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## Caesarean Section in Uninsured Women in the United States: Systematic Review and Meta-analysis

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## Caesarean Section in Uninsured Women in the United States: Systematic Review and Meta-analysis

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### Keywords

caesarean section, health insurance, uninsured, self-pay, access to care, medical practice variation, health services, financial incentives, underuse, underserved

### Word count

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## Abstract

**Objective:** The aim of this study is to assess the odds of caesarean section for uninsured women in the United States and understand the underlying mechanisms as well as consequences of lower use.

**Study design:** Systematic review and meta-analysis.

**Data sources:** MEDLINE, Embase, The Cochrane Library and CINAHL from the first year of records through April 2018.

**Eligibility criteria:** We included studies that reported data to allow the calculation of odds ratios of caesarean section of uninsured as compared to insured women.

**Outcomes:** The pre-specified primary outcome was the adjusted odds ratio of deliveries by caesarean section of uninured women as compared with privately or publicly insured women. The pre-specified secondary outcome was the crude odds ratio of deliveries by caesarean section of uninsured women as compared with insured women.

**Results:** Twelve articles describing sixteen separate studies involving more than 8.8 million women were included in this study. We found: 0.70 times lower odds of caesarean section in uninsured as compared to privately insured women (95%CI 0.63 to 0.78), with no relevant heterogeneity between studies ( $\tau^2=0.01$ ); and, 0.92 times lower odds for caesarean section in uninsured as compared to publicly insured women (95%CI 0.80, 1.07), with no relevant heterogeneity between studies ( $\tau^2=0.02$ ). The lower odds were noticed in subgroup analyses as well as in crude analysis. We found 0.70 times lower odds in uninsured as compared to privately and publicly insured women (95%CI 0.69, 0.72).

**Conclusions:** Caesarean sections are less likely to be performed in uninsured women as compared with insured women. In many regions the rates for uninsured women are close or below the benchmarks for appropriate caesarean section rates, therefore efforts to assess the

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delivery outcomes as well as policy options that could improve insurance coverage for women giving birth are important.

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## Strengths and limitations of this study

- ✓ Extensive literature search, screening and data extraction performed in duplicate, review and analysis of study characteristics as well as thorough quality assessment of included studies.
- ✓ All studies are from one country, i.e. the United States, and this limits the effect of contextual factors.
- ✓ A major limitation of our study is the variation across studies, in terms of the study populations characteristics, type of data used, types of caesarean section analyzed and adjusting variables used in statistical analyses.
- ✓ Despite similar features, the uninsured are a diverse group of United States citizens.
- ✓ While a population level caesarean section rate of less than 15 or 19 percent suggests underuse, we cannot determine the mix of under, over, and appropriate use in a specific population.

## Introduction

Introduction of clinical procedures in medical practice have saved and improved the lives of many people worldwide. But with time, these clinical procedures become subject to overuse or underuse; i.e. some people get them without really needing them while others do not get them although in need of them.<sup>1</sup> As a result, overuse of procedures may result in unnecessary harm due to the side effects of the procedures or, in case of underuse, not receiving the care they need.<sup>1-3</sup> These adverse effects occur due to differing health systems and other contextual factors.<sup>3,4</sup> These factors include financial and non-financial barriers in accessing healthcare even in the most advanced economies in the world, such as the United States (US). Consequently, specific segments of the population may be underserved as healthcare systems are unable to address structural problems that leave patients without the care they need.<sup>1</sup>

Globally, Caesarean section (CS) is an example of overuse and underuse of clinical procedures. Once introduced into clinical practice, it greatly improved maternal and newborn outcomes.<sup>5</sup> Presently, many countries have long exceeded the 15 or 19 percent benchmarks for CS out of total deliveries, argued to be the ideal rate of CS in terms of improving the health of women and newborns.<sup>6-8</sup> CS rates average as high as 40.5 percent among countries in Latin America and the Caribbean region,<sup>9</sup> 32.3 percent in Northern America<sup>9</sup> (32.2 percent in US),<sup>10</sup> while on the other extreme, it is as low as 7.3 percent in Africa<sup>9</sup> and known to range even lower in specific countries: 1 percent in Nepal and Cambodia to 0.6 percent in Ethiopia and Niger.<sup>11</sup> Variations are also observed within countries,<sup>5, 11</sup> for instance, in the US<sup>5</sup> a recent study reported a range between 4 to 65 percent across health markets.<sup>12</sup>

Insurance coverage is one health system factors known to influence the use of medical procedures,<sup>13, 14</sup> including CS.<sup>15-18</sup> While private insurance, for example, seems to increase the odds of having a CS delivery,<sup>15</sup> the lack of insurance appears to decrease it.<sup>18-20</sup> Millions of people worldwide, as well as in the US, are not covered by any insurance scheme and are

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3 exposed to the hazard of being underserved with clinical procedures,<sup>21-25</sup> including perinatal  
4 services.<sup>26</sup> The US has a mixed health insurance system dominated by private insurance.<sup>22</sup>  
5  
6 The Federal Medicare program, covers people over 64 years old and/or disabled, which  
7  
8 accounts for about 16.7 percent of the population.<sup>22</sup> State Medicaid programs cover children  
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10 and parents from low income families as well as partially caring for Medicare beneficiaries  
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12 with low incomes and, in total, accounts for about 19.4 percent of the US population.<sup>27</sup> Over  
13  
14 half of US population is covered with voluntary employer based private insurance.<sup>27</sup> The  
15  
16 remaining population is uninsured and can range from 2.5 (Massachusetts) to 16.6 (Texas)  
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18 percent according to 2016 estimates.<sup>27</sup> For decades, in the US, there has been an ongoing  
19  
20 debate for and against universal health coverage and related topics with limited but  
21  
22 substantial progress towards more coverage through the Affordable Care Act (ACA).<sup>21 28-35</sup>  
23  
24 Nonetheless, millions of Americans remain uninsured for various reasons and are not able to  
25  
26 access the healthcare they need.<sup>21 29 36</sup> The aim of this study is to assess the odds of CS for  
27  
28 uninsured women in the US and understand the underlying mechanisms as well as  
29  
30 consequences of lower use in the US context.<sup>37</sup>  
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## 36 **Materials and methods**

### 37 *Search strategy and data sources*

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39 Search words referring to CS, such as 'caesarean section', 'caesarean delivery', 'caesarean',  
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41 were combined with words referring to factors contributing to variation and increase of CS  
42  
43 rates, such as 'insurance', 'social class', 'socioeconomic', and words referring to study  
44  
45 design, such as 'geographic variation', 'medical practice variation' (Appendix 1). No  
46  
47 publication date or language restrictions were applied. We searched MEDLINE, Embase, the  
48  
49 Cochrane Library and CINAHL from the beginning of records to the end of April 2018, when  
50  
51 we last updated our search. A manual search was applied on the reference lists of included  
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53 studies and previous systematic reviews.  
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### ***Study selection and outcomes***

To be included in the analysis, studies had to report odds ratio (OR) of CS comparing uninsured against privately and/or publicly insured women. Adjusted OR of deliveries by CS of uninsured women in comparison to insured women was the pre-specified primary outcome. Crude OR of deliveries by CS of uninsured women in comparison to insured women was the pre-specified secondary outcome.

### ***Data extraction***

Papers screening and independent data extraction was done by two researchers (IH and MB). Differences were resolved based on consensus. We extracted data on study population, study design, data sources, setting, type of CS analyzed, statistical analysis, and (primary and secondary) outcome measures.

### ***Quality assessment***

We used Quality In Prognostic Studies (QUIPS) to assess the risk of bias across six study domains.<sup>38</sup> Each study was evaluated independently by two researchers (IH and MB) and any differences among evaluators were discussed and resolved. A single rating was assigned for all studies. As specified in the QUIPS tool, a “high”, “moderate”, or “low” rating was applied for individual domains and overall rating of a study.<sup>38</sup> If a study was rated with a low risk of bias across all the six domains, it would receive an overall rating of low risk of bias.<sup>15</sup> If one or more domains of a study were rated with a moderate risk of bias, it would receive an overall moderate risk of bias.<sup>15</sup> If one or more domains of a study were rated with a high risk of bias, it would receive an overall high risk of bias.<sup>15</sup>

### ***Main analysis***

Standard inverse-variance random effects meta-analysis was used to combine the overall ORs. An OR lower than one implies a lower frequency of CS in uninsured than in insured women. We calculated  $\tau^2$  to measure heterogeneity between studies.<sup>39</sup> Pre-specified cutoffs of

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3  $\tau^2$  of 0.04, 0.16 and 0.36 were used to represent low, moderate, and high heterogeneity  
4 between studies.<sup>40</sup> Subgroup analysis by study design, period of data collection, state, type of  
5 CS analyzed, parity, inclusion of women with previous CS, pregnancy risk of included  
6 women and level of (QUIPS) risk of bias was performed to examine between-study  
7 heterogeneity and chi-square test was used to calculate p-values for interaction among  
8 subgroups. Test for linear trend was performed in case of more than two ordered strata. All p-  
9 values were two-sided. STATA, release 13, was used for analyses (Stata-Corp, College  
10 Station, Texas).

### 21 *Additional analysis*

22 We calculated CS rates among different insurance subgroups for the studies included in the  
23 analysis.

### 27 *Patient involvement*

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

## 33 **Results**

34 We identified a total of 1837 records: 1123 from Medline; 556 from Embase; 39 from the  
35 Cochrane Library, 119 from CINAHL and 28 from manual search (Figure 1). We removed  
36 240 duplicates. 1597 records were screened for eligibility. We performed full text  
37 examination on 177 records. We excluded 139 that did not report insurance status of women  
38 and 26 that were otherwise irrelevant. Finally, 12 records describing 16 separate studies<sup>18-20</sup>  
39 <sup>41-49</sup> including more than 8.8 million women were included in review and meta-analysis.

40 Characteristics of studies are presented in Table 1 and Appendices 2, 3, 4 and 5. All studies  
41 were from the US. Thirteen studies were cross-sectional and three were retrospective cohort  
42 studies. Population size of studies ranged from 9,017 to 6,717,486 cases. Studies used data  
43 from years 1986 to 2011 and most studies used hospital records data (Appendix 2). Case  
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3 exclusion criteria varied considerably (Appendix 3) as well as variables studies used for  
4 statistical adjustment (Appendix 4). Appendix 5 reports evaluation of studies using QUIPS  
5 risk of bias tool. Four studies were classified with low risk of bias, two studies with moderate  
6 risk, and ten studies with high risk of bias (Appendix 5).

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12 Figure 2 presents meta-analyses for primary outcome measure, i.e. adjusted ORs of CS in  
13 uninsured women as compared to privately or publicly insured. Since there was a positive  
14 interaction between uninsured vs privately insured group and uninsured vs publicly insured  
15 group ( $p=0.016$ ), we performed meta-analyses for each group separately. In the meta-analysis  
16 comparing uninsured with privately insured women, including seven studies in 556,454  
17 women, we found that the odds of CS were 0.70 times lower in uninsured as compared to  
18 privately insured women (95%CI 0.63 to 0.78), with no relevant heterogeneity between  
19 studies ( $\tau^2=0.01$ ). In meta-analysis comparing uninsured with publicly insured women,  
20 including four studies in 510,010 women, we found that the odds of CS were 0.92 times  
21 lower in uninsured as compared to publicly insured women (95%CI 0.80, 1.07), with no  
22 relevant heterogeneity between studies ( $\tau^2=0.02$ ). An additional study in 6,717,486 women,  
23 which did not distinguish between privately and publicly insured women,<sup>49</sup> reported that the  
24 odds of CS were 0.70 times lower in uninsured as compared to insured women (95%CI 0.69,  
25 0.72).

