Journal of Midwifery & Women's Health www.jmwh.org
Research Article

Factors Associated With Normal Physiologic Birth for Women Who Labor In Water: A Secondary Analysis of A Prospective Observational Study

Jane Carpenter[1], RM, DPhil, MRes, MSc, Ethel Burns[1], RM, PhD, Lesley Smith[2], PhD

Introduction: Research to understand factors associated with *normal physiologic birth* (unassisted vaginal birth, spontaneous labor onset without epidural analgesia, spinal, or general anesthetic, without episiotomy) is required. Laboring and/or giving birth in water has been shown to be associated with a high proportion of physiologic birth but with little understanding of factors that may influence this outcome. This study explored factors associated with normal physiologic birth for women who labored in water.

Methods: We conducted a secondary analysis of a UK-based prospective observational study of 8064 women at low risk of childbirth complications who labored in water. Consecutive women were recruited from birth settings in England, Scotland, and Northern Ireland. Planned place of birth, maternal characteristics, intrapartum events, and maternal and neonatal outcomes were measured. Univariable and multivariable logistic regression modelling explored factors associated with normal physiologic birth.

Results: In total, 5758 (71.4%) of women who labored in water had a normal physiologic birth. Planned birth in the community (adjusted odds ratio [aOR], 2.58; 95% CI, 2.22-2.99) or at an alongside midwifery unit (aOR, 1.21; 95% CI, 1.04-1.41) was positively associated with normal physiologic birth compared with planned birth in an obstetric unit. Duration of second stage (aOR, 0.66; 95% CI, 0.62-0.70), duration in the pool [aOR, 0.93; 95% CI, 0.90-0.96), and birth weight of the neonate (aOR, 0.74; 95% CI, 0.65-0.85) were negatively associated with normal physiologic birth. Parity was not associated with normal physiologic birth in multivariate analyses.

Discussion: Our findings largely reflected wider research, both in and out of water. We found midwifery-led birth settings may increase the likelihood of normal physiologic birth among healthy women who labor in water, irrespective of parity. This association supports growing evidence demonstrating the importance of planned place of birth on reducing intervention rates and adds to research on labor and birth in water.
J Midwifery Womens Health 2022;00:1–8

Keywords: birth setting, birthing pool, intrapartum, midwifery-led care, normality, water immersion, waterbirth

INTRODUCTION

There is an increasing global commitment to respect the physiology of childbirth and adopt strategies to facilitate it,[1–3] including growing interest in ways to enhance physiologic birth, generally defined in research and health policy literature as a birth with no, or limited, clinical intervention.[4] Promoting physiologic birth aims to reduce the routine use of technology and interventions to manage pregnancy and childbirth, which is a global cause for concern.[1,5]

The use of water immersion during labor and birth has been widely purported to support physiologic birth.[6–11] Laboring in water has been shown to provide a woman-centered, low-tech experience,[7–12] optimize physiology and relaxation, reduce pain, and increase maternal satisfaction with the birth experience.[6,12–15] Furthermore, studies demonstrate high levels of spontaneous vaginal birth,[10,12] and physiologic birth,[6,12] for healthy pregnant women, particularly in midwifery-led settings. However, it remains the case that not all women who labor in water have a physiologic birth, although at the onset of labor these women will usually be considered at low risk of obstetric complications. This raises the question of why such women do not go on to have a physiologic birth. This is important to understand; if factors are identified that are modifiable, it may be possible to enhance outcomes.

Monitoring physiologic birth rates, however, has been complicated by differing definitions[16–18] and irregular reporting of physiologic birth statistics.[19] In 2008, the Maternity Care Working Party (a panel of experts reporting to the UK government on maternity) produced a definition of *normal birth* as an unassisted vaginal birth with spontaneous onset of labor; without epidural analgesia, spinal, or general anesthetic; and without episiotomy.[20] This definition sought to remain focused on the process of childbirth, unlike some other definitions that also include outcomes.[16,18] Including outcomes that occur after birth is less useful when investigating factors which may influence physiologic birth, as such outcomes may not be related to the birth process.[4] The Maternity Care Working Party *normal birth* definition has been adopted in the research literature both when reporting rates,[4,12,19,21] and factors associated with it.[4,19] This definition is also used in the UK's National Maternity and Perinatal Audit (NMPA), which audits and regularly reports on the National Health Service maternity services across England, Scotland and

[1]Oxford School of Nursing and Midwifery, Oxford Brookes University, Oxford, United Kingdom
[2]Faculty of Health Sciences, Hull University, Hull, United Kingdom

Correspondence
Jane Carpenter
Email: jane.carpenter@brookes.ac.uk

ORCID
Jane Carpenter https://orcid.org/0000-0002-7846-2489

1526-9523/09/$36.00 doi:10.1111/jmwh.13315

Quick Points

- There is currently limited research investigating factors associated with physiologic birth, despite current international interest in reducing unnecessary intervention
- This study examined factors associated with physiologic birth for women with a healthy pregnancy who labor in water
- Choosing community and midwifery-led birth settings for women who labored in water was associated with higher likelihood of physiologic birth.
- Parity was not associated with physiologic birth. Instead, duration of second stage, a modifiable variable, was negatively associated with physiologic birth.

