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Original Research

Outcomes of Waterbirth in a US Hospital-Based Midwifery Practice: A Retrospective Cohort Study of Water Immersion During Labor and Birth

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Introduction: Although the safety of water immersion during labor is largely supported by evidence from research, the risks to women and neonates during waterbirth are not well established. The purpose of this study was to generate evidence regarding maternal and neonatal outcomes related to water immersion in labor and during birth.

Methods: A retrospective cohort study included a convenience sample of women receiving prenatal care at a nurse-midwifery practice. Participants were categorized into 3 groups: 1) waterbirth, 2) water labor, or 3) neither. Participant characteristics, maternal outcomes, and newborn outcomes were collected at time of birth and health record abstraction. At the 6-week postpartum visit, another maternal outcome, satisfaction with birth, was measured using the Care in Obstetrics: Measure for Testing Satisfaction (COMFORTS) scale. Analysis included effect size, descriptive statistics (sample characteristics), and maternal and neonatal group differences (analysis of variance and chi-square) with a significance level of $P < .05$.

Results: Women in the waterbirth (n = 58), water labor (n = 61), and neither (n = 111) groups were primarily white, married, and college educated and did not differ by age or education. Women in the waterbirth group were more likely to be multiparous. Nulliparous women who had a waterbirth had a significantly shorter second stage of labor than nulliparous women who did not have a waterbirth ($P = .03$). The most commonly cited reasons for discontinuation of hydrotherapy were maternal choice (42.6%) and need for pain medication (29.5%). Significantly more women in the waterbirth group experienced a postpartum hemorrhage, compared with water labor or neither (n = 5, n = 3, n = 1, respectively; $P = .045$); there was no difference in related clinical measures. Neonatal outcomes were not significantly different. Maternal satisfaction was high across all groups.

Discussion: The results of this study suggest that waterbirth, attended by qualified intrapartum care providers in hospital settings in the United States, is a reasonable option for low-risk women and their neonates.
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Keywords: waterbirth, water birth, natural childbirth, midwifery, maternal and neonatal outcomes, hydrotherapy, labor, water immersion, birth

INTRODUCTION

Giving birth while submerged in water has gained in popularity over the past 40 years, as women seek a lower-intervention birth and nonpharmacologic pain relief options.[1–3] In 2016, the American College of Nurse-Midwives released a position statement stating that low-risk women should be given the choice to remain immersed in water for birth as part of a shared decision-making process.[3] This document also states that labor management for these women should be evidence-based and include ongoing maternal and fetal assessment during labor. Furthermore, the American College of Nurse-Midwives recommends that women should have access to qualified perinatal care providers and considers certified nurse-midwives (CNMs) and certified midwives to be qualified to provide safe waterbirth.[3]

Background

The benefits of hydrotherapy (water immersion) during labor have been reported in the literature over the past 2 decades.[1–10] Studies of hydrotherapy during labor show decreased use of analgesia or anesthesia[4,8] and shortened duration of the first stage of labor.[5] Positive maternal effects of immersion in water during labor include less pain,[4,6,10] lower blood pressure,[1] a sense of control,[1] and high maternal satisfaction.[1,4] Water immersion during labor has shown mixed results for perineal integrity.[2,5] Studies have not demonstrated neonatal harm from the use of hydrotherapy in the first stage of labor.[7]

The body of evidence that addresses the safety of hydrotherapy during birth (waterbirth) is not extensive, with few studies conducted in the United States. In studies that have been published evaluating water immersion

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Quick Points

- This research adds to the evidence base on waterbirth in a less-studied population: women giving birth in a US hospital.
- There were no increased risks to neonates who were born in the water.
- Maternal satisfaction in the birthing process, as measured by the Care in Obstetrics: Measure for Testing Satisfaction (COMFORTS) scale, was high among women offered the option of a waterbirth.
- There was a higher incidence of postpartum hemorrhage among women who had a waterbirth; more research should be done to explore this finding.
- Waterbirth is a reasonable option for low-risk women and their neonates in a US hospital setting when attended by qualified intrapartum care providers.

