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Labor Intervention and Outcomes in Women Who Are Nulliparous and Obese: Comparison of Nurse-Midwife to Obstetrician Intrapartum Care

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Abstract

Background—Women who are obese have slower labors than women of normal weight, and show reduced response to interventions designed to speed labor progress like oxytocin augmentation and artificial rupture of membranes. The optimal labor management for these women has not been described.

Methods—This retrospective cohort study compared 2 propensity score-matched groups of women ($N = 360$) who were healthy, nulliparous, spontaneously laboring, and obese (body mass index 30 kg/m^2). Labors were managed by either a certified nurse-midwife (CNM) or an obstetrician at one hospital from 2005 through 2012. Comparisons were made on a range of labor processes and outcomes.

Results—Women who were obese and cared for in labor by CNMs were 87.0% less likely to have operative vaginal birth (adjusted odds ratio [aOR], 0.15; 95% confidence interval [CI], 0.06–0.41) and 76.3% less likely to have third- or fourth-degree perineal lacerations (aOR, 0.31; 95% CI, 0.13–0.79) compared to a matched group of women who were obese and had similarly sized neonates but who were cared for by obstetricians. The rates of unplanned cesarean birth, postpartum hemorrhage, maternal intrapartum fever, and neonatal intensive care unit admission were similar between groups. CNM patients were significantly less likely than patients of obstetricians to have labor anesthesia, synthetic oxytocin augmentation, or intrauterine pressure catheters. By contrast, CNM patients were significantly more likely than patients of obstetricians to use physiologic labor interventions, including intermittent fetal monitoring, ambulation, and hydrotherapy.

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CONFLICT OF INTEREST

Authors report no conflict of interest.

Discussion—In women with spontaneous labor onset who were healthy, obese, and nulliparous, watchful waiting and use of physiologic labor interventions, characterizing CNM intrapartum care, were associated with outcomes that were similar to, or better than, those of women who were obese and exposed to more high-technology interventions characterizing intrapartum care by obstetricians. In women who were obese, physiologic labor interventions were safe for both mothers and neonates.

Keywords

cesarean birth; hydrotherapy; interventions; intrapartum; labor; labor dystocia; obesity; physiologic labor; pregnancy

INTRODUCTION

Women who are obese are at particular risk for slow labor progress, a complication known as labor dystocia.^{1,2} Among nulliparous women with body mass index (BMI) greater than or equal to 40 kg/m², it can take more than 7 hours longer to progress from 4 cm dilatation to 10 cm than among similar women with normal BMI.² Women who are obese also show decreased response to the 2 primary clinical interventions used to speed labor progress: synthetic oxytocin infusion^{3,4} and artificial rupture of membranes (AROM).⁵ Unfortunately, these research findings of slower labor progress and decreased response to labor interventions are not integrated in modern labor management protocols for women who are obese, despite the fact that more than one-third of childbearing women in the United States are obese, with higher proportions among racial and ethnic minorities.⁶

As a result of their slower labors and decreased response to commonly used intrapartum interventions, women who are obese are more often exposed to multiple labor interventions,⁷ but nevertheless have higher rates of unplanned cesarean birth.^{8–11} In a large, multisite study, for each 1 kg/m² increase in maternal BMI, there was a 2% to 5% increase in the cesarean birth rate (cesarean birth rate among normal weight women 11.1% versus 42.8% among women with BMI 40 kg/m²).¹⁰ Nulliparity¹⁰ and maternal comorbid conditions like gestational diabetes and hypertension¹² further increase the risk of cesarean birth among women who are obese. When women who are obese experience cesarean birth, they are at heightened risk for a range of poor postoperative outcomes, including infection,^{13,14} postpartum hemorrhage, and prolonged hospitalization.¹⁵

Although maternal obesity involves multiple physiologic changes that may contribute to women's slow labor progress and decreased response to labor interventions,¹⁶ it is possible that excellent maternal and neonatal outcomes can still be achieved when women who are obese are managed optimally. In women of mixed weights, care by nurse-midwives^{17–19} is associated with decreased risk of cesarean birth, and physiologic labor interventions (intermittent electronic fetal monitoring, ambulation, hydrotherapy) are associated with decreased use of high-technology interventions (epidural anesthesia, AROM, oxytocin augmentation) and fewer operative births.^{20,21} However, in randomized controlled trials, some physiologic labor interventions were not individually associated with vaginal birth,²²

and neither physiologic labor interventions nor care by nurse-midwives have been evaluated against labor outcomes in women who are obese.

