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

Original Research

The Cost-Effectiveness of Professional Doula Care for a Woman's First Two Births: A Decision Analysis Model

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Introduction: Multiple studies have demonstrated the benefits of intrapartum doula care, including lower risk for cesarean birth and shortened labor time for nulliparous women. However, analyses investigating the cost-effectiveness of doula care are limited. This study evaluated the potential cost-effectiveness of professional doula support during a woman's first birth in a theoretical population of US women, with all women having a second birth without doula care.

Methods: A cost-effectiveness model was designed to compare outcomes in women with a professional doula versus no doula labor support. A theoretical cohort of 1.6 million women, the approximate number of annual low-risk, nulliparous, term, singleton births in the United States, was used. Outcomes included mode of birth, maternal death, uterine rupture, cesarean hysterectomy, costs, and quality-adjusted life years (QALYs). Probability estimates used in the model were derived from the literature, and a cost-effectiveness threshold was set at $100,000 per QALY. Sensitivity analyses were used to investigate the robustness of the results.

Results: In this theoretical model, professional doula care during the first birth resulted in fewer cesarean births and improved QALYs. Additionally, doula support resulted in 202,538 fewer cesarean births, 46 fewer maternal deaths secondary to fewer cesarean births, 99 fewer uterine ruptures, and 26 fewer hysterectomies, with an additional cost of $185 million and 7617 increased QALYs for the first and subsequent births. Sensitivity analyses demonstrated a professional doula was potentially cost-saving up to $884 and cost-effective up to $1360 per doula.

Discussion: Professional doula care during a woman's first birth may lead to improved outcomes and increased QALYs during her first and second births. Given the limitations of this analysis, the cost-effectiveness estimate is likely conservative, further supporting broader integration of professional doulas into the US maternity care system and highlighting the need for higher doula care reimbursement.
J Midwifery Womens Health 2019;00:1–11 © 2019 by the American College of Nurse-Midwives.

Keywords: professional doula, cost-effectiveness analysis, term birth, labor, labor care, low-risk, maternity care

INTRODUCTION

A professional doula is a trained birth companion who provides continuous emotional, physical, and informational support throughout a woman's labor and birth.[1] Whereas maternity care providers primarily focus on making safe and effective childbearing management decisions, in addition to attending to the laboring woman's overall well-being, professional doulas uniquely focus only on the woman's physical, social, and emotional needs throughout labor and birth.[1,2] This may include helping the laboring woman with breathing techniques, relaxation, and position changes; providing comfort via touch or other soothing actions; and offering continuous emotional support throughout labor.[1,3] Doulas also help women and their families anticipate events of labor and may facilitate communication between a woman and her maternity care provider.[1,3,4]

Randomized controlled trials have demonstrated that doula care during labor and birth results in fewer cesarean births and shorter labors among low-risk nulliparous women.[5,6] In addition to improving outcomes, doula care has also been demonstrated to reduce hospital costs.[7–11] In 2012, a US midwifery consensus statement affirmed the benefit of continuous labor support.[12] And in 2014, the American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine published a consensus statement supporting doula care as an important initiative to improve labor and birth outcomes for women with low-risk pregnancies.[13] Given growing evidence and national maternity care leadership support for doula care, there is a need to refine estimates of costs and outcomes related to this model of care.[14] Additionally, prior studies have evaluated the costs and outcomes associated with doula care during one birth only. But most childbearing women in the United States experience 2 births, and events of the first birth meaningfully shape options and risks related to the second birth (eg, repeat cesarean). To further elucidate the likely benefits of doula care, the authors evaluated the potential cost-effectiveness of support from a professional doula during a nulliparous woman's first labor and birth related to this first birth as well as one subsequent birth. Thus, maternal outcomes and costs were considered over 2 births,

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1526-9523/09/$36.00 doi:10.1111/jmwh.12972