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43 Figure 3 presents results of subgroup analyses of adjusted odds ratios in uninsured vs  
44 privately insured women (upper panel) and in uninsured vs publicly insured women (lower  
45 panel). In the analysis of uninsured vs privately insured women, estimates varied for  
46 subgroups state ( $p$  for interaction $<0.001$ ), type of CS ( $p$  for interaction $<0.001$ ), parity ( $p$  for  
47 interaction=0.07), and pregnancy risk ( $p$  for interaction $<0.001$ ). There was no positive trend  
48 in the period of data collection subgroup. In the lower panel, which presents subgroup  
49 analyses of adjusted odds ratios in uninsured vs publicly insured women, estimates varied for  
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3 subgroups period of data collection (p for interaction=0.03), state (p for interaction=0.004),  
4 type of CS (p for interaction=0.03), parity (p for interaction=0.03) and QUIPS risk of bias (p  
5 for interaction=0.03).  
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10 In Figure 4 we present meta-analyses for crude ORs of CS in uninsured as compared to  
11 privately or publicly insured women as secondary outcome. In the meta-analysis comparing  
12 uninsured with privately insured women, including eleven studies in 2,010,483 women, we  
13 found that the odds of CS were 0.71 times lower in uninsured as compared to privately  
14 insured women (95%CI 0.66 to 0.76), with no relevant heterogeneity between studies  
15 ( $\tau^2=0.018$ ). In the meta-analysis comparing uninsured with publicly insured women,  
16 including eleven studies in 2,010,483 women, we found that the odds of CS were 0.93 times  
17 lower in uninsured as compared to publicly insured women (95%CI 0.85, 1.01), with no  
18 relevant heterogeneity between studies ( $\tau^2=0.017$ ).  
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29 Appendix 6 presents rates of CS among groups with different insurance status for individual  
30 studies. Two studies found CS rates for uninsured women below the 19 percent benchmark,  
31 another five studies found CS rates below the 15 percent benchmark. The rates of other  
32 studies range from 19.3 percent to 23.0 percent, close to 19 percent benchmark.  
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## 39 **Discussion**

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41 Our systematic review and meta-analyses estimated that the overall odds of receiving a  
42 caesarean section are on average 0.70 times lower for uninsured women as compared with  
43 privately insured women, 0.92 times lower for uninsured women as compared with publicly  
44 insured women and 0.70 times lower for uninsured women as compared to privately and  
45 publicly insured women. The lower odds were noticed across all subgroups of studies in  
46 subgroup analyses as well as in crude analyses.  
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## 54 **Context**

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3 To our knowledge, this is the first meta-analysis that examines CS rates of uninsured women  
4 compared to insured women. Two recently published meta-analyses by our group reported  
5 the association of CS with for profit status of hospitals and type of insurance.<sup>15 50</sup>  
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9 Investigating the association of for-profit vs non-profit status of hospital with the odds of CS,  
10 we found that the odds of CS were 1.41 higher in for-profit hospitals as compared with non-  
11 profit hospitals (95% CI 1.24 to 1.60).<sup>50</sup> The findings were consistent in subgroup analyses.<sup>50</sup>  
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15 Investigating the association of CS with private insurance, we found that the odds of CS were  
16 1.13 times higher for privately insured women compared with women covered with public  
17 insurance.<sup>15</sup> Again, the increased risk was observed across all subgroups.<sup>15</sup>  
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### 22 ***Strengths and limitations***

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24 The major strengths of our meta-analysis include an extensive literature search, screening and  
25 data extraction performed in duplicate, review and analysis of study characteristics as well as  
26 thorough quality assessment of included studies. In addition, all studies are from one country,  
27 i.e. the US, and this limits the effect of contextual factors. A major limitation is the variation  
28 across studies, in terms of the study populations characteristics (i.e. parity, inclusion of  
29 women with previous CS, risk for CS), type of data used, types of CS analyzed and adjusting  
30 variables used in statistical analyses. It should also be taken into consideration, that despite  
31 similar features, the uninsured are a diverse group of US citizens.<sup>24 25</sup> Finally, while a  
32 population level CS rate of less than 15 or 19 percent suggests underuse, we cannot determine  
33 the mix of under, over, and appropriate use in a specific population.  
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### 47 ***Mechanism***

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49 There are several possible explanations why uninsured women have lower odds of CS when  
50 compared to insured women. One likely factor is that financial incentives are stronger with  
51 private insurance than in the publicly insured or uninsured.<sup>15 16</sup> These incentives result from  
52 higher payment for CS by private insurers through reimbursement arrangements that  
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3 encourage more expensive procedures as means to increase profits, as well as providers'  
4 (hospitals and individual physicians) responses to these incentives.<sup>15 50 51</sup> The responses to  
5 incentives by hospitals exist in the form of patient scheduling policies that direct privately  
6 insured patients to profit inclined physicians.<sup>18 50</sup> It is also a known association that  
7 physicians who have a higher share of privately insured patients will tend to overuse CS.<sup>19 20</sup>  
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<sup>50</sup> They do so as they perceive patients to have a higher social class, i.e. able to pay higher fees, or fear malpractice liability.<sup>16 41 50 52</sup>

Additional reasons are likely reflected in the comparison between uninsured and publicly insured women. A first set of reasons are related to deliberate or forced decisions of uninsured women to keep out-of-pocket payments low.<sup>16</sup> The uninsured patients are more likely to seek less expensive care when they face the need for healthcare services.<sup>16</sup> In the case of giving birth, this would lead to a greater preference for vaginal delivery. A second set of reasons may be discrimination of providers towards uninsured women. Providers have a preference for profitable, i.e. privately insured patients, a preference commonly referred to as “cream skimming”.<sup>19 20 50 53</sup>

### ***Implications for uninsured women***

Most studies included in our meta-analysis, including the most recent studies from California<sup>47</sup> and Florida,<sup>48</sup> show that rates for CS among uninsured women are below or close to the 15 and 19 percent benchmarks previously reported.<sup>6-8</sup> Even in instances where the average state rates are slightly above the 19 percent benchmark, some hospitals service areas are likely to have CS rates lower than 19 percent or even 15 percent for uninsured women because of the well-established within state variation in CS rates.<sup>5 52</sup> Uninsured women in these areas are highly likely to be underserved with caesarean section during delivery. Uninsured patients generally have higher unmet needs than insured patients due to access barriers.<sup>21 22 24 26 54-58</sup> Such barriers encourage inappropriate health seeking behaviors among

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2  
3 uninsured.<sup>21-23 30 56 59-61</sup> Consequently, uninsured populations face higher health risks and  
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5 have worse healthcare outcomes.<sup>21-24 30 54-57 59 60 62 63</sup>  
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8 The uninsured also face financial burdens which result from out-of-pocket payments that are  
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10 more severe/extensive than co-payments or premiums that are paid by people that are  
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12 publicly or privately insured. The uninsured are known to pay higher prices for services as  
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14 compared to other payers for the same care,<sup>25 64</sup> spend a high portion of income to cover  
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16 medical expenses<sup>22</sup> (although they spend less for their health compared to patients who have  
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18 insurance),<sup>24</sup> are frequently charged for full price for healthcare services,<sup>22 64</sup> often do not  
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20 benefit from discounts from providers,<sup>22 25</sup> and face severe financial difficulties.<sup>21 22</sup>  
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23 Uninsured manage to pay only part of the costs for their care.<sup>24</sup> The remaining costs are  
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25 uncompensated costs<sup>21 24 65 66</sup> and most of such costs are covered by the local, state or federal  
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27 government,<sup>24 65</sup> eventually resulting in tax increases.<sup>24</sup>  
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### 29 ***Implications for research and policy making***

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32 Future studies should examine the association of a lack of insurance in pregnant women  
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34 across health care markets with varying CS rates and assess if delivery outcomes were  
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36 correspondingly worse, in the effort to investigate the presence of underuse of CS.  
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39 In parallel, policy options that could lead to improvements of insurance coverage for  
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41 delivering women should be assessed in terms of their ability to address healthcare outcomes  
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43 while keeping overall costs at minimum. In the past, states have adopted different strategies  
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45 for covering uninsured people.<sup>22 23 37 67</sup> While there are many known benefits to insurance  
46  
47 coverage,<sup>21 22 30-33 35 57 60 66 68-70</sup> other important policy aspects should be considered. At a time  
48  
49 of rising healthcare costs<sup>22 33 70 71</sup> regulation of financial incentives is crucial. A revision of  
50  
51 payment policies should be pursued<sup>15 16 22 50</sup> to align financial incentives with proper health  
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53 outcomes.<sup>15 22 50</sup> Reimbursement policies that would pay the same amount for CS and vaginal  
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55 delivery is one option.<sup>50 72</sup>  
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## **Conclusion**

Caesarean sections are less likely to be performed in uninsured women as compared with insured women. The lower odds are consistent in all subgroups and in crude analyses. In many regions the rates for uninsured women are close or below the benchmarks for appropriate CS rates, therefore efforts to assess the delivery outcomes as well as policy options that could improve insurance coverage for women giving birth are important.

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### **Contributorship Statement**

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



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4 search strategy, Arjana Shala for her help with literature search and Hossein Meyer-Troeltsch  
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10 ***Competing interests statement***

11 *All authors have completed the ICMJE uniform disclosure form at*  
12 *www.icmje.org/coi\_disclosure.pdf and declare: no support from any organisation for the*  
13 *submitted work; no financial relationships with any organisations that might have an interest*  
14 *in the submitted work in the previous three years; no other relationships or activities that*  
15 *could appear to have influenced the submitted work.*  
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25 *No funding was received to perform this study. All authors, had full access to all of the data*  
26 *(including statistical reports and tables) in the study and take responsibility for the integrity*  
27 *of the data and the accuracy of the data analysis.*  
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34 ***Data sharing statement***

35 *No additional unpublished data are available from the study.*  
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**Table 1. Characteristics of included studies**

Author	Year	State	Study design	Number of cases	Number of hospital units	Year of data collection	Population	Sampling	Type of CS analyzed
Stafford	1990	California	Cross sectional	461066	Not reported	1986	Primi- and multipara; any risk	Consecutive	Any
Haas et al. A	1993	Massachusetts	Cross sectional	57257	Not reported	1984	Primi- and multipara; any risk	Consecutive	Any
Haas et al. B	1993	Massachusetts	Cross sectional	64346	Not reported	1987	Primi- and multipara; any risk	Consecutive	Any
Braveman et al.	1995	California	Retrospective cohort	213761	Unclear	1991	Primipara; no previous CS; any risk	Consecutive	Any
Burns et al.	1995	Arizona	Cross sectional	33233	36	1989	Primi- and multipara; any risk	Consecutive	Any

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 38 39 40 41 42 43 44 45 46 47	Onion et al. A	1999	Maine	Cross sectional	41177	Not reported	1990- 1992	Primipara; no previous CS; any risk	Consecutive	Any
	Onion et al. B	1999	New Hampshire	Cross sectional	41401	Not reported	1990- 1992	Primipara; no previous CS; any risk	Consecutive	Any
	Onion et al. C	1999	Vermont	Cross sectional	19077	Not reported	1990- 1992	Primipara; no previous CS; any risk	Consecutive	Any
	Aron et al.	2000	Ohio	Retrospective cohort	25697	21	1993- 1995	Primipara; no previous CS; any risk	Consecutive	Any
	Grant A	2005	All states	Cross sectional	9017	Not reported	1988	Primi- and multipara; any risk	Random	Any
	Grant B	2005	Florida	Cross sectional	147821	Not reported	1992	Primi- and multipara; any risk	Consecutive	Any
	Coonrod et al.	2008	Arizona	Cross sectional	28863	40	2005	Primipara; low risk	Consecutive	Any
	Huesch	2011	New Jersey	Cross sectional	182108	Not reported	2004- 2007	Primi- and multipara; no previous CS; low	Consecutive	Planned

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							risk		
Kozhimannil et al.	2013	All states	Cross sectional	6717486	Over 1000	2002-2009	Primi- and multipara; any risk	Random	Any
Huesch et al.	2014	California	Cross sectional	408355	254	2010	Primi- and multipara; no previous CS; any risk	Consecutive	Planned
Sebastião et al.	2016	Florida	Retrospective cohort	412192	122	2004-2011	Primipara; no previous CS; low risk	Consecutive	Emergency

CS = caesarean section

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3 **Figure legends**  
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5 **Figure 1. The flow diagram of review**  
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7 **Figure 2. Adjusted odds ratios of caesarean section**  
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9 **Figure 3. Subgroup analyses for adjusted estimates/Legend: \*P for trend**  
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11 **Figure 4. Crude odds ratios of caesarean section**  
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17 **Supporting information**  
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19 **Appendix 1. Search Strategy**  
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21 **Appendix 2. Type of data used**  
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23 **Appendix 3. Reported exclusion criteria**  
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25 **Appendix 4. Covariates used for statistical adjustment**  
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27 **Appendix 5. QUIPS risk of bias**  
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29 **Appendix 6. Caesarean section rates among groups with different insurance status**  
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Figure 1. The flow diagram of review