The purpose of this study was to compare 2 matched cohorts of healthy, nulliparous, women who were obese and had spontaneous labor onset with different models of intrapartum care. One group had care by a certified nurse-midwife (CNM); the other group received care from an obstetrician. Groups were compared on a range of labor processes and outcomes. We hypothesized that since women who are obese have longer labor courses, a strategy of watchful waiting by intrapartum providers (waiting longer to initiate high-technology interventions including epidural anesthesia, AROM, oxytocin augmentation, or intrauterine pressure catheter contraction monitoring) such as the care provided by CNMs, might lead to better labor outcomes (decreased use of cesarean birth for the indication of slow labor progress or operative vaginal birth and lower rates of maternal and neonatal morbidities). We were also interested in comparing the use and associated outcomes of physiologic labor interventions as a strategy of delaying high-technology labor interventions between cohorts of women who were obese.

METHODS

This was a retrospective cohort study using medical record review. Women who gave birth at the University of Colorado Hospital between October 1, 2005, and December 31, 2012 ($n = 22,443$), were identified from the University of Colorado Perinatal Database (Figure 1). Of these, 8431 met the inclusion criteria: term birth (37 0/7 to 41 6/7 weeks' gestation based on certain first day of last menstrual period and/or first-trimester ultrasound), singleton, maternal age 18 through 40 years, nulliparous, and spontaneous onset of painful contractions and progressive cervical change prior to hospital admission. Among these 8431 women, 7889 were excluded because admission data indicated one of the following: intrauterine fetal death, major fetal anomaly (chromosomal or ultrasound evidence of anomaly), planned cesarean birth, premature rupture of membranes (>24 hours prior to birth), low amniotic fluid (anhydramnios or oligohydramnios noted on admission record), severe maternal comorbidities (cancer, major cardiac disease), chronic or gestational hypertension, preeclampsia, pregestational or gestational diabetes, intrapartum care with a private midwifery group serving patients who self-select midwifery care, missing maternal height or medical record number, or not obese at birth ($\text{BMI} < 30 \text{ kg/m}^2$).

A total of 542 women met the inclusion and exclusion criteria. From these, we selected 2 cohorts of 200 women each who differed by provider type (CNM or obstetrician), but were propensity matched as described below to be as similar as possible on other variables. Although some women self-select provider type at this hospital, the women included in this study were largely assigned a provider based on their geographic catchment area. However, given that we cannot be certain of each woman's path to her particular provider type in this retrospective review, we used propensity score matching to decrease bias in sample selection.

The lead author, a clinician with expertise in intrapartum nursing and midwifery care, then performed detailed medical record reviews on these 400 labors using REDCap electronic

data tools hosted at the University of Colorado. REDCap is a secure, Web-based application designed to support data capture for research studies, providing an interface for validated data entry, audit trails for tracking data manipulation and export procedures, automated export for statistical analysis, and procedures for importing from external sources.²³ To confirm the accuracy of data taken from medical records, we randomly selected 20 charts for repeat medical record review (10 charts from women cared for by CNMs, 10 charts from women cared for by obstetricians), representing 5% of the reviews performed in this study, as recommended in protocols for chart abstraction reliability testing.²⁴ Record reviews were accurate for 95.14% of data, meeting accuracy standards of greater than 95%.²⁵

After medical record reviews, we excluded women with missing labor records or who had labors that ended in unplanned cesarean for the sole indication of fetal intolerance of labor, with the rationale that we were focused on the labors of women where there were not concerns about fetal tolerance of labor as a primary indication for intervention. Our final sample included 360 women. The Colorado Multiple Institutional Review Board approved the study (Protocol #14-0557). This sample size met a priori calculations for a minimum total sample of 352 participants (alpha level = 0.05, power = 0.80 to test for moderate difference [$\delta = 0.30$] in rates of unplanned cesarean birth due to slow labor progress or fetal descent).²⁶

Propensity Score Matching

We anticipated that more CNMs than obstetricians might care for lower-risk women in labor, despite the fact that women attending prenatal clinics and subsequent intrapartum care at this hospital generally do not self-select provider type. Therefore, we used a composite perinatal risk score based on women's perinatal risk to allocate participants to comparison groups via propensity score nearest neighbor matching.²⁷ Propensity score matching balances baseline covariates among samples, thus reducing confounding of the relationship between group allocation and a measured outcome. In nearest neighbor matching, each woman assigned to the CNM provider group was matched to a woman who had a similar estimated propensity score, but received care from obstetricians. Thus, our comparison groups were built to be as similar as possible on perinatal risk, yet differing by provider type.