Quick Points

- ✦ In this theoretical model, professional doula care during a woman's first labor and birth leads to fewer cesarean births, fewer adverse maternal outcomes, and improved quality-adjusted life years (QALYs) in the woman's first and subsequent births.
- ✦ Having a professional doula with a woman during her first labor and birth could be both cost-effective and cost-saving when reimbursement for this care is less than $884. Doula support costing $884 to $1360 remains cost-effective because the additional expenditure for care is accompanied by higher QALYs.
- ✦ When the model was adjusted to include contemporary cesarean rates (26% in this population), doula support was both cost-effective and cost-saving when reimbursement for this care was less than $1153, and doula support costing $1153 to $1808 remained cost-effective. Given the limitations of a decision analysis model, this estimated cost-effectiveness threshold is likely conservative.
- ✦ If a professional doula provided care during labor to all low-risk nulliparous women in the United States using the current cesarean birth rate, this model estimates that this would result in $247 million in savings and 10,483 additional QALYs every year.
- ✦ This cost-effectiveness analysis adds to the literature supporting the integration of professional doula support into a woman's first labor and signals the need for increased doula care reimbursement.

reflecting the average number of births per woman in the United States.[15]

METHODS

A decision-analytic model was created using TreeAge Pro 2018 software (TreeAge Software Inc, Williamstown, Massachusetts) (Figure 1). This study employed a theoretical decision-analytic model, which involved no human participants and was exempt from institutional review board approval. No primary research was conducted for this analysis. The purpose of this analysis was not to study the effect of doula care on maternal or neonatal outcomes; it was to create a model to estimate the costs and outcomes related to the decision for a woman to receive doula care (vs no doula care) during her first birth (see Table 1 for a description of and definitions for a decision and cost-effectiveness analysis).

This theoretical model used the results of previously published research about the impact of doula care on birth outcomes to estimate relevant costs and outcomes of this decision. The cost-effectiveness model was designed to assess the birth outcomes of pregnant women receiving professional doula support during birth versus no doula (Figure 1). The initial decision node was whether a woman did or did not have a professional doula during her first labor and birth. For the first birth, the primary maternal outcomes included in the theoretical model were mode of birth and maternal death, which varied by mode of birth. For the subsequent birth, the primary maternal outcomes included in the theoretical model were mode of birth, maternal death, and uterine rupture after an unsuccessful trial of labor after cesarean (TOLAC). For those with TOLAC, the primary maternal outcomes included in the theoretical model were vaginal birth after cesarean (VBAC), repeat cesarean, and a hysterectomy (vs no hysterectomy) after uterine rupture. In this model, women were provided a professional doula only during the first labor and birth in order to isolate the immediate (first birth) and downstream (second birth) impact of doula care. Additionally, all births were assumed to be carried out in a hospital or birth center.

A theoretical cohort of 1.6 million women, the approximate number of annual low-risk, nulliparous, term, singleton births in the United States, was used.[15] Specifically, according to the National Vital Statistics System, in 2016 there were approximately 3.8 million singleton births, of which 3.5 million were term births.[15] The researchers excluded births that were considered high risk, which included 6.9% of births to women with diabetes and was inflated by the authors to 10% to include other high-risk births. This left 3.2 million low-risk term births. The researchers then assumed that half of these births were to nulliparous women and half were to multiparous women, which resulted in the final theoretical cohort of 1.6 million women. These women were considered to have uncomplicated pregnancies (term, singleton, vertex fetuses), presenting in spontaneous labor at term.

After using the model to estimate the outcomes and costs related to the first birth, the authors then modeled the impact of a second birth, reflecting the average number of births per woman in the United States. Two main strategies were compared: professional doula support during a woman's first labor and birth versus no doula support during a woman's first labor and birth. In this model, a doula was defined as a person who had received formal training in doula care and who provided continuous bedside support throughout labor and birth.[5,6] This model also assumed that women without a professional doula received routine care, including intermittent support from family members, friends, or hospital staff.

All probabilities incorporated into the decision analysis model were derived from previously published research (Table 2). The probability of undergoing a cesarean or vaginal birth with the support of a professional doula was derived from 2 randomized controlled trials included in the 2017 Cochrane review of continuous support for women during childbirth.[16] Only these 2 experimental studies, which used a professionally trained doula, rather than another health care professional or layperson, to provide continuous support, were included in this theoretical model. In the first trial from 2008, all doulas providing continuous support had completed training equivalent to Doulas of North America International doula certification.[6] This trial included 420 nulliparous women with an uncomplicated term pregnancy planning to give birth at a hospital in Cleveland, Ohio. In the second trial, published in 1991, the doulas had prior birth experience and underwent a 3-week training period covering normal and abnormal labor, obstetric procedures, and supportive techniques.[5] This study consisted of 616 nulliparous women with an uncomplicated term pregnancy planning to give birth at a hospital in Houston, Texas. Although the authors recognize that the second trial is over 25 years old, it is generally considered more appropriate when evaluating literature quality to use findings from randomized controlled trials over nonexperimental studies. Thus, in decision-analytic models, such trials, when available, are used preferentially to inform cost-effectiveness analysis probabilities. Including probabilities from a randomized controlled research design allows for a less biased estimate of the effects of a professional doula versus no doula in this model.