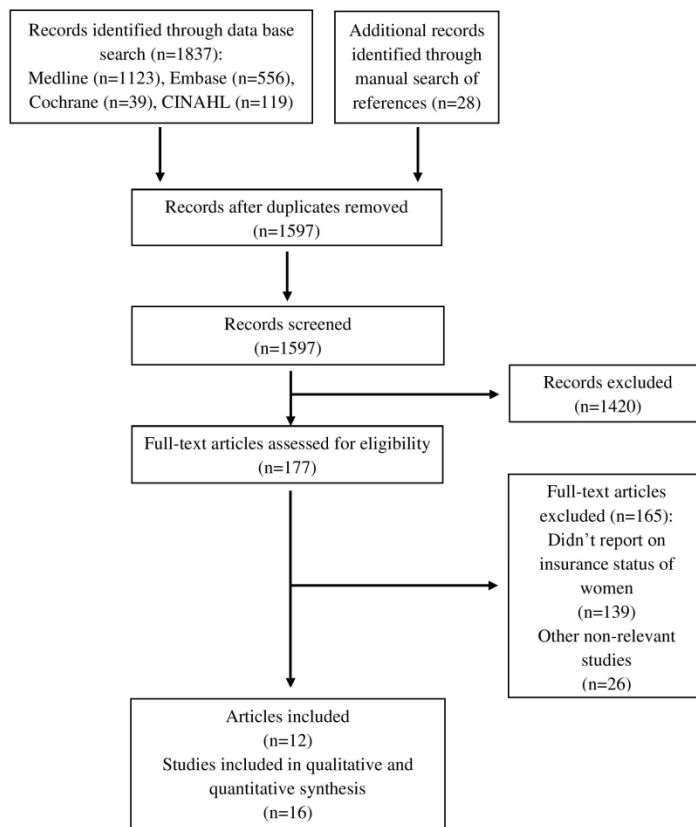


Figure 1. The flow diagram of review

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Figure 2. Adjusted odds ratios of caesarean section

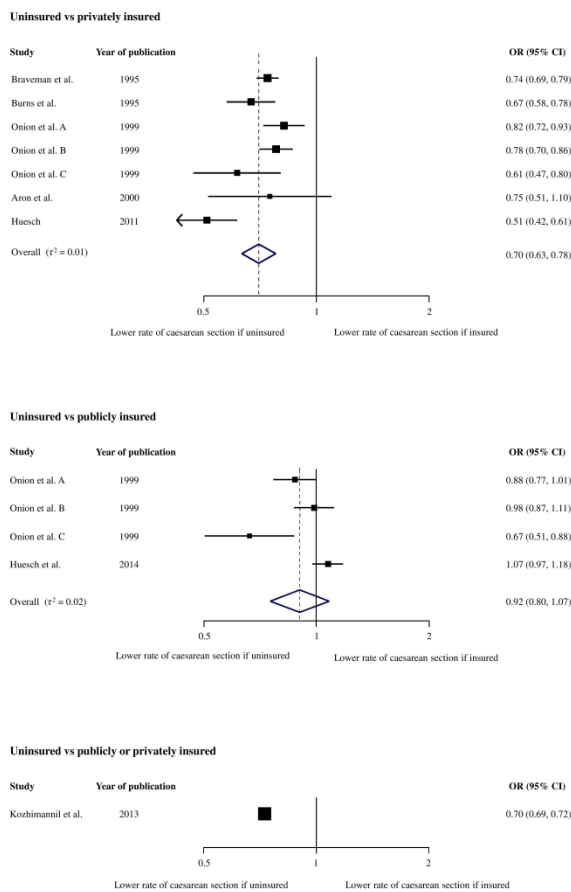


Figure 2. Adjusted odds ratios of caesarean section

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Figure 3. Subgroup analyses for adjusted estimates

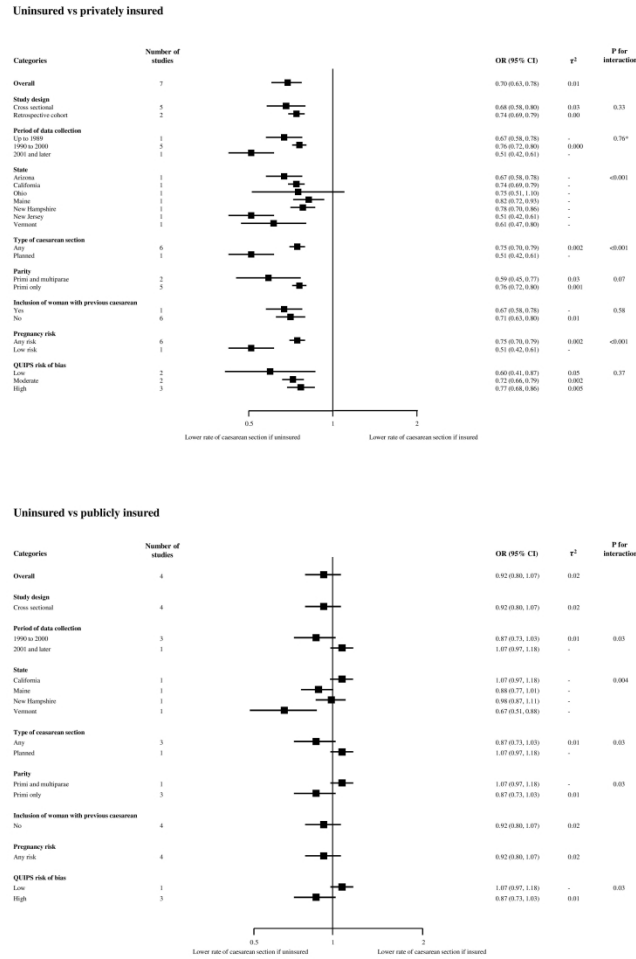


Figure 3. Subgroup analyses for adjusted estimates/Legend: \*P for trend

338x518mm (300 x 300 DPI)

Figure 4. Crude odds ratios of caesarean section

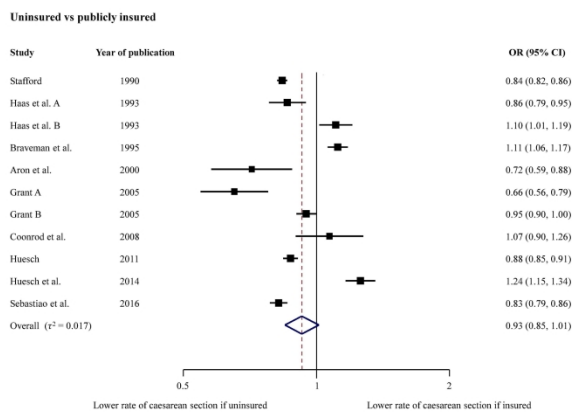
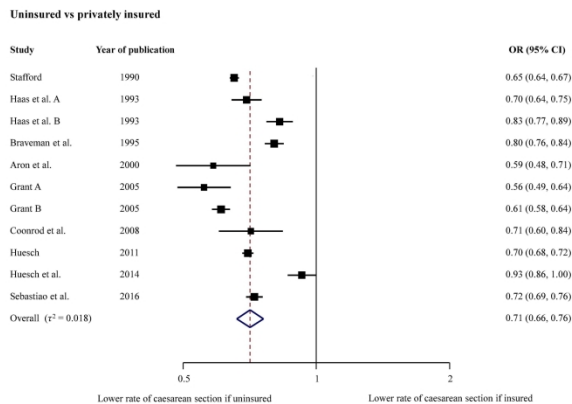


Figure 4. Crude odds ratios of caesarean section

279x361mm (300 x 300 DPI)

## 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, 6)

Hypothesis statement

Manuscript (page 5, 6)

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, 7)

Study population

Manuscript (page 6, 7) Table 1,  
Appendix 1

### Reporting of search strategy should include

Qualifications of searchers (eg, librarians and investigators)

Manuscript (page 1)

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

Manuscript (page 6), Appendix 1

Effort to include all available studies, including contact with authors

Manuscript (page 6)

Databases and registries searched

Manuscript (page 6)

Search software used, name and version, including special features used (eg, explosion)

Manuscript (page 6)

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

Manuscript (page 6)

List of citations located and those excluded, including justification

Figure 1

Method of addressing articles published in languages other than English

n/a

Method of handling abstracts and unpublished studies

Manuscript (page 6, 7)

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, 7)

1 2 3 4 5 6 7	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	Manuscript (page 6, 7)
8 9 10 11 12 13 14 15 16 17 18	Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	Manuscript (pages 6, 7)
19 20 21 22 23 24 25 26 27 28 29	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	Manuscript (page 6-7), Appendix 2, 3, 4
30 31 32 33 34 35	Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	Manuscript (page 7), Figure 2, Appendix 5,
36 37 38 39 40	Assessment of heterogeneity	Manuscript (page 7)
41 42 43 44 45 46 47	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 7)
48 49 50 51 52 53 54 55	Provision of appropriate tables and graphics	Table 1, Figure 1-3 and Appendixes 1-7
56 57 58 59 60	<b>Reporting of results should include</b>	
	Graphic summarizing individual study estimates and overall estimate	Figure 2, Appendix 6
	Table giving descriptive information for each study included	Table 1
	Results of sensitivity testing (eg, subgroup analysis)	Figure 3
	Indication of statistical uncertainty of findings	Manuscript, Figure 2-4
	<b>Reporting of discussion should include</b>	
	Quantitative assessment of bias (eg, publication bias)	Manuscript (page 8)
	Justification for exclusion (eg, exclusion of non—English-language citations)	Manuscript (page 8)
	Assessment of quality of included studies	Manuscript (page 8)

**Reporting of conclusions should include**

1		
2	Consideration of alternative explanations for observed results	Manuscript (pages 9-13)
3		
4	Generalization of the conclusions (ie, appropriate for the data	Manuscript (page 13)
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6	presented and within the domain of the literature review)	
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8	Guidelines for future research	Manuscript (page 13)
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10	Disclosure of funding source	Manuscript (page 13)
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## PRISMA checklist

<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Manuscript (page 1)
<b>ABSTRACT</b>			
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.	Manuscript (page 3,4)
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Manuscript (page 5,6)
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Manuscript (page 6)
<b>METHODS</b>			
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.	Manuscript (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.	Manuscript (page 6)
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 1

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).	Manuscript (page 6), Figure 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.	Manuscript (page 6,7)
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Manuscript (page 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.	Manuscript (page 7)
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Manuscript (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.	Manuscript (page 6, 7)
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).	Manuscript (page 6)
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	Manuscript (page 7)
<b>RESULTS</b>			
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.	Manuscript (page 8), Figure 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.	Manuscript (page 8) Table 1, Appendix 2, 3, 4
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).	Manuscript

			(page 8), Appendix 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.	Figure 2, Appendix 6
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Manuscript (page 8,9) Figure 2, Appendix 6
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Manuscript (page 8), Appendix 5
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Manuscript (page 9), Figure 3, Appendix 7
<b>DISCUSSION</b>			
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).	Manuscript (page 9, 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).	Manuscript (page 10)
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Manuscript (page 10- 13)
<b>FUNDING</b>			
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.	Manuscript (page 13)



## Appendix 1. 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))))))

Appendix 2. Type of data used

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		+	+	
Onion et al. A	1999		+		
Onion et al. B	1999		+		
Onion et al. C	1999		+		
Aron et al.	2000		+		
Grant A	2005	+			
Grant B	2005		+		
Coonrod et al.	2008			+	
Huesch	2011		+		
Kozhimannil et al.	2013		+		
Huesch et al.	2014		+		
Sebastião et al.	2016		+	+	

**Appendix 3. Reported exclusion criteria**

Authors	Year	Source population	Maternal characteristics					Fetus characteristics						Not in labor	Cases with missing data	Provider characteristics	Other factors	
			Age ≤14	Racial or ethnic minorities	Multipara	Previous caesarean section	Other risk factors for caesarean section	Stillbirth	Multiple delivery (twin or more)	Newborn weighting <500 gr	Breach presentation	Other malpresentation	Preterm delivery (less than 37 weeks)					Other risk factors for caesarean section
Stafford	1990	All deliveries in California, United States																+
Haas et al. A	1993	All deliveries in Massachusetts, United States						+	+	+								+
Haas et al. B	1993	All deliveries in Massachusetts, United States						+	+	+								+
Braveman et al.	1995	All deliveries in California, United States			+	+		+	+				+					+
Burns et al.	1995	All deliveries in Arizona, United States																+
Onion et al. A	1999	All deliveries in Maine, United States			+	+			+									+
Onion et al. B	1999	All deliveries in New Hampshire, United States			+	+			+									+
Onion et al. C	1999	All deliveries in Vermont, United States			+	+			+									+
Aron et al.	2000	All deliveries in Cleveland, Ohio, United States				+				+	*							+
Grant A	2005	All deliveries, United States																+
Grant B	2005	All deliveries in Florida, United States																+
Coonrod et al.	2008	All deliveries in Arizona, United States		+	+			+	+			+	+	+				+
Huesch	2011	All deliveries in New Jersey, United States				+	+		+			+	+	+	+			+
Kozhimannil et al.	2013	All deliveries in 44 states, United States																+
Huesch et al.	2014	All deliveries in California, United States	+			+									+			+
Sebastião et al.	2016	All deliveries in Florida, United States			+	+		+	+			+	+	+	+			+

\*500 or less grams

Appendix 4. Covariates used for statistical adjustment

Author	Year	Maternal preconception status										Maternal clinical status				Fetus characteristics			Prenatal care	Delivery 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	Other characteristics																			
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
Onion et al. A	1999										+																									1	
Onion et al. B	1999										+																									1	
Onion et al. C	1999										+																									1	
Aron et al.	2000										+	+				++	++	++	+	++																39	
Grant A*	2005																																				0
Grant B*	2005																																				0
Coonrod et al.*	2008																																				0
Huesch	2011	+		+							+																							+	++		8
Kozhimannil et al.	2013	+									+	+	+	++	++	+			++																	16	
Huesch et al.	2014	+			+						+			++	++	+			++	+	++	+	++	+	++	+	++	++	++	++	++	++	++	++	++	124	
Sebastião et al. *	2016																																				

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

\*Studies reported only crude estimates.