We identified 8 perinatal risk variables that are associated in the literature with either the outcome of cesarean birth^{10,28} or the allocation of women to prenatal or intrapartum care.^{27,29} These 8 propensity score items included non-partnered status; ethnic minority status; smoking in pregnancy; alcohol use in pregnancy; illegal drug use in pregnancy; maternal minor chronic disease (renal, liver, or minor cardiac disease); maternal additional minor chronic disease (pulmonary disease, clotting disorders, neurological disorders, autoimmune diseases, epilepsy, sickle cell disorders, other bleeding disorders); and maternal psychosocial complications (lifetime history or current diagnosis of schizophrenia, bipolar disorder, psychosis, major depression, panic attacks, posttraumatic stress disorder, autism, suicide attempt, psychiatric hospitalization, domestic violence, physical assault).

For each woman, we assigned a score of 0 or 1 on each of the 8 perinatal risk variables based on evidence from the clinical database. We then used the R Integration Package for IBM- SPSS version 21 (IBM Corporation, Armonk, NY) to perform propensity score

matching with 1:1 nearest neighbor method with the restriction that 2 women could not be matched if the absolute difference between their propensity scores was greater than a prespecified threshold, or caliper (caliper = 0.15), thereby eliminating approximately 99% of bias due to measured confounding variables.²⁷ Finally, we compared covariate balance between provider groups using overall propensity scores and unadjusted odds ratios for each maternal characteristic.

Maternal Characteristics—From each medical record, we collected information on maternal characteristics. These characteristics included self-reported race, ethnicity, married or partnered status, height, comorbid conditions, and use of alcohol, drugs, or tobacco during pregnancy. Maternal age was calculated from date of birth.

Pregnancy and Labor Characteristics—We also collected information on characteristics of the woman's pregnancy or neonate that might influence her labor interventions and/or outcomes. We calculated maternal BMI using the height and weight of women upon hospital admission for labor (maternal birth BMI) and classified using World Health Organization criteria.³⁰ We were interested in maternal birth BMI rather than prepregnancy BMI because it better reflects maternal physiology during labor, the timing of interest for this study.^{10,31} Gestational age was calculated by certain last menstrual period or first-trimester ultrasound at the time of hospital admission for labor and birth. Neonatal birth weight was recorded from the birth note, and presence of maternal fever ($>38.0^{\circ}\text{C}$) was noted in provider's and/or nurse's notes.

Labor and Birth Interventions and Outcomes—We collected information from nurses' and providers' notes on the use of labor interventions during each woman's hospitalization, including timing and cervical progression at hospital admission, use of high-technology interventions (AROM, anesthesia in labor [epidural or combined spinal-epidural], synthetic oxytocin augmentation, intrauterine pressure catheter for contraction monitoring), and use of physiologic labor interventions (intermittent fetal heart rate monitoring, ambulation in labor, and hydrotherapy). For a woman to be counted as being exposed to a physiologic labor intervention, she had to have used it for a duration of at least 15 contiguous minutes. We also tracked the total time each woman used each physiologic labor intervention. Hydrotherapy was defined as use of either shower or tub during labor.

We tracked the numbers of women who had operative vaginal birth (forceps or vacuum) or unplanned cesarean birth for labor progression or fetal descent indications. Although both cesarean and operative vaginal births at this institution require a transfer of care from CNM to obstetrician, we analyzed these outcomes with the CNM cohort if the woman started her intrapartum care with a CNM. There was no minimum amount of time that a woman had to experience CNM care to be included in the CNM cohort; if the woman was admitted to the CNM service in labor, her outcomes were considered with the CNM cohort (intent to manage analysis). We also tracked the number of women experiencing labor outcomes of intrapartum fever ($>38.0^{\circ}\text{C}$), shoulder dystocia, third- or fourth-degree perineal laceration, postpartum hemorrhage ($>500\text{ mL}$ estimated blood loss following vaginal birth or $>1000\text{ mL}$ following cesarean birth), Apgar score less than 7 at 5 minutes of age, and neonatal intensive care unit (NICU) admission in first 48 hours of life.

Timing of Labor and Intervention Use—We noted the duration of first- and second-stage labor (first-stage labor defined as period between 4 cm and 10 cm cervical dilatation, second-stage labor defined as period between 10 cm cervical dilatation and vaginal birth) and the time since hospital admission for each type of high-technology and physiologic labor intervention. We also made note of the time and results of each cervical examination, which were used to create plots of intervention use across women's labors that were standardized by labor progress.

Analysis Methods

We compared demographic characteristics by provider groups using Pearson's 2-sided chi-square test. We calculated unadjusted odds ratios of intrapartum care by a CNM or obstetrician for labor interventions and outcomes, then fit adjusted models describing these same labor interventions and outcomes that also included as covariates those maternal and pregnancy or labor characteristics found to be significantly different by provider type (Hispanic ethnicity, white or Asian race, maternal history of minor chronic disease, gestational age). We then compared means and standard deviations for time intervals describing women's labors for the 2 cohorts. All analyses were estimated using IBM SPSS, version 23 (IBM Corporation. Armonk, NY, 2015). Statistical significance for these analyses was set at $P < .05$.

