



Factors associated with prolonged second stage of labor in freestanding birth centers

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Abstract

Background: There is a small but significant higher risk to both women and newborns as the length of second stage labor increases. Higher risks to women include intensive care unit (ICU) admission, postpartum hemorrhage, episiotomy, 3rd or 4th degree perineal laceration, prolonged hospital stay, chorioamnionitis, and endometritis. Newborn risks include asphyxia, neonatal intensive care unit (NICU) admissions, sepsis, seizures, and low apgar scores.

Factors associated with prolonged second stage labor are poorly understood, and research has largely focused on the effect of obstetrical interventions such as labor augmentation and use of epidural analgesia, with little focus on physiologic birth.

The goal of the current research was to determine whether there were relationships between a broad variety of demographic, health, pregnancy, and labor factors and prolonged second stage labor in a population of healthy women experiencing physiologic birth.

Methods: This was a retrospective analysis of de-identified client-level data collected in the American Association of Birth Centers Perinatal Data Registry (PDR), including more than 34,000 pairs of women and newborns who began labor in freestanding birth centers between 2007 and 2016. Univariable relationships of demographic, health, pregnancy, and labor factors with prolonged second stage labor were explored. Multivariable logistic regression modeling was used to determine which factors had independent associations with prolonged second stage labor.

Results: The sample consisted of 1671 primiparous women and 16,137 multiparous women. The second stage of labor exceeded parameters for prolonged in 2.1% of first labors and 6.6% of subsequent labors. In multivariable analysis, only birth weight was positively associated with prolonged second stage of labor for primiparous people, and malposition, birth weight, narcotic analgesia and use of nitrous oxide were independently associated with prolonged second stage for multiparous people. Greater maternal age and greater maternal body mass index were negatively associated with prolonged second stage for multiparous people.

Conclusions: Factors associated with prolonged second stage of labor in freestanding birth centers largely mirrored those found in births occurring in hospital settings. Anticipating complications helps midwives make decisions about appropriate birth site and prepare for maternal and newborn complications from prolonged second stage of labor.

Keywords: Labor, Second stage, labor complications

Introduction

Maternal and newborn morbidity increase with longer duration of the second stage of labor (the time from complete cervical dilatation until the birth of the newborn.) Maternal morbidity includes greater incidence of chorioamnionitis, endometritis, postpartum hemorrhage, 3rd or 4th degree perineal laceration, prolonged hospitalization, and intensive care unit admission [1-5]. Newborn morbidity includes greater incidence of sepsis, seizures, low Apgar scores, asphyxia, and neonatal intensive care unit admission [1,2,4-8]. Research on prolonged second stage of labor has focused on births occurring in hospitals, but our previous work has demonstrated that longer second stages are also associated with greater maternal and newborn morbidity for births occurring in freestanding birth centers [9]. While the absolute risks from a prolonged second stage of labor are low, identification of clients at greater risk for experiencing long second stage labor may be beneficial [1]. In birth center settings, identifying clients at high risk of prolonged second stage of labor may help providers choose appropriate care settings (birth center or hospital) for laboring clients.

Researchers have identified fetal, maternal, and labor factors associated with prolonged second stage of labor. While there is some inconsistency between studies, in general fetal factors include greater birthweight, greater gestational age, and relative malposition (such as occiput posterior position) at the onset of labor [10,11]. Maternal factors associated with prolonged second stage include white race [10] and age greater than 35 years [10,12]. Labor factors include prolonged first stage of labor [13], use of neuraxial analgesia [7,10], and labor augmentation [10].

Researchers have primarily explored the duration of second stage in medicalized hospital settings with high use of neuraxial anesthesia, and have focused on medical risk factors. This limits the applicability of the research to clients giving birth in community settings such as freestanding birth centers, where neuraxial anesthesia is not used and there is low use of other medical interventions [14]. Freestanding birth centers are facilities separate from hospitals designed to facilitate woman-centered, physiologic birth [15]. The safety of birth in freestanding birth centers has been well-established [14,16] and the percentage of out-of-hospital births increased 85%, to 1.6% of births, between 2004 and 2017, in the United States [17].

The goal of the current work is to determine whether there are associations between a broad variety of demographic, health, pregnancy, and labor factors and prolonged second stage labor in a population of healthy women experiencing physiologic birth in freestanding birth centers.

