OUTCOMES OF HOME VS. HOSPITAL BIRTHS BY ATTENDED BY MIDWIVES: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Abstract

Background: Studies conducted in the US and other high income countries show that an increasing number of women elect homebirth because it is considered safe, involves less medical interventions, and gives them the opportunity of having their babies in the comfort of their own homes. The objective of this review was to critically assess and summarize evidence on outcome of home versus hospital births attended by midwives.

Data source: The following databases were searched up to February, 2013: Medline/PubMed, Embase, Web of Science, EBSCO (PsycINFO and CINAHL), Ovid, the Cochrane Fertility Review Group Specialized Register, Cochrane Pregnancy and Childbirth Group Specialized Register, and the Cochrane Central Register of Controlled Trials.

Study selection: Five reviewers independently screened titles and abstracts of identified studies to assess their eligibility for inclusion. We reviewed 20 studies that met the inclusion criteria, and conducted meta-analysis on 10 that had sufficient data for statistical analysis.

Data extraction: Data from eligible studies were independently extracted by four reviewers. Differences were resolved by consensus among all reviewers.

Results: Nine studies included in the meta-analysis reported data on 8 child health outcomes. Analysis of combined data from all 8 studies showed a three-fold increase in risk of neonatal deaths for homebirth attended by midwives, compared to hospital births. There were no significant differences in outcome for home or hospital births attended by midwives for the other child health measures. Eight studies reported data on 13 maternal outcomes. Meta-analysis of combined data from all 8 studies showed that women who delivered at home with midwives were about twice more likely to have spontaneous delivery and intact perineum. Homebirths by midwives were associated with decreased risk for postpartum hemorrhage >500ml and retained placenta. Homebirths were also not associated increased risk for vacuum extraction, cervical tear, blood transfusion and prolapsed cord. On the other hand, hospital births by midwives were associated with increased risk of assisted delivery, caesarean sections, forceps, episiotomy, and lacerations/perineal tear (3-4 degrees).

Introduction

Homebirths in the United States have undergone resurgence in the past decade, with a notable increase of 29% from 2004-2009.[1] Providers attending homebirths usually include midwives, who can be classified as direct entry, certified professional, or certified nurse midwives. Direct-entry midwives (DEMs), who may include licensed and certified professional midwives, differ from Certified Nurse Midwives (CNMs), in that the former do not obtain nursing degrees, but rather receive their training and education through an apprenticeship, a self-study program, or a midwifery school. The legal status and educational requirements for DEMs also differ by state as does their scope of practice. These regulations may affect where and to what extent these professionals can attend births.[2] In contrast, Certified Nurse Midwives receive a nursing degree with a sub-specialization in midwifery. CNMs are legally allowed to practice in all states.[2] With the increase in homebirths, there has been a substantial increase in the number of births attended by midwives other than certified nurse midwives (direct entry or certified professional), reaching an all-time high of 21,787 in 2009.[3] This marked increase in the trend of homebirths and attendance of direct entry and certified professional midwives is presumably due to an increase in the number of non-Hispanic white women choosing to have homebirths, which increased by 36% from 2004-2009.[1] The incidence of homebirths has risen nationally, yet with no specific region seeing more out-of-hospital births than another. Variations in the percentage of homebirths by state are likely attributable to differences in state laws (see Tables 1-3) and regulations overseeing homebirths and midwifery scope of practice, as well as differences in racial and ethnic profiles of each state.[1]

Outcomes for direct entry midwives attending homebirths in the United States and other developed nations have been found to be positive, as reported by several large studies and based on indicators such as intrapartum and neonatal mortality, transfer to hospital, interventions during labor, breastfeeding, and maternal satisfaction.[4-7] While a few studies, including a recent high-profile meta-analysis by Wax and

colleagues, have argued for higher perinatal mortality risks in homebirth,[8-10] methodological and reporting problems have been extensively described in response to these studies, such as inconsistencies in the categorizing of planned versus unplanned home or hospital births, statistical errors, and inclusion of premature or unattended births.[11-17]

Table 1. Licensing and Education Regulation and Oversight in Selected States

State	Advisory board personnel requirements	State administered exam/credentials	Medicaid reimbursement
Arizona[a,b]	2 licensed midwives 2 members of public/consumers 1 CNM 1 M.D./OBGYN 1 M.D. 1 D.O./OBGYN	State administered exam through licensing department	Yes
California[a,c]	Council members are licensed midwives who are in good standing with their practice, but can also be consumers of homebirth, though half of members must be licensed midwives.	CPM certification from NARM	Yes
New Mexico[a,d]	3 state licensed midwives (at least 2 actively practicing) 1 state licensed certified and actively practicing nurse-midwife 3 consumer members 1 state licensed physician actively practicing obstetrics 1 member from the Division 1 representative of the Maternal and Child Health Bureau in the Public Health Division will be an ex-officio member of the Board	State licensure exam offered twice/year. Certified Midwives must also take an abbreviated version of the licensing exam to practice in NM.	Yes
Oregon[a,e]	4 licensed direct entry midwives. 1 certified nurse midwife. 1 practicing or educating physician 1 member of the public	Licensing is voluntary, by state exam or by demonstration of being licensed to practice DEM in another state	Yes, when birth is attended by a licensed midwife
Tennessee[a,f]	3 CPMs 1 consumer 1 certified nurse midwife 1 physician	CPM certification from NARM	No
Texas[a,g]	1 pediatrician/family physician 1 OB/GYN 3 midwives 1 CPM 3 members who represent the public and who are not practicing or trained in a health care profession, 1 of whom is a parent with at least one child born with the assistance of a midwife	State-approved comprehensive exam or contracts with NARM and recognizes CPM certification	No
Vermont[a,h]	2 licensed midwives 1 physician	CPM certification from NARM	Yes
Washington[a,i]	Comprised of midwives, physicians, and consumers	Must pass NARM exam and state-issued licensing exam	Yes

[a]Midwives Alliance of North America. Direct-Entry Midwifery State-by-State Legal Status. May 11, 2011. http://mana.org/statechart.html. Accessed March 24, 2013.

[b]State of Arizona House of Representatives. Arizona House Bill 2247. http://www.azleg.gov/legtext/50leg/2r/bills/hb2247h.pdf. Accessed March 30, 2013.

[c]The Medical Board of California. Licensed Midwives. http://www.mbc.ca.gov/allied/midwives.html. Accessed March 24, 2013.

[d]New Mexico Department of Health. Title 16: Occupational and professional licensing: Chapter 11: Midwives: Part 3: Licensed midwives. http://www.health.state.nm.us/PHD/midwife/LMRule.pdf. Accessed March 24, 2013.