RESULTS

Maternal Characteristics

Post-matching checks of covariate balance showed an equal distribution of propensity scores in CNM and obstetrician cohorts (chi-square = 3.04, $P = .80$).³² However, despite having similar overall propensity scores, there were some significant differences between these matched cohorts on a few maternal characteristics (Table 1). Women receiving care from a CNM were significantly less often Asian or white and were more often Hispanic than women who received care from an obstetrician. CNM patients were also significantly younger than patients of obstetricians and less likely to have minor miscellaneous chronic diseases.

Pregnancy and Labor Characteristics

Among pregnancy and labor characteristics (Table 1), there were no differences by provider group on maternal BMI on admission, which along with provider type was the primary exposure variable of interest in this study. Other pregnancy and labor characteristics were similar by provider group, with the exception of gestational age. CNM patients were significantly less likely to experience spontaneous labor and birth between 37 0/7 and 37 6/7 weeks' gestation and more likely to go into labor between 40 0/7 and 40 6/7 weeks' gestation.

Labor and Birth Interventions and Outcomes

Labor and birth interventions and outcomes included several significant differences by provider group in unadjusted analyses (Table 2). These differences remained significant, even when included in multivariate analyses that controlled for those characteristics found to

be different in the CNM and obstetrician groups (Hispanic ethnicity, Asian or white race, maternal history of minor chronic disease, gestational age, Table 1). Among these spontaneously laboring women, significantly fewer CNM patients were admitted to the hospital at less than 4 cm cervical dilatation. Although CNMs and obstetricians used AROM with similar frequency, CNM patients were significantly less likely to use labor anesthesia, synthetic oxytocin augmentation, or intrauterine pressure catheters. By contrast, CNM patients used physiologic labor interventions after hospital admission much more frequently than patients of obstetricians, including intermittent fetal monitoring, ambulation, and hydrotherapy. CNM patients were significantly less likely to end labor with an operative vaginal birth, but their cesarean birth rates were similar. Among other labor outcomes, CNM patients were similar to patients of obstetricians except for third- or fourth-degree perineal lacerations, which occurred significantly less frequently among CNM patients despite the fact that neonates from each provider group had similar birth weights (mean 3.34 kg in the CNM group versus 3.26 kg in the obstetrician group, $P = .065$).

Timing of Labor and Intervention Use

We also compared the timing of labor stages and intervention onset for each provider group (Table 3). CNM patients took significantly longer to progress from 4 cm to 10 cm cervical dilatation (mean 7.94 hours for the CNM group versus 7.03 hours for the obstetrician group, $P = .08$), but had similar lengths of second-stage labor. Although patients in both groups who used epidural anesthesia waited about the same amount of time after hospital admission before starting this intervention, CNMs waited significantly longer than obstetricians before starting oxytocin augmentation (mean 8.12 hours versus 6.31 hours, respectively, $P = .001$), performing AROM (mean 6.88 hours versus 5.13 hours, respectively, $P = .002$), or inserting intrauterine pressure catheters for contraction monitoring (mean 9.35 versus 6.65 hours, respectively, $P = .02$).

Differences in the use and timing of different labor interventions by provider group are demonstrated in bar graphs (Figure 2), in which the number of women in each provider group experiencing labor intervention over the same hour of labor, both before and after reaching 4 cm cervical dilatation, is plotted. During times when fewer CNM patients than obstetrician patients were experiencing high-technology interventions (see the shifts in normal curve of women using these interventions about 2–5 hours after the woman's cervix was 4 cm dilated), more CNM patients were using physiologic labor interventions.

In further subgroup analysis, we found that women had a median cervical dilatation of 4 cm when they initiated hydrotherapy and used this intervention for about an hour (median 65 minutes). Women using hydrotherapy were significantly less likely to receive oxytocin augmentation (38.6% oxytocin augmentation in women with hydrotherapy versus 50.8% oxytocin augmentation in women without hydrotherapy, $P < .05$), but had no increased risk for cesarean birth, operative vaginal birth, postpartum hemorrhage, or maternal intrapartum fever despite having longer labors between 4 and 10 cm (mean 7.65 hours versus 6.15 hours, $P = .002$ U test). Neonatal outcomes were also similar in women who did and did not use hydrotherapy.

