Prevalence and main outcomes of placenta accreta spectrum: a systematic review and meta-analysis

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OBJECTIVE DATA: The objective of this study was to evaluate the prevalence of placenta accreta spectrum in general population studies and the main maternal outcomes at delivery.

STUDY: We searched PubMed, Google Scholar, clinicalTrials.gov, and MEDLINE between 1982 and 2018. Articles that provided data on the number of cases of placenta accreta spectrum per pregnancies, births, or deliveries in a defined population were used.

STUDY APPRAISAL AND SYNTHESIS METHODS: Study characteristics were evaluated by 2 independent reviewers who used a predesigned protocol. Primary outcomes were the prevalence of placenta accreta spectrum and clinical diagnostic data at birth; the pathologic criteria were used to confirm the diagnosis. Secondary outcomes included cases that required transfusion, incidence of peripartum hysterectomy, and maternal mortality rates. Heterogeneity between studies was analyzed with the Cochran's Q-test and the I^2 statistics.

RESULTS: Of the 98 full-text studies that were identified, 29 articles met the defined criteria and included 22 retrospective and 7 prospective studies comprising 7001 cases of placenta accreta spectrum of 5,719,992 births. Prevalence rates ranged from 0.01—1.1% with an overall pooled prevalence of 0.17% (95% confidence interval, 0.14—0.19). Only 10 studies provided detailed histopathologic data. The pool prevalence for the adherent vs the invasive grades was 0.5 (95% confidence interval, 0.3—0.36) and 0.3 (95% confidence interval, 0.2—0.4) per 1000 births, respectively. The pooled incidence for peripartum hysterectomy was 52.2% (95% confidence interval, 38.3—66.4; I^2=99.8%) and 46.9% (95 % confidence interval, 34—59.9; I^2=98.8%) for hemorrhage that required transfusion. The pooled estimate of maternal death was 0.05% (95% confidence interval, 0.06—0.69; I^2=73%). We found large amounts of heterogeneity between studies for all parameters and further quantification was limited because of methodologic inconsistencies between studies with regards to clinical criteria that were used for the diagnosis of the condition at birth and the histopathologic confirmation of the diagnosis and differential diagnosis between adherent and invasive accreta placentation.

CONCLUSION: This meta-analysis indicated wide variation between studies for the prevalence rate of placenta accreta spectrum and for the different grades of accreta placentation that highlighted the need for consistency in definitions that are used to describe placenta accreta spectrum at birth and in the reporting of this increasing common obstetric complication.

Key words: cesarean delivery, placentation, placenta accreta spectrum, prevalence

Placenta accreta spectrum is a pathologic condition of placentation in which the villous tissue adheres or invades the uterine wall.[1,2] The abnormally adherent grade of placenta spectrum accreta, also described by early pathologists as "placenta creta", "placenta adherenta" or "placenta vera," refers to villous tissue that is attached directly to the underlying myometrium without interposing decidua. The invasive grades include placenta increta when the villi invade the myometrium down to the uterine serosa and placenta percreta when the villi cross the entire uterine wall and may reach the surrounding pelvic organs and vasculature.[1,2] Both the adherent and invasive grades of placenta accreta spectrum lead to failure of parts or the whole placenta to separate spontaneously from the uterine wall at delivery.[1,2]

The main anatomic impact of placenta accreta spectrum is at the level of the deep uterine vasculature[2] and, when unsuspected at the time of delivery, attempts to remove accreta placental tissue manually typically provoke rapid massive obstetric hemorrhage.[3] The risk is particularly high in invasive cases because of the disruption of the main branches of uterine arteries and the possible invasion of the bladder wall and surrounding pelvic vessels.[4,5] Women with placenta accreta spectrum are also more likely to deliver early,[6,7] and most cases of placenta increta and percreta require complex surgical management that often involves different surgical specialists, interventional radiologists, intensivist anesthesiologists, hematologists, and neonatologists.[5,8] Prenatal diagnosis has been shown to decrease maternal morbidity and has become crucial in improving the management of placenta accreta spectrum.[9–11] Recent retrospective cohort studies from the United States have also shown that women who were treated

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No funding was obtained for this study. C.B.'s post is partly funded/supported by the National Institute for Health Research (NIHR) Biomedical Research Centre based at Guy's and St Thomas' NHS Foundation Trust and King's College London. The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR, or the Department of Health.

The authors report no conflict of interest.

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0002-9378/$36.00 • © 2019 Elsevier Inc. All rights reserved. • https://doi.org/10.1016/j.ajog.2019.01.233

AJOG at a Glance

Why was this study conducted?

From a rare pathologic condition of placentation, placenta accreta spectrum is now a new risk factor for major obstetric complications, but its prevalence and main outcomes in general population of births have not yet been studied comprehensively.

Key findings

Large amounts of heterogeneity were found among population studies for prevalence, incidence of peripartum hysterectomy, and hemorrhages that required transfusions because of inconsistency between the different types of population studies with regards to the criteria that was used to diagnose and confirm the condition at birth.

What does this add to what is known?