Methods

Study Design and Population

This was a retrospective analysis of de-identified client level data from the American Association of Birth Centers (AABC) Perinatal Data Registry v.2.0 and 3.0™. The PDR is a clinical

data registry available for use by all types of birth attendants in all settings, but is primarily used by midwives in birth center or homebirth practices. Providers enter data prospectively into the PDR through a secure web interface at pre-specified times during the pregnancy and postpartum cycle. Quality assurance mechanisms ensure systematic client enrollment, timely completion of data, minimization of loss to follow-up, and data consistency [18,19]. Data included consist of demographic, descriptive, process and outcome indicators, and includes factors often not included in other registries such as information on nutrition, exercise, and prior histories of sexual abuse. Registry protocols adhere to guidelines from the Agency for Healthcare Research and Quality [20]. A 2010 validation study found 97.1% concordance between PDR and health records for 29 key variables [19]. The PDR is thus well suited to exploring associations with prolonged second stage of labor in a low-risk, low intervention cohort.

Inclusion criteria included women giving birth in a freestanding birth center that contributed data to the PDR between January 1, 2007 and December 31, 2016, who had a documented length of the second stage of labor. The exclusion criteria included multiple gestations, non-vertex presentations, prior cesarean birth, and newborns with major congenital anomalies.

Birth center clients signed a consent for their data to be included in the PDR and used for research purposes. The institutional review board of the University of Pittsburgh Human Research Protection Office deemed this study as exempt from institutional review as not involving human subjects.

Variables

The primary dependent variable is prolonged second stage of labor, defined according to recommendations from the 2012 National Institute of Child Health and Human Development (NICHD) consensus workshop on preventing primary cesarean births. These parameters define prolonged second stage as no progress for more than 3 hours in nulliparous women and more than 2 hours in multiparous women [21].

Independent variables include demographic factors and maternal, newborn, and labor variables chosen based on previous studies of prolonged second stage of labor. Demographic information, including race and ethnicity, is self-reported. Body mass index was calculated from height, and either self-reported pre-pregnancy weight or weight measured at first prenatal visit. Smoking status is positive if the client reported any smoking within a year prior to pregnancy. Sexual abuse survivors are defined as people who self-reported any episodic, ongoing, or isolated sexual abuse or assault at any time, including childhood. Birth weight is reported in grams, but included as 100-gram increments in regression analysis. Malposition is coded as fetal position at birth being occiput posterior, occiput transverse, or other, including face or brow presentation. Providers do not document exact length of the first stage of labor in the PDR, so we used first stage of

labor greater than 16 hours as a proxy for prolonged first stage of labor.

Statistical Analysis

Participants were stratified into 2 groups by parity: primiparous women and multiparous women. Descriptive statistics are presented as means and standard deviations or number and percent, as appropriate. Logistic regression was used to calculate univariable odds ratios. We then performed backwards regression modeling to assess independent relationships between various exposures and prolonged second stage of labor. When exposure variables were strongly correlated, we chose the one with the greatest biologic plausibility to include in the multivariable modeling. Maternal age was included in all modeling due to its consistent relationship with prolonged second stage of labor in the literature. Water birth was not included in the multivariable modeling because prolonged second stage of labor is sometimes considered a contraindication to water birth. Analysis was performed using SAS statistical software release 9.4 (SAS Institute, Cary, NC).

Results

The sample included 2196 primiparous women and 23,093 multiparous women. Data on length of second stage labor was not available for all participants, leaving a sample size of 1671 primiparous women and 16,137 multiparous women. Demographic characteristics of clients are in **Tables 1-3**. Overall, participants were primarily white, well educated, and somewhat older than the typical childbearing population, reflecting national birth center clientele. Fewer than 6% of clients reported smoking in the year before pregnancy. Since only births in the birth center are included, all clients gave birth spontaneously. A large proportion of births occurred in the water (34% primiparous, 40% multiparous) and few participants used narcotic analgesia (6% primiparous, 3% multiparous) or nitrous oxide (4% primiparous, 2% multiparous) for pain relief. Average birth weight was about 3400 grams for first newborns and 3550 grams for subsequent newborns, and about 4% of newborns were born in positions other than occiput anterior. The second stage of labor exceeded parameters for prolonged in 2.1% of first labors and 6.6% of subsequent labors.