DISCUSSION

Our study adds to previous investigations by contrasting different models of intrapartum care in matched groups of women who were obese to better understand the influence of intrapartum interventions on the outcomes of labor. In these healthy women who were obese with spontaneous labor onset, care by a CNM was associated with an 87.0% reduction in the use of operative vaginal birth and a 76.3% reduction in third- or fourth-degree perineal lacerations compared to matched groups of women having similarly sized neonates who were cared for by obstetricians. CNM care was also associated with watchful waiting (longer intervals between hospital admission and initiation of AROM or oxytocin augmentation to speed labor progress), increased use of physiologic labor interventions (hydrotherapy, ambulation, intermittent electronic fetal monitoring), and decreased use of high-technology interventions (epidural anesthesia, oxytocin augmentation, intrauterine pressure catheter monitoring) compared to obstetrician care. Care by a CNM using more physiologic interventions was safe among women who were obese in this study, with no difference between groups on rates of postpartum hemorrhage, maternal intrapartum fever, or NICU admissions.

Women in our study were just as likely to end their spontaneous labor with an unplanned cesarean birth, regardless of their provider type. The University of Colorado Hospital, where these women labored, has cesarean birth rates that are lower than the national average (overall cesarean birth rate of 25.6%, compared to national rate of 32.7% during time of this study).³³ In such an environment, both CNMs and obstetricians are likely accustomed to intrapartum decision making that prioritizes avoidance of cesarean. In addition, most of the women in this study had BMIs between 30.00 and 34.99 kg/m² (223/360, 61.9%), reflecting this hospital's geographic setting in the state with the lowest rate of obesity in the United States.³⁴ Unplanned cesarean birth is known to occur more frequently as maternal BMI increases, and is most pronounced in women with a BMI greater than or equal to 35.00 kg/m.^{2,10} In another setting with higher rates of cesarean and higher degrees of maternal obesity, differences by intrapartum provider type in risk for cesarean birth among women who are obese may be more noticeable.

Although created using propensity score matching, several significant differences remained between our provider cohort groups. CNM patients were younger, less often Asian, more often Hispanic, and less frequently reported minor comorbidities compared to patients of obstetricians. As mentioned, women at the University of Colorado Hospital generally do not self-select their type of provider prenatally, but are instead assigned to an obstetrician or CNM based on their geographic catchment area or the first available appointment for prenatal care. Significant differences in the provider cohorts largely reflect differences by geographic area in demographic variables. CNM patients were also significantly more likely than patients of obstetricians to have spontaneous labor between 40 0/7 and 40 6/7 weeks' gestational age. This difference likely reflects practice differences by provider type in the use of labor induction, leaving disproportionate numbers of women to enter spontaneous labor at different gestational ages. To correct for these differences between provider cohort groups, we estimated the adjusted odds ratios for each labor intervention or outcome that included variables for all maternal or pregnancy characteristics that were significantly

different by provider group (Table 2). These adjusted odds ratios reveal that differences by provider group in maternal and pregnancy characteristics did not have a significant influence on labor interventions or outcomes.

Labor between 4 cm and 10 cm cervical dilatation was about one hour longer for women cared for by CNMs compared to those with care by obstetricians. However, CNM patients did not have higher rates of intrapartum fever or any other negative maternal or neonatal outcome (cesarean or operative vaginal birth, third- or fourth-degree perineal laceration, shoulder dystocia, postpartum hemorrhage, low Apgar score, or admission to NICU) compared to patients of obstetricians despite their longer labors. The lower use of epidural anesthesia among CNM patients also implies that these women tolerated their labors well, possibly with the help of physiologic interventions like hydrotherapy.

Currently, the safety and optimal use of labor interventions like oxytocin augmentation has not been established among women who are obese,⁷ although it is known that these women more often show poor response to oxytocin augmentation¹¹ and require higher titrations of oxytocin to achieve vaginal birth, even after spontaneous labor onset.³⁵ Oxytocin use is associated with uterine tachysystole with fetal distress, and has been linked to multiple maternal and neonatal complications, prompting its classification as one of the 12 most dangerous medications used in a hospital.³⁶ Until we have more information on maternal and fetal safety after exposure to the higher doses of oxytocin required by many women who are obese, it seems prudent to avoid this intervention whenever possible. Prospective studies comparing intrapartum care by different providers in a variety of birth settings are needed to better understand the relationship between model of intrapartum care and labor outcomes.

Our finding that hydrotherapy in labor was associated with delayed or absent use of oxytocin augmentation in women who are obese is possibly attributable to known patterns of slower cervical dilatation among women with higher BMI.² Hydrotherapy was typically initiated during the period of labor when women who are obese dilate most slowly, 4 cm to 6 cm cervical dilatation. By the time women left the tub or shower about an hour later, their rate of cervical change may have increased, resulting in fewer orders for oxytocin augmentation by their providers. Although women in this study who used hydrotherapy had labors that were about 1.5 hours longer than those who did not, hydrotherapy users were not at increased risk for poor maternal or neonatal outcomes. Use of hydrotherapy as one alternative to oxytocin augmentation and a strategy for optimal labor management in women who are obese is therefore an area for further future investigation.