Maternal mortality is difficult to study with experimental research design. Therefore, estimated maternal mortality after first cesarean birth and after vaginal birth was derived from a retrospective cohort study.[17] Maternal mortality was included as an outcome in this model given the small difference in rates of maternal mortality based on mode of birth (eg, women who have a cesarean birth have a higher risk for death than do those who have a vaginal birth). By including maternal mortality, this demonstrates important downstream effects of a professional doula's presence during a nulliparous woman's labor and birth, both on her risk of death secondary to cesarean at the first birth and on her risk of death secondary to repeat cesarean or complications of VBAC at the second birth. In other words, if a professional doula supporting a woman during her first birth leads to fewer cesarean births, this also results in overall fewer maternal deaths for first and second births compared with a system in which doula support is not used.

The probabilities for TOLAC, cesarean birth after TOLAC, and uterine rupture after TOLAC were derived from a large systematic review.[18] The probabilities of both planned and unplanned cesarean birth after prior vaginal birth were drawn from a large data set of births in Massachusetts from 1998 to 2003.[19] Results from a prospective cohort study were included to determine the probability of maternal death after planned repeat cesarean birth, maternal death after TOLAC, and hysterectomy after uterine rupture.[20] The probability for maternal death after uterine rupture was derived from a literature review of 72 primary research articles assessing outcomes for women attempting VBAC.[21] Finally, the probability for maternal death after hysterectomy secondary to uterine rupture was derived from a literature review of studies including cases of emergency postpartum hysterectomy.[22] This study provided the most specific probability representing the outcome for the relevant branch in the decision analysis tree.

Costs incorporated into the decision analysis model were derived from previously published research and estimates (Table 3). All costs were inflated to 2018 dollars using an average of the medical component of the Consumer Price Index for 2018 and assuming a societal perspective. The cost for a doula was estimated to be an average of $1000, ranging from $600 to $2000 based on doula experience and region in the United States. This fee includes standard doula care, consisting of several prenatal visits, on-call time throughout labor and birth, several postpartum visits, and 24-hour availability via phone or email during the first 6 weeks postpartum. The costs for a cesarean and vaginal birth, labor time for a nulliparous and multiparous woman, labor time for a TOLAC, hospital cost related to maternal death, and uterine rupture requiring repair were estimated from a single hospital.[23] Given that costs in health care are not well studied and not ubiquitously available across the range of health care inputs, this high-quality study allowed for a stronger estimate of the costs in this analysis.

The average labor time of a vaginal birth for a nulliparous woman and for a multiparous woman was derived from the data set of the Consortium on Safe Labor, a large multicenter retrospective observational study.[24] This study estimated 7.1 hours as the average nulliparous and 4.1 hours as the average multiparous length of the first and second stage of labor for women who arrived to the hospital in spontaneous labor and assuming all women had epidural analgesia in the second stage. Nulliparous women's labor durations were found to be 1.73 times longer than multiparous women's (based on a ratio of length of labor time by parity).[24] Assuming 50% of births were nulliparous and 50% were multiparous, the researchers calculated the cost of labor time for a nulliparous and multiparous birth based on the estimated additional hours of labor unit costs,[23] thus generating estimates of the total costs for the time to labor and give birth vaginally.[23] From this, the authors were able to calculate the total cost of labor time resulting in a vaginal birth for a nulliparous and multiparous birth. Additional hours of labor unit costs were estimated for women experiencing a TOLAC. Women who were not accompanied by a professional doula experienced an average of 1.0 additional hour of labor.[5]

The cost of maternal death was estimated as the opportunity cost of lost working years calculated using the median weekly earnings for a woman receiving a full-time wage or salary from the Bureau of Labor Statistics.[25] Given that the average age at first birth is estimated to be 26.6 years and the average age for retirement is 62 years,[15,26] the number of lost wages due to maternal death after a first birth and after a second birth were calculated (with a second birth occurring on average at age 29 years).[15]

