More >>

3. Cochrane Library

Caesarean section and insurance

Research Checklist

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2 According to MOOSE statement for meta-analyses of observational studies
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Reporting of background should include

Where to find in manuscript

8 Problem definition

Manuscript (page 5)

10 Hypothesis statement

Manuscript (page 5)

13 Description of study outcome(s)

Manuscript (page 6)

16 Type of exposure or intervention used

Manuscript (page 6)

18 Type of study designs used

Manuscript (Table 1)

21 Study population

Manuscript (Table 1, Appendix 1)

Reporting of search strategy should include

25 Qualifications of searchers (eg, librarians and investigators)

Manuscript (page 6)

28 Search strategy, including time period included in the synthesis and

Manuscript (page 5, 6), Appendix 11

30 keywords

32 Effort to include all available studies, including contact with authors

Manuscript (page 5-6)

35 Databases and registries searched

Manuscript (page 6)

37 Search software used, name and version, including special features

Manuscript (page 6)

40 used (eg, explosion)

42 Use of hand searching (eg, reference lists of obtained articles)

Manuscript (page 6)

44 List of citations located and those excluded, including justification

Figure 1

47 Method of addressing articles published in languages other than

n/a

49 English

51 Method of handling abstracts and unpublished studies

Manuscript (page 6)

54 Description of any contact with authors

No contact made

Reporting of methods should include

58 Description of relevance or appropriateness of studies assembled for

Manuscript (page 6)

60 assessing the hypothesis to be tested

1 2 3 4 5 6 7 8	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	Manuscript (page 6)
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32	Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	Manuscript (pages 6)
33 34 35 36 37	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	Manuscript (page 6-7) Appendix 3, 4, 5
38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60	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

- 1
- 2 Consideration of alternative explanations for observed results Manuscript (pages 11-13)
- 3
- 4 Generalization of the conclusions (ie, appropriate for the data Manuscript (page 14)
- 5
- 6 presented and within the domain of the literature review)
- 7
- 8
- 9 Guidelines for future research Manuscript (page 14)
- 10
- 11 Disclosure of funding source Manuscript (page 16)
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For peer review only

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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

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	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
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47	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