As mentioned, CNM patients were significantly less likely to end labor with operative vaginal birth compared to matched groups of women having similarly sized neonates who were cared for by obstetricians. Although CNMs at this institution do not perform operative vaginal births, any CNM patient who had an operative vaginal birth with an obstetrician was counted with the CNM cohort. Possibly, CNMs delayed their use of operative vaginal birth, resulting in more spontaneous vaginal births. As discussed earlier, CNM patients used epidural anesthesia less often than patients of obstetricians; this also might partially explain the lower operative vaginal birth rate in the CNM cohort.

There are several important limitations of our study. First, we used a retrospective design. A prospective study of labor management among obese, nulliparous women would be necessary to establish causality for any of these findings. Bias in the selection of cohort members might also be a limitation in this retrospective cohort study; however, this limitation was reduced by our use of random propensity score matching for group allocation. Although some significant differences remained after propensity score matching between our provider cohorts, these differences did not significantly change the results of adjusted analyses, and the overall comparison of cohorts on both propensity score and maternal BMI were not significantly different. We also reduced risk of bias from allocation of patients to cohorts by focusing on a birth setting where women do not generally self-select for these providers and by analyzing the labor processes and outcomes of women according to their initial allocation group.

Another limitation of our study is generalizability. Women in this study labored at an institution with overall low rates of cesarean birth and dual models of intrapartum care providers. In addition, we excluded women who were higher risk (significant comorbidities, including diabetes, hypertension, etc), multiparous, or who did not have prenatal care. Labor outcomes and interventions may vary depending on maternal comorbidities, the independence of CNMs in an institution, the overall cesarean birth rate, and the comprehensiveness of prenatal care.

To conclude, we present findings that among matched groups of healthy, obese, nulliparous women with spontaneous labor onset, watchful waiting and use of physiologic labor interventions, characterizing CNM intrapartum care, were associated with outcomes that were similar to or better than those of women who were exposed to more high-technology interventions, characterizing intrapartum care by obstetricians. Different use of labor interventions in the 2 cohorts were likely not due to physiologic differences, as the cohorts were similar in maternal BMI and other important maternal/infant characteristics.

Although CNM care was associated with longer labor length than care by obstetricians, slightly longer labors might be preferable to the use of multiple high-technology interventions for healthy women who are obese with spontaneous labor onset, such as those included in this study. Moreover, physiologic labor management of labor in women who are obese as a strategy for avoiding high-technology labor interventions could have significant cost implications. Epidural anesthesia use among low-risk women was associated with a 32% increase in the cost of birth in an Australian study,³⁷ and women in a Swedish cost analysis had significant increases in their cost of birth with each addition of a high-technology labor intervention.³⁸

Physiologic labor management did not significantly decrease the use of unplanned cesarean birth in this setting, possibly a result of this hospital's prioritization across provider types of cesarean birth avoidance. Among physiologic labor interventions, hydrotherapy was significantly associated with the delay or avoidance of high-technology labor interventions in women who are obese with no increased risk of maternal or neonatal morbidity. With better understanding of the biology and intrapartum management factors leading to poor

outcomes in women who are obese, we hope to develop better strategies to reduce obstetric complications in this population.

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Quick Points

- ✦ There is a gap in our understanding of the optimal labor management for women who are obese.
- ✦ It is unknown if physiologic labor interventions like ambulation, intermittent fetal heart rate monitoring, and hydrotherapy are safe for use in women who are obese.
- ✦ Care during labor by a nurse-midwife compared to care by an obstetrician resulted in an 87.0% reduced chance of operative vaginal birth, a 76.3% reduced chance of a third or fourth-degree laceration, and less frequent use of epidural anesthesia or oxytocin augmentation among nulliparous women who were obese. By contrast, nurse-midwives more often used physiologic labor interventions compared to obstetricians.
- ✦ Physiologic labor interventions appear safe to use during labor in women who are obese.
- ✦ Physiologic labor management is one strategy for avoiding multiple high-technology labor interventions and may reduce the cost of birth care.

Figure 1. Participant selection flow diagram

Abbreviation: BMI, body mass index.

High-Technology Labor Interventions

Physiologic Labor Interventions

Figure 2. Bar graphs demonstrating differences by intrapartum provider type on use of high-technology and physiologic labor interventions in each hour of labor before or after 4 cm cervical dilation (–10 hours to +20 hours)

Abbreviations: AROM, artificial rupture of membranes; CNM, certified nurse-midwife.