during labor and birth, the findings include no differences in maternal infection rates,[11–14] decreased episiotomy rates,[1,2,5,11–13,15–17] decreased duration of labor,[5,11,15,18–20] decreased reported pain,[12,21] decreased use of analgesia and anesthesia,[11,13,15,18,20] decreased blood loss or incidence of postpartum hemorrhage,[12,15,22] and increased maternal satisfaction.[12,19,23] Evidence is conflicting regarding the incidence of perineal lacerations. Some studies have found an increase in intact perineums,[5,12,13] whereas others report a decrease in severe perineal lacerations,[12,13,15,22] a decrease in episiotomy rates,[2,11–13,15–18] an increase in perineal lacerations,[2,13–15,18] and/or an increase in minor perineal or vaginal or periurethral lacerations.[13,14]

Neonatal outcomes have also been studied. A 2018 Cochrane review included 15 trials of water immersion during the first and/or second stage of labor with 3663 participants in hospital settings.[8] Four of the trials evaluated the effects of water immersion during the second stage of labor, and the meta-analysis found no evidence of an increased risk of adverse outcomes to neonates born in the water versus conventional birth.[8] However, the overall quality of the studies provided low-quality evidence, and further study is needed.

Case reports have documented rare neonatal adverse effects of hydrotherapy during birth, such as cord avulsion,[2,12,19,24,25] drowning,[24] near-drowning or water aspiration,[24,26,27] and bacterial infections such as pneumonia, sepsis, or meningitis.[24,26] An evidence review published in response to these case studies found a lack of evidence to support these neonatal concerns.[28] Other studies have demonstrated no significant difference in neonatal infection rates,[11,12,29] Apgar scores,[11,14–19,21,22,29,30] or neonatal intensive care unit admission rates.[11,12,17–19,30]

Water immersion for labor and birth is endorsed by professional midwifery organizations based on current available evidence of benefits and risks.[3,9] Conversely, in 2014, the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists (ACOG) released a joint statement in which they recommended that waterbirth not be offered outside the scope of research.[31] The statement reported concerns regarding maternal and neonatal infection, neonatal asphyxia, hemorrhage, and respiratory distress.[31] The statement cited a general lack of research in the United States concerning the risks and benefits of waterbirth in a hospital setting.[31] ACOG revised its position in a November 2016 committee opinion stating that waterbirth may be offered to women who are appropriately screened and provided informed consent about possible risks and benefits of hydrotherapy, but continues to recommend against waterbirth.[32] The purpose of this study was to generate evidence regarding maternal and neonatal outcomes related to water immersion in labor and birth.

METHODS

The nurse-midwifery practice at the study site has offered the option of waterbirth to low-risk women since early 2013. The practice was asked to cease waterbirth unless in the context of a study in 2014 when the ACOG–American Academy of Pediatrics statement was published. The midwifery practice began an institutional review board–approved study in March 2016 to evaluate maternal and neonatal outcomes of waterbirth, recruiting participants from a midwifery practice of an academic medical center in the United States. All births occurred at the associated academic medical center. All of the women who participated in the study expressed a desire to give birth using the option of immersion in water. The primary outcome of this retrospective cohort study was maternal and neonatal risks and benefits of waterbirth.

Established institutional guidelines for water immersion during labor and birth were followed (Appendix 1). Inclusion criteria for water immersion during labor were 1) term pregnancy, 2) singleton pregnancy, 3) vertex presentation, 4) spontaneous onset of labor, 5) category I fetal heart rate tracing, and 6) meeting requirements for hydrotherapy in labor per hospital policy. Exclusion criteria were 1) induction of labor, 2) meconium-stained amniotic fluid, 3) prior cesarean birth, 4) maternal infection or suspected infection, 5) administration of opioid analgesia less than 6 hours prior, 6) category II or III fetal heart rate pattern, or 7) any other condition requiring continuous electronic fetal monitoring upon admission to the labor and delivery unit.