Accurate estimation of the prevalence and outcome of placenta accreta spectrum is currently problematic because of the varying use of clinical criteria to define it at birth and the lack of detailed pathologic examination in most cohort studies published so far in the international literature.

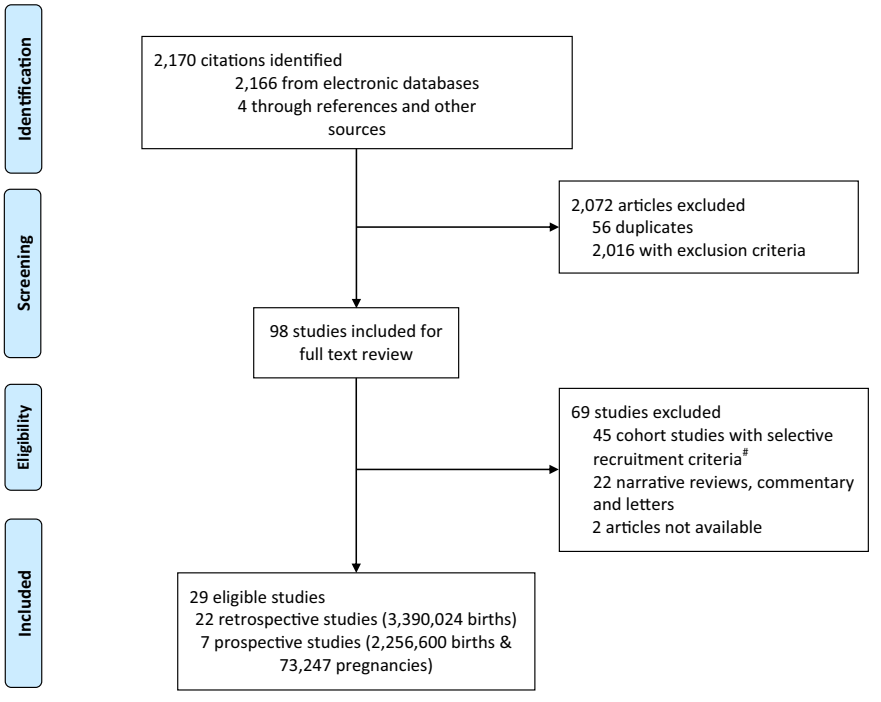
by a multidisciplinary team in expert centers were less likely to require emergency surgery, large-volume blood transfusions, and reoperation within a week of delivery compared with women who were treated by standard obstetric care without a specific protocol.[12–16]

Access to specialist centers, to blood products for transfusion, and neonatal and maternal intensive care is variable in many high-income countries and often limited or nonexistent in most middle- and low-income countries. The 2017 report from the United Kingdom and Ireland indicated that, although there was no overall significant change in maternal death rates in the United Kingdom from 2010–2012 and 2013–2015, there has been an increase in the mortality rate of women with abnormal placentation.[17]

Cesarean deliveries are an essential component of a functioning and comprehensive maternity system in all countries; health interventions, in particular in low-income countries, have been focused mainly on access to safe obstetric surgical and anesthesia procedures. However, population studies[18,19] and a recent systematic review and meta-analysis[20] have shown a strong association between cesarean delivery rates, number of previous cesarean deliveries, and incidence of accreta placentation in subsequent pregnancies. There has been a worldwide increase in cesarean delivery rates, with rates rising from <7% in 1990s to well over the 10–15% World Health Organization upper limit at the population level in the last 2 decades.[21,22] In many middle- and high-income countries cesarean delivery rates have reached 25–30% of all deliveries without any improvement in maternal and neonatal mortality rates.[22] In some middle-income countries such as Turkey, Mexico, Brazil, and Egypt, more than one-half of births are delivered by cesarean section, mostly elective. As a consequence, in countries with high-birth rate like Egypt,[23] the prevalence of placenta accreta spectrum and its impact on maternal morbidity and mortality rates rapidly will outweigh the benefit of improving access to quality obstetric care.

Considering the rapid increase in cesarean delivery rates worldwide in the last decade, we undertook a systematic review and meta-analysis on the prevalence of placenta accreta spectrum in general obstetric population studies. The

FIGURE 1
Flow diagram



Prior caesarean delivery; aneuploidy screening; maternal mortality or environment factor.

The diagram shows the selection of reports included in the review.

Jauniaux. Prevalence and outcome of placenta accreta spectrum. Am J Obstet Gynecol 2019.