[e]Oregon Health Licensing Agency, Board Of Direct Entry Midwifery. Chapter 687 - Massage Therapists; Direct Entry Midwives. http://www.leg.state.or.us/ors/687.html. Accessed March 29, 2013.

[f]Tennessee Code: Title 63: Professions of the Healing Arts: Chapter 29 Midwifery. http://mana.org/laws/laws_tn.htm. Accessed March 24, 2013.

[g]Midwives Alliance of North America. Texas Occupations Code: Chapter 203: Midwives. http://mana.org/laws/laws_tx.htm. Accessed March 24, 2013.

[h]The Vermont Statutes Online. Title 26: Professions and Occupations: Chapter 85 Midwives. http://www.leg.state.vt.us/statutes/fullchapter.cfm?Title=26&Chapter=085. Accessed March 30, 2013.

[i]Washington State Legislature. Midwifery advisory committee - Generally. http://apps.leg.wa.gov/RCW/default.aspx?cite=18.50.140. Accessed March 30, 2013.

Studies of homebirths tend to focus on women classified as low risk, so information on women who are attempting vaginal birth after caesarian section (VBAC), who are pregnant with multiple fetuses, who have a non-cephalic fetal presentation, or who have other risk factors is not often described in the studies cited above. Even in states where midwives may attend VBACs, multiples births, and births with malpresentations (usually with conditions; see Tables 2 and 3), they may opt to refer these patients to other providers; this tendency may explain the lack of data on higher risk deliveries at home. Similarly, to more accurately compare and contrast births at home versus in births in hospitals, some studies excluded high risk women in their analyses.[4-6]

Table 2. Scope of Practice in Selected States

		Requirements on overseeing and attending high-risk pregnancies/births			Requirements prior to delivery	
State	Administration of pharmaceuticals	Vaginal birth after Cesarean (VBAC)	Non-cephalic presentation	Multiple fetuses	Facilitate and Record Physician Referral (regardless of high risk circumstances)	Create Emergency Transfer of Care Plan
Arizona[a,b]	No	No	Yes, but after 36 weeks must obtain physician consultation which may require transfer of care, referral, or other treatment	No	If referral is deemed necessary with any present abnormalities	Yes
California[a,c]	Yes, but only in accordance with licensed midwives professional training and the Licensed Midwife Practice Act of 1993	Yes, but must provide patient with informed consent and educational materials on risks.	Yes, but must make physician referral	Yes, but must make physician referral	Referral only if any deviations from normal	Yes, prior to delivery
New Mexico[a,d]	Yes, antihemorrhagic and others	Out-of-Hospital VBAC allowed if: -Only 1 previous cesarean at least 18 months prior to EDD of current pregnancy, or last birth was a successful VBAC -Records documenting low transverse uterine incision without extension, or proof of subsequent VBAC -Placental location documented by ultrasound	Transfer of care with any variances. Primary care provided by physician or CNM	Primary care from physician or CNM. Transfer after 36 weeks	Midwife must make record of patient referral and appointment with a duly licensed physician	Yes
Oregon[a,e]	No unusual restrictions	Three previous caesareans without successful vaginal birth, or four or more caesareans considered "absolute risk" *under absolute risk circumstance midwife must plan and arrange for transfer to hospital unless birth is imminent, in which case action is decided on case by case basis	Footling or kneeling breeches are considered "absolute risk"; frank breeches do not require special conditions/restrictions	"Higher order" (more than three); monochorionic, monoamniotic twins; twins in transverse presentation; and twin-to-twin transfusion considered "absolute risk"	Not required	Yes

[a] Arizona Department of Health Services. Midwifery Scope of Practice by State: VBAC, Multiple Births, Breech Births in Non-Hospital Settings. http://www.azdhs.gov/als/midwife/documents/committee/additional-resources/state-laws-chart-vbac-br-mg.pdf. Accessed March 24, 2013.

[b] State of Arizona House of Representatives. Arizona House Bill 2247. http://www.azleg.gov/legtext/50leg/2r/bills/hb2247h.pdf. Accessed March 30, 2013.

[c] The Medical Board of California. Licensed Midwives. http://www.mbc.ca.gov/allied/midwives.html. Accessed March 24, 2013.

[d] New Mexico Department of Health. Practice guidelines for New Mexico midwives. http://www.health.state.nm.us/PHD/midwife/NMMA%202008%20practice%20guidelines.pdf. Accessed March 24, 2013.

[e] Oregon Health Licensing Agency, Board Of Direct Entry Midwifery. Chapter 687 - Massage Therapists; Direct Entry Midwives. http://www.leg.state.or.us/ors/687.html. Accessed March 29, 2013.

The American Congress of Obstetricians and Gynecologists (ACOG) uses the findings of Wax et al. to conclude there is a 2-3 threefold risk of neonatal mortality for homebirth, and they do not support homebirth attendance by certified professional midwives or any other category of midwives not certified by the American Midwifery Certification Board.[18] However, improved access to homebirths attended by direct entry midwives has been supported by the American Public Health Association.[19] Professional associations in other developed nations have also voiced support for homebirth access. A joint statement from the United Kingdom's Royal College of Midwives (RCM) and the Royal College of Obstetricians and Gynaecologists (RCOG) describes their support for homebirth in terms of safety, public interest, maternal satisfaction, and emotional and psychological wellbeing, among other factors.[20] The Society of Obstetricians and Gynaecologists of Canada released a policy statement in 2010, with approval from the Indigenous Physicians Association of Canada, the Canadian Association of Midwives, and the Aboriginal Council of Midwives, recommending increased support for births in home and community settings in rural, remote, and tribal settings.[21] Support for homebirths has also been expressed on behalf of the Arizona Affiliate of the American College of Nurse-Midwives (ACNM), who has issued a comment in response to Arizona HB 2247 in support of women's informed choice of homebirth by direct entry midwives. These comments are issued in spite of the fact that the bill's passage would not affect CNMs' scope of practice.[22]

Table 3. Scope of Practice in Selected States (continued)