Wales.[22] However, the use of the phrase *normal birth* is no longer considered appropriate by many. This has led to the NMPA referring to the outcome as *birth without intervention* and the use of the term physiologic or *physiologic birth* to be used in preference to normal birth in the research literature. Therefore, in this study, we use the phrase *normal physiologic birth* when we are referring to the Maternity Care Working Party definition of *normal birth,* and *physiologic birth* when we are referring to the general concept of labor and birth that occurs without intervention.

Research that has the explicit aim of identifying factors that influence normal physiologic birth remains limited to 2 cross-sectional studies.[4,19] These studies, both from Australia, included a total of 6612 women and used self-reported questionnaires to investigate factors that influenced whether women had a normal physiologic birth. They found normal physiologic birth to be associated with giving birth outside regular business hours, intrapartum continuity of care, mobility in labor, nonsupine birth positions, and labor without continuous fetal monitoring or augmentation.[4,19] In addition, the Birthplace in England study, a national prospective cohort study,[21] found that the rate of normal physiologic birth for women who were at low risk of complications differed depending on the place in which they were giving birth, with normal physiologic birth more likely at freestanding midwifery units or home than obstetric units.

Considering features associated with physiologic birth more generally, factors that potentially increase the incidence of physiologic birth or spontaneous vaginal birth include continuous support during labor and birth[23] and access to midwifery-led continuity models of care.[24] The latter Cochrane Review also found an increase in rates of intervention for women not receiving midwifery-led continuity models of care.[24] Other research on rates of intervention has shown a potential increase in intervention for women who gave birth in Germany who had less midwife involvement in birth,[25] gave birth during business hours,[25] and received continuous electronic fetal monitoring during labor.[26]

There is limited research explicitly investigating factors influencing physiologic birth during water immersion.[6] However, Shaw-Battista et al, in their systematic review, found that water immersion reduced the likelihood of intervention, provided pain relief, reduced maternal anxiety, and reduced fetal malpresentation while supporting greater mobility in labor.[6] All of these factors facilitate physiologic birth. However, further research to investigate factors influencing physiologic birth is certainly indicated and yet currently lacking.[6] The aim of this study, therefore, was to identify potential factors associated with normal physiologic birth, as defined by the Maternity Care Working Party,[20] for healthy pregnant women at low risk of obstetric childbirth complications who labored in water.

METHODS

Study Design

This was a secondary analysis of data collected during a prospective observational study.[12] The purpose of the parent study was to describe and compare the characteristics, interventions, and maternal and neonatal outcomes by planned place of birth for pregnant women who used a birthing pool. Research ethics approval to conduct the original study was sought and obtained from the host university.[12] Full methods for the original study can be found in the publication.[12] Methods relevant to this secondary analysis are reported here.

Study Setting and Participants

Data were prospectively collected for 8924 women who entered a birthing pool at some point during labor and birth. Twenty-six National Health Service Hospital Trusts provided data collected between 2000 and 2008. Birthing pool dimensions were ascertained to ensure that they were sufficiently large to enable a woman to adopt a range of different positions.

Three care settings contributed data to the study: (1) obstetric units, where care is obstetrician-led, supported by midwives and with anesthetic support available; (2) alongside midwifery units, where care is midwife-led, without obstetric or anesthetic care, but the unit is situated in the same hospital or site as an obstetric unit; and (3) community, which comprised both freestanding midwifery units, without adjacent access to obstetric or anesthetic care, and midwife-attended homebirths. These last 2 settings were combined into one variable as the care model is similar, and a sensitivity analysis performed in the original study showed no differences in perinatal outcomes between freestanding midwifery units alone and when merged with home.

Any woman who entered the birthing pool during labor in one of the participating centers was included in the original

study. To be eligible for birthing pool use in the United Kingdom, it is usually recommended that women have a low-risk obstetric profile. This profile is defined as an uncomplicated pregnancy, singleton fetus in a cephalic presentation, labor at 37 weeks' or more gestation, and no preexisting disease that may affect a woman's risk of adverse outcome during labor.[12] This requirement has not changed since the period of data collection for this study. Thirty-nine women were excluded from the current study (20 previous cesarean birth, 19 who had a breech presentation) because they did not meet these criteria.

Data Collection

Using a data proforma, data were collected for consecutive women who entered the birthing pool for any duration of time, reducing the risk of recording bias. It was recorded whether each woman used the birthing pool for labor only (labor in water) or used the birthing pool during labor *and* for birth (waterbirth). The date, specific birthing center, and planned place of birth (obstetric unit, alongside midwifery unit, or community) were recorded for each woman. In the original study, data were collected on maternal characteristics, time spent in the pool, intrapartum events, and a wide range of maternal (eg, mode of birth, place of birth, perineal trauma, mode of placental birth, estimated blood loss, infection, readmission to hospital) and neonatal (eg, Apgar scores at 5 and 10 minutes, admission to neonatal intensive care unit, infection) outcomes up to 7 days postpartum.