After approval from the institutional review board and the institutional Maternal-Fetal Welfare Committee, women were recruited during routine prenatal visits at approximately 35 to 37 weeks' gestation. Upon arrival to the labor unit at the medical center, women reconfirmed that they desired to participate in the waterbirth study. Women who qualified for the study on admission to the labor and delivery unit were then able to

direct their own use of the tub, including using the tub for none, some, or all of their labor, as long as they continued to meet inclusion criteria. Women in the waterbirth group were asked to leave the tub after birth and move to the bed for the birth of the placenta and repair of any lacerations. Women enrolled in the study prenatally who did not meet inclusion criteria upon admission to the labor and delivery unit were excluded from the study.

For the purpose of this study, women were categorized into 1 of 3 groups: 1) women who labored and gave birth in the tub (waterbirth group), 2) women who labored in the tub and got out of the water for birth (water labor group), and 3) women who did not use the tub for either labor or birth (neither group). Outcome data from the women and newborns were obtained immediately after the birth by the attending CNM. Data were also collected retrospectively from the health records. Maternal outcomes included perineal integrity, duration of stages of labor, incidence of postpartum hemorrhage (defined as ≥500 mL), epidural analgesia use, oxytocin use postpartum, shoulder dystocia, cesarean birth, discontinuation of hydrotherapy with the reason for discontinuation (applicable only for the water labor group), and maternal satisfaction. Neonatal outcomes included neonatal intensive care unit admission, Apgar score at 5 minutes, sepsis (as diagnosed by the hospital pediatricians), use of intravenous (IV) antibiotics, neonate rehospitalization within the first 6 weeks of life, and cord avulsion.

At the 6-week postpartum visit, women in the study were asked to complete the Care in Obstetrics: Measure for Testing Satisfaction (COMFORTS) scale.[33] This 40-item scale evaluates satisfaction with childbirth care in 6 subscales: confidence in newborn care, postpartum nursing care, provision of choice, the physical environment, respect for privacy, and labor and delivery nursing care. Answers are on a 5-point scale, with the dimensions varying by subscale. The scores for all items are then summed for a maximum score of 200, with higher scores indicating increased satisfaction. The COMFORTS scale was found to have internal reliability with an internal consistency for the overall scale of 0.95 and internal consistency estimates for the subscales of 0.82 or higher.[33]

Descriptive statistics were used to summarize sample characteristics and maternal and neonatal outcomes in each study group (waterbirth, water labor, and neither). The group differences in these variables (sample characteristics, maternal and neonatal outcomes) were analyzed using analysis of variance for continuous variables (eg, age, length of labor) and chi-square statistics for categorical variables (eg, nulliparity, perineal integrity). Exact chi-square tests were used for categorical variables with more than 20% of cells having expected counts less than 5. As nulliparity is a known factor related to length of labor and perineal integrity, a stratified analysis was conducted to examine the group difference in duration of labor and perineal integrity by parity. Women who had a cesarean birth were excluded from the analyses for duration of labor, perineal integrity, postpartum hemorrhage, and shoulder dystocia. All tests were 2-sided with a significance level of P less than .05. In addition to statistical significance, effect sizes were estimated for between-group (waterbirth vs water labor; waterbirth vs neither) comparisons using Cohen's d for continuous outcomes and odds ratio (OR) for dichotomous outcomes. The effect size quantifies the magnitude of the between-group differences and is advantageous over statistical significance because of its independence on sample size. Cutoffs for small, medium, and large effect sizes are Cohen's d equal to 0.2, 0.5, 0.8 for continuous outcomes; an OR that equals 1.7, 3.5, 6.7 if the OR is higher than one; or an OR equal to 0.6, 0.3, 0.1 if the OR is less than one for the binary outcomes.[34] Student's t tests and exact chi-square statistics were used to compare the sample characteristics of women with and without missing data to guide results interpretation. SAS 9.4 (SAS Institute, Cary, NC) was used for all the statistical analyses.