		Requirements on overseeing and attending high-risk pregnancies/births			Requirements prior to delivery	
State	Administration of pharmaceuticals	Vaginal birth after Cesarean (VBAC)	Non-cephalic presentation	Multiple fetuses	Facilitate and Record Physician Referral (regardless of high risk circumstances)	Create Emergency Transfer of Care Plan
Tennessee[a,c]	No unusual restrictions; Pitocin and Methergine only for emergency situations	The following circumstances require physician consultation and may require physician referral and/or transfer of care: 1. Previous cesarean with classical incision; 2. Three or more previous cesarean sections; 3. Previous Cesarean section within one year of current estimated delivery date	Requires physician consultation and may require physician referral and/or transfer of care	Requires physician consultation and may require physician referral and/or transfer of care	Yes, in the case of significant deviations	No
Texas[a,d]	No, except a pharmaceutical administered with oversight from physician, prophylaxis approved by the department to prevent opthalmia, and oxygen in accordance with midwifery board rule	Yes, but must document and make recommendation of referral. With the exception of prior classical or vertical incision	No	Yes, with required referral and documentation of such	No, unless abnormalities exist as outlined in "§831.60 Prenatal Care" in the Rules of the Texas Midwifery Board	No formal plan initiated. Will transfer if emergency occurs
Vermont[a,e]	No unusual restrictions	-Midwife must consult with licensed M.D. or D.O. to ascertain that client had only 1 documented previous lower uterine segment cesarean section with uterine closure of more than one layer -Must be at least 18 months from the client's cesarean to the due date of the current pregnancy -Client must obtain ultrasound documentation to determine that the location of the placenta is not previa or is not low and anterior -Signed informed consent must be present in the client's chart -Specific fetal auscultation requirements -Birth site must be located within 30 minutes transport time from a hospital emergency room -No labor induction or augmentation of any kind must be done -Two licensed midwives must be present during the birth	Midwife must not assume or continue to take responsibility for the client's pregnancy and birth care if fetus is in breech presentation at 38 weeks or after	Midwife must not assume or continue to take responsibility for the client's pregnancy and birth care in case of multiple gestation	Required signed informed consent document must include midwife's advice to client to consult with a physician at least once	Yes
Washington[a,f,g]	Yes. For prophylaxis, antihemorrhagic medication, and others	Yes, but must have physician consultation	Transfer of care	Transfer of care	Yes, if any deviations from normal	Yes

[a] Arizona Department of Health Services. Midwifery Scope of Practice by State: VBAC, Multiple Births, Breech Births in Non-Hospital Settings. http://www.azdhs.gov/als/midwife/documents/committee/additional-resources/state-laws-chart-vbac-br-mg.pdf. Accessed March 24, 2013.

[b] Tennessee Midwives Association. Tennessee Midwives Association Practice Guidelines. July 30, 2012. http://tnmidwives.org/documents/tennessee-midwives-association-practice-guidelines. Accessed March 24, 2013.

[c] Tennessee Birth Coalition. Regulating Midwives - History and Update. April 19, 2010. http://www.tennesseebirthcoalition.org/page1/files/dc1563791d22b199a2a53508afd1796e-0.html. Accessed March 24, 2013.

[d] Midwives Alliance of North America. Texas Occupations Code: Chapter 203: Midwives. http://mana.org/laws/laws_tx.htm. Accessed March 24, 2013.

[e] The Vermont Statutes Online. Title 26: Professions and Occupations: Chapter 85 Midwives. http://www.leg.state.vt.us/statutes/fullchapter.cfm?Title=26&Chapter=085.

[f] Midwives' Association of Washington State. Clinical guideline: Vaginal birth after Cesarean in the out-of-hospital setting. http://www.washingtonmidwives.org/documents/conferenceslides/MAWS-2011-FINAL-DRAFT-VBAC-GUIDELINES.pdf. Accessed March 24, 2013.

[g] Midwives' Association of Washington State. Indications for Discussion, Consultation and Transfer of Care in an Out-of-Hospital Midwifery Practice. http://www.washingtonmidwives.org/for-midwives/indications-consultation.html. April 24, 2008. Accessed March 24, 2013.

Public support for homebirths attended by midwives in the United States has increased since the natural childbirth movement of the 1970s and 1980s.[23] On an international scale, many women in developed nations see homebirth as the safest option.[24] Though there is scant information as to why women in the United States choose homebirths, research and data collected from studies conducted in other developed

countries may be extrapolated to make inferences as to why women choose to have out-of-hospital births. Several of such studies found common themes amongst consumers of homebirths, including but not limited to: control, comfort, freedom to move, and fewer medical interventions during labor.[25-29] From studies conducted in the United States among consumers of homebirths, similar themes were found, including: control, comfortable environment, and minimal intervention. Additional themes included trust in the natural birth process and a previous negative hospital experience.[30] Women in the United States, and conceivably in other countries, also choose out-of-hospital births due to barriers such as transport to health services in rural areas, access to another provider, and cost (homebirths cost on average, a third of the cost of hospital births[1]).

Licensing for direct entry midwives in the US was a long and piecemeal process, beginning in the early 20th century in the northeast, where there was a high concentration of immigrants served by "old country" midwives.[31] By 1975, 22 states and the District of Columbia had licensing laws.[31] Significant events punctuating this period included the emergence of trained nurse midwives in the 1930s, followed by the incorporation of the American College of Nurse Midwives (ACNM) in 1955.[31, 32] In 1958, an exposé in *Ladies' Home Journal* revealed many women's negative and traumatic experiences in hospital maternity wards, shedding popular light on a growing dissatisfaction with hospital births following the era of twilight sleep.[33]

Arizona began licensing midwives in 1957 through the Department of Health Services.[34] At this time, 25 women were licensed based on "evidence of sufficient knowledge and skill to assure reasonable safety for clients."[34] As women from poor and rural areas of the state became attuned to hospital-based obstetric care, fewer women demanded licensed midwives for their care.[34] Revisions to Arizona's licensing regulations were made in 1978, after a noticeable increase in demand for licensed midwives.

These amendments instituted more stringent qualifications and education requirements.[34] Amendments were made again to these regulations in 1990s, creating a more complex application for midwives, which has since become outdated.[35] Homebirths comprise a small percentage of births in Arizona, at 0.50-0.99% of all births.[1] Nationally, this is the same, with homebirths making up less than 1% of all births.[1] Licensed or certified professional midwives are presumably the providers in attendance at a majority of these births.[1] Currently there are 60 licensed or certified professional midwives licensed with the Arizona Department of Health Services (AzDHS).[36]

Most recently, the licensed midwife community has utilized the democratic process to their advantage to pass legislation to allow for an overhaul of the regulations overseeing homebirths and their profession in the state. Pursuant to HB 2247, AzDHS has formed a Midwife Scope of Practice Advisory Committee, which will evaluate evidence based literature and data to make informed decisions regarding regulation over licensing procedures, scope of practice, and education requirements for licensed midwives in Arizona by July 2013.[37] Of particular salience will be changes in regulations overseeing licensed midwife attendance at births for mothers undergoing a vaginal birth after cesarean (VBAC), breech birth presentation, and multiple fetuses.