A link person at each study center liaised with the study coordinator and compiled data. An initial pilot phase ensured any issues or inconsistencies with data recording were addressed early on in the study period. The link person entered the deidentified data onto a Microsoft Excel spreadsheet. The Excel file was checked for accuracy by the study coordinator.

Data Analysis

Data were imported into IBM SPSS version 26.0 statistical software (Armonk, NY) for analysis. Only complete data for the included variables were used. Summary descriptive statistics were calculated using appropriate measures of central tendency (mean, median) and dispersion (SD, range) for continuous data and number and percentage for categorical data.

A variable was selected for inclusion in the model if it was clinically plausible, according to best available evidence, for it to influence the likelihood of normal physiologic birth. Variables included in the analysis were as follows: Year of data collection was included to account for the possibility of a change in water immersion practice over the 8 years of data collection, affecting the normal physiologic birth rate. Categorical predictor variables were parity (nulliparous vs multiparous), planned place of birth (obstetric unit, alongside midwifery unit, community), augmentation with intravenous oxytocin infusion (yes or no), analgesia (no analgesia, opioid analgesia, or nonopioid analgesia), maternal age categorized as younger than 25 years, 25 to 34 years, and 35 years of age or older. Continuous variables included were total duration of time in the pool (completed hours), duration of the second stage of labor (completed hours), and birth weight of the neonate (grams). Waterbirth (yes or no) was included as a variable as a potential confounding factor. By having a waterbirth, most requirements for normal physiologic birth are automatically met, but waterbirth is also associated with other predictor variables (eg, birth in a midwifery-led setting compared to an obstetric unit).

First, univariable logistic regression analyses were run with *normal physiologic birth* as the response variable; then, all potential predictor variables were added to a multivariable model using the ENTER method. For each variable, the normative category was chosen as the reference category. For maternal age, the middle category of 25 to 34 years old was chosen as the reference, as this is considered the optimal age range for childbearing.[27,28] A P value less than .05 was considered to be statistically significant. The likelihood of explanatory variables being associated with normal physiologic birth is presented using odds ratios (ORs) and 95% CIs. All logistic regression model assumptions,[29] were met.

RESULTS

Detailed descriptive characteristics were published in the original study.[12] Summary descriptive statistics for the sample included in the current study are shown in Table 1. Summary descriptive statistics for the 39 women who were removed from analyses because they did not meet eligibility criteria can be found in the Supporting Information: Table S1. There are few published data on water immersion for such women to date, therefore inclusion of this information was considered important.

After removing women who did not meet eligibility criteria (n = 39) and had incomplete data (n = 821), the final sample size was 8064, compared with 8924 in the original study. Overall, of the 8064 women included, 5758 (71.4%) had a normal physiologic birth, and 2306 did not. Reasons for not having a normal physiologic birth included having an epidural analgesia (n = 1696), episiotomy (n = 734), operative vaginal birth (n = 560), a cesarean birth (n = 119), or induction of labor (n = 181). Sixty-two percent of the 4360 nulliparous women and 82.1% of the 3704 multiparous women had a normal physiologic birth (Table 2).

Univariable Analyses

Results of the univariable analyses are presented in Table 2. Eleven variables were tested for a potential association with normal physiologic birth. Multiparity, planned place of birth in an alongside midwifery unit or community setting, birth in water, and age over 35 years were associated with an increased likelihood of physiologic birth. There was a trend for increased likelihood of physiologic birth over time from 2000 to 2008. Augmentation with oxytocin, use of opioid or nonopioid analgesia, and age under 25 years were associated with a reduced likelihood of physiologic birth. Longer duration of time in the pool, duration of second stage, and heavier birth weight of the neonate reduced the likelihood of physiologic birth.

After adjustment for all other predictors via multivariable analysis, parity and maternal age over 35 years no longer showed significant association with physiologic birth. Given the recognized importance of parity as a determinant of

Table 1. Descriptive Characteristics Stratified by Normal Physiologic Birth

Characteristics	Analyzed, N	Normal Physiologic Birth[a]	
		Yes	No
Maternal age, n (%), y			
25-34	4803	3449 (59.9)	1354 (58.8)
<25	1791	1194 (20.7)	597 (25.9)
≥35	1470	1115 (19.4)	355 (15.4)
Gestational age, mean (SD), wk	8064	39.7 (1.1)	39.9 (1.1)
Parity, n (%)			
Nulliparous	4360	2716 (47.2)	1644 (69.2)
Multiparous	3704	3042 (52.8)	662 (30.9)
Planned place of birth, n (%)			
OU	3542	2304 (39.9)	1238 (53.7)
Community	2531	2083 (36.1)	448 (19.4)
AMU	1991	1371 (23.7)	620 (26.9)
Spontaneous vaginal birth, n (%)			
No	702	0 (0.0)	702 (30.5)
Yes	7362	5758 (100.0)	1604 (69.5)
Birth in water, n (%)			
No	3198	1505 (26.2)	1693 (73.4)
Yes	4866	4253 (73.8)	613 (26.6)
Augmentation with (oxytocin), n (%)			
No	7857	5734 (99.8)	2123 (92.1)
Yes	207	24 (0.4)	183 (7.9)
Analgesia, n (%)			
None	1225	1020 (25.4)	205 (5.1)
Nonopioid[b]	6779	4711 (74.0)	2068 (94.1)
Opioid	60	27 (0.7)	33 (0.8)
Duration in pool, median (IQR), h	8064	1.65 (1.8)	2 (2.3)
Duration second stage, mean (SD), h	8064	0.39 (0.62)	1.03 (1.8)
Newborn birth weight, mean (SD), g	8064	3528.9 (437.2)	3560.3 (440.1)