Appendix 5. 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	1990	low	low	low	low	high	moderate	high
Haas et al. 1993 A	1993	low	low	low	low	high	moderate	high
Haas et al. 1993 B	1993	low	low	low	low	high	moderate	high
Braveman et al. 1995	1995	low	low	low	low	moderate	low	moderate
Burns et al. 1995	1995	low	low	low	low	moderate	low	moderate
Onion et al. 1999 A	1999	low	low	low	low	high	low	high
Onion et al. 1999 B	1999	low	low	low	low	high	low	high
Onion et al. 1999 C	1999	low	low	low	low	high	low	high
Aron et al. 2000	2000	low	low	low	low	low	low	low
Grant 2005 A	2005	moderate	high	low	low	high	low	high
Grant 2005 B	2005	low	low	low	low	high	low	high
Coonrod et al. 2008	2008	low	low	low	low	high	low	high
Huesch 2011	2011	low	low	low	low	low	low	low
Kozhimannil et al. 2013	2012	low	low	low	low	low	low	low
Huesch et al. 2014	2013	low	low	low	low	low	low	low
Sebastião et al. 2016	2014	low	low	low	low	high	low	high

review only

Appendix 6. Caesarean section rates among groups with different insurance status

Author	Year	State	Year of data collection	CS rate of privately insured (%)	CS rate of publicly insured (%)	CS rate of uninsured (%)
Stafford 1990	1990	California	1986	26.8	22.1	19.3
Haas et al. 1993 A	1993	Massachusetts	1984	23.0	19.4	17.2
Haas et al. 1993 B	1993	Massachusetts	1987	25.9	20.8	22.4
Braveman et al. 1995	1995	California	1991	27.1	21.2	23.0
Burns et al. 1995	1995	Arizona	1989	n/a	n/a	n/a
Onion et al. 1999 A*	1999	Maine	1990-1992	15.9	14.9	13.4
Onion et al. 1999 B*	1999	New Hampshire	1990-1992	16.1	13.2	13.0
Onion et al. 1999 C*	1999	Vermont	1990-1992	14.5	13.5	9.4
Aron et al. 2000	2000	Ohio	1993-1995	17.0	14.2	10.7
Grant 2005 A	2005	All states	1988	27.0	23.7	17.1
Grant 2005 B	2005	Florida	1992	30.0	21.6	20.7
Coonrod et al. 2008	2008	Arizona	2005	26.0	19.0	20.0
Huesch 2011	2011	New Jersey	2004-2007	26.7	22.5	20.3
Kozhimannil et al. 2013	2012	All states	2002-2009	n/a	n/a	n/a
Huesch et al. 2014	2013	California	2010	13.9	10.7	13.0
Sebastião et al. 2016	2014	Florida	2004-2011	25.2	22.8	19.7

\*The rates are adjusted as compared to the rates from other studies which are crude rates.

CS rates bellow 15% benchmark

CS rates bellow 19% benchmark

# BMJ Open

## Caesarean Section in Uninsured Women in the United States: Systematic Review and Meta-analysis

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-025356.R1
Article Type:	Research
Date Submitted by the Author:	14-Nov-2018
Complete List of Authors:	Hoxha, Ilir; Kolegjin Heimerer, Health Management; Geisel School of Medicine at Dartmouth, Department of Community & Family Medicine Braha, Medina; International Business College Mitrovica, Syrogiannouli, Lamprini; Universität Bern, Berner Institut für Hausarztmedizin (BIHAM) Goodman, David C; Dartmouth College Geisel School of Medicine Jüni, Peter
<b>Primary Subject Heading</b>:	Health economics
Secondary Subject Heading:	Health services research, Obstetrics and gynaecology, Health policy
Keywords:	caesarean section, health insurance, uninsured, self-pay, medical practice variation, underuse

SCHOLARONE™  
Manuscripts

## Caesarean Section in Uninsured Women in the United States: Systematic Review and Meta-analysis

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### Keywords

caesarean section, health insurance, uninsured, self-pay, access to care, medical practice variation, health services, financial incentives, underuse, underserved

### Word count

Manuscript: 3147 words excluding title page, abstract, references, figures and tables.



## Abstract

**Objective:** The aim of this study is to assess the odds of caesarean section for uninsured women in the United States and understand the underlying mechanisms as well as consequences of lower use.

**Study design:** Systematic review and meta-analysis.

**Data sources:** PubMed, Embase, The Cochrane Library and CINAHL from the first year of records through April 2018.

**Eligibility criteria:** We included studies that reported data to allow the calculation of odds ratios of caesarean section of uninsured as compared to insured women.

**Outcomes:** The pre-specified primary outcome was the adjusted odds ratio of deliveries by caesarean section of uninsured women as compared with privately or publicly insured women. The pre-specified secondary outcome was the crude odds ratio of deliveries by caesarean section of uninsured women as compared with insured women.

**Results:** Twelve articles describing sixteen separate studies involving more than 8.8 million women were included in this study. We found: 0.70 times lower odds of caesarean section in uninsured as compared to privately insured women (95%CI 0.63 to 0.78), with no relevant heterogeneity between studies ( $\tau^2=0.01$ ); and, 0.92 times lower odds for caesarean section in uninsured as compared to publicly insured women (95%CI 0.80, 1.07), with no relevant heterogeneity between studies ( $\tau^2=0.02$ ). We found 0.70 times lower odds in uninsured as compared to privately and publicly insured women (95%CI 0.69, 0.72).

**Conclusions:** Caesarean sections are less likely to be performed in uninsured women as compared with insured women. While the higher rates for CS among privately insured women can be explained with financial incentives associated with private insurance, the lower odds among uninsured women draw attention at barriers to access for delivery care. In

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3 many regions the rates for uninsured women are above, close or below the benchmarks for  
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5 appropriate caesarean section rates and could imply both, underuse and overuse. .  
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For peer review only

## Strengths and limitations of this study

- ✓ Extensive literature search, screening and data extraction performed in duplicate, review and analysis of study characteristics as well as thorough quality assessment of included studies.
- ✓ All studies are from one country, i.e. the United States, and this limits the effect of contextual factors.
- ✓ A major limitation of our study is the variation across studies, in terms of the study populations characteristics, type of data used, types of caesarean section analyzed and adjusting variables used in statistical analyses.
- ✓ The results of this study are driven by the largest study which contains over two thirds of the population included in this review. Only five out of 16 studies included in the review report data after year 2000.
- ✓ While a population level caesarean section rate of less than 9, 10 or 19 percent suggests underuse, we cannot determine the mix of under, over, and appropriate use in a specific population.

## Introduction

Introduction of clinical procedures in medical practice have saved and improved the lives of many people worldwide. But with time, these clinical procedures become subject to overuse or underuse; i.e. some people get them without really needing them while others do not get them although in need of them.<sup>1</sup> As a result, overuse of procedures may result in unnecessary harm due to the side effects of the procedures or, in case of underuse, not receiving the care they need.<sup>1-3</sup> These adverse effects occur due to differing health systems and other contextual factors.<sup>3,4</sup> These factors include financial and non-financial barriers in accessing healthcare, present even in the most advanced economies of the world, such as the United States (US). Consequently, specific segments of the population may be underserved as healthcare systems are unable to address structural problems that leave patients without the care they need.<sup>1</sup>

Globally, Caesarean section (CS) is an example of overuse and underuse of clinical procedures. Once introduced into clinical practice, it greatly improved maternal and newborn outcomes.<sup>5</sup> Presently, many countries have long exceeded the 9 to 16 percent or 10 to 15 percent thresholds or 19 percent benchmark for CS out of total deliveries, argued to be the ideal rates of CS in terms of improving the health of women and newborns.<sup>6-9</sup> CS rates average as high as 40.5 percent among countries in Latin America and the Caribbean region,<sup>10</sup> 32.3 percent in Northern America<sup>10</sup> (32.2 percent in US),<sup>11</sup> while on the other extreme, it is as low as 7.3 percent in Africa<sup>10</sup> and known to range even lower in specific countries: 1 percent in Nepal and Cambodia to 0.6 percent in Ethiopia and Niger.<sup>12</sup> Variations are also observed within countries,<sup>5, 12, 13</sup> for instance, in the US a recent study reported a range between 4 to 65 percent across health markets.<sup>14</sup>

Insurance coverage is one health system factors known to influence the use of medical procedures,<sup>15, 16</sup> including CS.<sup>17-20</sup> While private insurance, for example, seems to increase the odds of having a CS delivery,<sup>17</sup> the lack of insurance appears to decrease it.<sup>20-22</sup> Millions of

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3 people worldwide, as well as in the US, are not covered by any insurance scheme and are  
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5 exposed to the hazard of being underserved with clinical procedures,<sup>23-27</sup> including perinatal  
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7 services.<sup>28</sup> The US has a mixed health insurance system dominated by private insurance.<sup>24</sup>  
8  
9 The Federal Medicare program, covers people over 64 years old and/or disabled, which  
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11 accounts for about 16.7 percent of the population.<sup>24</sup> State Medicaid programs cover children  
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13 and parents from low income families as well as partially caring for Medicare beneficiaries  
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15 with low incomes and, in total, accounts for about 19.4 percent of the US population.<sup>29</sup> Over  
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17 half of US population is covered with voluntary employer based private insurance.<sup>29</sup> The  
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19 remaining population is uninsured and can range from 2.5 (Massachusetts) to 16.6 (Texas)  
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21 percent according to 2016 estimates.<sup>29</sup> For decades, in the US, there has been an ongoing  
22  
23 debate for and against universal health coverage and related topics with limited but  
24  
25 substantial progress towards more coverage through the Affordable Care Act (ACA).<sup>23 30-37</sup>  
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27 Nonetheless, millions of Americans remain uninsured for various reasons and are not able to  
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29 access the healthcare they need.<sup>23 31 38</sup> The aim of this study is to assess the odds of CS for  
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31 uninsured women in the US and understand the underlying mechanisms as well as  
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33 consequences of lower use in the US context.<sup>39</sup>  
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## 41 **Materials and methods**

### 42 ***Search strategy and data sources***

43  
44 Search words referring to CS, such as 'caesarean section', 'caesarean delivery', 'caesarean',  
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46 were combined with words referring to factors contributing to variation and increase of CS  
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48 rates, such as 'insurance', 'social class', 'socioeconomic', and words referring to study  
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50 design, such as 'geographic variation', 'medical practice variation' (Appendix 1). No  
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52 publication date or language restrictions were applied. We searched PubMed, Embase, the  
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54 Cochrane Library and CINAHL from the beginning of records to the end of April 2018, when  
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3 we last updated our search. A manual search was applied on the reference lists of included  
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5 studies and previous systematic reviews.  
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### 8 ***Study selection and outcomes***

9  
10 To be included in the analysis, studies had to report odds ratio (OR) or data that enabled the  
11  
12 calculation of OR of CS comparing uninsured against privately and/or publicly insured  
13  
14 women. More specifically, we didn't exclude studies based on any population characteristic.  
15  
16 Studies had to report normal (vaginal) and CS deliveries with uninsured and privately and/or  
17  
18 publicly insured comparisons. In an ideal situation, studies would report adjusted OR of  
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20 uninsured as compared to privately and/or publicly insured women, but in cases ORs were  
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22 not calculated by the authors, we would extract data (rates and regression coefficients) and  
23  
24 perform calculations that would allow for the derivation of OR. We didn't exclude studies by  
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26 type of study design, variables used for adjustment or any other study characteristic. Adjusted  
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28 OR of deliveries by CS of uninsured women in comparison to insured women was the pre-  
29  
30 specified primary outcome. Crude OR of deliveries by CS of uninsured women in  
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32 comparison to insured women was the pre-specified secondary outcome.  
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### 38 ***Data extraction***

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40 Papers screening and independent data extraction was done by two researchers (IH and MB).  
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42 Differences were resolved based on consensus. We extracted data on study population, study  
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44 design, data sources, setting, type of CS analyzed, statistical analysis, and (primary and  
45  
46 secondary) outcome measures. (Appendix 2)  
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### 50 ***Quality assessment***

51  
52 We used Quality In Prognostic Studies (QUIPS) to assess the risk of bias across six study  
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54 domains.<sup>40</sup> Each study was evaluated independently by two researchers (IH and MB) and any  
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56 differences among evaluators were discussed and resolved. A single rating was assigned for  
57  
58 all studies. As specified in the QUIPS tool, a "high", "moderate", or "low" rating was applied  
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3 for individual domains and overall rating of a study.<sup>40</sup> If a study was rated with a low risk of  
4 bias across all the six domains, it would receive an overall rating of low risk of bias.<sup>17</sup> If one  
5 or more domains of a study were rated with a moderate risk of bias, it would receive an  
6 overall moderate risk of bias.<sup>17</sup> If one or more domains of a study were rated with a high risk  
7 of bias, it would receive an overall high risk of bias.<sup>17</sup>

### 15 ***Main analysis***

16  
17 Standard inverse-variance random effects meta-analysis was used to combine the overall  
18 ORs. An OR lower than one implies a lower frequency of CS in uninsured than in insured  
19 women. We calculated  $\tau^2$  to measure heterogeneity between studies.<sup>41</sup> Pre-specified cutoffs of  
20  $\tau^2$  of 0.04, 0.16 and 0.36 were used to represent low, moderate, and high heterogeneity  
21 between studies.<sup>42</sup> Subgroup analysis by study design, period of data collection, state, type of  
22 CS analyzed, parity, inclusion of women with previous CS, pregnancy risk of included  
23 women and level of (QUIPS) risk of bias was performed to examine between-study  
24 heterogeneity and chi-square test was used to calculate p-values for interaction among  
25 subgroups. Test for linear trend was performed in case of more than two ordered strata. All p-  
26 values were two-sided. STATA, release 13, was used for analyses (Stata-Corp, College  
27 Station, Texas).