Support for homebirths and an increased scope of practice for licensed midwives has become a visible public issue in Arizona since consumers have expressed their sentiments for having increased capacity to exercise agency with regard to their choices for where and how to give birth. As indicated in the "Rights for Homebirth response to Arizona House Bill 2247," consumers noted issues such as informed consent, patient rights, and legal attendance of licensed midwives at vaginal births after cesarean, breech presentation, and births of multiples to be addressed in the revised rules and regulations.[38] The Arizona Affiliate of the ACNM's support of consumer choice of homebirth is qualified by their position that

home birth services should not be provided for VBACs, non-cephalic presentations, or births of multiples.[22]

There are notable limitations to this search that should be recognized prior to evaluating the available literature. First, the aforementioned lack of data and evidence on the safety and efficacy of homebirths for high-risk pregnancies makes it challenging to compare outcomes in these two disparate settings. Homebirths have lower-risk profiles compared to in-hospital births, potentially resulting both from state regulations overseeing homebirths for high-risk pregnancies and from homebirth attendant choice to select low-risk patients.[39] Due to this inherently lower-risk status of many homebirth patients, evaluation of types of pregnancy status in accordance with outcomes in home and hospital settings should be taken into consideration when analyzing relative safety or risk. Second, differentiation of type of midwife is vital to grasping the appropriate scope of practice and regulations overseeing her practice and ability to attend births in different settings. Given that direct-entry and certified professional midwives attend most homebirths and are often not in attendance at hospital births, it is difficult to appropriately compare homebirth outcomes to hospital births, which are often attended by certified nurse midwives.[1] These health professionals often practice in different settings, have different educational and certification requirements, and may operate under different state and setting regulations. It is important to understand these differences, and to recognize that any comparison of birth outcomes between these professionals will be significantly qualified by variances in their professional scope of practice and background.

In light of Arizona homebirth practitioners' and clients' interest in midwives' scope of practice in the US and elsewhere, we seek in this meta-analysis to compare and contrast direct entry midwives' outcomes for homebirths with their outcomes in hospital or health care facility settings. The current limited and conflicting evidence on the outcomes of homebirths versus hospital births with midwives in

attendance generates both a need and justification for a review of the available evidenced-based literature. In doing so, we acknowledge the present biases in many of the available studies and sources on this subject. We thus seek to find evidenced based materials that mitigate said bias, and provide sound, clinical information on the safety and efficacy of the attendance of direct licensed midwives in these two distinct birthing settings.

Methods

Search strategy and selection criteria

The review was prepared following standard procedures of the Cochrane Collaboration [23] and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and checklist.[24] To identify eligible studies published up to end of February 2013, we searched Medline/PubMed, Embase, Web of Science, EBSCO (PsycINFO and CINAHL), Ovid, the Cochrane Fertility Review Group Specialized Register, Cochrane Pregnancy and Childbirth Group Specialized Register, and the Cochrane Central Register of Controlled Trials. We sought unpublished data from the grey literature through Google and Google Scholar searches. We hand-searched reference lists of identified articles. The search was not restricted by publication status or language. To maximize the retrieval of potentially relevant articles, we used a combination of free texts, index terms, and truncated terms that include “outcome of health facility birth by midwives”, “outcome of home birth by midwives”, “outcome of home deliveries by midwives, “home deliveries by midwives”, “home Births by Midwives”, “Healthcare Facility Births by Midwives”, ("Parturition"[Mesh])” AND "Home Childbirth"[Mesh])” AND "Midwifery"[Mesh]”, ("Parturition"[Mesh])” AND "Home Childbirth"[Mesh], “("Parturition"[Mesh])” AND "Health Facilities"[Mesh])” AND "Midwifery"[Mesh]”.

Inclusion/exclusion criteria

Type of studies: We included case-control studies, randomized controlled studies, cross-sectional studies, cohort studies, and time-series studies that investigated outcome of births attended by midwives in hospital/health facility settings or in homes. We extracted from systematic reviews, articles that met the criteria for inclusion.

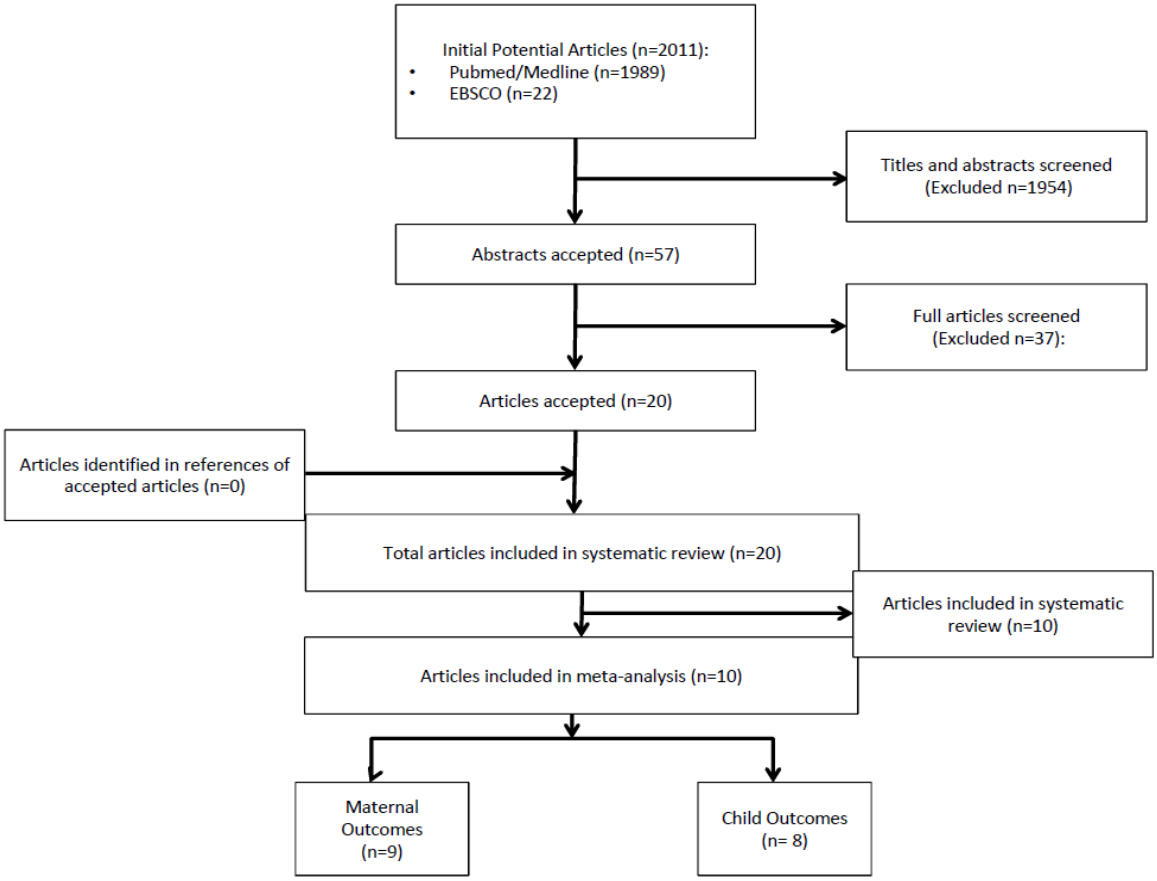
Participants: Women who delivered babies in hospital/health facility or in homes under the supervision of a midwife.