Table 1. Sample Characteristics by Study Groups

Characteristic	Waterbirth (n = 58)	Water Labor (n = 61)	Neither (n = 111)	*P* Value[a]
Age, mean (SD), y	30.1 (4.2)	29.2 (4.7)	28.9 (4.2)	.24
Marital status, n (%)				.29
Married	51 (87.9)	50 (82.0)	87 (78.4)	
Partnered	3 (5.2)	8 (13.1)	19 (17.1)	
Single	4 (6.9)	3 (4.9)	5 (4.5)	
Race, n (%)				.01
White	51 (87.9)	50 (82.0)	93 (83.5)	
Black	1(1.7)	5 (8.2)	16 (14.4)	
Other	6 (10.3)	6 (9.8)	2 (1.8)	
Payment source, n (%)				.67
Private	48 (82.8)	53 (86.9)	88 (79.3)	
Medicaid	9 (15.5)	8 (13.1)	22 (19.8)	
Self-pay	1 (1.7)	0.0 (0.0)	1 (0.9)	
Education, n (%)				.29
High school	5 (8.6)	2 (3.2)	8 (7.2)	
Some college	7 (12.1)	11 (18.0)	18 (16.2)	
College	24 (41.4)	33 (54.1)	49 (44.1)	
Graduate school	17 (29.3)	11 (18.0)	19 (17.1)	
Missing	5 (8.6)	4 (6.6)	17 (15.3)	
Nulliparity, n (%)				.02
Yes	16 (27.6)	32 (52.5)	45 (40.5)	
No	42 (72.4)	29 (47.5)	66 (59.5)	

[a]The statistics were derived from analysis of variance for age; exact chi-square tests for marital status, race, payment source, and education; and chi-square test for nulliparity.

RESULTS

A total of 230 women participated in the study (waterbirth, n = 58; water labor, n = 61; neither, n = 111; Table 1). The women in the 3 groups were similar with regard to age, marital status, payment source, and education. The majority identified as white, which is representative of the racial makeup of the CNM practice overall. There was a significant difference

Table 2. Duration of Labor and Perineal Integrity Among Study Groups, by Parity

Duration of Labor and Perineal Integrity	Nulliparous				Multiparous			
	Waterbirth (n = 16)	Water Labor (n = 31)	Neither (n = 42)	*P* Value[a]	Waterbirth (n = 42)	Water Labor (n = 27)	Neither (n = 66)	*P* Value[a]
Duration of labor, mean (SD), min								
First stage[b]	505.9 (311.4)	764.7 (512.9)	757.8 (442.8)	.13	423.6 (260.3)	469.3 (236.4)	401.9 (317.3)	.59
Second stage[c,d]	32.2 (21.2)	88.4 (68.2)	79.7 (82.8)	.03	9.5 (8.3)	20.6 (21.1)	16.8 (26.5)	.08
Third stage	10.2 (5.6)	9.6 (9.0)	6.8 (4.0)	.09	9.5 (4.4)	9.5 (7.1)	8.0 (3.9)	.19
Perineal integrity, n (%)				.97				
Intact	3 (18.8)	5 (16.1)	7 (16.7)		13 (31.0)	10 (37.0)	28 (42.4)	.49
Minor laceration[e]	13 (81.3)	24 (77.4)	33 (78.6)		28 (66.7)	16 (59.3)	35 (53.0)	
Major laceration[e]	0 (0.0)	0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	0 (0.0)	
Episiotomy	0 (0.0)	2 (6.5)	1 (2.4)		0 (0.0)	1 (3.7)	0 (0.0)	
Other laceration (not perineal)[e]	0 (0.0)	0 (0.0)	1 (2.4)		1 (2.4)	0 (0.0)	3 (4.5)	

[a]The statistics were derived from analysis of variance for continuous outcomes (duration of first, second, and third stage of labor) and exact chi-square tests for categorical outcome (perineal integrity).
[b]Effect sizes for the difference in average duration of first stage of labor for nulliparous women in the waterbirth group compared with water labor and neither groups were medium ($d = 0.61$ and 0.66, respectively).
[c]Effect sizes for the difference in average duration of second stage of labor for nulliparous women in the waterbirth group compared with water labor and neither groups were medium to large ($d = 1.11$ and 0.79, respectively).
[d]Effect size for the difference in average duration of second stage of labor for multiparous women in the waterbirth group compared with water labor group was medium ($d = 0.69$).
[e]Minor lacerations were defined as first- or second-degree perineal lacerations. Major lacerations were defined as third- or fourth-degree perineal lacerations. Other lacerations (not perineal) were defined as periurethral, clitoral, or labial lacerations.

in racial makeup ($P = .01$) as there were more black women in the neither group (n = 16 [14.4%]) than in the water labor group (n = 5 [8.2%]) and waterbirth group (n = 1 [1.7%]). Nulliparity also differed significantly across the 3 groups with the smallest number of nulliparous women in the waterbirth group (n = 16 [27.6%]) followed by the neither group (n = 45 [40.5%]) and the water labor group (n = 32 [52.5%]) ($P = .02$).