### 43 ***Additional analysis***

44 We calculated CS rates among different insurance subgroups for the studies included in the  
45 analysis.

### 51 ***Patient involvement***

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

## 57 **Results**

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3 We identified a total of 1837 records: 1123 from PubMed; 556 from Embase; 39 from the  
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5 Cochrane Library, 119 from CINAHL and 28 from manual search (Figure 1). We removed  
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7 240 duplicates. 1597 records were screened for eligibility. We performed full text  
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9 examination on 177 records. We excluded 139 that did not report insurance status of  
10  
11 women<sup>43-181</sup> and 26 that were otherwise irrelevant.<sup>182-207</sup> (Appendix 3) Finally, 12 records  
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13 describing 16 separate studies<sup>20-22 62 208-215</sup> including more than 8.8 million women were  
14  
15 included in review and meta-analysis.  
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19 Characteristics of studies are presented in Table 1 and Appendices 4, 5, 6 and 7. All studies  
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21 were from the US. Thirteen studies were cross-sectional and three were retrospective cohort  
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23 studies. Population size of studies ranged from 9,017 to 6,717,486 cases. Studies used data  
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25 from years 1986 to 2011 and most studies used hospital records data (Appendix 4). Case  
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27 exclusion criteria varied considerably (Appendix 5) as well as variables studies used for  
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29 statistical adjustment (Appendix 6). Appendix 7 reports evaluation of studies using QUIPS  
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31 risk of bias tool. Four studies were classified with low risk of bias, two studies with moderate  
32  
33 risk, and ten studies with high risk of bias (Appendix 7).  
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37 Figure 2 presents meta-analyses for primary outcome measure, i.e. adjusted ORs of CS in  
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39 uninsured women as compared to privately or publicly insured. Since there was a positive  
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41 interaction between uninsured vs privately insured group and uninsured vs publicly insured  
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43 group ( $p=0.016$ ), we performed meta-analyses for each group separately. In the meta-analysis  
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45 comparing uninsured with privately insured women, including seven studies in 556,454  
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47 women, we found that the odds of CS were 0.70 times lower in uninsured as compared to  
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49 privately insured women (95%CI 0.63 to 0.78), with no relevant heterogeneity between  
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51 studies ( $\tau^2=0.01$ ). In meta-analysis comparing uninsured with publicly insured women,  
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53 including four studies in 510,010 women, we found that the odds of CS were 0.92 times  
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55 lower in uninsured as compared to publicly insured women (95%CI 0.80 to 1.07), with no  
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3 relevant heterogeneity between studies ( $\tau^2=0.02$ ). An additional study in 6,717,486 women,  
4 which did not distinguish between privately and publicly insured women,<sup>215</sup> reported that the  
5 odds of CS were 0.70 times lower in uninsured as compared to insured women (95%CI 0.69  
6 to 0.72).  
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13 Figure 3 presents results of subgroup analyses of adjusted odds ratios in uninsured vs  
14 privately insured women (upper panel) and in uninsured vs publicly insured women (lower  
15 panel). In the analysis of uninsured vs privately insured women, estimates varied for  
16 subgroups state (p for interaction<0.001), type of CS (p for interaction<0.001), parity (p for  
17 interaction=0.07), and pregnancy risk (p for interaction<0.001). There was no positive trend  
18 in the period of data collection subgroup. In the lower panel, which presents subgroup  
19 analyses of adjusted odds ratios in uninsured vs publicly insured women, estimates varied for  
20 subgroups period of data collection (p for interaction=0.03), state (p for interaction=0.004),  
21 type of CS (p for interaction=0.03), parity (p for interaction=0.03) and QUIPS risk of bias (p  
22 for interaction=0.03).  
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37 In Figure 4 we present meta-analyses for crude ORs of CS in uninsured as compared to  
38 privately or publicly insured women as secondary outcome. In the meta-analysis comparing  
39 uninsured with privately insured women, including eleven studies in 2,010,483 women, we  
40 found that the odds of CS were 0.71 times lower in uninsured as compared to privately  
41 insured women (95%CI 0.66 to 0.76), with no relevant heterogeneity between studies  
42 ( $\tau^2=0.018$ ). In the meta-analysis comparing uninsured with publicly insured women,  
43 including eleven studies in 2,010,483 women, we found that the odds of CS were 0.93 times  
44 lower in uninsured as compared to publicly insured women (95%CI 0.85 to 1.01), with no  
45 relevant heterogeneity between studies ( $\tau^2=0.017$ ).  
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58 Table 2 presents rates of CS among groups with different insurance status for individual  
59 studies. Six studies found CS rates for uninsured women below the 19 percent benchmark.  
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3 One study found CS rates below the 10 percent benchmark. The rates of other studies range  
4  
5 from 19.3 percent to 23.0 percent, close to 19 percent benchmark.  
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## 8 9 **Discussion**

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11 Our systematic review and meta-analyses estimated that the overall odds of receiving a  
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13 caesarean section are on average 0.70 times lower for uninsured women as compared with  
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15 privately insured women (95%CI 0.63 to 0.78), 0.92 times lower for uninsured women as  
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17 compared with publicly insured women (95%CI 0.80 to 1.07) and 0.70 times lower for  
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19 uninsured women as compared to privately and publicly insured women (95%CI 0.69 to  
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21 0.72). The lower odds were noticed across all subgroups of studies in subgroup analyses as  
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23 well as in crude analyses.  
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## 27 28 **Context**

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30 To our knowledge, this is the first meta-analysis that examines CS rates of uninsured women  
31  
32 compared to insured women. Two recently published meta-analyses by our group reported  
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34 the association of CS with for profit status of hospitals and type of insurance.<sup>17 216</sup>  
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37 Investigating the association of for-profit vs non-profit status of hospital with the odds of CS,  
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39 we found that the odds of CS were 1.41 higher in for-profit hospitals as compared with non-  
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41 profit hospitals (95% CI 1.24 to 1.60).<sup>216</sup> The findings were consistent in subgroup  
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43 analyses.<sup>216</sup> Investigating the association of CS with private insurance, we found that the odds  
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45 of CS were 1.13 times higher for privately insured women compared with women covered  
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47 with public insurance (95% CI 1.07 to 1.18).<sup>17</sup> Again, the increased risk was observed across  
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49 all subgroups.<sup>17</sup>  
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## 53 54 **Strengths and limitations**

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56 The major strengths of our meta-analysis include an extensive literature search, screening and  
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58 data extraction performed in duplicate, review and analysis of study characteristics as well as  
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3 thorough quality assessment of included studies. In addition, all studies are from one country,  
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5 i.e. the US, and this limits the effect of contextual factors. A major limitation is the variation  
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7 across studies, in terms of the study populations characteristics (i.e. parity, inclusion of  
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9 women with previous CS, risk for CS), type of data used, types of CS analyzed and adjusting  
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11 variables used in statistical analyses. The results of this study are driven by the largest study  
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13 which contains over two thirds of the population included in this review. Only five out of 16  
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15 studies included in the review report data after year 2000. It should also be taken into  
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17 consideration, that despite similar features, the uninsured are a diverse group of US citizens.<sup>26</sup>  
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21 <sup>27</sup> We considered but could not make use of the Robson criteria to classify studies and  
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23 analyze CS rates among the studies reviewed. Only two out of sixteen studies could be  
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25 classified using the Robson criteria.<sup>62 214</sup> While a population level CS rate of less than 9, 10 or  
26  
27 19 percent suggests underuse, we cannot determine the mix of under, over, and appropriate  
28  
29 use in a specific population.  
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### 32 33 ***Mechanism***

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35 There are several possible explanations why uninsured women have lower odds of CS when  
36  
37 compared to insured women. One likely factor is that financial incentives are stronger with  
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39 private insurance than in the publicly insured or uninsured.<sup>17 18</sup> These incentives result from  
40  
41 higher payment for CS by private insurers through reimbursement arrangements that  
42  
43 encourage more expensive procedures as means to increase profits, as well as providers'  
44  
45 (hospitals and individual physicians) responses to these incentives.<sup>17 70 216</sup> The responses to  
46  
47 incentives by hospitals exist in the form of patient scheduling policies that direct privately  
48  
49 insured patients to profit inclined physicians.<sup>20 216</sup> It is also a known association that  
50  
51 physicians who have a higher share of privately insured patients will tend to overuse CS.<sup>21 22</sup>  
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55 <sup>216</sup> They do so as they perceive patients to have a higher social class, i.e. able to pay higher  
56  
57 fees, or fear malpractice liability.<sup>18 111 208 216</sup>  
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3 Additional reasons are likely reflected in the comparison between uninsured and publicly  
4 insured women. A first set of reasons are related to deliberate or forced decisions of  
5 uninsured women to keep out-of-pocket payments low.<sup>18</sup> The uninsured patients are more  
6 likely to seek less expensive care when they face the need for healthcare services.<sup>18</sup> In the  
7 case of giving birth, this would lead to a greater preference for vaginal delivery. A second set  
8 of reasons may be discrimination of providers towards uninsured women. Providers have a  
9 preference for profitable, i.e. privately insured patients, a preference commonly referred to as  
10 “cream skimming”.<sup>21 22 216 217</sup>  
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### 22 ***Implications for uninsured women***

23  
24 Most studies included in our meta-analysis, including the most recent studies from  
25 California<sup>213</sup> and Florida,<sup>214</sup> show that rates for CS among uninsured women are below or  
26 close to the 10 and 19 percent benchmarks previously reported.<sup>6-8</sup> Even in instances where  
27 the average state rates are slightly above the 19 percent benchmark, some hospitals service  
28 areas are likely to have CS rates lower than 19 percent or even 9 percent for uninsured  
29 women because of the well-established within state variation in CS rates.<sup>5 111</sup> Uninsured  
30 women in these areas are highly likely to be underserved with caesarean section during  
31 delivery. Uninsured patients generally have higher unmet needs than insured patients due to  
32 access barriers.<sup>23 24 26 28 218-222</sup> Such barriers encourage inappropriate health seeking behaviors  
33 among uninsured.<sup>23-25 32 220 223-225</sup> Consequently, uninsured populations face higher health  
34 risks and have worse healthcare outcomes.<sup>23-26 32 218-221 223 224 226 227</sup>  
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50 The uninsured also face financial burdens which result from out-of-pocket payments that are  
51 more severe/extensive than co-payments or premiums that are paid by people that are  
52 publicly or privately insured. The uninsured are known to pay higher prices for services as  
53 compared to other payers for the same care,<sup>27 228</sup> spend a high portion of income to cover  
54 medical expenses<sup>24</sup> (although they spend less for their health compared to patients who have  
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3 insurance),<sup>26</sup> are frequently charged for full price for healthcare services,<sup>24 228</sup> often do not  
4 benefit from discounts from providers,<sup>24 27</sup> and face severe financial difficulties.<sup>23 24</sup>

5  
6  
7 Uninsured manage to pay only part of the costs for their care.<sup>26</sup> The remaining costs are  
8 uncompensated costs<sup>23 26 229 230</sup> and most of such costs are covered by the local, state or  
9 federal government,<sup>26 229</sup> eventually resulting in tax increases.<sup>26</sup>

### 15 ***Implications for research and policy making***

16  
17 Future studies should examine the association of a lack of insurance in pregnant women  
18 across health care markets with varying CS rates and assess if delivery outcomes were  
19 correspondingly worse, in the effort to investigate the presence of underuse of CS.