In the figure, CNM patients are represented by black bars and patients of obstetricians represented by hatched bars. Counts of CNM patients using using high-technology interventions of AROM, oxytocin augmentation, and intrauterine pressure catheters show use that is later in labor than patients of obstetricians (hatched bars). During time period when CNM patients were less often using high-technology interventions than patients of

obstetricians (2–6 hours after woman reached 4 cm cervical dilatation), more CNM patients used physiologic labor interventions, including intermittent external fetal monitoring, ambulation, and hydrotherapy.

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Table 1

Maternal and Pregnancy Characteristics by Provider Type: Certified Nurse-Midwife or Obstetrician

Maternal Characteristics	Total Sample (N = 360) n (%)	Intrapartum Provider		P-Value for Difference by Provider Type
		Obstetrician (n = 182) n (%)	CNM (n = 178) n (%)	
Race, ethnicity, and partnered status				
Asian	19 (5.3)	15 (8.2)	4 (2.2)	0.016
Black	46 (12.8)	24 (13.2)	22 (12.4)	0.814
White	105 (29.2)	63 (34.6)	42 (23.6)	0.021
Hispanic	153 (42.5)	61 (33.5)	92 (51.7)	<0.001
Other race	6 (1.7)	2 (1.1)	4 (2.2)	0.635
Missing race	31 (8.6)	17 (9.3)	14 (7.9)	
Married or partnered	209 (58.1)	111 (61.0)	98 (55.1)	0.254
Maternal age and height				
18–29 years	306 (85.0)	148 (81.3)	158 (88.8)	0.048
30–40 years	54 (15.0)	34 (18.7)	20 (11.2)	
Height 1.5 m (4 feet, 9 inches)	20 (5.6)	11 (6.0)	9 (5.1)	0.682
History of maternal risk factors				
Chronic kidney, liver, or heart disease	3 (0.8)	2 (1.1)	1 (0.6)	0.575
Other chronic disease	73 (20.3)	46 (25.3)	27 (15.2)	0.017
Mental health or social risk conditions	58 (16.1)	30 (16.5)	28 (15.7)	0.846
Maternal use during pregnancy				
Smoked cigarettes	28 (7.8)	17 (9.3)	11 (6.2)	0.263
Consumed alcohol	9 (2.5)	5 (2.7)	4 (2.2)	0.761
Used illegal drugs	16 (4.4)	8 (4.4)	8 (4.5)	0.964
Maternal birth BMI (kg/m²)				
Obese I 30–34.99	223 (61.9)	109 (59.9)	114 (64.0)	0.417
Obese II 35–39.99	99 (27.5)	51 (28.0)	48 (27.0)	0.823
Obese III 40.00	38 (10.6)	22 (12.1)	16 (9.0)	0.339
Gestational age at birth, weeks and days				
37 0/7–37 6/7	19 (5.3)	14 (7.7)	5 (2.8)	0.038
38 0/7–38 6/7	55 (15.3)	32 (17.6)	23 (12.9)	0.219
39 0/7–39 6/7	122 (33.9)	66 (36.3)	56 (31.5)	0.336
40 0/7–40 6/7	135 (37.5)	56 (30.8)	79 (44.4)	0.008
41 0/7–41 6/7	29 (8.1)	14 (7.7)	15 (8.4)	0.798
Neonatal birth weight, kg				
Low (<2.5)	7 (1.9)	4 (2.2)	3 (1.7)	0.719
Normal (2.50–3.99)	341 (95.0)	171 (94.5)	170 (95.5)	0.655
High (4.0)	11 (3.1)	6 (3.3)	5 (2.8)	0.781
Missing data	1			

Abbreviations: CNM, certified nurse midwife; BMI, body mass index.

Unadjusted and Adjusted Odds Ratios for Being Assigned Intrapartum Care from a Certified Nurse-Midwife Versus Obstetrician for Labor Interventions and Outcomes