Utilities were assessed from the maternal perspective only. Utilities are a measure of disease burden and are frequently used in economic analyses to assess individual's valuation of outcomes. Such utilities can then be applied over time to create estimated quality-adjusted life years (QALYs). In this model, the value of each outcome (eg, maternal state at each terminal branch of the decision analysis tree) is represented by an estimated utility, which is a quantitative measure representing the strength of a person's preference for that outcome.[27] Utilities have a range from 0 to 1: a utility of 1 represents perfect health, and 0 represents death. Utilities in this study were derived from the most robust literature available. This analysis included a utility of 0.996 for cesarean birth[28] and a

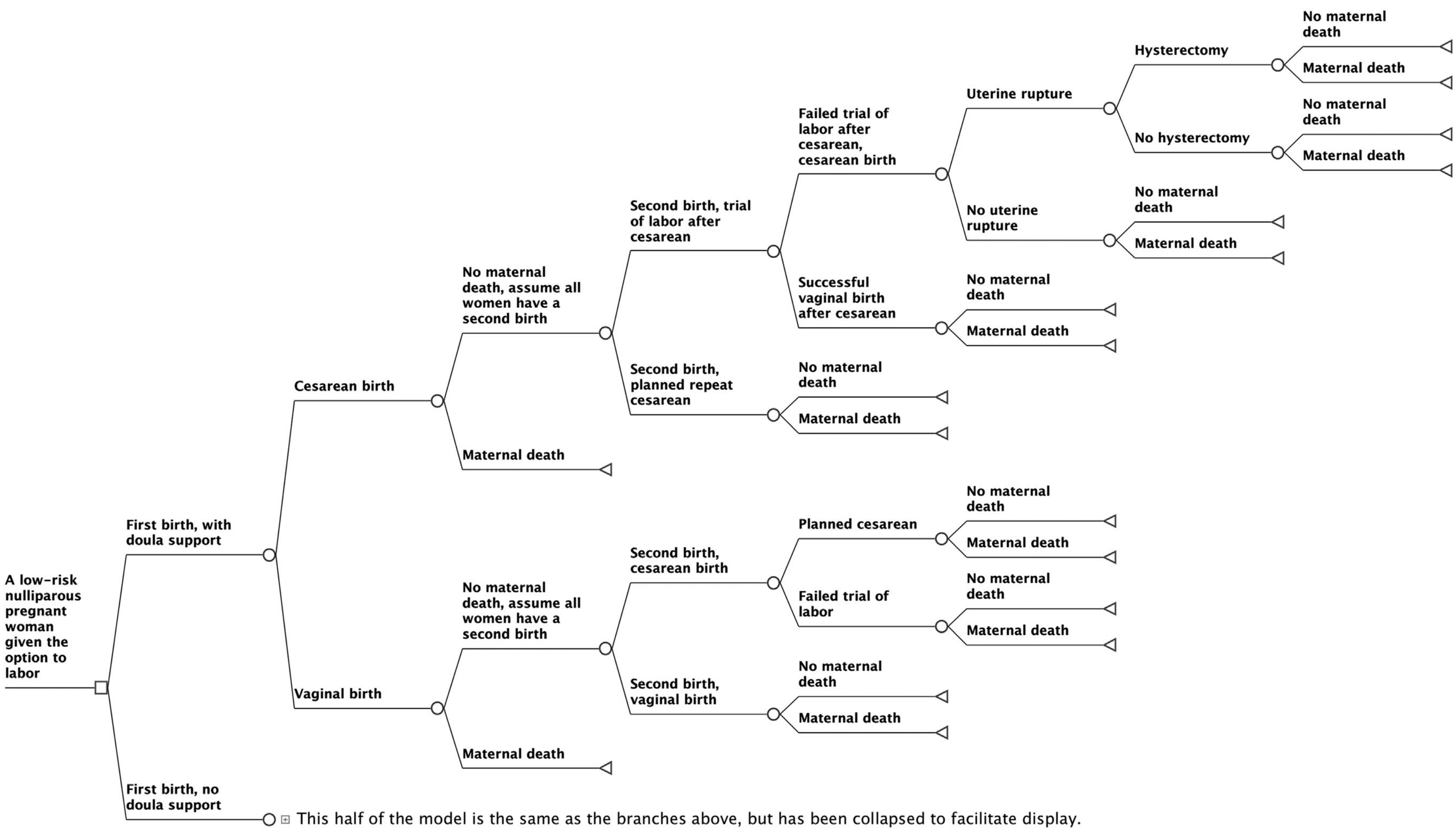

Figure 1. Schematic of Decision Tree Analysis
The square represents the decision node (eg, whether a professional doula is present during a woman's first birth or not). The subsequent circles represent chance nodes, with the branches representing the possible outcomes of each option. The triangles represent the terminal node or the final outcome of that decision branch.