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21  
22 In parallel, policy options that could lead to improvements of insurance coverage for  
23 delivering women should be assessed in terms of their ability to address healthcare outcomes  
24 while keeping overall costs at minimum. In the past, states have adopted different strategies  
25 for covering uninsured people.<sup>24 25 39 231</sup> While there are many known benefits to insurance  
26 coverage,<sup>23 24 32-35 37 221 224 230 232-234</sup> other important policy aspects should be considered. At a  
27 time of rising healthcare costs<sup>24 35 234 235</sup> regulation of financial incentives is crucial. A  
28 revision of payment policies should be pursued<sup>17 18 24 216</sup> to align financial incentives with  
29 proper health outcomes.<sup>17 24 216</sup> Reimbursement policies that would pay the same amount for  
30 CS and vaginal delivery is one option.<sup>216 236</sup>

### 46 ***Conclusion***

47  
48 Caesarean sections are less likely to be performed in uninsured women as compared with  
49 insured women. The lower odds are consistent in all subgroups and in crude analyses. While  
50 the higher rates for CS among privately insured women can be explained with financial  
51 incentives associated with private insurance, the lower odds among uninsured women draw  
52 attention at barriers to access for delivery care. In many regions, the rates for uninsured  
53 women are above, close or below the benchmarks for appropriate CS rates and imply both,

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3 underuse and overuse. Therefore, efforts to assess the delivery outcomes as well as policy  
4 options that could improve insurance coverage for women giving birth are important.  
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## 9 **Acknowledgments**

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### 42 ***Contributorship Statement***

43  
44 IH, DG, PJ conceived and designed the study. IH, MB performed the data extraction and  
45 preparation. IH, LS analyzed the data. IH, MB, LS drafted the paper, which was critically  
46 reviewed and approved by all authors.  
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**Competing interests statement**

All authors have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://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**

<b>Author</b>	<b>Year</b>	<b>State</b>	<b>Study design</b>	<b>Number of cases</b>	<b>Number of hospital units</b>	<b>Year of data collection</b>	<b>Population</b>	<b>Sampling</b>	<b>Type of CS analyzed</b>
Stafford	1990	California	Cross sectional	461066	Not reported	1986	Primi- and multipara; any risk	Consecutive	Any
Haas et al. A	1993	Massachusetts	Cross sectional	57257	Not reported	1984	Primi- and multipara; any risk	Consecutive	Any
Haas et al. B	1993	Massachusetts	Cross sectional	64346	Not reported	1987	Primi- and multipara; any risk	Consecutive	Any
Braveman et al.	1995	California	Retrospective cohort	213761	Unclear	1991	Primipara; no previous CS; any risk	Consecutive	Any
Burns et al.	1995	Arizona	Cross sectional	33233	36	1989	Primi- and multipara; any risk	Consecutive	Any

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1 2 3 4 5 6 7	Onion et al. A	1999	Maine	Cross sectional	41177	Not reported	1990- 1992	Primipara; no previous CS; any risk	Consecutive	Any
8 9 10 11 12	Onion et al. B	1999	New Hampshire	Cross sectional	41401	Not reported	1990- 1992	Primipara; no previous CS; any risk	Consecutive	Any
13 14 15 16	Onion et al. C	1999	Vermont	Cross sectional	19077	Not reported	1990- 1992	Primipara; no previous CS; any risk	Consecutive	Any
17 18 19 20 21	Aron et al.	2000	Ohio	Retrospective cohort	25697	21	1993- 1995	Primipara; no previous CS; any risk	Consecutive	Any
22 23 24 25 26	Grant A	2005	All states	Cross sectional	9017	Not reported	1988	Primi- and multipara; any risk	Random	Any
27 28 29 30	Grant B	2005	Florida	Cross sectional	147821	Not reported	1992	Primi- and multipara; any risk	Consecutive	Any
31 32 33 34 35 36 37 38 39 40 41 42	Coonrod et al.	2008	Arizona	Cross sectional	28863	40	2005	Primipara; low risk	Consecutive	Any

Huesch	2011	New Jersey	Cross sectional	182108	Not reported	2004-2007	Primi- and multipara; no previous CS; low risk	Consecutive	Planned
Kozhimannil et al.	2013	All states	Cross sectional	6717486	Over 1000	2002-2009	Primi- and multipara; any risk	Random	Any
Huesch et al.	2014	California	Cross sectional	408355	254	2010	Primi- and multipara; no previous CS; any risk	Consecutive	Planned
Sebastião et al.	2016	Florida	Retrospective cohort	412192	122	2004-2011	Primipara; no previous CS; low risk	Consecutive	Emergency

CS = caesarean section



**Table 2. Caesarean section rates among groups with different insurance status**

<b>Author</b>	<b>Year</b>	<b>State</b>	<b>Year of data collection</b>	<b>CS rate of privately insured (%)</b>	<b>CS rate of publicly insured (%)</b>	<b>CS rate of uninsured (%)</b>
Stafford	1990	California	1986	26.8	22.1	19.3
Haas et al. A	1993	Massachusetts	1984	23.0	19.4	17.2
Haas et al. B	1993	Massachusetts	1987	25.9	20.8	22.4
Braveman et al.	1995	California	1991	27.1	21.2	23.0
Burns et al.	1995	Arizona	1989	n/a	n/a	n/a
Onion et al. A	1999	Maine	1990-1992	15.9	14.9	13.4
Onion et al. B	1999	New Hampshire	1990-1992	16.1	13.2	13.0
Onion et al. C	1999	Vermont	1990-1992	14.5	13.5	9.4
Aron et al.	2000	Ohio	1993-1995	17.0	14.2	10.7
Grant A	2005	All states	1988	27.0	23.7	17.1
Grant B	2005	Florida	1992	30.0	21.6	20.7
Coonrod et al.	2008	Arizona	2005	26.0	19.0	20.0
Huesch	2011	New Jersey	2004-2007	26.7	22.5	20.3

			2002-			
Kozhimannil et al.	2013	All states	2009	n/a	n/a	n/a
Huesch et al.	2014	California	2010	13.9	10.7	13.0
Sebastião et al.	2016	Florida	2004- 2011	25.2	22.8	19.7

\*The rates are adjusted as compared to the rates from other studies which are crude rates.

CS rates bellow 10% benchmark

CS rates bellow 19% benchmark

## Figure legends

**Figure 1. The flow diagram of review**

**Figure 2. Adjusted odds ratios of caesarean section**

**Figure 3. Subgroup analyses for adjusted estimates/Legend: \*P for trend**

**Figure 4. Crude odds ratios of caesarean section**

## Supporting information

**Appendix 1. Search Strategy**

**Appendix 2. List of the extracted variables**

**Appendix 3. List of excluded articles**

**Appendix 4. Type of data used**

**Appendix 5. Reported exclusion criteria**

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3 **Appendix 6. Covariates used for statistical adjustment**  
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5 **Appendix 7. QUIPS risk of bias**  
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For peer review only

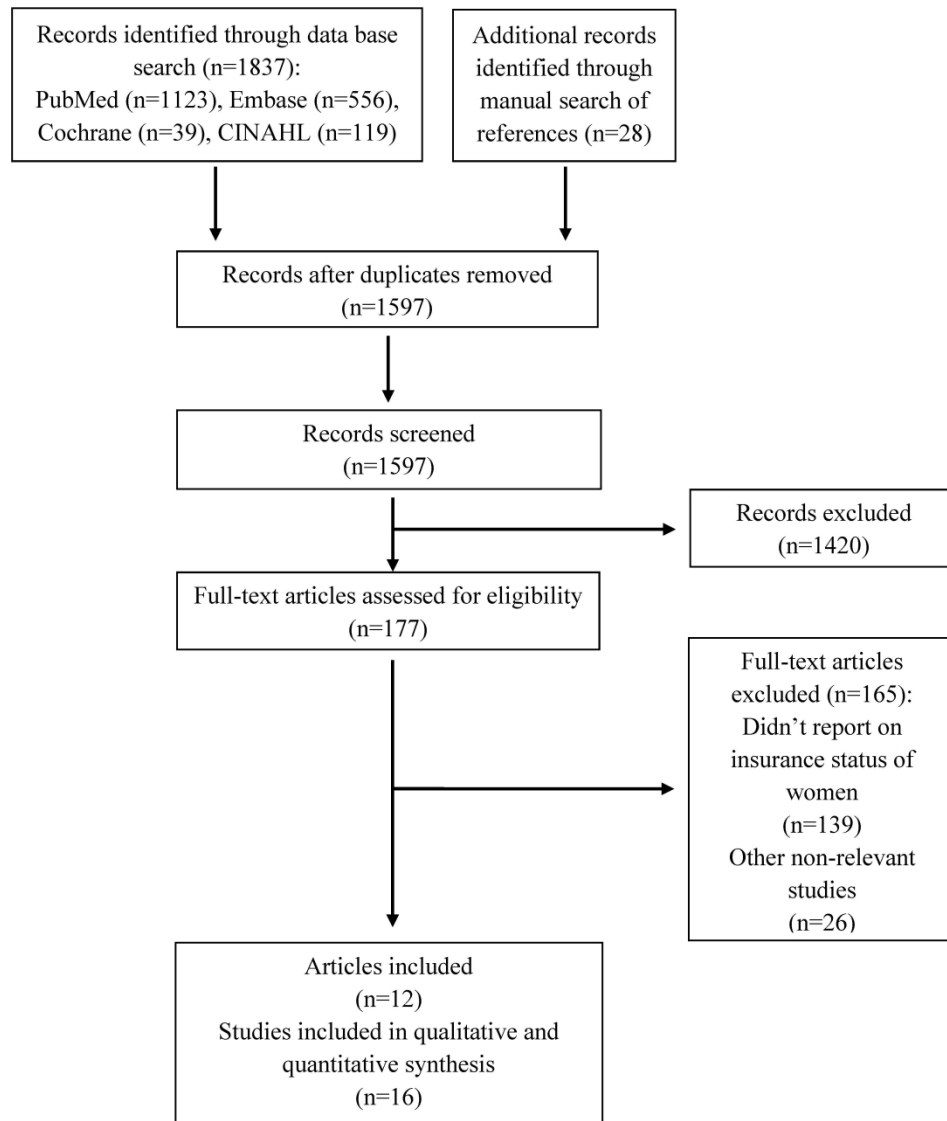
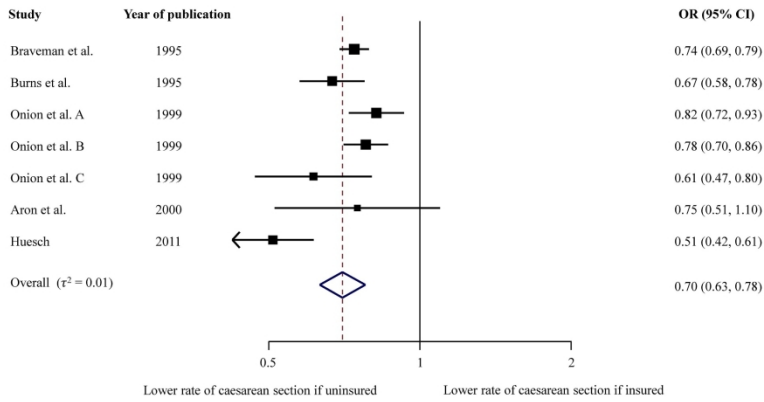


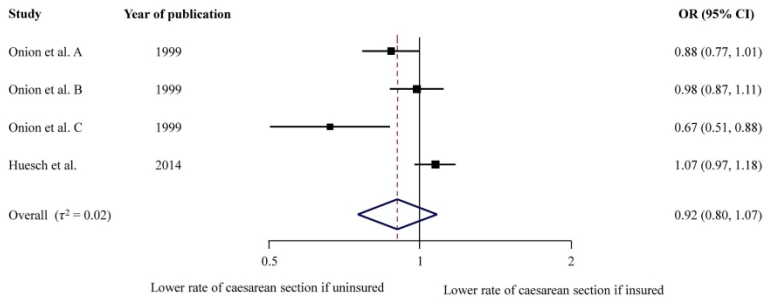
Figure 1. The flow diagram of review

1072x1261mm (96 x 96 DPI)