Abbreviations: AMU, alongside midwifery unit; OU, obstetric unit; Community, freestanding midwifery unit and home birth; IQR, interquartile range.
[a] Defined as an unassisted vaginal birth of spontaneous labor onset without epidural analgesia, spinal or general anesthetic, and without episiotomy.
[b] Included Transcutaneous Electrical Nerve Stimulation (TENS) machine and inhalational analgesia.

maternal outcome in other studies,[21,30–32] this result was investigated further. Exploratory analyses found that adding duration of second stage into the model caused parity to lose its significance. These 2 variables were therefore tested for an interaction by entering the interaction term into the model in SPSS, but none was found (Table 2).

There was a positive association between year of study and normal physiologic birth, with increased likelihood of normal physiologic birth over time (Table 2). Planning to give birth in community or at an alongside midwifery unit increased the odds of normal physiologic birth, as did having a waterbirth (Table 2). Oxytocin augmentation, use of opioid or nonopioid analgesia, and maternal age under 25 years were associated with a reduction in the odds of normal physiologic birth. Increasing duration of time spent in the pool and duration of the second stage reduced the likelihood of normal physiologic birth, as did increasing birth weight of the neonate (Table 2).

DISCUSSION

This study examined potential factors associated with normal physiologic birth (as per the Maternity Care Working Party definition): unassisted vaginal birth with spontaneous onset of labor; without epidural analgesia, spinal, or general anesthetic; and without episiotomy,[20] for women at low risk of childbirth complications who used a birthing pool during labor. As might be expected for this cohort of women, a high proportion (n = 5758, 71.4%) of women who labored in water had a normal physiologic birth. This is higher than the original target of 60% set by the Maternity Care Working Party.[20] It is also higher than the level reported in the Birthplace study,[21] which included a similar low-risk population but without a focus on water immersion and found 61.5% of 64,105 women had a normal physiologic birth. This may support the idea that water immersion is supportive of promoting normal physiologic birth, as found in the systematic review by

Table 2. Factors Associated with Normal Physiologic Birth for Women at Low Risk of Childbirth Complication Who Labored in Water

	Univariable		Multivariable	
Factors	**OR (95% CI)**	***P* Value**	**aOR (95% CI)**	***P* Value**
Year[a]	1.07 (1.04-1.11)	<.001	1.05 (1.00-1.09)	.03
Maternal age, y				
25-34	1.00		1.00	
<25	0.79 (0.70-0.88)	<.001	0.87 (0.76-0.99)	.05
35+	1.23 (1.08-1.41)	.002	1.07 (0.91-1.26)	.42
Parity				
Nulliparous	1.00		1.00	
Multiparous	2.78 (2.51-3.09)	<.001	1.10 (0.96-1.26)	.19
Planned place of birth				
OU	1.00		1.00	
Community	2.50 (2.21-2.83)	<.001	2.58 (2.22-2.99)	<.001
AMU	1.19 (1.06-1.33)	.004	1.21 (1.04-1.41)	.02
Birth in water				
No	1.00		1.00	
Yes	7.81 (7.00-8.71)	<.001	4.89 (4.31-5.53)	<.001
Augmentation with oxytocin				
No	1.00		1.00	
Yes	0.05 (0.03-0.08)	<.001	0.21 (0.14-0.34)	<.001
Analgesia				
None	1.00		1.00	
Nonopioid[b]	0.46 (0.39-0.54)	<.001	0.78 (0.65-0.94)	.008
Opioid	0.16 (0.10-0.28)	<.001	0.52 (0.29-0.95)	.03
Duration in pool, h[a]	0.87 (0.87-0.89)	<.001	0.93 (0.90-0.96)	<.001
Duration second stage, h[a]	0.45 (0.43-0.47)	<.001	0.66 (0.62-0.70)	<.001
Newborn birth weight, g[a]	0.85 (0.76-0.95)	.004	0.74 (0.65-0.85)	<.001
Interaction term: parity by length second stage	0.94 (0.80-1.11)	.46	1.14 (0.96-1.35)	.13

Abbreviations: AMU, alongside midwifery unit; OU, obstetric unit; Community, freestanding midwifery unit and home birth.
[a] Continuous variables.
[b] Included Transcutaneous Electrical Nerve Stimulation (TENS) machine and inhalational analgesia.