Table 1. Description of Decision and Cost-Effectiveness Analyses

Decision analysis is a quantitative method used when making decisions in the face of uncertainty. Decision analysis allows clinicians to compare the expected outcomes of choosing one strategy over another in a systematic and explicit way.[38] It is believed that decision analysis can improve the quality of decision making among health care professionals and guide policy-making decisions.[27]

A *decision-analytic model* or *decision tree* is a simplified model of the most important components of the clinical decision and its primary anticipated outcomes. This model should include the key factors to appropriately represent the risk-benefit tradeoff of the decision under consideration, but it will be unable to capture the full complexity of clinical care and decision making.[39] A decision tree includes probabilities for each decision node, which are derived from the best available evidence, specifically randomized controlled trials when available. For an example of probabilities related to a decision node that is relevant to this model, the probability of cesarean birth was 10.8% if the decision was to include doula care during a woman's first labor, and the probability of cesarean birth was 18.9% if the decision was to not include doula care during a woman's first labor, which were derived from available randomized controlled trials (Table 2).

The value of each outcome is represented by a *utility*, which is a quantitative measure representing the strength of a person's preference for that outcome.[27] Utilities have a range from 0 to 1: a utility of 1 represents perfect health, and 0 represents death. Utilities in this study were derived from the most robust literature available. So, for example, 0.996 has been identified as the utility of cesarean birth whereas 0.963 has been identified as the utility of cesarean hysterectomy after uterine rupture (Table 2).

Cost-effectiveness analysis is a type of decision analysis that includes the costs of each decision (eg, doula support during a woman's first labor vs no doula support during a woman's first labor) in addition to the health effectiveness or utility of that decision. This type of analysis allows researchers to estimate efficiency and costs related to an intervention (eg, doula care vs no doula care). The measure used in this modeling approach for valuing health outcomes is quality-adjusted life years (QALYs), where one QALY is equal to one year of life multiplied by the utility of the outcome.

Given the uncertainty in the probabilities, costs, and utilities included in any decision analysis model, sensitivity analyses are used. Sensitivity analyses allow the researchers to vary the uncertain variables across a range of plausible values, thereby estimating what effect this uncertainty has on the final decision of the model.[27]

Overall, when a randomized controlled trial is unable to be performed because of ethical or monetary constraints, or a randomized controlled trial does not include all important clinical decisions and outcomes, decision analysis and specifically cost-effectiveness analyses may be used to derive evidence-informed estimates of health care decisions. These analyses allow clinicians and policy-makers to evaluate the impact of specific health care decisions in terms of their likely costs and outcomes in a systematic and evidence-based manner.

utility of 1 for vaginal birth, given this is the optimal mode of birth. Utilities were combined with estimates of maternal life expectancy from the National Center for Health Statistics to calculate QALYs.[29] These QALYs were used to assess the final health state at each terminal branch of the decision analysis tree, which included the utility for mode of birth, maternal death, and hysterectomy, when applicable. The utility for hysterectomy was 0.963,[23] which was applied to the remaining years of maternal fertility (estimated to be 20 years after second birth at age 29). An annual discount rate of 3% was applied to generate discounted QALYs and costs according to the Panel on Cost-Effectiveness in Health Medicine recommendations.[30]

Total costs and QALYs were calculated to determine the incremental cost-effectiveness of having continuous support from a professional doula during a woman's first birth. The incremental cost-effectiveness ratio (ICER) is used to compare 2 strategies (for this analysis, doula support vs no doula support during a woman's first labor), which represents the average incremental cost in relation to one additional QALY. In other words, the ICER shows how much it would cost to increase a QALY by one. The cost-effectiveness threshold was set at $100,000 per QALY, which is the recommended and one of the most commonly used thresholds in cost-effectiveness analyses in the United States.[31] This threshold represents the maximum price society will pay to gain one additional QALY or one year of perfect health. Next, maternal clinical outcomes for each strategy were computed, including those related to the subsequent pregnancy such as uterine rupture and cesarean hysterectomy.