**Uninsured vs privately insured**



**Uninsured vs publicly insured**



**Uninsured vs publicly or privately insured**

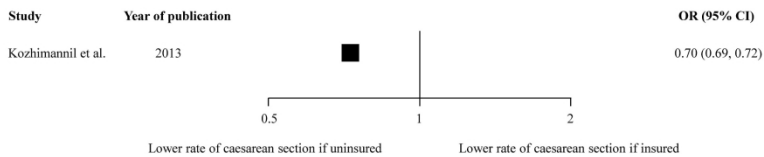
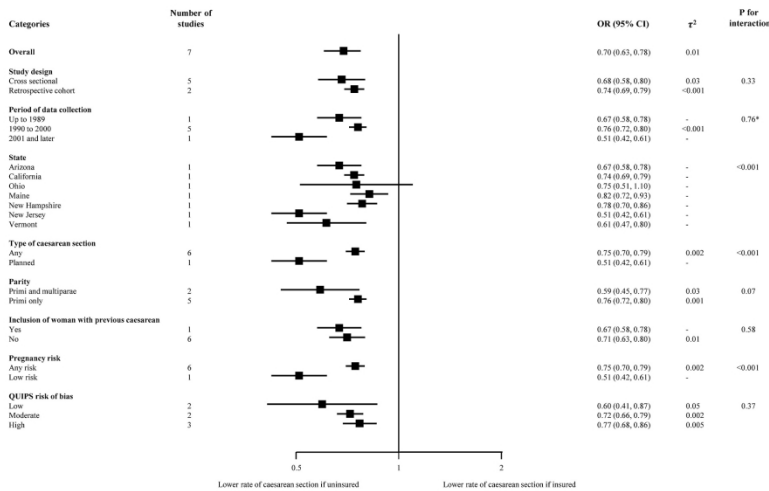


Figure 2. Adjusted odds ratios of caesarean section

529x791mm (96 x 96 DPI)

Uninsured vs privately insured



Uninsured vs publicly insured

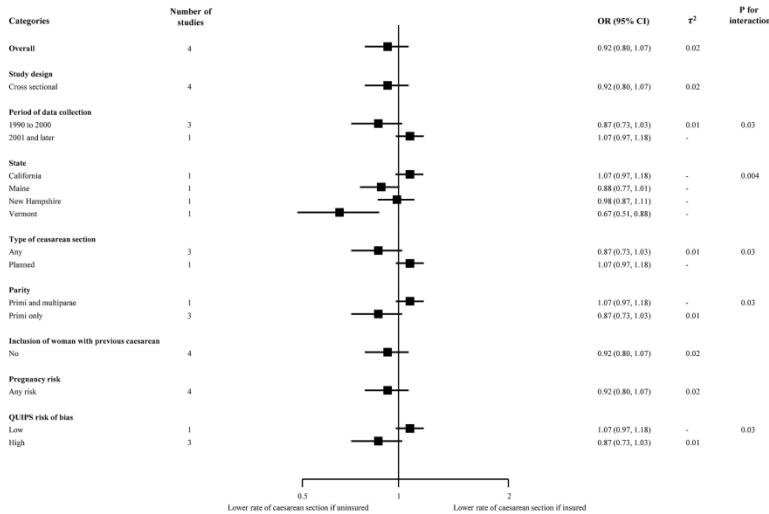


Figure 3. Subgroup analyses for adjusted estimates/\*P for trend

529x784mm (96 x 96 DPI)

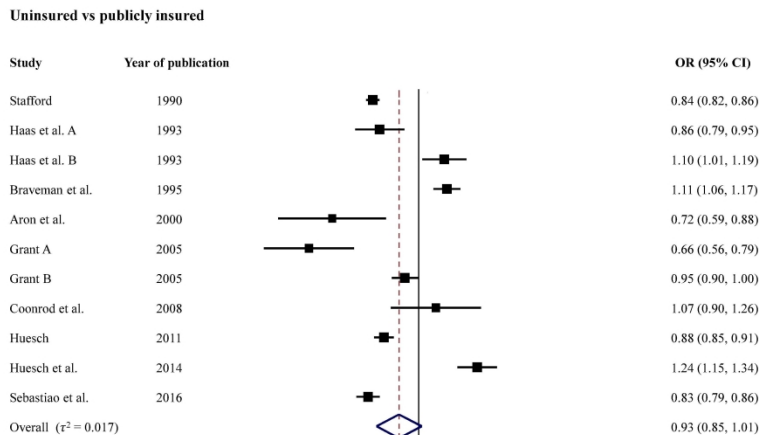
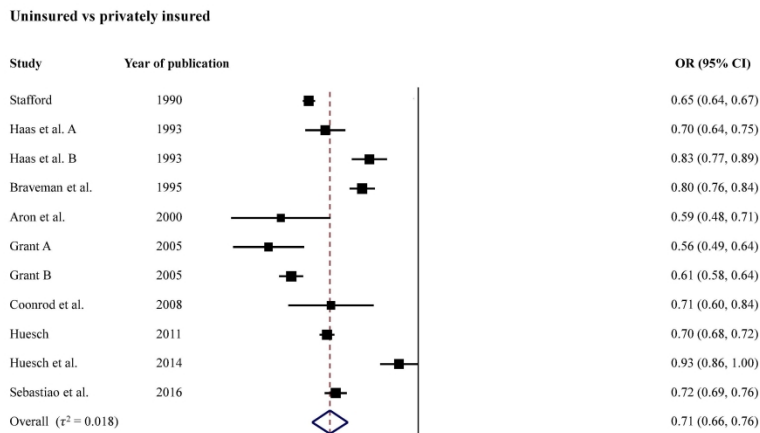


Figure 4. Crude odds ratios of caesarean section

862x1308mm (96 x 96 DPI)

## Appendix 1. 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))))))



**Appendix 2. List of the extracted variables**

<b>General information</b>		
		Author
		Year
		State
		Study design
		Number of cases
		Number of hospital units
		Year of data collection
		Population
		Sampling
		Type of CS analyzed
<b>Type of data used</b>		
		Type of data used
<b>Reported exclusion criteria</b>		
		Source population
	Maternal characteristics	Age $\leq 14$
		Racial or ethnic minorities
		Multipara
		Previous caesarean section
		Other risk factors for caesarean section
	Fetus characteristics	Stillbirth
		Multiple delivery (twin or more)
		Newborn weighting <500 gr
		Breach presentation
		Other malpresentation
		Preterm delivery (less than 37 weeks)
		Other risk factors for caesarean section
		Not in labor
		Cases with missing data
		Provider characteristics
		Other factors
<b>Covariates used for statistical adjustment</b>		
	Maternal preconception status	Ethnicity/Race
		Educational level
		Marital status
		Economic status
		Insurances status
		Urban status

		Weight
		Height
		Body mass index
		Age
	Maternal clinical status	Parity
		Previous caesarean section
		Pre-existing (before pregnancy) conditions
		Conditions developed during pregnancy
	Fetus characteristics	Gestational age
		Birth weight
		Other characteristics
	Prenatal care	
	Delivery characteristics	
	Provider characteristics	
	Other variables	
	Total number of covariates	
	<b>QUIPS risk of bias</b>	
	Study Participation	
	Study Attrition	
	Prognostic Factor Measurement	
	Outcome Measurement	
	Study Confounding	
	Statistical Analysis and Reporting	
	Overall rating	
	<b>Caesarean section rates among groups with different insurance status</b>	
	State	
	Year of data collection	
	CS rate of privately insured (%)	
	CS rate of publicly insured (%)	
	CS rate of uninsured (%)	
	<b>Effect estimate</b>	
	Determinant being compared	
	Comparator (reference)	
	Unadjusted outcome measure	
	Effect size	
	Lower CI95%	
	Upper CI95%	
	SE	
	Determinant being compared	
	Comparator (reference)	

	Adjusted outcome measure	
	Effect size	
	Lower CI95%	
	Upper CI95%	
	SE	
	<b>Number of cases by groups</b>	
	Total births (all groups)	
	Total No-CS (all groups)	
	Total CS (all groups)	
	Total births in group 1	
	No-CS in group 1	
	CS in group 1	
	Total births in group 2	
	No-CS in group 2	
	CS in group 2	
	Total births in group 3	
	No-CS in group 3	
	CS in group 3	

### Appendix 3. List of excluded articles

<b>Author, Year</b>	<b>Reason for exclusion</b>
1 Adhikari Dahal, et al., 2017	Didn't report on insurance status of women
2 Armstrong, et al., 2016	Didn't report on insurance status of women
3 Bailit, et al., 2006	Didn't report on insurance status of women
4 Bannister-Tyrrell, et al., 2015	Didn't report on insurance status of women
5 Blais, 1993	Didn't report on insurance status of women
6 Brown, 2007	Didn't report on insurance status of women
7 Brown, et al., 2013	Other non-relevant studies
8 Butcher, et al., 1997	Didn't report on insurance status of women
9 Caceres, et al., 2013	Didn't report on insurance status of women
10 Carayol, et al., 2007	Didn't report on insurance status of women
11 Carayol, et al., 2007	Didn't report on insurance status of women
12 Carayol, et al., 2008	Didn't report on insurance status of women
13 Carlisle, et al., 1996	Didn't report on insurance status of women
14 Chauhan, et al., 2008	Other non-relevant studies
15 Chen, et al., 2003	Other non-relevant studies
16 Chen, et al., 2014	Didn't report on insurance status of women
17 Chen, et al., 2016	Didn't report on insurance status of women
18 Cheng, et al., 2015	Other non-relevant studies
19 Cisse, et al., 1998	Other non-relevant studies
20 Clark, et al., 2007	Didn't report on insurance status of women
21 Clark, et al., 2014	Didn't report on insurance status of women
22 Clarke, et al., 1995	Didn't report on insurance status of women
23 Clarke, et al., 1996	Didn't report on insurance status of women
24 Clayton, et al., 2013	Didn't report on insurance status of women
25 Coonrod, et al., 2008	Didn't report on insurance status of women
26 Coulm, et al., 2012	Didn't report on insurance status of women
27 Cressie, 1993	Other non-relevant studies
28 Da Silva Campi, et al., 2014	Didn't report on insurance status of women
29 da Silva, et al., 2003	Other non-relevant studies
30 Danishevski, et al., 2008	Other non-relevant studies
31 Daw, et al., 2018	Didn't report on insurance status of women
32 de Regt, et al., 1986	Didn't report on insurance status of women
33 Di Mario, et al., 2013	Didn't report on insurance status of women
34 Dimitrov, 1998	Other non-relevant studies
35 Eckerlund, et al., 1998	Didn't report on insurance status of women
36 Edmonds, et al., 2015	Other non-relevant studies
37 Edmonds, et al., 2017	Didn't report on insurance status of women
38 Emmett, et al., 2010	Other non-relevant studies
39 Epstein, et al., 2009	Didn't report on insurance status of women
40 Franca, et al., 2016	Didn't report on insurance status of women