Outcome measures: neonatal death, prenatal death, Apgar<7 at 5 min, intrapartum death, low birth weight < 2500g, birth seizures, meconium aspiration. Intrapartum and neonatal mortality, transfer to hospital, interventions during labor, breastfeeding, and maternal satisfaction. Application of inclusion and exclusion criteria to identified studies was done by five reviewers (KH, JC, HR, YL, and JE).

Study selection

Five reviewers (KH, JC, HR, YL, and JE) independently screened titles and abstracts of identified studies to assess their eligibility for inclusion in the review using an eligibility form based on the inclusion criteria. Where there were uncertainties regarding eligibility of studies, all reviewers participated in the decision about inclusion. Fig. 1 presents a summary of the search output and the process of study selection.

Fig. 1: Study selection



Study quality assessment

We assessed the quality of case-control and cohort studies using the Newcastle-Ottawa Scale.[25] For case-control studies, we assessed the adequacy of case and control definition, representativeness of the cases, whether controls were derived from the same population as cases, comparability of cases and controls on the basis of design and analyses, ascertainment exposure, and non-response rates. For cohort studies, we assessed the representativeness of the exposed cohort in the study setting, the selection of non-exposed cohort, ascertainment of exposure, demonstration that outcome of interest was

not present at start of the study, comparability of cohorts on the basis of design and analyses, outcome assessment and adequacy of follow-up.[25] After reviewing the quality of each included study on the basis of these criteria, we assigned a composite grade score ranging from 0 to 9. Studies that scored less than 6 were judged to be of low quality.

For cross-sectional studies, we used the guideline for critical appraisal of cross-sectional studies developed by the National Collaborating Center for Environmental Health[26] which was adapted from a combination of items from the Newcastle-Ottawa Scale,[25] the Critical Appraisal Skills Program [27], Critical Appraisals by Elwood[28], and Aschengrau and Seage III[29] Specifically, we assessed representativeness of the study participants, methods for ascertaining exposure; comparability of exposure groups (including unexposed) in terms of age, socioeconomic status, determination and validation of outcomes; internal validity; and how confounding factors were assessed and addressed. After reviewing the quality of each included study on the basis of these criteria, we assigned a composite grade score that ranged from 0 to 4. Two reviewers (YL and JE) assessed study quality and reached a consensus grade for each included study.

Data extraction

Data from eligible studies were independently abstracted by four reviewers (YL, KH, JC, HR,). Differences were resolved by consensus among all reviewers. We extracted on data number of homebirths attended by midwives and associated outcomes (maternal and child) and number of hospital births attended by midwives and associated outcomes (maternal and child). Where results of a study were published more than once, only the study with the most complete data was included in the analysis.

Data Analysis

We conducted meta-analyses of outcomes of home versus hospital deliveries by midwives by maternal or child health outcomes. We calculated pooled odds ratios (ORs) for case-control studies and cross-sectional studies, and relative risks (RRs) for cohort studies, using RevMan 5.0 software.[23] Heterogeneities were evaluated using the Q test[30] and the I-squared statistic.[31] We used the fixed effect model where the level of heterogeneity was acceptable (i.e., p =>0.10, or p =≤0.10 but I^2 = ≤50%), and the random effects model, where there was significant heterogeneity (i.e., p=≤0.10, I^2 = >50%). In addition, we performed subgroup analyses to explore possible reasons for heterogeneity.

Results

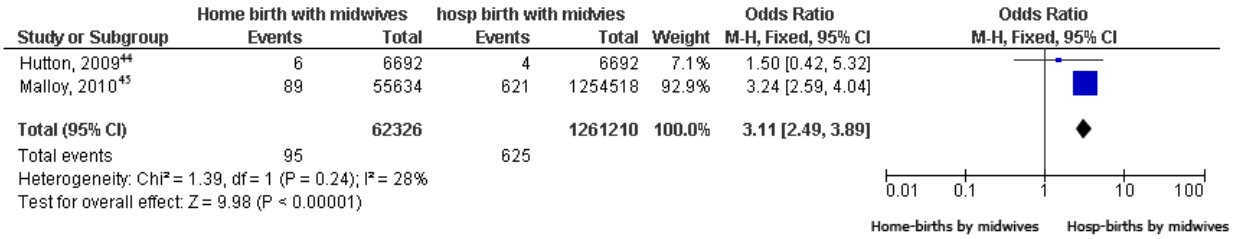
Child health

Nine studies[5,6,40-46] were included in the meta-analysis of child health outcome of births attended by midwives in homes or in hospitals. We analyzed 8 outcomes of child health (neonatal deaths, prenatal deaths, Apgar<7 at 5 min, intrapartum deaths, low birth weight < 2500g, birth seizures, and meconium aspiration) (Fig. 2 and Table 4).

Marked heterogeneity was found among the studies for prenatal deaths (P= 0.05). Thus, as stated in the data analysis section, we conducted all meta-analyses using the random effects model. Studies on the remaining 7 outcomes of child health had very low heterogeneity. Thus, we used the fixed effects model to conduct their meta-analysis (Table 4). Pooled results indicated that homebirths attended by midwives were associated with increased risks for neonatal deaths [pooled OR (95%CI): 3.11 (2.49,

3.89)]. There were no significant differences in outcome of home or hospital births attended by midwives for the other child health measures (Fig. 2 and Table 6).