In univariable analysis, for primiparous people fetal malposition and greater birth weight were positively associated with prolonged second stage of labor, and water birth was negatively associated. For multiparous people, maternal education, Asian race, malposition, first stage of labor exceeding 16 hours, and use of narcotic analgesia or nitrous oxide were positively associated with prolonged second stage of labor, and water birth was negatively associated. In multivariable analysis, only birth weight was positively associated with prolonged second stage of labor for primiparous people, and malposition, birth weight, narcotic analgesia and use of nitrous oxide were independently associated with prolonged second stage for multiparous people. Greater maternal age

Table 1. Baseline maternal, newborn, and labor characteristics stratified by parity.

	Primiparous (n=2196)	Multiparous (n=22,093)
Age (years)	28.6 (5.1)	29.5 (4.8)
Education (years)	15.1 (2.7)	15.1 (3.0)
Public insurance	683 (31.2)	5790 (26.4)
BMI (kg/m ²)	23.9 (4.1)	24.2 (4.7)
Height (inches)	65.2 (2.7)	65.0 (2.7)
Hispanic ethnicity	184 (16.4)	1804 (13.4)
White race	1720 (78.4)	18,385 (83.2)
Black race	150 (6.8)	1139 (5.2)
Smoker in	125 (5.7)	581 (2.6)
Sexual abuse survivor	81 (3.7)	622 (2.8)
Birth weight (g)	3435.3 (420.1)	3551.1 (440.2)
Malposition	59 (3.7)	619 (4.1)
Water birth	633 (34.3)	7150 (39.9)
1 st stage labor > 16 hours	297 (17.8)	1258 (7.8)
Narcotics in labor	129 (5.9)	761 (3.4)
Nitrous oxide	93 (4.2)	463 (2.1)
Prolonged 2 nd stage of labor	39 (2.1)	1071 (6.6)

Results as means (standard deviation) or number (percent) as appropriate.

Table 2. Odds ratios for univariable associations with prolonged second stage of labor.

	Primiparous (n=1671)	Multiparous (n=16,137)
Maternal age (years)	1.04 (0.98 – 1.11)	0.98 (0.96 – 0.99)
Education (years)	1.13 (1.00 – 1.28)	1.06 (1.04- 1.09)
BMI (kg/m ²)	1.00 (0.93 – 1.08)	0.95 (0.93-0.96)
Height in inches	0.94 (0.83 – 1.05)	1.01 (0.98 – 1.03)
Public pay	0.74 (0.35 – 1.58)	0.64 (0.55 - 0.75)
Hispanic ethnicity	1.17 (0.43 – 3.18)	0.88 (0.69 – 1.12)
Black vs. white	*	0.52 (0.36 -0.75)
Asian vs. white	*	1.56 (1.05 - 2.32)
Smoking in pregnancy	*	0.90 (0.60 – 1.33)
History of abuse	*	1.25 (0.90 – 1.73)
Malposition	3.49 (1.19 – 10.25)	2.54 (1.98 - 3.25)
1 st stage > 16 hours	1.62 (0.78 – 3.36)	4.27 (3.65 – 5.00)
Birth weight (per 100 g)	1.11 (1.02 – 1.21)	0.99 (0.98 – 1.01)
Narcotics in labor	2.32 (0.95 - 5.65)	2.03 (1.61 - 2.55)
Nitrous oxide in labor	2.11 (0.73 – 6.07)	3.14 (2.44 - 4.05)
Water birth	0.38 (0.16 – 0.91)	0.22 (0.19 – 0.27)

* Sample size too small to interpret.

Table 3. Odds ratios for multivariable associations with prolonged second stage of labor.

	Primiparous (n=1671)	Multiparous (n=16,137)
Maternal age (years)	1.04 (0.96 – 1.14)	0.98 (0.97 – 0.995)
BMI (kg/m ²)	--	0.94 (0.93 - 0.96)
Malposition	3.18 (0.89 – 11.32)	2.46 (1.89-3.20)
1 st stage > 16 hours	--	4.31 (3.62 - 5.14)
Birth weight (100 g)	1.12 (1.02 – 1.23)	--
Narcotics in labor	--	1.69 (1.29 - 2.21)
Nitrous oxide in labor	--	2.65 (1.96 - 3.57)

and greater maternal body mass index were negatively associated with prolonged second stage for multiparous people.