TABLE 1
Study characteristics and corresponding prevalence of placenta accreta spectrum

Study	Population	Dates	Study type	Placenta accreta spectrum cases prevalence, n (%)
Makhseed and Moussa (1999)[26]	Kuwait/162,273 births	1981–1993	Retrospective/institution	16 (0.010)
Gielchinsky et al (2002)[27]	Israel/34,450 births	1990–2000	Retrospective/institution	310 (0.900)
Sheiner et al (2003)[28]	Israel/117,685 births	1988–2009	Retrospective/institution	513 (0.436)
Armstrong et al (2004)[29]	Australia/23,331 births	1998–2002	Retrospective/institution	32 (0.137)
Wu et al (2005)[30]	United States /64,359 births	1982–2002	Retrospective/institution	111 (0.173)
Bencaiova et al (2007)[31]	Switzerland/10,181 births	1999–2003	Retrospective/institution	31 (0.304)
Bretelle et al (2007)[32]	France/41,119 births	1993–2003	Retrospective/2 institutions	50 (0.122)
Umezurike and Nkwocha (2007)[33]	Nigeria/3,098 births	1999–2005	Retrospective/institution	11 (0.355)
Eller et al (2009)[34]	United States /91,566 births	1996–2008	Retrospective/2 institutions	76 (0.083)
Esh-Broder et al (2011)[35]	Israel/25,193 births	2005–2009	Retrospective/institution	42 (0.167)
Woodring et al (2011)[36]	United States /15,420 births	<2011	Retrospective/institution	26 (0.169)
Lim et al (2012)[37]	United States /9,868 births	2009–2010	Retrospective/institution	10 (0.101)
Grace Tan et al (2013)[38]	Australia/69,664 births	1999–2009	Retrospective/institution	27 (0.039)
Guleria et al (2013)[39]	India/100,892 births	2001–2010	Retrospective/institution	56 (0.056)
Higgins et al (2013)[40]	Ireland/275,121 births	1975–2010	Retrospective/institution	25 (0.010)
Weiniger et al (2013)[47]	Israel/46,623 births	2002–2011	Prospective/institution	52 (0.112)
Al-Khan et al 2(014)[14]	United States /58,044 births	2001–2011	Retrospective/institution	67 (0.115)
Bowman et al (2014)[48]	United States /73,247 pregnancies	1999–2002	Prospective/network	196 (0.268)
Fitzpatrick et al (2014)[49]	United Kingdom/798,634 births	2010–2011	Prospective/national	134 (0.017)
Upson et al (2014)[41]	Ireland/403,602 births	2005–2010	Retrospective/national	357 (0.088)
Bailit et al (2015)[50]	United States/115,502 births	2008–2011	Prospective/network	158 (0.137)
Brennan et al (2015)[42]	Australia/111,056 births	2000–2013	Retrospective/institution	101 (0.091)
Kelekci et al (2015)[51]	Turkey/22,543 births	2010–2014	Prospective/2 institutions	16 (0.071)
Mehrabadi et al (2015)[43]	Canada/570,637 births	2009–2010	Retrospective/regional	819 (0.144)
Thurn et al (2015)[19]	Scandinavia[a]/605,362 births	2009–2012	Prospective/international	205 (0.034)
Vinograd et al (2015)[44]	Israel/239,089 births	1988–2010	Retrospective/institution	551 (0.231)
Michikawa et al (2016)[45]	Japan/40,573 births	2005–2010	Retrospective/national	429 (1.058)
Baldwin et al (2017)[46]	Australia/922,925 births	2003–2012	Retrospective/regional	2285 (0.248)
Farquhar et al (2017)[52]	Australia & New Zealand/667,936 births	2010–2012	Prospective/international	295 (0.044)

[a] Denmark, Sweden, Norway, and Finland.

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main objective was to assess the sources of heterogeneity across studies in reporting on the clinical diagnostic criteria used to identify and confirm the different grades of placenta accreta spectrum at birth and to evaluate their possible impact on the incidence on main maternal outcome data.

Materials and methods

Eligibility criteria, information sources and search strategy

We undertook a PubMed, Google Scholar, clinicalTrials.gov, and MEDLINE search for studies published in any language between the first prenatal ultrasound description of placenta accreta in July 1982 by Tabsh et al[24] and April 1, 2018. The search protocol was designed a priori and registered on PROSPERO (CRD42017068589; www.crd.york.ac.uk/PROSPERO) in line with current recommendations and reported as per PRISMA 2009 guidelines (www. prisma-statement.org). We used MeSH headings, text words,

and word variants for "placenta accreta," "placenta increta," "placenta percreta," "abnormally invasive placenta," and "morbidly adherent placenta." We combined these with terms related to "prevalence," "maternal morbidity," "maternal mortality," "obstetric hemorrhage," "peripartum hysterectomy," and "cesarean hysterectomy." We screened titles and abstracts of all citations for potentially relevant papers. Full-texts were assessed independently by 2 authors (E.J. and J.L.R.) for content, data extraction, and analysis. Additional relevant studies were identified from reference lists of reviews and editorials.

Study selection

We defined the prevalence of placenta accreta spectrum as the number of cases found in general populations according to the total numbers of pregnancies, births, or deliveries (in the main text of each study). We excluded studies published before July 1982, cohort studies of specific conditions that increased the risk of placenta accreta spectrum, cohort studies with <10 cases, and case reports.