Fig. 2: Impact of birth setting on neonatal deaths



Maternal Outcomes

Eight studies[5,40-44, 46-47] qualified for inclusion in the meta-analysis of the impact of setting (home or hospital) of births attended by midwives. Thirteen maternal outcomes were assessed (Fig. 2 and Table 4). Due high heterogeneity (P=0.54, 0.29 and 0.52 respectively) for studies on cervical tear, retained placenta and prolapsed cord, the fixed effects model was used for their meta-analysis. Significant heterogeneities were found among studies on the remaining 10 outcomes of maternal health (P<0.1 or I^2 >50%). We therefore, conducted their meta-analyses using the random effects model (Table 4). Pooled results indicated that homebirth attended by midwives had marked impact on outcome of delivery: women who delivered at home with midwives were more likely to have spontaneous delivery and intact lacerations/perineal tear [pooled ORs (95%CIs): 1.64 (1.35, 2.00) and 1.94 (1.25, 3.01) respectively. (Fig. 3.1 and Table 6). Women who delivered in hospitals under the supervision of midwives were more likely to experience assisted delivery, caesarean sections, forceps, episiotomy, and lacerations/perineal tear (3-4 degrees) [pooled ORs (95%CI s): 0.58 (0.40, 0.84); 0.55 (0.49, 0.60); 0.54 (0.33, 0.90); 0.56 (0.41, 0.77) and 0.48 (0.32, 0.72) respectively (Fig. 3.2-3.3 and Table 6). Results of

the meta-analysis also revealed that homebirths attended by midwives were associated with decreased risk for postpartum hemorrhage >500ml and retained placenta [pooled ORs (95%CI s0.60 (0.44, 0.81) and 0.58 (0.40, 0.86) respectively. Homebirths were also not associated increased risk for vacuum extraction, cervical tear, blood transfusion and prolapsed cord (Fig. 3.3 and Table 6).

Fig. 3.1: Impact of birth setting on spontaneous delivery and intact lacerations tear

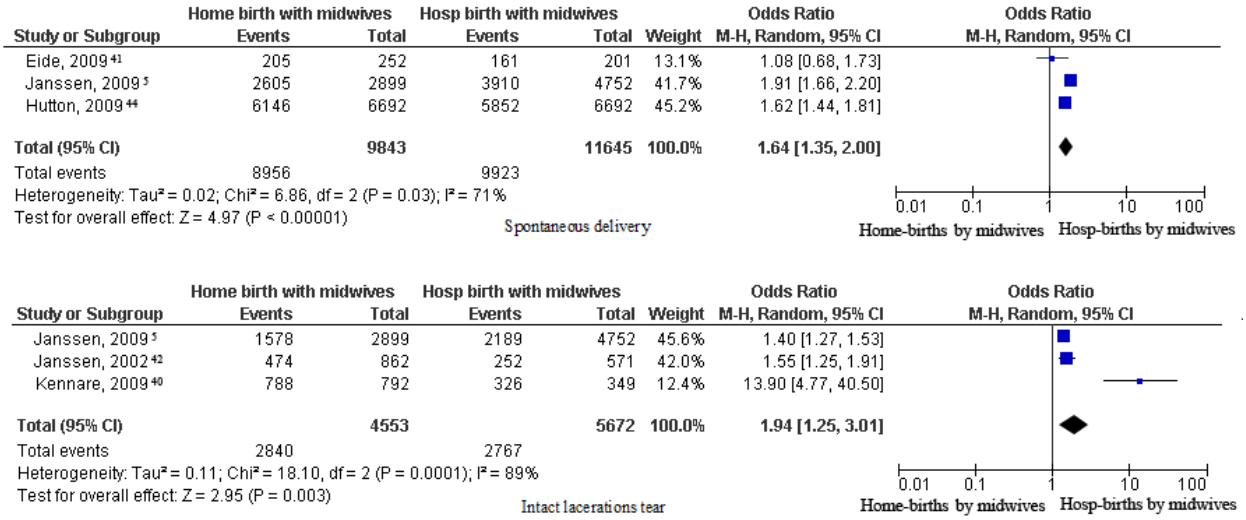


Figure 3.2: Impact of birth setting on assistant delivery, caesarean and forceps and episiotomy

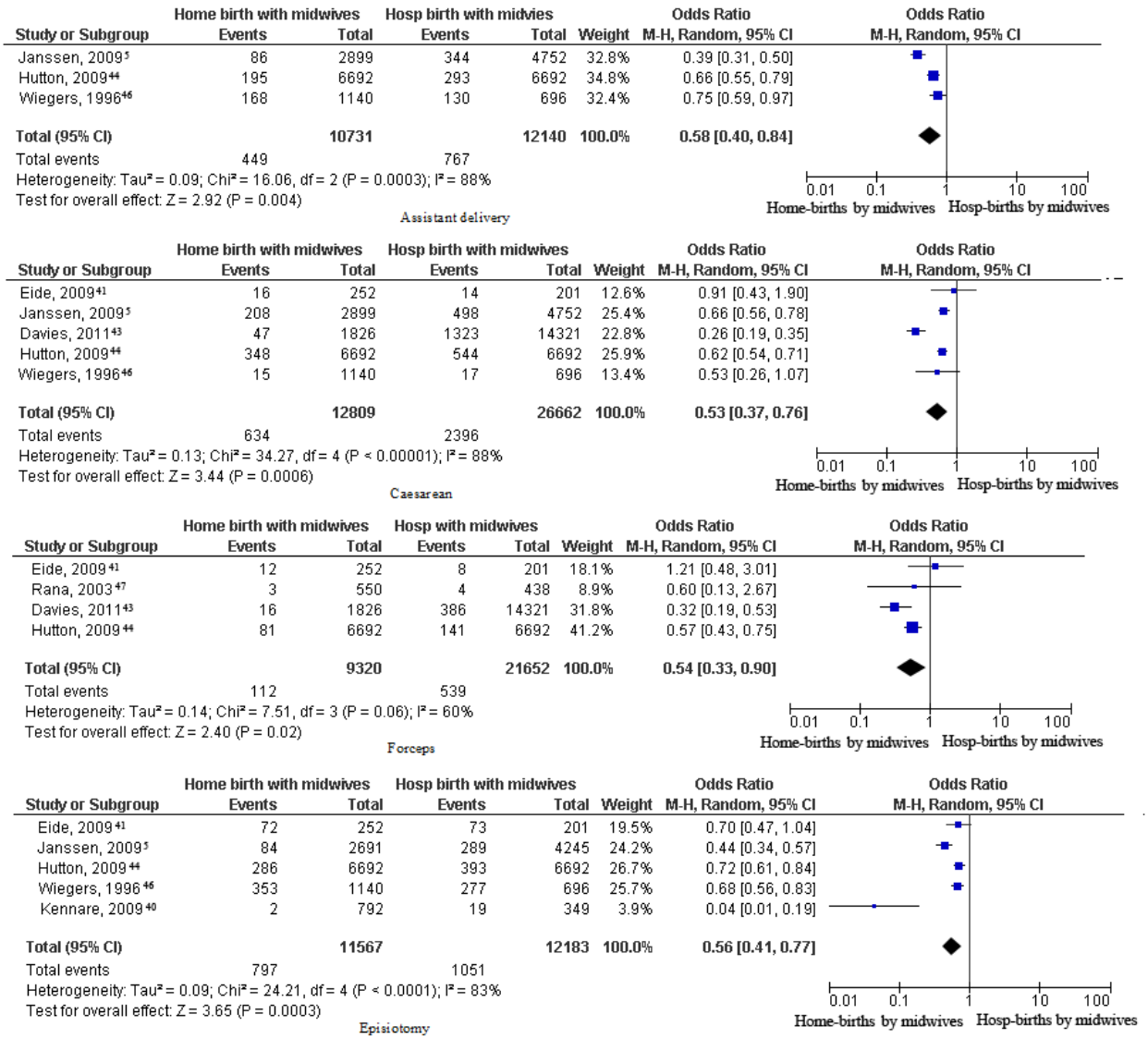
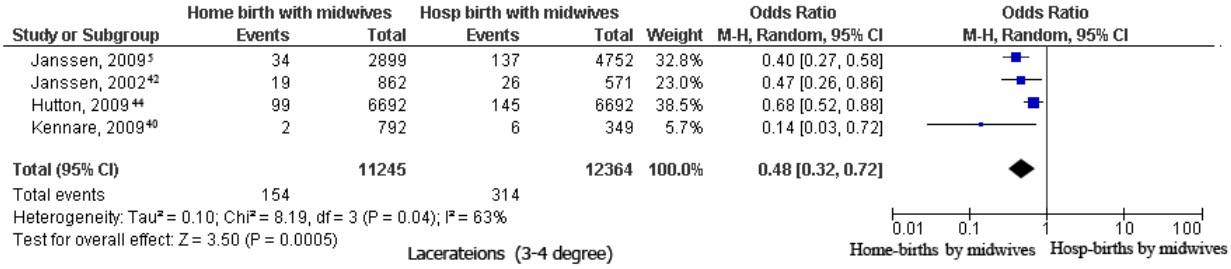
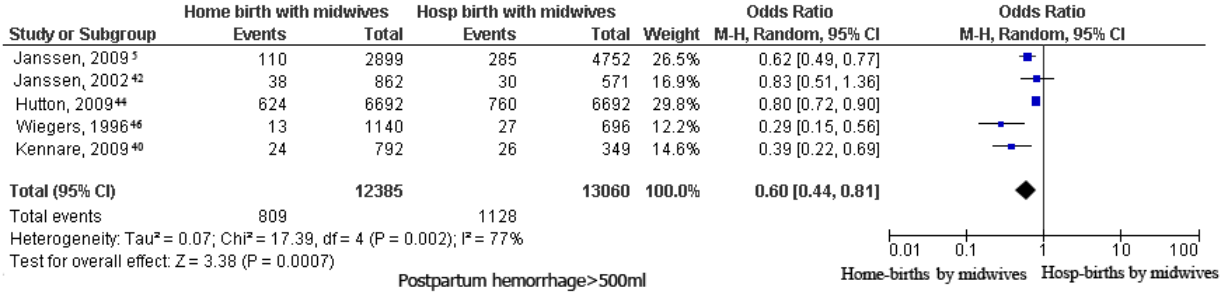