Shaw-Battista.[6] Comparison with the few other studies that report incidence of normal physiologic birth is made difficult by the inclusion of women with mixed levels of obstetric risk, leading to much lower levels of normal physiologic birth of 29.6% and 28.7%.[4,19]

Planned place of birth was associated with normal physiologic birth in this study. In the multivariable analysis, women who planned birth in an alongside midwifery unit or community setting were more likely to have a normal physiologic birth than those who planned birth in an obstetric unit. The likelihood was twice as high (adjusted OR [aOR], 2.58; 95% CI, 2.22-2.99) in community settings (freestanding midwifery unit or at home) compared with alongside midwifery units (aOR, 1.04; 95% CI, 1.04-1.41). This adds to a growing body of knowledge demonstrating the importance of birth place, and particularly the community, in supporting normal physiology and vaginal birth.[21,33,34]

Parity was not a significant predictor of normal physiologic birth in the multivariable model, despite univariable analysis showing multiparous women having strongly increased odds of normal physiologic birth. This was unexpected, as parity is often shown as an influential predictor of outcome for women.[21,33,34] Studies evaluating the effect of parity on perinatal outcomes often include populations of women in the hospital (obstetric unit) setting and/or women with mixed risk factors,[30,31] but this is not always the case.[21,32] Our study only included healthy women who labored in several different birth settings available in the United Kingdom. We found that the association between parity and normal physiologic birth was lost when duration of second stage was entered into the model, suggesting that this finding may be affected by the fact that multiparous women are more likely to have a shorter second stage. The reliability of measures of duration of labor have been questioned, however, because of the reliability of assessing the onset of the second stage.[35] Nonetheless, this finding is still interesting, as unlike parity, second stage duration is a modifiable variable, which appears to be more important in terms of achieving normal physiologic birth. It may be that a longer second stage was associated with more intervention, leading to this effect, suggesting

careful consideration before intervention is required.[2] Or, it may be that midwifery practices to encourage a shorter second stage could directly influence normal physiologic birth rates. One such practice might be encouraging the use of upright positions during labor, including the second stage. These have been cited as methods to shorten the second stage of labor[36,37] and have been found to be associated with normal physiologic birth in previous studies.[4,19] However, a Cochrane Review of trials undertaken in a hospital setting found no significant effect of maternal position on second stage duration and calls for a higher quality of study on the subject,[38] suggesting further research on the topic is needed. One might consider that augmentation of labor would also encourage a shorter duration of second stage, and thereby positively influence normal physiologic birth rates. However, in this study, augmentation using intravenous oxytocin infusion was actually associated with a reduction in the likelihood of normal physiologic birth. In addition, augmentation also brings associated risks,[39] and Gaudernack et al concluded that augmentation with oxytocin should be used with caution.[39]

It was important to explore any potential effect of time in our analyses, and indeed, we found a positive relationship between an increased incidence of normal physiologic birth over time (albeit weak). As this was only a period of 8 years, this may or may not reflect a long-term trend, but it is encouraging, and ongoing investigation is warranted. Such monitoring of long-term outcomes is important as a measure of quality improvement.[6] Indeed, this has led to the inclusion of normal physiologic birth as an outcome in the NMPA.[22]

Women who had a waterbirth were almost 5 times more likely to have a normal physiologic birth than women who exited the pool to birth on land. However, by virtue of having a waterbirth, most of the criteria for normal physiologic birth are met. Some women may have intended to have a waterbirth but then chose to exit the pool for reasons related to fetal and/or maternal well-being or a change of mind, biasing the results in favor of waterbirth and making further interpretation of this finding impossible. Recording "planned waterbirth," as suggested by Bovbjerg et al,[40] would have gone some way to address this concern. Waterbirth was included in the model, however, as a potential confounder.

Despite the recognized need to promote physiologic birth and reduce the incidence of unnecessary obstetric interventions, there is little published research investigating factors that may influence normal physiologic birth.[4,19,41] This may be partly due to the multiple definitions of physiologic birth making routine reporting difficult, and indeed, there is a greater body of research reporting on physiologic birth more generally, or individual components of it.

When comparing our results with wider research exploring factors influencing physiologic birth or its components, there is substantial overlap, even where those studies do not focus on water immersion. Such findings include a negative association between physiologic birth and augmentation of labor,[4,19] duration of second stage,[42] and neonatal birth weight[43,44] and a positive association with planning to give birth in a community setting or an alongside midwifery unit.[21,33,34,45] However, unlike other research,[21,30–32] we found no association between parity and normal physiologic birth in the multivariable model; instead, duration of second stage appeared to be a more important association. We also found a negative association with duration of time spent in the pool. It is difficult to fully understand the reason for this, but it may be due to longer labors being more likely to lead to intervention[42] or that such women entered the pool earlier, as there is limited and dated evidence that this may increase intervention.[47]

There is little comparable research available on factors influencing physiologic birth during water immersion.[6] Shaw-Battista et al found that water immersion reduced the likelihood of intervention, provided pain relief, reduced maternal anxiety, and reduced fetal malpresentation while supporting greater movement in labor.[6] Although not directly comparable, our findings certainly appear supportive of the findings reported in this study. Internationally, however, well-constructed prospective studies reporting intervention rates, physiologic birth rates, and birthing pool use, and factors influencing these, are certainly indicated.