TABLE 2
Clinical and histopathologic criteria described by the authors for the diagnosis of placenta accreta spectrum at delivery

Criteria	Description
Clinical	Basic description: placenta adherent to the uterine wall without easy separation and/or bleeding from the placental bed at cesarean delivery
	Extended description: difficult manual and/or piecemeal removal of the placenta and/or no evidence of placental separation after 20 minutes, despite active management and/or bleeding from the placental site in a well-contracted uterus
	World Health Organization international statistical classification of diseases (International Classification of Diseases—10) and related health problems (www.who.int/classifications/icd)
Histopathologic	Absence of decidual layer/Nitabuch layer between the placenta and myometrium with direct attachment of the villous tissue to the uterine musculature
	Placenta increta (villous tissue invading the myometrium down to the uterine serosa) and placenta percreta (villous tissue crossing the entire uterine wall with or without invading pelvic tissues, organs and/or vasculature)

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Data extraction

Clinical study characteristics subsequently were extracted independently by 2 reviewers (E.J. and L.G.) who used a predesigned data extraction form for all studies: year of publication, country of origin, years of study, and study type. The primary outcomes were the number of cases of placenta accreta spectrum in the corresponding obstetric population, the different clinical criteria used for the diagnosis of placenta accreta spectrum at birth, and pathologic confirmation of the clinical diagnosis that includes the

TABLE 3
Studies with detailed histopathologic data on placenta accreta spectrum and corresponding distribution of depth of villous invasion

Study	Placenta accreta spectrum cases examined/total cases in study, n/N (%)	Placenta creta, n (%)[a]	Placenta increta, n (%)	Placenta percreta, n (%)
Armstrong et al, 2004[29]	28/32 (87.5)	20 (71.4)	4 (14.3)	4 (14.3)
Wu et al, 2005[30]	76/111 (68.5)	62 (81.6)	9 (11.8)	5 (6.6)
Bencaiova et al, 2007[31]	14/31 (45.2)	7 (50)	3 (21.4)	4 (28.6)
Woodring et al, 2011[36]	10/10[b] (100)	8 (80.0)	1 (10.0)	1 (10.0.7)
Lim et al, 2012[37]	9/10 (90.0)	5 (55.6)	3 (33.3)	1 (11.1)
Grace Tan et al, 2013[38]	27/27 (100)	12 (44.4)	1 (3.7)	14 (51.9)
Al-Khan et al, 2014[17]	67/67 (100)	25 (37.4)	21 (31.3)	21 (31.3)
Fitzpatrick et al, 2014[49]	133/134 (99.3)	87 (65.4)	7 (5.3)	39 (29.3)
Brennan et al, 2015[42]	98/101 (97.0)	34 (34.7)	31 (31.6)	33 (33.7)
Farquhar et al., 2017[52]	295/295 (100)	213 (72.2)	37 (12.5)	45 (15.3)
Total	757/818 (92.5)	473 (62.5)	117 (15.4)	167 (22.1)

[a] Abnormally adherent placenta; [b] Only data on cases diagnosed prenatally and confirmed by histopathologic evidence are included.

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TABLE 4
Description of study outcomes

Study	Peripartum hysterectomy, n (% of placenta accreta spectrum)	Cases that required blood transfusion, n	Maternal death cases, n
Makhseed and Moussa (1999)[26]	14 (87.5)	5	1
Gielchinsky et al (2002)[27]	11 (3.6)	64	1
Sheiner et al (2003)[28]	3 (0.59)	No data	No data
Armstrong et al (2004)[29]	27 (84.4)	Yes (median)	0
Wu et al (2005)[30]	76 (68.5)	No data	No data
Bencaiova et al (2007)[31]	5 (16.1)	7	0
Bretelle et al (2007)[32]	14 (28.0)	Yes (mean)	0
Umezurike and Nkwocha (2007)[33]	8 (72.7)	Yes (median)	1
Eller et al (2009)[34]	75 (98.7)	62	0
Esh-Broder et al (2011)[35]	4 (2.4)	15	0
Woodring et al (2011)[36]	10[a] (100)	9[a]	0[a]
Lim et al (2012)[37]	9 (90.0)	8	0
Grace Tan et al (2013)[38]	27 (100)	27	0
Guleria et al (2013)[39]	44 (78.6)	No data	13
Higgins et al (2013)[40]	25 (100)	No data	2
Weiniger et al (2013)[47]	45 (100)	33	0
Al-Khan et al 2(014)[14]	56 (83.6)	Yes (mean)	0
Bowman et al (2014)[48]	147 (75.0)	No data	No data
Fitzpatrick et al (2014)[49]	79 (59.0)	104	0
Upson et al (2014)[41]	62 (17.4)	123	0
Bailit et al (2015)[50]	110 (69.6)	105	0
Brennan et al (2015)[42]	98 (97.0)	Yes (median)	0
Kelekci et al (2015)[51]	1 (6.3)	2	0
Mehrabadi et al (2015)[43]	137 (16.7)	157	No data
Thurn et al (2015)[19]	90 (44.0)	80	0
Vinograd et al (2015)[44]	No data	No data	No data
Michikawa et al (2016)[45]	No data	No data	No data
Baldwin et al (2017)[46]	280 (12.3)	645	0
Farquhar et al (2017)[52]	196 (66.4)	No data	2

[a] Only data on cases diagnosed prenatally and confirmed by histopathologic evidence are included.