Discussion

Prolonged second stage of labor according to the NICHD guidelines occurred in 2.1% of first labors and 6.6% of subsequent labors. We found that factors associated with prolonged second stage of labor were largely similar in birth center clients to those in the general childbearing population. Considering maternal factors, older maternal age was associated with slightly lower odds of prolonged second stage of labor. This is similar to findings in the Consortium on Safe Labor study, in which maternal age was not associated with length of the second stage for multiparous people [12]. Our slightly lower odds may represent the effect of residual confounding due to parity. Older parturients may likely have higher parity. Our results showed that for primiparous people, each additional year of age was associated with 1.04 times higher odds of prolonged second stage. This difference was not statistically significant, but this may have been due to small sample size. In the large Consortium on Safe Labor study, the length of second stage increased with age for primiparous women without epidural analgesia [12]. This is similar to the findings of a retrospective cohort study in which primiparous people without epidural analgesia with prolonged second stages were older than those with shorter second stage labors [10]. Our finding that BMI was not related to occurrence of prolonged second stage labor is consistent with the literature [2,22]. While history of childhood sexual abuse has been associated with prolonged labor, we did not find this to be the case [23]. Sexual abuse history is not a mandatory field in the PDR, and it is likely that sexual abuse was underreported in our dataset.

Similarly to other studies, we found that relative malposition of the fetal head was associated with approximately 3 times higher odds of prolonged second stage labor for both primiparous and multiparous people [10,24]. While human pelvises vary in size and shape, many have wider anterior segments and narrower posterior segments, facilitating birth in the occiput anterior position.

We found that greater birth weight was independently

associated with prolonged second stage only in first births. This was similar to a retrospective cohort study that found that newborns of primiparous women without epidurals were approximately 200g heavier after prolonged second stages of labor than after normal second stages, and that newborns of multigravida women were approximately 110 g heavier, [2] and another retrospective cohort study which found 1.85 times higher odds of prolonged second stage labor for primigravidas with birth weight greater than 4000 g [24].

Also consistent with the literature, we found that for multiparous women, first stage of labor greater than 16 hours and use of labor analgesia were independently associated with prolonged second stage of labor [25,26]. Relative fetal head malposition is associated with both prolonged first and second stages of labor, but we found that prolonged first stage was associated with prolonged second stage even independently of fetal head position. Both prolonged stages of labor could be due to dysfunctional labor, with either inadequate endogenous oxytocin production or insensitivity of the myometrium to oxytocin. A first stage of labor greater than 16 hours could thus serve as a signal to the birth attendant to be vigilant for a prolonged second stage of labor. Use of analgesia could either reflect a particularly difficult first stage of labor, or could itself affect the length of the second stage.

This study benefited from the use of the well validated PDR and large sample size. It is limited by the PDRs status as a clinical dataset. There was substantial missing data for our primary outcome, length of second stage, decreasing study power. In previous work we have established that midwives in birth centers use cervical exams sparingly in labor, using an embodied, multi-sensory approach to identifying the onset of the second stage of labor [27]. This could lead to under-identification of prolonged second stage, weakening the associations found in the analysis.

Conclusions

We found that factors associated with prolonged second stage of labor in freestanding birth centers largely mirror those found in births occurring in hospital settings. Midwives should be aware that for primiparous women, greater birth weight and probably fetal malposition are associated with longer second stages of labor, and that for multiparous women fetal malposition, first stage of labor longer than 16 hours, and use of analgesia in labor are associated with longer second stages of labor. Anticipating complications helps midwives make decisions about appropriate birth site and prepare for maternal newborn complications of prolonged second stage of labor. Future research can explore whether there are benefits to women and newborns with prolonged second stage of labor of birthing in the hospital instead of a freestanding birth center.

List of Abbreviations

AABC: American Association of Birth Centers

PDR: Perinatal Data Registry
NICHD: National Institute of Child Health and Human Development

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	NAN	DR	SRS
Research concept and design	√	--	--
Collection and/or assembly of data	--	--	√
Data analysis and interpretation	√	√	--
Writing the article	√	--	--
Critical revision of the article	√	√	√
Final approval of article	√	√	√

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