The large sample size, prospective observational methodology, and inclusion of different settings across multiple sites in the current study means that this study makes a significant contribution to the evidence base on the use of water immersion during labor and/or birth. Furthermore, there are few studies investigating factors that may influence the likelihood of normal physiologic birth,[4,19] and we are not aware of any other studies investigating it across the range of birth settings for women who labored in water. There is also a lack of research on this topic related to physiologic birth more generally.[6] This study therefore adds to our understanding of factors influencing physiologic birth for women who labor in water.

Although there are strengths to the research design used, there are also limitations to any observational research design, particularly with respect to bias and confounding.[46] For example, although this was a prospective study, with careful consideration given to variables included, it is possible that variables were not included that would have influenced the results obtained, for example, continuity of care model, or accoucheur experience were not accounted for and could have had an impact on outcomes. In addition, although great effort was made to reduce errors during data collection and entry, the possibility of some recorder or transcriber error cannot be ruled out. For these reasons, the inability to infer causality from observational research is acknowledged. In addition, no comparator group (of women at low risk of complication who did not labor in water), is available for these data, which would have enabled direct comparison between the 2 groups, and as discussed above, obtaining data on planned waterbirth would have been beneficial. The data used in this secondary analysis are now more than 10 years old. Although birthing pool eligibility criteria have not changed over this period, and any women using the pool who did not fit these criteria were removed from the current analysis, this limitation should still be acknowledged.

The women included in this study were those considered to be at low risk of childbirth complication, and results will not be applicable to women with known obstetric or clinical complications. Some information that may have been valuable in the study was not collected, for example, on ethnicity and body mass index (BMI) status. Therefore, we do not know how the results vary by ethnicity or BMI.

CONCLUSION

There is currently limited research exploring factors associated with physiologic birth for women with a straightforward pregnancy who labor in water. There is increasing evidence that for such women, both in and out of water, planning to birth in a community setting or an alongside midwifery unit, rather than an obstetric unit, may increase the likelihood of normal physiologic birth. Our study found that duration of second stage and duration of time in the pool were both negatively associated with likelihood of normal physiologic birth. However, further research is warranted to examine these relationships further. Careful monitoring of long-term trends of normal physiologic birth rates over time, including those in birthing pools, nationally and internationally, should be undertaken. This is particularly important given the current drive to reduce unnecessary intervention in childbirth and may enable better understanding of the efficacy of any changes to practice implemented with the aim of reducing intervention and increasing physiologic birth.

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Selected Characteristics of Women Who Used a Birthing Pool During Labor but Were Excluded from Analysis Because of Not Meeting Usual Birthing Pool Access Criteria