Table 2 shows the comparison across the 3 groups with respect to duration of labor and perineal integrity. For nulliparous women, those in the waterbirth group had the shortest duration of first and second stages of labor. The average duration of the first stage of labor was 505.9 minutes, compared with 767.7 minutes for women in the water labor group and 757.8 minutes for women in the neither group ($P = .13$). The differences were of medium effect sizes ($d = .61$ and .66, respectively). The average duration of the second stage of labor was 32.2 minutes for women in the waterbirth group, compared with 88.4 minutes for women in the water labor group and 79.7 minutes for women in the neither group ($P = .03$). The differences were of medium to large effect sizes ($d = 1.11$ and 0.79, respectively). Nulliparous women in the waterbirth group had a slightly longer third stage of labor (10.2 minutes) compared with women in the water labor (9.0 minutes) and neither groups (6.8 minutes) ($P = .09$).

For multiparous women, only the duration of the second stage of labor was different across groups ($F = 2.59$, $P = .08$) with medium effect size for women in the waterbirth versus water labor groups ($d = .69$). There was no difference in perineal integrity across the 3 groups for either nulliparous or multiparous women (Table 2).

Comparisons of other maternal outcomes across the 3 study groups are shown in Table 3. More women in the waterbirth group (n = 5 [8.6%]) experienced a postpartum hemorrhage compared to women in the water labor group (n = 3 [5.2%]) and neither group (n = 1 [0.9%]). Two women (3.4%) in the waterbirth group experienced shoulder dystocia, more than women in the water labor group (n = 0 [0.0%]) and neither group (n = 1 [0.9%]; OR, 3.79; 95% CI, 0.19-227.51). There were no differences in change of antepartum to postpartum hemoglobin ($F = .03$, $P = .97$) or hematocrit ($F = .34$, $P = .72$) values.

Of the women who discontinued hydrotherapy, the majority cited that they did not want to continue to labor in the tub (maternal choice, n = 26 [42.6%]) or because they desired pain medication (n = 18 [29.5%]). Other reasons for discontinuing hydrotherapy included nonreassuring fetal well-being (n = 8 [13.1%]), meconium (n = 4 [6.6%]), CNM decision (n = 4 [6.6%]), and augmentation of labor (n = 1 [1.6%]) (Table 3). Women in the waterbirth group experienced several complications during birth, including unplanned vaginal breech birth (n = 1 [1.7%]), shoulder dystocia (n = 2 [3.4%]), and cord avulsion (n = 1 [1.7%]), none of which resulted in adverse maternal or neonatal outcomes.

Overall, mean COMFORTS scale scores indicating maternal satisfaction were very high among the 3 groups of women, ranging from 184.6 to 186.6 out of a maximum score of 200. Scores on the COMFORTS scale were not significantly different between groups. Effect sizes were small for all the scales for between-group comparisons (the women in the waterbirth vs water labor, and women in the waterbirth vs neither). There were 16% to 23% missing data for maternal COMFORTS scales.

Outcomes for neonates born to women who gave birth in the tub were not significantly different than those born to