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depth (grades) of villous invasiveness. Secondary outcomes included the incidence of peripartum hysterectomies, the number of cases of obstetric hemorrhage that required transfusion, and direct maternal death.

Assessment of risks of bias

The QUADAS-2 tool for the quality assessment of diagnostic accuracy studies was used to score the methodologic quality of the included articles.[25] The quality items that were assessed were study design and the conduct and analysis of all included studies. Each item was scored "high," "low," or "unclear" if there was insufficient information to make an accurate judgment on the risk for bias. No study was excluded based on the risk of bias assessment. Two independent reviewers (E.J. and L.G.) undertook the quality assessment. Discrepancies were resolved with evaluation from the third reviewer (J.L.R.). We assessed the following criteria: main study characteristics, description of clinical criteria used to diagnose the placenta accreta spectrum at birth, detailed histopathologic confirmation, and description of the main management interventions.

Data synthesis

Metaanalyses were conducted to evaluate the variation in study outcomes between studies using STATA software (version 15; StataCorp, College Station, TX). A random effects model was used to combine the studies while incorporating variations among studies, unless there were ≤ 3 studies contributing to the meta-analysis in which case a fixed effect model was used. Statistical heterogeneity was assessed with the Cochran's Q-test and the I^2 statistic (the proportion of variation in study estimates because of heterogeneity rather than sampling error). The "metaprop" (StataCorp) routine, which provides procedures for pooling proportions in a meta-analysis and uses confidence intervals based on score or exact binomial procedures, was used. Metaregression was used to assess whether variability among study estimates was due to the study being prospective or retrospective. Forest plots are presented to summarize the study results and the pooled results graphically. A test for heterogeneity between subgroups (ie, study type) was conducted. The Pearson chi-square test was used to compare the distribution of the different grades of placenta accreta spectrum in the different types of studies. A probability value of $<.05$ was considered significant.

Results

From 2170 citations that were identified, we included 29 population studies from

13 different countries for the quantitative analysis (Figure 1).

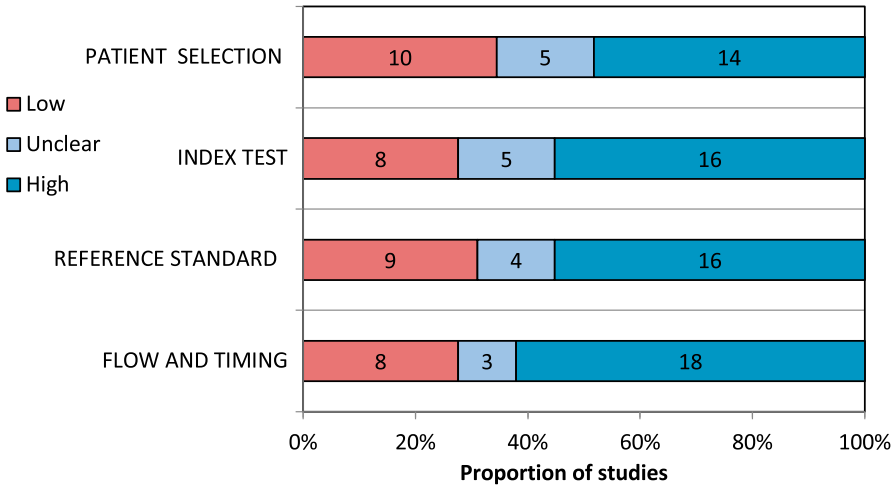
Study characteristics

There were 22 retrospective [14,26–46] and 7 prospective studies.[19,47–52] Twenty-eight of the studies (28/29) were published after the year 2000 (Table 1). There were 18 studies from a single institution,[14,26–31,33,36–40,42,44] 3 studies that involved 2 affiliated institutions,[32,34,51] 2 studies from the National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network,[48,50] 2 regional studies,[43,46] 3 national studies,[41,45,49] and 2 international studies that involved 4[19] and 2[52] countries, respectively.

The clinical criteria described by the authors for the clinical diagnosis of placenta accreta spectrum at delivery fell into three categories (Table 2): basic description,[32,34,35,38–40,44,47,48,50,51] extended description,[27,30,33] and World Health Organization international classification.[19,36,43,46] More than one-third of the studies (11/29)[14,26,29,31,37,41,42,45,49,52] did not describe the clinical criteria used for the diagnosis of placenta accreta spectrum at birth. Lateral extension of the accreta areas and detailed description of the uterine vasculature anatomic changes that were associated with invasive placentation were not reported by any of the 29 studies.

Six studies[14,26,30–32,42] used the histologic description proposed by Irving and Hertig[53] (the absence of decidua between the placental villi and uterine myometrium) to confirm the clinical diagnosis (Table 2). Three studies reported on the invasion of the myometrium by placental villous tissue,[34,35,38] and 4 studies reported having confirmed the clinical diagnosis by pathologic examination at birth but with no description or reference to the criteria used.[20,45,46,50] Detailed histopathologic data on the depth of villous invasiveness were reported by only 10 studies[14,29,30,31,36–38,42,49,52] and included 473 of 757 (62.5%) cases of placenta creta, 117 of 757 (15.4%) cases of placenta increta, and 167 of 757 (22.1%) cases of placenta percreta (Table 3).