Sensitivity analyses were conducted to investigate the robustness of the results. A tornado diagram was created to assess which variables most impacted the model. This diagram acts as a comparative sensitivity analysis and allows researchers to consider the uncertainty with model inputs by using distributions for each input to evaluate the impact

Table 2. Outcomes, Probabilities, and Utilities for the Professional Doula Cost-Effectiveness Model

Outcome	Probability	Utility[a]
Current Pregnancy		
Cesarean birth[28]		0.996
With a professional doula[5,6]	0.1078	
With no doula[5,6]	0.1894	
Maternal death		0
After cesarean[17]	0.000163	
After vaginal birth[17]	0.0000170	
Subsequent Pregnancy		
TOLAC[18]	0.580	
Cesarean after unsuccessful TOLAC[18]	0.280	
Planned cesarean after prior vaginal birth[19]	0.00650	
Cesarean after prior vaginal birth (planned and unsuccessful trial of labor)[19]	0.0310	
Uterine rupture[18]	0.00470	
Cesarean hysterectomy after uterine rupture[20,23]	0.263	0.963
Maternal death		0
After planned repeat cesarean[20]	0.000443	
After TOLAC[20]	0.000168	
After uterine rupture[21]	0.00114	
After cesarean hysterectomy[22]	0.0194	

Abbreviation: TOLAC, trial of labor after cesarean.
[a]Utilities define quality-of-life measures for different states of well-being, ranging from 0 for death to 1 for optimal health. In this model, utilities were used to represent the final health state at each terminal branch of the decision analysis tree, which included the utility for mode of birth, maternal death, and hysterectomy, when applicable.

Table 3. Costs for the Professional Doula Cost-Effectiveness Model

Cost	Amount, $
Professional doula in first birth	1000
Cesarean birth[23]	13,476
Vaginal birth (excluding labor time)[23]	7542
Labor time for a nulliparous woman[23]	2113
Labor time for a multiparous woman[23]	1221
Additional labor time with no professional doula support[5,23]	167
Uterine rupture requiring cesarean hysterectomy[23]	2391
Uterine rupture requiring repair[23]	1029
Maternal death (hospital cost)[23]	4000
Maternal death (annual lost wage[a])[25,26,29]	40,862

[a]Total lost wages were calculated by multiplying annual lost wages by number of years from birth (26.6 years if death after first birth and 29 years if death after second birth) until retirement (62 years old).

of these values on the model. The purpose of this step in the analysis is to determine how the estimated costs and outcomes related to each choice in the decision node may vary if the range of one variable is changed. For example, based on average costs for doula care in Portland, Oregon, it was assumed that doulas were paid $1000 for their work; however, it is clear that the cost of doula care may vary based on many factors. Sensitivity analyses enabled examination of how the model would change if doulas were paid more or less than $1000. This tests the strength of the model to changes in probabilities and costs related to one variable. For univariate (or one variable) sensitivity analysis, the cost of a doula was varied between $600 and $2000. The rate of cesarean birth with doula support was also varied to measure how this would change the results (from 5% to 20%). Furthermore, the effect size of cesarean birth with and without doula support from the available randomized controlled trials was applied to today's rate of 26% for low-risk (nulliparous, term, singleton, vertex fetus) cesarean births in the United States to compare this outcome with the expected outcome using the baseline probabilities.[32] Put simply, in this final analytic step the authors estimated the cost-effectiveness of doula care during a woman's first labor using contemporary estimates of how frequently low-risk nulliparous women give birth via cesarean. These provided threshold values below which the intervention would be cost-saving or cost-effective.

Professional doula support was deemed cost-saving if it resulted in lower costs and higher QALYs compared with no doula support. Alternatively, professional doula support was considered cost-effective if it resulted in lower costs and higher QALYs or higher QALYs in relation to higher costs, yet remained below $100,000 per QALY, compared with no doula.

Additionally, a Monte Carlo simulation analysis was conducted. The purpose of this step in the analysis is to determine how the estimated costs and outcomes related to each choice in the decision node may vary if the range of multiple variables is changed simultaneously. This tests the strength of the model to simultaneous multivariable changes in probabilities and costs. This analysis was performed to simulate the outcomes of 1000 low-risk nulliparous women given the option to labor. In other words, the Monte Carlo simulation analysis is a method of simulating reality by running the model 1000 times using the standard distributions of the model inputs to determine 1) how the model is impacted by variability and 2) the strength of the model given these wide distributions. In this simulation, the costs were assumed to have a gamma (γ) distribution. This is similar to a normal distribution but with a right skew, which is more appropriate for analyzing health care costs. Furthermore, a wide standard deviation of 50% was used given the intrinsic uncertainty and significant variation in health care costs estimates. Additionally, beta (β) distributions were used for the probability estimates.