Table 3. Maternal Outcomes Among Study Groups

Maternal Outcome	Waterbirth (n = 58)	Water Labor (n = 61)	Neither (n = 111)	*P* Value[a]
Hemoglobin values, mean (SD), g/dL[b]				
AP hemoglobin	12.6 (1.1)	12.9 (3.4)	12.6 (2.5)	.771
PP hemoglobin	10.9 (1.3)	11.2 (3.3)	11.1 (3.3)	.854
Hemoglobin change (PP-AP)	−1.6 (0.9)	−1.6 (4.9)	−1.5 (4.0)	.971
Hematocrit values, mean (SD), %				
AP hematocrit	37.2 (2.9)	36.5 (4.9)	36.9 (3.8)	.655
PP hematocrit	32.6 (3.7)	31.2 (5.5)	31.8 (4.4)	.254
Hematocrit change	−4.7 (2.8)	−5.4 (5.9)	−5.1 (4.8)	.715
Hemorrhage, n (%)				.045
Yes	5 (8.6)	3 (5.2)	1 (0.9)	
No	53 (91.4)	55 (94.8)	107 (99.1)	
Shoulder dystocia, n (%)				.441
Yes	2 (3.4)	0 (0.0)	1 (0.9)	
No	56 (96.6)	58 (100.0)	107 (99.1)	
Cesarean birth, n (%)				.287
Yes	0 (0.0)	3 (4.9)	3 (2.7)	
No	58 (100.0)	58 (95.1)	108 (97.3)	
Reason hydrotherapy discontinued, n (%)				NA
Maternal choice	—	26 (42.6)	—	
Maternal request for pain medication	—	18 (29.5)	—	
Fetal distress	—	8 (13.1)	—	
Meconium	—	4 (6.6)	—	
CNM choice	—	4 (6.6)	—	
Augmentation of labor	—	1 (1.6)	—	

Abbreviations: —, participants in the Waterbirth and Neither groups did not discontinue hydrotherapy; AP, antepartum; NA, not applicable; PP, postpartum.
[a]The statistics were derived from analysis of variance for continuous outcomes (AP hemoglobin, PP hemoglobin, hemoglobin change, AP hematocrit, PP hematocrit, and hematocrit change) and exact chi-square tests for categorical outcomes (perineal integrity, hemorrhage, shoulder dystocia, and cesarean birth).
[b]Women who had a cesarean birth were excluded for the analyses on AP hemoglobin, PP hemoglobin, hemoglobin change, AP hematocrit, PP hematocrit, hematocrit change, hemorrhage, and shoulder dystocia, leaving n = 58, 58, and 108 for the waterbirth, water labor, and neither groups.

women who only labored in the tub or did not use the tub for labor (Table 4). No neonates had a 5-minute Apgar score lower than 7 or an umbilical artery blood gas pH lower than 7.0, reflecting uncomplicated extrauterine transition. Two neonates experienced cord avulsion, one in the waterbirth group and one in the neither group. Additionally, there were one neonate with sepsis diagnosed by the pediatric team in a neonate born to a woman in the water labor group and 3 neonates administered IV antibiotic (2 in the water labor group and one in the neither group). No neonates in the waterbirth group were diagnosed with sepsis or received IV antibiotics. Overall, the incidence rates of cord avulsion, neonatal sepsis, and neonatal IV antibiotic administration were low and not significantly different across groups ($\chi^2 = 1.03$, $P = .74$ for cord avulsion; $\chi^2 = 2.78$, $P = .52$ for neonatal sepsis; and $\chi^2 = 2.75$, $P = .44$ for neonatal IV antibiotic administration).

DISCUSSION

Key results from this study show that women who had a waterbirth had a shorter second stage of labor, satisfaction on par with women in the other study groups, no difference in perineal lacerations, and a higher incidence of postpartum hemorrhage and shoulder dystocia. There was no increase in adverse neonatal outcomes related to mode of birth. One neonate in the waterbirth group experienced cord avulsion, in addition to one neonate in the neither group.

Consistent with the results of previous research, multiparous women were more likely to have a waterbirth.[2,5,35] Additionally, factors prompting discontinuation of water immersion during labor were consistent with those reported by others, identifying maternal choice as the primary reason followed by reasons related to health indications.[5,35]

As found in other studies,[5,11,15,18,20] the duration of the second stage of labor was shorter in the waterbirth group. In this study, only the difference in duration of the second stage of labor among nulliparous women reached significance. There were no significant differences in duration of other stages of labor, regardless of parity, although nulliparous women in the waterbirth group tended to have a shorter first stage of labor and a longer third stage of labor.