FIGURE 2
Quality assessment



Quality assessment of population studies included in the systematic review using the Quadas-2 tool for diagnostic accuracy studies.

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Twenty-seven of 29 studies (90%) reported on surgical treatment that included 1656 cases of 6007 patients who were treated by peripartum hysterectomy (Table 4). Data on the number of blood transfusions was provided by one-half of the studies (16/29), including 1146 cases of 4562 patients who required a transfusion. Information on maternal death were reported in 23 studies, with a total of 20 maternal deaths of 4382 patients. One study reported 13 cases of maternal death[39]; 2 studies reported 2 maternal deaths,[40,52] and 3 studies reported 1 maternal death.[26,27,33] The other studies reported no maternal death. Six studies reported no data on maternal mortality.[28,30,43–45,48]

Risks of bias of included studies

The quality of the studies is shown in Figure 2. Fourteen of the included studies had a risk of bias for patient selection; 16 studies had a risk bias for the index test; 16 studies had a risk bias for the reference standard, and 18 studies had a risk bias for flow and timing.

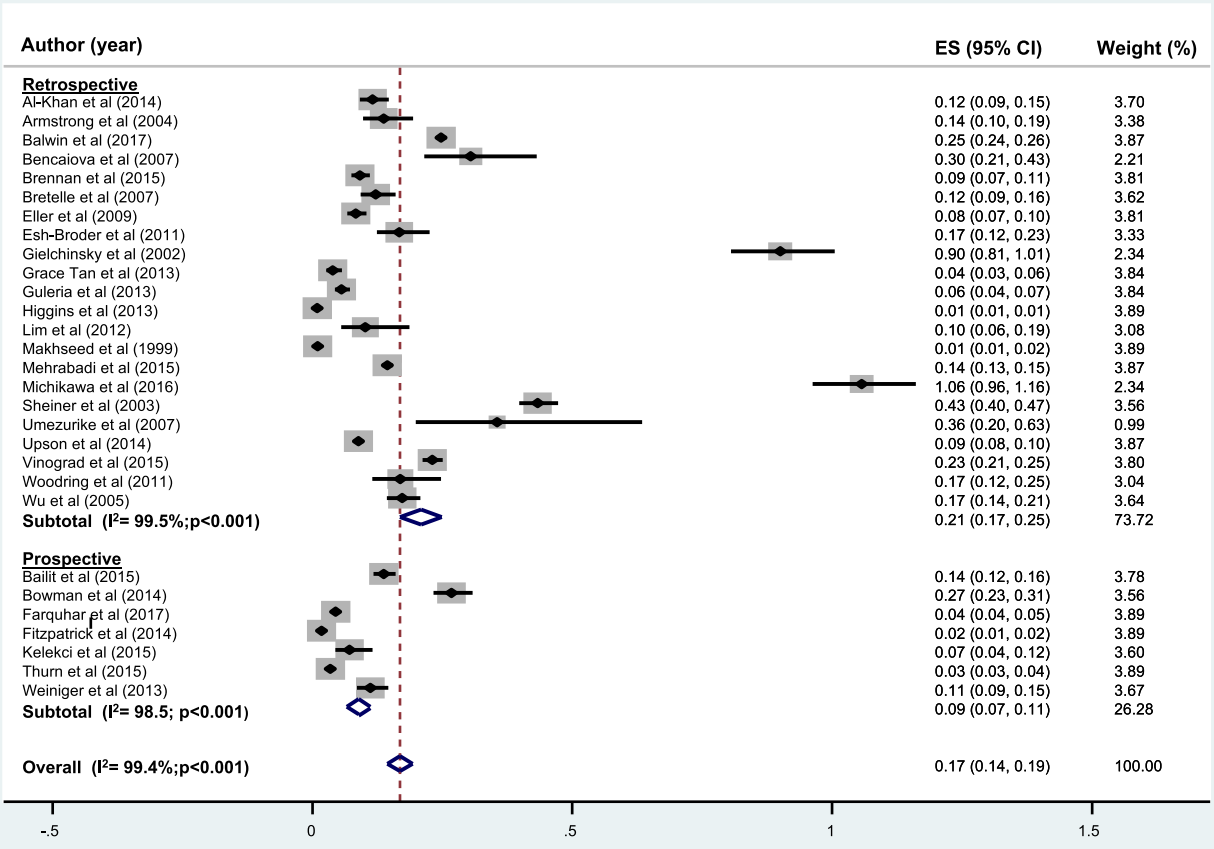
Synthesis of results

A total of 7001 cases of placenta accreta spectrum of 5,719,992 births or pregnancies were included in the analysis. The meta-analysis showed a pooled prevalence of 0.17% (95% confidence interval [CI], 0.14–0.19) for placenta accreta spectrum in 29 studies that were included in the review. There was considerable heterogeneity in prevalence data among studies with an I^2 value of 99.4% (Figure 3). We explored whether this heterogeneity was due to study design; however, even looking at the retrospective and prospective studies separately, there was considerable heterogeneity with I^2 values that ranged from 98.5–99.5%. The prevalence of placenta accreta spectrum in the different types of population studies is given in Table 5. There was significant ($P<.001$) in-between studies heterogeneity ($I^2=99.4\%$).