Fig. 3.3: Impact of birth setting on 3-4 degree lacerations, postpartum hemorrhage>500 ml and retained placenta





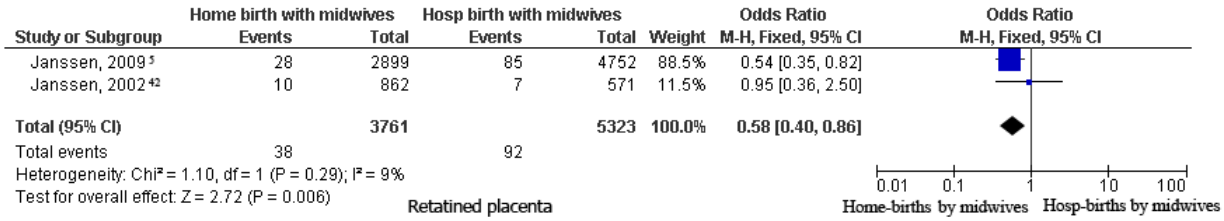


Table 6: Results of meta-analysis of the studies on the impact of birth setting on outcome of birth (compared birth outcome between home birth by midwives and hospital birth by midwives)

Factors	No. of studies	No. of participants	Variance between studies		Pooled OR/RR	95% CI	Test for overall effect (p)
			Q(*p*)	I^2 (%)			
Child health							
1. Neonatal death	2	1323536	0.24	28	3.11	(2.49, 3.89)	**<0.00001**
2. Prenatal death	3	4400	0.04	68	0.70	(0.09, 5.29)	0.73
3. Apgar <7 at 5 min	2	14807	0.27	16	0.86	(0.60, 1.25)	0.44
4. Intrapartum death	2	485709	0.66	0	0.82	(0.60, 1.12)	0. 21
5. Low birth weight <2500g	2	14807	0.43	0	0.71	(0.48, 1.05)	0.09
6. Birth seizures and midwives	2	1133575	0.36	3	1.49	(0.86, 2.58)	0.15
8. Meconium aspiration	2	1350153	0.77	0	0.90	(0.68, 1.20)	0.49
Maternal health							
1. Spontaneous delivery	3	21488	0.03	71	1.64	(1.35, 2.00)	**<0.00001**
2. Vacuum extraction	3	29984	<0.00001	92	0.51	(0.21, 1.23)	0.13
3. Assistant delivery	3	22871	0.0003	88	0.58	(0.40, 0.84)	**0.004**
4. Caesarean	5	39471	<0.00001	88	0.55	(0.49, 0.60)	**0.0006**
5. Forceps	4	30972	0.06	60	0.54	(0.33, 0.90)	**0.02**
6. Episiotomy	5	23750	<0.0001	83	0.56	(0.41, 0.77)	**0.0003**
7. Lacerations/perineal tear (3-4 degree)	4	23609	0.04	63	0.48	(0.32, 0.72)	**0.0005**
8. Lacerations/perineal tear (intact)	3	10225	0.0001	89	1.94	(1.25, 3.01)	**0.003**
9. Cervical tear	2	9084	0.54	0	0.84	(0.21, 3.38)	0.80
10. Postpartum hemorrhage >500ml	5	25445	0.002	77	0.60	(0.44, 0.81)	**0.0007**
11. Retained placenta	2	9084	0.29	9	0.58	(0.40, 0.86)	**0.006**
12. Blood transfusion	3	10920	0.08	61	0.33	(0.08, 1.37)	0.13
13. Prolapsed cord	2	9084	0.52	0	0.40	(0.11, 1.48)	0.17

Discussion

After meta-analyses of the outcomes for both home and hospital deliveries were completed for nine studies, the pooled results showed that the risk of neonatal death increased among homebirths (OR=3.11, 95% CI: 2.49-3.89). However, there were no significant differences between home and hospital births attended by midwives with regard to any other infant health outcome measure. Eight studies were included in the meta-analysis for maternal outcomes; results of the meta-analyses showed several health benefits of delivering with a midwife. Homebirths were more likely to result in a spontaneous birth with an intact perineum. Women who delivered at home with midwives were more likely to have spontaneous delivery and intact lacerations/perineal tear. Women who delivered in hospitals under the supervision of midwives were more likely to experience assisted delivery, caesarean sections, forceps, episiotomy, and lacerations/perineal tear (3-4 degrees). Additionally, homebirths attended by midwives were associated with decreased risk for postpartum hemorrhage >500ml and retained placenta. Homebirths were also not associated increased risk for vacuum extraction, cervical tear, blood transfusion and prolapsed cord.