Contrary to prior research,[2,11–18,21,22] there was no difference in the type or severity of perineal lacerations. Additionally, although the increase in maternal satisfaction previously

Table 4. Newborn Outcomes by Study Groups[a]

Newborn Outcome	Waterbirth (n = 58)	Water Labor (n = 61)	Neither (n = 111)	*P* Value
Birth weight, mean (SD), g[b]	3570 (444.9)	3458 (512.9)	3487 (468.1)	.41
5-min Apgar score, n (%)				NE
<7	0 (0.0)	0 (0.0)	0 (0.0)	
≥7	58 (100.0)	61 (100.0)	111 (100.0)	
Umbilical artery cord blood gas, n (%), pH[c]				NE
<7.0	0 (0.0)	0 (0.0)	0 (0.0)	
≥7.0	18 (100.0)	19 (100.0)	33 (100.0)	
Cord avulsion, n (%)				.74
Yes	1 (1.7)	0 (0.0)	1 (0.9)	
No	57 (98.3)	61 (100.0)	110 (99.1)	
Neonatal sepsis, n (%)				.52
Yes	0 (0.0)	1 (1.6)	0 (0.0)	
No	58 (100.0)	60 (98.4)	111 (100.0)	
Neonatal IV antibiotic administration, n (%)				.44
Yes	0 (0.0)	2 (3.3)	1 (0.9)	
No	58 (100.0)	69 (96.7)	110 (99.1)	

Abbreviations: IV, intravenous; NE, not estimable.
[a]The statistics were derived from analysis of variance for continuous outcomes (birth weight, Apgar score, arterial cord gas) and exact chi-square tests for categorical outcomes (cord avulsion, neonatal sepsis, neonatal IV antibiotic administration).
[b]The analyses were based on participants with available data. The number of participants with available birth weight data in the waterbirth, water labor, and neither groups were n = 57, 61, 111.
[c]The analysis were based on participants with available arterial cord gas data in the waterbirth, water labor, and neither groups were n = 18, 19, 33 (62%-70% missing data).

demonstrated[12,15,23] among women who had a waterbirth was not found in this study, women in all groups reported high levels of satisfaction. Because all the women in this study were given the option to use the tub, it is possible that it is the option of waterbirth that provides increased satisfaction, rather than the waterbirth itself. This may explain why satisfaction with the labor and birth process was similar among women in all groups.

The complicated births in the waterbirth group are a point of concern. Regardless of parity, more women in the waterbirth group had a postpartum hemorrhage The higher rate of postpartum hemorrhage did not have a significant clinical effect on outcomes for women in this study, as there were no instances of blood transfusion for women in the waterbirth group and there were no differences between study groups in antepartum and postpartum hemoglobin or hematocrit indices. It is important to consider that the amount of blood loss was a visual estimate on the part of the attending CNM, rather than a quantitative value. This estimate can be confounded by some of the blood loss after birth taking place in the tub. Additionally, the practice of asking women to leave the tub and move to the bed for birth of the placenta may have increased postpartum blood loss, as it may have lengthened the third stage, representing an area for future research to explore.

Outcomes for neonates in this study are similar to those reported in other studies to date.[11–19,21,22,29,30] Waterbirth was not associated with an increased risk of lower 5-minute Apgar scores, lower arterial cord gases, neonatal intensive care unit admission, neonatal sepsis, neonatal IV antibiotic administration, neonate rehospitalization in the first 6 weeks of life, or cord avulsion. The current study was not large enough to detect statistically significant differences for rare outcome measures.

One instance of cord avulsion occurred in the waterbirth group. Other studies have also reported findings of cord avulsion during a waterbirth,[2,12,19,25] and one case study reported a cord avulsion that led to neonatal hemorrhage.[24] It is important to note that there was also one instance of cord avulsion in the neither group in the current study; thus it is not clear from this study if there is a relationship between waterbirth and risk of cord avulsion. In addition, there were more shoulder dystocias in the women in the waterbirth group, compared with the women in the water labor or neither groups. It is difficult to determine if the waterbirth itself was related to the difference seen in shoulder dystocia, as many other factors, such as parity and maternal position during birth, are possible contributors and were not controlled for in this study. Regardless, instances of cord avulsion and shoulder dystocia were managed without adverse maternal or neonatal outcomes. This finding reinforces the importance of having adequately trained perinatal care providers to attend births in all settings;[25] however, more research is needed on the incidence of these rare outcomes during waterbirth.