The overall pooled estimate for peripartum hysterectomy was 52.2% (95% CI, 38.3–66.4; $I^2=99.8\%$) and 46.9% (95% CI, 34–59.9; $I^2=98.8\%$) for hemorrhage that required transfusion. The overall pooled estimate of maternal death was 0.05% (95% CI, 0.06–0.69; $I^2=73\%$).

The pooled prevalence for the different grades of placenta accreta spectrum was 0.5 (95% CI, 0.3–0.36; $I^2=94.8\%$) per 1000 births for placenta creta (adherent) grade compared with 0.3 (95% CI, 0.2–0.4; $I^2=92.7\%$) per

FIGURE 3
Forest plots



Plots of prevalence data heterogeneity in prospective and retrospective population studies.

CI, confidence interval; *ES*, effect size.

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1000 births for the abnormally invasive placenta category that combines placenta increta and percreta (Table 6).

Comment

Principal findings of the study

Our findings have quantified the variability between population studies in the prevalence of placenta accreta spectrum at birth. There was strong evidence of inconsistency between the different types of population studies with regards to the criteria that are used to diagnose and/or confirm the condition at delivery. The meta-analysis found large amounts of heterogeneity for the incidence of peripartum hysterectomy and for hemorrhage that requires transfusion and moderate amounts for maternal death rates. These findings highlight the effect of the absence of standardization in reporting on placenta accreta spectrum in many cohort studies. This affects all study types independently of their study design and impairs the evaluation of the corresponding maternal outcomes and the efficacy of different management strategies and techniques.

Results of the study in the context of existing literature

The reported prevalence of placenta accreta spectrum seems to have been always highly variable. In their literature review, Luke et al[54] found that, before 1966, the combined prevalence of adherent and invasive placenta accreta ranged between in 1 in 948 deliveries and 1 in 40,000 deliveries. An expert review of the literature from 1977–2012 on maternal and neonatal outcomes in placenta accreta found that the pooled prevalence during that period was 1 in 588 deliveries.[55] In the present review, the prevalence of placenta accreta spectrum in population studies published between 1982 and 2018 ranged between around 1 in 100[27,45] and 1 in 10,000.[26,40] These data are influenced directly by the characteristics of the studies included in the review (Table 1). In particular, we found a 2-fold increase in the prevalence of placenta accreta spectrum in retrospective, compared with prospective,

studies and a 3- to 5-fold increase in institution, network, and regional studies compared with national and international studies (Table 5). Institution and network studies usually involve centers with expertise in the diagnosis and management of placenta accreta spectrum, which could explain the higher prevalence of the condition in the corresponding populations.

TABLE 5
Estimates of prevalence of placenta accreta spectrum in different types of population studies

Type of study	Median prevalence, % (95% confidence interval)	I^2, %
All studies (n=29)	0.15 (0.13–0.17)	99.4
Retrospective studies (n=22)	0.18 (0.15–0.21)	99.5
Prospective studies (n=7)	0.09 (0.07–0.11)	98.5
Institution studies (n=21)	0.16 (0.13–0.20)	98.9
Network studies (n=2)	0.17 (0.15–0.19)	—
Regional studies (n=2)	0.19 (0.19–0.20)	—
National/international studies (n=4)[a]	0.17 (0.13–0.22)	99.5

[a] Reference 45 not included because no data on clinical diagnosis or histopathologic confirmation of placenta accreta spectrum were provided.

Jauniaux. Prevalence and outcome of placenta accreta spectrum. Am J Obstet Gynecol 2019.

Clinical implications

Maternal outcomes in placenta accreta spectrum disorders depend on the identification of the condition before or during delivery and, in particular, on the differential diagnosis between its adherent and invasive forms. One-third of the studies that were included in this review did not provide a description of the clinical criteria that was used for the diagnosis at birth, and none of them reported on the anatomic changes of the uterine vasculature[2] that should alert the surgeon to the presence of invasive accreta placentation. If the surgeon is unaware of the diagnostic signs of the different grades of placenta accreta spectrum, an attempt at delivering the placenta at the time of repeat cesarean delivery will lead to rapid bleeding from the placentation site. In this case, the patient outcome will depend not only on the surgical skills of the attending obstetrician at performing a complex hysterectomy procedure but also on immediate access to blood for massive transfusion and postoperative adult intensive care.