REFERENCES

1. Renfrew MJ, McFadden A, Bastos MH, et al. Midwifery and quality care: findings from a new evidence-informed framework for maternal and newborn care. *Lancet*. 2014;384(9948):1129-1145. https://doi.org/10.1016/S0140-6736(14)60789-3
2. Lothian JA. Healthy birth practice #4: avoid interventions unless they are medically necessary. *J Perinat Educ*. 2014;23(4):198-206.
3. Amis D. Healthy birth practice #1: let labor begin on its own. *J Perinat Educ*. 2019;28(2):68-80.
4. Prosser SJ, Barnett AG, Miller YD. Factors promoting or inhibiting normal birth. *BMC Pregnancy Childbirth*. 2018;18(1):241. https://doi.org/10.1186/s12884-018-1871-5
5. Renfrew MJ, Homer CSE, Downe S, et al. *Midwifery: An Executive Summary for The Lancet's Series*. Lancet; June 2014.
6. Shaw-Battista J. Systematic review of hydrotherapy research: does a warm bath in labor promote normal physiologic childbirth? *J Perinat Neonatal Nurs*. 2017;31(4):303-316. https://doi.org/10.1097/JPN.0000000000000260.
7. Nutter E, Meyer S, Shaw-Battista J, Marowitz A. Waterbirth: an integrative analysis of peer-reviewed literature. *J Midwifery Womens Health*. 2014;59(3):286-319. https://doi.org/10.1111/jmwh.12194.
8. Camargo JCS, Varela V, Ferreira FM, et al. The Waterbirth Project: São Bernardo Hospital experience. *Women Birth*. 2018;31(5):e325-e333.
9. Menakaya U, Albayati S, Vella E, Fenwick J, Angstetra D. A retrospective comparison of water birth and conventional vaginal birth among women deemed to be low risk in a secondary level hospital in Australia. *Women Birth*. 2013;26(2):114-118. https://doi.org/10.1016/j.wombi.2012.10.002
10. Maude RM, Kim M. Getting into the water: a prospective observational study of water immersion for labour and birth at a New Zealand District Health Board. *BMC Pregnancy Childbirth*. 2020;20(1):312. https://doi.org/10.1186/s12884-020-03007-6
11. Liu Y, Liu Y, Huang X et al. A comparison of maternal and neonatal outcomes between water immersion during labour and conventional labour and delivery. *BMC Pregnancy Childbirth*. 2014;14:160. https://doi.org/10.1186/1471-2393-14-160
12. Burns EE, Boulton MG, Cluett E, Cornelius VR, Smith LA. Characteristics, interventions, and outcomes of women who used a birthing pool: a prospective observational study. *Birth*. 2012;39(3):192-202. https://doi.org/10.1111/j.1523-536X.2012.00548.x
13. Cluett ER, Burns E, Cuthbert A. Immersion in water during labour and birth. *Cochrane Database Syst Rev*. 2018;5(5):CD000111. https://doi.org/10.1002/14651858.CD000111.pub4.
14. Otigbah C, Dhanjal MK, Harsworth G, Chard T. A retrospective comparison of water births and conventional vaginal deliveries. *Eur J Obstet Gynecol Reprod Biol*. 2000;91(1):15-20. https://doi.org/10.1016/s0301-2115(99)00238-9
15. Feeley C, Cooper M, Burns E. A systematic meta-thematic synthesis to examine the views and experiences of women following water immersion during labour and waterbirth. *J Adv Nurs*. 2021;77(7):2942-2956. https://doi.org/10.1111/jan.14720
16. American College of Nurse-Midwives; Midwives Alliance of North America; National Association of Certified Professional Midwives. Supporting healthy and normal physiologic childbirth: a consensus statement by the American College of Nurse-Midwives, Midwives Alliance of North America, and the National Association of Certified Professional Midwives. *J Midwifery Womens Health*. 2012;57(5):529-532. 11.
17. Queensland Clinical Guidelines. *Normal Birth*. Queensland Government; 2017. Accessed November 29, 2021. https://www.health.qld.gov.au/__data/assets/pdf_file/0014/142007/g-normalbirth.pdf
18. Society of Obstetricians and Gynaecologists of Canada et al. Joint policy statement on normal childbirth. *J Obstet Gynaecol Can*. 2008;30(12):1163-1165.
19. Miller YD, Prosser SJ, Thompson R. Back to normal: a retrospective, cross-sectional study of the multi-factorial determinants of normal birth in Queensland, Australia. *Midwifery*. 2015;31(8):818-827. https://doi.org/10.1016/j.midw.2015.04.005
20. Maternity Care Working Party. *Making Normal Birth a Reality: Consensus Statement from the Maternity Care Working Party*. National Childbirth Trust; Royal College of Midwives; Royal College of Obstetricians and Gynaecologists; 2007. Accessed November 29, 2021. http://bhpelopartonormal.pbh.gov.br/estudos_cientificos/arquivos/normal_birth_consensus.pdf
21. Birthplace in England Collaborative Group; Brocklehurst P, Hardy P, Hollowell J, et al. Perinatal and maternal outcomes by planned place of birth for healthy women with low risk pregnancies: the Birthplace in England National Prospective Cohort study. *BMJ*. 2011;343:d7400. https://doi.org/10.1136/bmj.d7400
22. NMPA Project Team. National Maternity and Perinatal Audit: Clinical Report 2019: Based on Births in NHS Maternity Services between 1 April 2016 and 31 March 2017. Royal College of Obstetricians and Gynaecologists; 2019. Accessed September 11, 2021. https://maternityaudit.org.uk/filesUploaded/NMPA%20Clinical%20Report%202019.pdf
23. Bohren MA, Hofmeyr GJ, Sakala C, Fukuzawa RK, Cuthbert A. Continuous support for women during childbirth. *Cochrane Database Syst Rev*. 2017;7(7):CD003766. https://doi.org/10.1002/14651858.CD003766.pub6
24. Sandall J, Saltani H, Gates S, Shennan A, Devane D. Midwife-led continuity models versus other models of care for childbearing women. *Cochrane Database Syst Rev*. 2015;15(9):CD004667. https://doi.org/10.1002/14651858.CD004667.pub5
25. Lerchl A. Where are the Sunday babies? III. Caesarean sections, decreased weekend births, and midwife involvement in Germany. *Naturwissenschaften*. 2008;95(2):165-170.
26. Alfirevic Z, Devane D, Gyte GML, Cuthbert A. Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour. *Cochrane Database Syst Rev*.