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2	41 Gama, et al., 2009	Other non-relevant studies
3	42 Garcia, et al., 2001	Didn't report on insurance status of women
4	43 Gates, 1995	Didn't report on insurance status of women
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6	44 Gittelsohn, et al., 1995	Didn't report on insurance status of women
7	45 Gomes, et al., 1999	Didn't report on insurance status of women
8	46 Gonzalez-Perez, et al., 2001	Didn't report on insurance status of women
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10	47 Goyert, et al., 1989	Didn't report on insurance status of women
11	48 Gregory, et al., 2001	Didn't report on insurance status of women
12	49 Gross, et al., 2015	Didn't report on insurance status of women
13	50 Grytten, et al., 2011	Didn't report on insurance status of women
14	51 Grytten, et al., 2012	Didn't report on insurance status of women
15	52 Gumedde, et al., 2017	Didn't report on insurance status of women
16	53 Hanley, et al., 2010	Didn't report on insurance status of women
17	54 Haraldsdottir, et al., 2015	Didn't report on insurance status of women
18	55 Haupt, 1982	Other non-relevant studies
19	56 Heffner, et al., 2003	Didn't report on insurance status of women
20	57 Helfand, et al., 1997	Didn't report on insurance status of women
21	58 Henke, et al., 2014	Didn't report on insurance status of women
22	59 Hofmeyr, et al., 2015	Other non-relevant studies
23	60 Hopkins, et al., 2014	Didn't report on insurance status of women
24	61 Hsu, et al., 2008	Didn't report on insurance status of women
25	62 Hueston, et al., 2001	Didn't report on insurance status of women
26	63 Jessee, et al., 1982	Didn't report on insurance status of women
27	64 Johnson, et al., 1995	Didn't report on insurance status of women
28	65 Joyce, et al., 2002	Didn't report on insurance status of women
29	66 Kennare, 2003	Other non-relevant studies
30	67 Keskimaki, et al., 1994	Didn't report on insurance status of women
31	68 Khan, et al., 2017	Didn't report on insurance status of women
32	69 Kim, et al., 2012	Didn't report on insurance status of women
33	70 Kim, et al., 2016	Didn't report on insurance status of women
34	71 Kimsey, et al., 2017	Didn't report on insurance status of women
35	72 Klassen, 1975	Didn't report on insurance status of women
36	73 Klemetti, et al., 2010	Didn't report on insurance status of women
37	74 Koroukian, et al., 2001	Didn't report on insurance status of women
38	75 Korst, et al., 2005	Didn't report on insurance status of women
39	76 Kozhimannil, et al., 2014	Didn't report on insurance status of women
40	77 Krivenko, et al., 1994	Other non-relevant studies
41	78 Kyu-Tae, et al., 2017	Didn't report on insurance status of women
42	79 Lee, et al., 2007	Didn't report on insurance status of women
43	80 Lee, et al., 2014	Didn't report on insurance status of women
44	81 Leung, et al., 2001	Didn't report on insurance status of women
45	82 Li, et al., 2017	Didn't report on insurance status of women
46	83 Librero, et al., 2000	Didn't report on insurance status of women
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2	84 Lidegaard, et al., 1994	Didn't report on insurance status of women
3	85 Little, et al., 2015	Didn't report on insurance status of women
4	86 Liu, et al., 2007	Didn't report on insurance status of women
5	87 Localio, et al., 1993	Didn't report on insurance status of women
6	88 Lundsberg, et al., 2017	Didn't report on insurance status of women
7	89 Lutomski, et al.,	Didn't report on insurance status of women
8	90 Lutomski, et al., 2014	Didn't report on insurance status of women
9	91 Maeda, et al., 2018	Didn't report on insurance status of women
10	92 Marquez-Calderon, et al., 2011	Didn't report on insurance status of women
11	93 McKenzie, et al., 1993	Didn't report on insurance status of women
12	94 Menard, 1999	Didn't report on insurance status of women
13	95 Mendlovic, et al., 2017	Didn't report on insurance status of women
14	96 Mesterton, et al., 2017	Didn't report on insurance status of women
15	97 Mikolajczyk, et al., 2013	Didn't report on insurance status of women
16	98 Mindell, et al., 1982	Didn't report on insurance status of women
17	99 Misra, 2008	Didn't report on insurance status of women
18	100 Mitler, et al., 2000	Didn't report on insurance status of women
19	101 Mossialos, et al., 2005	Didn't report on insurance status of women
20	102 Movsas, et al., 2012	Didn't report on insurance status of women
21	103 Murray, 2000	Didn't report on insurance status of women
22	104 Murray, et al., 1997	Didn't report on insurance status of women
23	105 Naiditch, et al., 1997	Didn't report on insurance status of women
24	106 Newton, et al., 1989	Didn't report on insurance status of women
25	107 Nicholson, et al., 2009	Didn't report on insurance status of women
26	108 Nigam, 2011	Didn't report on insurance status of women
27	109 Nilsen, et al., 2014	Didn't report on insurance status of women
28	110 Nirupam, et al., 1995	Other non-relevant studies
29	111 Oleske, et al., 1991	Didn't report on insurance status of women
30	112 Ono, et al., 2016	Didn't report on insurance status of women
31	113 Paranjothy, et al., 2005	Didn't report on insurance status of women
32	114 Parazzini, et al., 2015	Didn't report on insurance status of women
33	115 Pel, et al., 1995	Other non-relevant studies
34	116 Phipps, et al., 2014	Other non-relevant studies
35	117 Placek, et al., 1980	Didn't report on insurance status of women
36	118 Rabilloud, et al., 1998	Didn't report on insurance status of women
37	119 Raifman, et al., 2014	Didn't report on insurance status of women
38	120 Rattner, 1996	Didn't report on insurance status of women
39	121 Ravindran, 2003	Other non-relevant studies
40	122 Ravindran, 2008	Didn't report on insurance status of women
41	123 Renzi, et al., 2012	Didn't report on insurance status of women
42	124 Ribeiro, et al., 2007	Didn't report on insurance status of women
43	125 Riddell, et al., 2017	Didn't report on insurance status of women
44	126 Rohrer, 1993	Other non-relevant studies
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2	127 Roohan, et al., 2001	Didn't report on insurance status of women
3	128 Rossignol, et al., 2013	Didn't report on insurance status of women
4	129 Rowe, et al., 2014	Didn't report on insurance status of women
5	130 Sandall, et al., 2013	Other non-relevant studies
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7	131 Sarria Santamera, et al., 1994	Didn't report on insurance status of women
8	132 Schemann, et al., 2015	Didn't report on insurance status of women
9	133 Schemann, et al., 2016	Didn't report on insurance status of women
10	134 Sentell, et al., 2016	Didn't report on insurance status of women
11	135 Shiono, et al., 1987	Didn't report on insurance status of women
12	136 Shorten, et al., 2007	Didn't report on insurance status of women
13	137 Signorelli, et al., 1991	Didn't report on insurance status of women
14	138 Singata, et al., 2013	Other non-relevant studies
15	139 Snyder, et al., 2011	Didn't report on insurance status of women
16	140 Souza, et al., 2016	Didn't report on insurance status of women
17	141 Sufang, et al., 2007	Didn't report on insurance status of women
18	142 Tang, et al., 2006	Didn't report on insurance status of women
19	143 Tang, et al., 2006	Didn't report on insurance status of women
20	144 Tracy, et al., 2006	Didn't report on insurance status of women
21	145 Tucker, et al.,	Didn't report on insurance status of women
22	146 Tussing, et al., 1994	Didn't report on insurance status of women
23	147 Vadnais, et al., 2017	Didn't report on insurance status of women
24	148 Vankan, et al., 2017	Didn't report on insurance status of women
25	149 Vayda, et al., 1984	Didn't report on insurance status of women
26	150 Vecino-Ortiz, et al.,	Didn't report on insurance status of women
27	151 Wang, et al., 2017	Didn't report on insurance status of women
28	152 Ward, et al., 2010	Other non-relevant studies
29	153 Weber, 1990	Other non-relevant studies
30	154 Wei, et al., 2013	Other non-relevant studies
31	155 Woolbright, 1996	Didn't report on insurance status of women
32	156 Xing Lin, et al., 2012	Didn't report on insurance status of women
33	157 Xirasagar, et al., 2004	Didn't report on insurance status of women
34	158 Xirasagar, et al., 2006	Didn't report on insurance status of women
35	159 Xirasagar, et al., 2007	Didn't report on insurance status of women
36	160 Yang, et al., 2014	Didn't report on insurance status of women
37	161 Yi-Chen, et al., 2012	Didn't report on insurance status of women
38	162 Zdeb, et al., 1980	Didn't report on insurance status of women
39	163 Zere, et al., 2010	Didn't report on insurance status of women
40	164 Zhang, et al., 2013	Didn't report on insurance status of women
41	165 Zwecker, et al., 2011	Didn't report on insurance status of women
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3 **Appendix 4. Type of data used**

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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		+	+	
Onion et al. A	1999		+		
Onion et al. B	1999		+		
Onion et al. C	1999		+		
Aron et al.	2000		+		
Grant A	2005	+			
Grant B	2005		+		
Coonrod et al.	2008			+	
Huesch	2011		+		
Kozhimannil et al.	2013		+		
Huesch et al.	2014		+		
Sebastião et al.	2016		+	+	



## Appendix 5. Reported exclusion criteria

Authors	Year	Source population	Maternal characteristics						Fetus characteristics						Not in labor	Cases with missing data	Provider characteristics	Other factors	
			Age ≤14	Racial or ethnic minorities	Multipara	Previous caesarean section	Other risk factors for caesarean section	Stillbirth	Multiple delivery (twin or more)	Newborn weighting <500 gr	Breach presentation	Other malpresentation	Preterm delivery (less than 37 weeks)	Other risk factors for caesarean section					
Stafford	1990	All deliveries in California, United States																	
Haas et al. A	1993	All deliveries in Massachusetts, United States						+	+	+							+		
Haas et al. B	1993	All deliveries in Massachusetts, United States						+	+	+							+		
Braveman et al.	1995	All deliveries in California, United States			+	+		+	+				+				+		
Burns et al.	1995	All deliveries in Arizona, United States															+	+	
Onion et al. A	1999	All deliveries in Maine, United States			+	+			+									+	
Onion et al. B	1999	All deliveries in New Hampshire, United States			+	+			+									+	
Onion et al. C	1999	All deliveries in Vermont, United States			+	+			+									+	
Aron et al.	2000	All deliveries in Cleveland, Ohio, United States				+					+	*					+	+	+
Grant A	2005	All deliveries, United States															+		
Grant B	2005	All deliveries in Florida, United States															+	+	+
Coonrod et al.	2008	All deliveries in Arizona, United States		+	+			+	+				+	+	+			+	
Huesch	2011	All deliveries in New Jersey, United States				+	+		+				+	+	+	+		+	
Kozhimannil et al.	2013	All deliveries in 44 states, United States																+	
Huesch et al.	2014	All deliveries in California, United States	+			+											+		
Sebastião et al.	2016	All deliveries in Florida, United States			+	+		+	+				+	+	+	+	+	+	+

\*500 or less grams

### Appendix 6. Covariates used for statistical adjustment

Author	Year	Maternal preconception status										Maternal clinical status			Fetus characteristics			Prenatal care	Delivery 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						Other characteristics												
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	
Onion et al. A	1999																																	1	
Onion et al. B	1999																																	1	
Onion et al. C	1999																																	1	
Aron et al.	2000																																	39	
Grant A*	2005																																	0	
Grant B*	2005																																	0	
Coonrod et al.*	2008																																	0	
Huesch	2011	+		+																														8	
Kozhimannil et al.	2013	+																																16	
Huesch et al.	2014	+				+																													124
Sebastião et al. *	2016																																		

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

\*Studies reported only crude estimates.

## Appendix 7. 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
Onion et al. A	1999	low	low	low	low	high	low	high
Onion et al. B	1999	low	low	low	low	high	low	high
Onion et al. C	1999	low	low	low	low	high	low	high
Aron et al.	2000	low	low	low	low	low	low	low
Grant A	2005	moderate	high	low	low	high	low	high
Grant B	2005	low	low	low	low	high	low	high
Coonrod et al.	2008	low	low	low	low	high	low	high
Huesch	2011	low	low	low	low	low	low	low
Kozhimannil et al.	2013	low	low	low	low	low	low	low
Huesch et al.	2014	low	low	low	low	low	low	low
Sebastião et al.	2016	low	low	low	low	high	low	high

## Research Checklist

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2 *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, 6)
Hypothesis statement	Manuscript (page 5, 6)
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, 7)
Study population	Manuscript (page 6, 7) Table 1, Appendix 1
<b>Reporting of search strategy should include</b>	
Qualifications of searchers (eg, librarians and investigators)	Manuscript (page 1)
Search strategy, including time period included in the synthesis and keywords	Manuscript (page 6), Appendix 1
Effort to include all available studies, including contact with authors	Manuscript (page 6)
Databases and registries searched	Manuscript (page 6)
Search software used, name and version, including special features used (eg, explosion)	Manuscript (page 6)
Use of hand searching (eg, reference lists of obtained articles)	Manuscript (page 6)
List of citations located and those excluded, including justification	Figure 1
Method of addressing articles published in languages other than English	n/a
Method of handling abstracts and unpublished studies	Manuscript (page 6, 7)
Description of any contact with authors	No contact made
<b>Reporting of methods should include</b>	
Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	Manuscript (page 6, 7)

1 2 3	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	Manuscript (page 6, 7)
4 5 6 7	Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	Manuscript (pages 6, 7)
8 9 10 11 12	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	Manuscript (page 6-7), Appendix 2, 3, 4
13 14 15 16 17	Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	Manuscript (page 7), Figure 2, Appendix 5,
18 19	Assessment of heterogeneity	Manuscript (page 7)
20 21 22 23 24 25 26 27 28 29 30	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 7)
31 32 33 34 35 36	Provision of appropriate tables and graphics	Table 1, Figure 1-3 and Appendixes 1-7
37	<b>Reporting of results should include</b>	
38 39 40 41 42	Graphic summarizing individual study estimates and overall estimate	Figure 2, Appendix 6
43 44 45	Table giving descriptive information for each study included	Table 1
46 47	Results of sensitivity testing (eg, subgroup analysis)	Figure 3
48 49 50	Indication of statistical uncertainty of findings	Manuscript, Figure 2-4
51	<b>Reporting of discussion should include</b>	
52 53 54	Quantitative assessment of bias (eg, publication bias)	Manuscript (page 8)
55 56 57 58 59	Justification for exclusion (eg, exclusion of non—English-language citations)	Manuscript (page 8)
60	Assessment of quality of included studies	Manuscript (page 8)

**Reporting of conclusions should include**

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