Many of the studies that were included in the present review have used the clinical and histopathologic criteria described in 1937 by Irving and Hertig[53] for abnormally adherent placenta accreta. The clinical symptoms of placenta accreta spectrum disorders, in particular in cases of a partially adherent placenta (creta), can be very similar to those of placental retention (ie, difficult manual, piecemeal removal of the placenta; the absence of spontaneous placental separation 20–30 minutes after birth, despite active management; retained placental fragment that requires curettage after vaginal birth, and heavy bleeding from the placentation site after removal of the placenta during cesarean delivery). These criteria have been used by several studies in this review.[27,30,33,20] However, a retained placenta, which is merely entrapped in the uterus after childbirth because of the constriction of the cervix, should not be included in the category of placenta accreta spectrum nor should cases in which a retained placenta is removed easily within 30 minutes to 24 hours after birth. Overall, the criteria used by most authors of cohort and population studies to describe individual cases of placenta accreta spectrum have been highly variable; the World Health Organization International Classification of Diseases–10 classification provides no clinical description of the condition and, in particular, no clue on the differential diagnosis between adherent and invasive accreta placentation (Table 2). This can explain the wide heterogeneity in prevalence in the studies that were analyzed in the present review and emphasizes the need to involve perinatal pathologists in multidisciplinary team.

Research implications

Controversies still exist among experts regarding optimal timing of delivery, use of adjunctive measures, and conservative (uterine-sparing) methods.[3] The principal management approach to controlling excessive bleeding because of accreta placentation during delivery has been

TABLE 6
Prevalence of the different placenta accreta spectrum grades in 10 population studies with detailed histopathologic data[a]

Grade	Pooled prevalence, % (95% confidence interval)	I^2, %
All grades	0.10 (0.08–0.13)	96.5
Placenta creta (adherenta)	0.05 (0.03–0.06)	94.8
Placenta increta	0.01 (0.01–0.02)	90.3
Placenta percreta	0.01 (0.01–0.02)	81.1
Abnormally invasive placenta[b]	0.03 (0.02–0.04)	92.7

[a] References 17, 29–31, 36–38, 42, 49, 52; [b] Placenta increta+placenta percreta.

Jauniaux. Prevalence and outcome of placenta accreta spectrum. Am J Obstet Gynecol 2019.

and remains, for the majority of specialists around the world, to perform a primary cesarean hysterectomy, leaving the placenta in situ.[3,56–59]

Recent cohort studies have shown that prenatal diagnosis of placenta accreta spectrum allows planned delivery by a multidisciplinary team and thus reduces maternal peripartum hemorrhage and morbidity.[60,61] However, despite >35 years of experience in ultrasound imaging diagnosis of placenta accreta spectrum,[24] there currently are no national screening protocols, and population studies in high-income countries have shown that placenta accreta spectrum remains undiagnosed before delivery between one-half[49,50] and two-thirds of cases.[19]

The rates of blood transfusion and peripartum hysterectomy provide indirect estimates of management strategies of placenta accreta spectrum. The deeper the villous tissue invades and the larger the accreta area, the more complex the management and the higher the risk of poor outcome. Maternal death from placenta accreta spectrum previously has been reported to be as high as 7% of cases.[62] The authors of a decision-analytic model that was built with the use of data on national birthing order trends after cesarean delivery in the United States from 1995–2005 have estimated that, if primary and secondary cesarean rates continue to rise, by 2020 the rate will be 56.2%; as a consequence, there will be an additional 6236 cases of placenta previa, 4504 cases of placenta accreta, and 130 maternal deaths annually.[63] In the present review, 1 study from India[39] accounted for 13 of the 20 cases of maternal death that may be due to local conditions such as access to prenatal diagnosis, specialist surgeons, blood transfusion, and intensive care facilities. The disproportionately high prevalence of placenta accreta spectrum and low rates of peripartum hysterectomy in several studies suggest a high rate of misclassification with regards to placental retention in the corresponding population (Table 4).

These data highlight the need to standardize the definition and classification of placenta accreta spectrum to identify the real healthcare burden of this condition. Although the concept of core outcome measures within clinical trials is now well-recognized and championed, greater efforts to disseminate this approach in epidemiologic research is needed to facilitate global estimation and recognition of new obstetric complications that are emerging on a global scale.

Strengths and limitations

This large and comprehensive systematic review and meta-analysis provides the first critical evaluation of the global epidemiologic condition of placenta accreta spectrum. Before this review, data on the prevalence of placenta accreta spectrum were based mainly on individual observational studies and expert reviews.

The main limitations of this review are the publication bias of mainly retrospective and single institutions studies and considerable variation between studies that may impact the interpretation of the analysis of outcome data. It is also possible that some of the data of single institutions may have been included in specialist network analysis and reports, but the numbers are probably small. The lack of data on the depth of accreta placentation in most studies of the present review limits also the evaluation of differences in outcome between the adherent and invasive accreta placentation. In addition, outcomes such as amount of blood loss or blood transfused are not reported or are reported as mean values by most authors, which limits the overall outcome analysis.

Conclusions

The current knowledge of the epidemiologic condition of placenta accreta spectrum limits the capacity building of healthcare providers on improvements in training, implementation of guidelines, and changes in clinical practice. Our data highlight the need to standardize the definition, clinical description, and classification of placenta accreta spectrum at the international level to better identify the healthcare burden of this condition and facilitate its estimation and recognition on a global scale. This information is necessary for prospective studies with participatory methods that involve local service providers to evaluate accurately the consequences of increasing cesarean delivery rates within a particular population context. ■

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