These results suggest that homebirth is a suitable alternative to the traditional hospital setting, as it reduces medical interventions and has been found to have positive maternal health outcomes. However, homebirths should only be recommended to women who are classified as low-risk, as this data demonstrates an increased risk of neonatal mortality among homebirths. The findings suggest that homebirths attended by midwives may be equally safe if not safer for women with low-risk pregnancies. Unfortunately, home births attended by midwives increase safety concerns for the child. Relevant literature supports this claim, and suggests that women who self-select and are also chosen by an experienced midwife for a homebirth have proven positive birth outcomes.[46,48] Often, women who are found to be good homebirth candidates have low obstetrical risk profiles, leading to anticipated

favorable birth outcomes.[49-52] However, access to emergency services, prior consultation, and having a contingency plan with a nearby medical facility with appropriate obstetrical equipment is encouraged, in the case that a medical emergency occurs.[44,51] Many states require such a plan, as seen in Tables 2 and 3.

Women with high-risk pregnancies may require greater use of obstetrical interventions in a hospital setting and with a health professional other than a midwife such as an obstetrician. Studies reviewed here tended to exclude high-risk pregnancies, exclusions attributable at least in part to the tendency for women with high-risk pregnancies to be referred to or to opt for obstetrical care rather than midwifery-led care.[39,50-52] The findings of this meta-analysis have implications primarily for women with generally low-risk pregnancies and the midwives who may be their primary perinatal care providers, because low-risk women account for most of the sample analyzed. Midwives are not licensed to perform surgical procedures, like cesarean sections that comprise some of the most common obstetrical interventions, although they do play the important role in high-risk pregnancies of counseling and referring women to obstetrical care when appropriate.

Positive maternal outcomes in homebirths settings, such as those found in this analysis, are supported by other relevant literature. Wax et al. contend that low-risk parous women who choose homebirths are "in large part successful in achieving their goal of delivering with less morbidity and medical intervention than experienced during hospital-based childbirth."[8] In support of the option of homebirths, Weigers posits increasing women's free choice of having birth within the comfort of their home.[46] The environment of the home may have marked difference in the level of anxiety the woman experiences during birth, thus determining the birth outcomes and need for intervention.[44,46]

This analysis and others have focused on disparate birth settings, homes and hospitals, making for some marked differences in the types of professionals and technologies used during birth. Following a resurgence in the homebirth movement and state policy changes to broaden the scope of practice for licensed midwives, it may be beneficial to further study the outcomes of homebirths with only direct entry or licensed midwives in attendance. The lack of data on neonatal and maternal outcomes focused solely on this group of professionals in homebirth settings creates barriers to adequately assessing the issues of safety and efficacy associated with these births. Comparisons of state-based policies for transfers of care and regulations regarding high-risk pregnancies would merit consideration in a further investigation of outcomes of homebirths attended by direct entry or licensed midwives. As some states re-assess the scope of practice for these professionals, such state-based data may prove useful in maintaining or amending the scope of practice as deemed necessary.

As discussed above, patient choice of place of labor and birth is a key part of the discussion of midwifery care. Consumers of midwife-led care seek a particular type of birth experience, without the use of invasive technologies or pharmaceutical agents that may be potentially dangerous or unnecessary if they have a low-risk pregnancy. Further examination of maternal satisfaction indicators, as has been done in some extant literature, may prove to be pertinent to this conversation. For example, Johnson et al. found high maternal satisfaction with midwifery led care and associated positive birth outcomes.[4]

Limitations of this meta-analysis include the aforementioned lack of data and evidence on the safety and efficacy of homebirths for high-risk pregnancies. This makes it challenging to compare outcomes across settings. Homebirths tend to have lower-risk profiles compared to in-hospital births, potentially resulting both from state regulations overseeing homebirths for high-risk pregnancies and from homebirth attendant choice to select low-risk patients.[39] An assessment of the relative safety or risk of

homebirth must take into account patient risk profiles. Second, differentiation of type of midwife is vital to grasping the appropriate scope of practice and regulations overseeing her practice and ability to attend births in different settings. Given that direct-entry and certified professional midwives attend most homebirths and are often not in attendance at hospital births, it is difficult to appropriately compare homebirth outcomes to hospital births, which are often attended by certified nurse midwives.[1] These health professionals often practice in different settings, have different educational and certification requirements, and may operate under different state and setting regulations. It is important to understand these differences, and to recognize that any comparison of birth outcomes between these professionals will be significantly qualified by variances in their professional scope of practice and background.

Heterogeneity among the studies may also pose as a limitation, as studies were included from several different countries where education and regulation of midwives may differ from that in the United States in addition to any differences in the actual place of birth. This variation may affect overall differences in findings or conclusions. However, these differences were accounted for in part through the use of the random effects model. There is also considerable strength in the inclusion of studies from different parts of the world, as the findings having increasing external validity across multiple geographic locations and with different scopes of practice, education, and training.

The evident lack of data on vaginal births after cesarean (VBAC), multiple births, and breech births also poses as a limitation, as these presentations and types of delivery are of considerable concern when evaluating the safety of homebirths attended by midwives. These were not included in the analysis due to the fact that these are high-risk pregnancy conditions and are not typical of women elected for homebirths in attendance by midwives. While data may at present be lacking in this area, future

examination of high-risk pregnancies in homebirth settings would provide further insight into the issues of safety and efficacy of midwife attendance at these births.

Conclusions

With the increased demand for homebirths over the past decade, it is necessary to examine the maternal and neonatal outcomes associated with homebirths. Since a majority of homebirths are attended by midwives, our review primarily focused on the outcomes of births attended by midwives in the home and in the hospital. This review of the literature, as it pertains to births that occur in the home versus a hospital, provides evidence that midwives are effective in assisting with both home and hospital deliveries, however, there may be some increased risk for infants among births that occur in the home.

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