2017;2(2):CD006066. https://doi.org/10.1002/14651858.CD006066.pub3
27. Bloomberg M, Birch Tyrberg R, Kjølhede P. Impact of maternal age on obstetric and neonatal outcome with emphasis on primiparous adolescents and older women: a Swedish Medical Birth Register Study. *BMJ Open*. 2014;4(11):e005840. https://doi.org/10.1136/bmjopen-2014-005840
28. Cleary-Goldman J, Malone FD, Vidaver J, et al. Impact of maternal age on obstetric outcome. *Obstet Gynecol*. 2005;105(5 Pt 1):983-990. https://doi.org/10.1097/01.AOG.0000158118.75532.51
29. Stoltzfus JC. Logistic regression: a brief primer. *Acad Emerg Med*. 2011;18(10):1099-1104.
30. Kalogiannidis I, Margioula-Siarkou C, Petousis S et al. Parity affects pregnancy outcomes in women 35 and older. *Clin Exp Obstet Gynecol*. 2011;38(2):146-149.
31. Boudet-Berquier J, Salanave B, Desenclos JC, Castetborn K. Sociodemographic factors and pregnancy outcomes associated with prepregnancy obesity: effect modification of parity in the nationwide Epifane birth-cohort. *BMC Pregnancy Childbirth*. 2017;17(1):273. https://doi.org/10.1186/s12884-017-1456-8
32. Hollowell J, Pillas D, Rowe R, Linsell L, Knight M, Brocklehurst P. The impact of maternal obesity on intrapartum outcomes in otherwise low risk women: secondary analysis of the Birthplace national prospective cohort study. *BJOG*. 2014;121:343-355. https://doi.org/10.1111/1471-0528.12437
33. Janssen PA, Saxell L, Page LA, Klein MC, Liston RM, Lee SK. Outcomes of planned home birth with registered midwife versus planned hospital birth with midwife or physician *CMAJ*. 2009;181(6-7):377-383. https://doi.org/10.1503/cmaj.081869
34. Scarf VL, Rossiter C, Vedam S, et al. Maternal and perinatal outcomes by planned place of birth among women with low-risk pregnancies in high-income countries: a systematic review and meta-analysis. *Midwifery* 2018;62:240-255. https://doi.org/10.1016/j.midw.2018.03.024
35. Walker KF, Kibuka M, Thornton JG, Jones NW. Maternal position in the second stage of labour for women with epidural anaesthesia. *Cochrane Database Syst Rev*. 2018;11(11):CD008070. https://doi.org/10.1002/14651858.CD008070.pub4
36. Kopas ML. A review of evidence-based practices for management of the second stage of labor. *J Midwifery Womens Health*. 2014;59(3):264-276. https://doi.org/10.1111/jmwh.12199
37. Moraloglu O, Kansu-Celik H, Tasci Y, et al. The influence of different maternal pushing positions on birth outcomes at the second stage of labor in nulliparous women. *J Matern Fetal Neonatal Med*. 2017;30(2):245-249. https://doi.org/10.3109/14767058.2016.1169525
38. Gupta JK, Sood A, Hofmeyr GJ, Vogel JP. Position in the second stage of labour for women without epidural anaesthesia. *Cochrane Database Syst Rev* 2017;5(5):CD002006. https://doi.org/10.1002/14651858.CD002006.pub4
39. Gaudernack LC, Frøslie KF, Michelsen TM, et al. De-medicalization of birth by reducing the use of oxytocin for augmentation among first-time mothers – a prospective intervention study. *BMC Pregnancy Childbirth*. 2008;18(1):76. https://doi.org/10.1186/s12884-018-1706-4
40. Bovbjerg ML, Cheyney M, Everson C. Maternal and neonatal outcomes following waterbirth: the Midwives Alliance of North America Statistics Project, 2004 to 2009 cohort. *J Midwifery Womens Health*. 2016;61(1):11-20. https://doi.org/10.1111/jmwh.12394
41. Jepsen P, Johnsen SP, Gillman MW, Sørensen HT. Interpretation of observational studies. *Heart*. 2004;90:956-960.
42. Romano AM, Lothian JA. Promoting, protecting, and supporting normal birth: a look at the evidence. *J Obstet Gynecol Neonatal Nurs*. 2008;37(1):94-105.
43. Matta P, Turner J, Flatley C, Kumar S. Prolonged second stage of labour increases maternal morbidity but not neonatal morbidity. *Aust N Z J Obstet Gynaecol* 2019;59(4):555-560. https://doi.org/10.1111/ajo.12935
44. Siggelkow W, Boehm D, Skala C, Grosslercher M, Schmidt M, Koelbl H. The influence of macrosomia on the duration of labor, the mode of delivery and intrapartum complications *Arch Gynecol Obstet*. 2008;278(6):547-553. https://doi.org/10.1007/s00404-008-0630-7
45. Stotland NA, Caughey AB, Breed EM Escobarc GJ. Risk factors and obstetric complications associated with macrosomia. *Int J Gynaecol Obstet*. 2004;87(3):220-226. 10.1016/j.ijgo.2004.08.010.
46. Davis D, Baddock S, Pairman S, et al. Planned place of birth in New Zealand: does it affect mode of birth and intervention rates among low-risk women? *Birth*. 2011;38(2):111-119. https://doi.org/10.1111/j.1523-536X.2010.00458.x
47. Eriksson M, Mattsson LA, Ladfors L. Early or late bath during the first stage of labour: a randomised study of 200 women. *Midwifery*. 1997;13(3):146-148. https://doi.org/10.1016/s0266-6138(97)90005-x