Table 2

Labor and Birth Interventions and Outcomes ^a	Total Sample (N = 360) n (%)	Intrapartum Provider		Unadjusted OR for CNM Intrapartum Care (95% CI)	Adjusted OR ^b for CNM Intrapartum Care (95% CI)
		Obstetrician (n = 182) n (%)	CNM (n = 178) n (%)		
Hospital admission at <4 cm	102 (28.3)	61 (33.5)	41 (23.0)	0.60 ^c (0.38–0.96)	0.55 ^c (0.34–0.89)
High-technology labor interventions					
Artificial rupture of membranes	171 (47.5)	85 (46.7)	86 (48.3)	1.06 (0.70–1.60)	1.00 (0.64–1.21)
Anesthesia during labor ^e	278 (77.2)	160 (87.9)	118 (66.3)	0.27 ^d (0.16–0.47)	0.29 ^d (0.17–0.52)
Synthetic oxytocin augmentation	171 (47.5)	98 (53.8)	73 (41.0)	0.60 ^c (0.40–0.91)	0.64 ^c (0.41, 0.99)
Intrauterine pressure catheter use	116 (32.2)	76 (41.8)	40 (22.5)	0.41 ^d (0.26–0.65)	0.38 ^d (0.23, 0.61)
Physiologic labor interventions					
Intermittent fetal heart rate monitoring	155 (43.1)	51 (28.0)	104 (58.4)	3.58 ^d (2.31–5.56)	3.50 ^d (2.21–5.53)
Ambulation in labor	114 (31.7)	37 (20.3)	77 (43.3)	2.97 ^d (1.86–4.74)	2.89 ^d (1.77–4.70)
Hydrotherapy in labor	101 (28.1)	24 (13.2)	77 (43.3)	4.99 ^d (2.96–8.41)	4.51 ^d (2.63–7.73)
Mode of birth					
Operative vaginal birth	34 (9.4)	29 (15.9)	5 (2.8)	0.15 ^d (0.06–0.40)	0.15 ^d (0.6–0.41)
Cesarean birth unplanned (all)	36 (10.0)	20 (11.0)	16 (9.0)	0.84 (0.42–1.70)	0.64 (0.31–1.32)
Indication: labor dystocia	24 (6.7)	13 (7.1)	11 (6.2)	0.93 (0.40–2.16)	0.65 (0.28–1.53)
Indication: labor dystocia + failure to descend	13 (3.6)	7 (3.8)	6 (3.4)	0.87 (0.29–2.63)	0.81 (0.25–2.56)
Indication: labor dystocia + fetal intolerance	6 (1.7)	5 (2.7)	1 (0.6)	0.20 (0.02–1.72)	0.15 (0.02–1.34)
Labor outcomes					
Shoulder dystocia	10 (2.8)	8 (4.4)	2 (1.1)	0.25 (0.05–1.17)	0.26 (0.05–1.33)
Third- or fourth-degree perineal laceration	28 (7.8)	21 (11.5)	7 (3.9)	0.31 ^c (0.13–0.75)	0.31 ^c (0.13–0.79)
Postpartum hemorrhage	66 (18.3)	36 (19.8)	30 (16.9)	0.82 (0.48–1.40)	0.73 (0.42–1.29)
Maternal fever in labor (>38.0° C)	52 (14.5)	29 (15.9)	23 (12.9)	0.78 (0.43–1.41)	0.78 (0.42–1.45)
Apgar score <7 at 5 minutes	1 (0.3)	0	1 (0.6)		
NICU admission in first 48 hours	17 (4.7)	10 (5.5)	7 (3.9)	0.70 (0.26–1.88)	0.65 (0.23–1.83)

Abbreviations: CI, confidence interval; CNM, certified nurse-midwife; NICU, neonatal intensive care unit; OR, odds ratio.

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^bInterventions as used after triage and admission for labor and birth.

^cAdjusted by maternal, pregnancy, and labor variables found to be significantly different by provider-type groups (Table 1): Hispanic ethnicity, white race, Asian race, maternal history of minor chronic disease, and gestational age (continuous).

^d $P < .05$.

^e $P < .001$.

^fEpidural or combined-spinal epidural.

Table 3

Comparison of Time Intervals in Labor by Intrapartum Care Assignment to Certified Nurse-Midwife or Obstetrician

Time Interval, h	Total Sample Mean (SD)	Intrapartum Provider		P-Value
		Obstetrician Mean (SD)	CNM Mean (SD)	
Cervical progression from 4 to 10 cm	7.48 (4.81)	7.03 (4.63)	7.94 (4.96)	0.08
Second-stage labor (10 cm to birth)	1.55 (1.23)	1.62 (1.29)	1.48 (1.17)	0.29
Time between hospital admission and:				
Epidural anesthesia	3.44 (3.81)	3.23 (3.71)	3.74 (3.94)	0.27
Oxytocin augmentation	7.08 (3.61)	6.31 (3.47)	8.12 (3.57)	0.001
AROM	6.01 (3.70)	5.13 (3.07)	6.88 (4.06)	0.002
Intrauterine pressure catheter insertion	8.03 (4.41)	6.65 (3.92)	9.35 (4.99)	0.02

Abbreviations: AROM, artificial rupture of membranes; CNM, certified nurse-midwife.