Limitations

This study has a small sample size, and as such, is not adequately powered to detect statistical significance. In addition, the observational design precludes controlling for selection bias. This self-selection may have made this population

different in some ways from a typical US population of birthing women. Additionally, this sample included a highly educated, well-insured, white population, limiting generalizability to other demographic groups. Because of the fact that women in this midwifery practice were only offered the option for waterbirth if they were enrolled in the study, there is potential for coercion.

Although all the women in the study were classified as low risk upon admission in labor, not all of them maintained low-risk status during labor. It should be noted that women were included in the study who met the inclusion criteria on admission but developed a higher level of risk after admission (use of epidural analgesia or opioid analgesia, meconium-stained amniotic fluid, maternal infection or suspected infection, category II or III fetal heart rate pattern). These women were then included in the water labor group or the neither group, depending on their use of the tub prior to the higher level of risk being noted. Consequently, change in risk status represents a reason for the discontinuation of immersion in water during labor. It is possible that indications for leaving the tub may have affected some of the outcomes, as women in the water labor group may have become at higher risk during labor but were still included in a comparison group.

It was clinically challenging for the midwives to obtain umbilical cord gases, as many women opted for delayed cord clamping and samples could not be obtained. Therefore, a large amount of data was missing (62%-70%) for arterial umbilical blood gas data. In addition, there were missing data (16%-23%) for COMFORTS scales. Caution is needed when interpreting results regarding umbilical cord gases and COMFORTS scores.

Lastly, the study does not have adequate power for subgroup analysis (eg, nulliparity) to examine the heterogeneity of treatment effect. This is indicated by the stratified analysis of duration of stage of labor by nulliparity. Although medium effect sizes were noted for the duration of the first and third stages of labor for nulliparous women in the waterbirth versus neither group, the differences failed to reach statistical significance. The study also lacks power to detect between-group difference for rare adverse outcomes. For example, the overall incidence of shoulder dystocia was low (<4%). Although the incidence of shoulder dystocia was higher among women in the waterbirth group than in the neither group, the difference failed to reach statistical significance, and the OR estimate had a wide CI. Nevertheless, the effect sizes established in this study will provide valuable information to guide sample size for future large-scale studies.

CONCLUSION

This study adds to the evidence on the risks and benefits of waterbirth for women and neonates and speaks to the importance of adequate training of perinatal care providers to attend births in all settings. More research is needed on the specific outcomes of shoulder dystocia, postpartum hemorrhage, and cord avulsion during waterbirth. Overall, these findings are consistent with the literature to date and suggest that waterbirth is a reasonable option for low-risk women and their neonates when giving birth with qualified perinatal care providers in US hospital settings.

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

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Appendix 1: Hydrotherapy for Labor Guidelines

Hydrotherapy for Labor Guidelines

Women who are at full-term gestation may use hydrotherapy for the first stage of labor.

Consent will be signed prior to hydrotherapy for the first stage of labor.

Maternal vital signs must be stable, and fetal tracing must be category I prior to hydrotherapy.

The woman must be evaluated by the perinatal care provider prior to entering the hydrotherapy tub.

The perinatal care provider must be on site while the woman is in the hydrotherapy tub.

The woman must be attended while in the hydrotherapy tub.

Family members and support persons are not permitted in the hydrotherapy tub.

If meconium-stained fluid is noted in the hydrotherapy tub, the woman should be removed from tub, a continuous external monitor applied, and the woman reevaluated by the perinatal care provider prior to returning to hydrotherapy tub.

Vaginal examinations may be done in the water, in the bed, or standing.

Contraindications include the following:

- Untreated communicable infections (blood or skin), eg, HIV-positive status; vaginal, urinary tract, or skin infection
- Maternal fever higher than 38°C (100.4°F) or suspected maternal infection
- Active genital herpes
- History of previous cesarean birth
- Lack of category I fetal heart rate tracing
- Excessive vaginal bleeding
- Meconium-stained amniotic fluid
- Narcotic analgesia less than 6 hours prior to entering hydrotherapy tub
- Any condition that requires continuous fetal monitoring