RESULTS

This theoretical model estimated that having the continuous support of a professional doula during a woman's first birth leads to fewer cesarean births, fewer adverse maternal outcomes, increased costs, and increased QALYs (Table 4). Among the theoretical cohort of 1.6 million nulliparous women, in the first birth, there were 172,477 cesarean births for women with a professional doula present versus 303,030 among those without a doula. This would represent 130,553 fewer cesarean births with a doula present. Additionally, in the first birth, this theoretical model estimated 52 maternal deaths with a professional doula and 71 maternal deaths with no doula, demonstrating potentially 19 fewer maternal deaths with a doula present during the first labor and birth. Next, assuming all 1.6 million women have a second birth, among women in this model with a professional doula during the first birth only, 144,581 would have a cesarean birth during the second birth compared with 216,565 without a doula. This would represent 71,984 fewer second birth cesareans among women with a doula during the first birth. For the second birth, an estimated 69 maternal deaths would occur among the women with a professional doula versus 96 without a doula, demonstrating 26 fewer maternal deaths in the second birth among women with a doula during the first birth only. For the second birth only, having a professional doula during the first birth would result in 99 fewer uterine ruptures and among women with a uterine rupture, 26 fewer cesarean hysterectomies.

Over the 2 pregnancies, in this theoretical cohort, doula care during the first birth would result in 202,537 fewer cesarean births, or a 6.3% reduction, and 46 fewer maternal deaths, or a decrease of 0.0014%. Doula care would lead to an additional cost of $185 million but also an increase of 7617 QALYs. Using the univariate sensitivity analysis to vary the cost of a professional doula, it was estimated that when compared with laboring without a professional doula during a woman's first birth, having a doula is cost-saving or the dominant strategy (lower costs, higher QALYs) up to a doula cost of $884. Additionally, laboring with a professional doula is cost-effective (results in an ICER less than $100,000 per QALY) when doula care costs between $0 and $1360 (Figure 2). This cost includes several prenatal visits, doula support during labor and birth, several postpartum visits, and availability during the first 6 weeks postpartum. When varying the probability of having a cesarean birth with a professional doula (from 5% to 20%, assuming a baseline probability of 10.8%), having a professional doula would be cost-saving (lower costs, higher QALYs) up to a cesarean birth rate of 9.5% when a professional doula is present during a woman's first birth and would remain cost-effective up to a rate of 13.2%. Based on the Monte Carlo simulation of 1000 nulliparous women given the opportunity to labor, doula care during a woman's first birth would be cost-effective in 74% of the trials using a willingness-to-pay threshold of $100,000 per QALY (Figure 3).

Alternatively, if the baseline risk of cesarean birth was changed to the current US low-risk cesarean birth rate of 26%, and the effect size of cesarean birth rate was applied (see Table 2; $0.1894/0.1078 = 1.76$), this would result in a cesarean birth rate of 14.77% with a professional doula present. When including these new baseline probabilities and running the model informed by contemporary estimates of cesarean rates among low-risk nulliparous women, having a professional doula during a women's first labor and birth becomes the dominant, cost-saving strategy resulting in lower costs and higher QALYs. Results from this step in the analysis estimate that doula care during a woman's first birth would result in $247 million in savings and 10,483 additional QALYs. Furthermore, when varying the cost of a professional doula using these updated probabilities, having a doula is found to be cost-saving up to a doula cost of $1153 and cost-effective when the cost of a doula is anywhere from $0 up to $1808, compared with no professional doula.

DISCUSSION

In this theoretical analysis, it was estimated that doula care during a nulliparous woman's labor and birth would result in fewer cesarean births, fewer adverse maternal outcomes, and improved QALYs for the first and subsequent birth. The authors concluded that having a professional doula would be both cost-effective and cost-saving when reimbursement for this care is $884 or less. Doula support costing $884 to $1360 would remain cost-effective because the additional expenditure for care would be accompanied by higher QALYs. Using contemporary estimates of the cesarean birth rate among low-risk nulliparous women, having a professional doula would be both cost-effective and cost-saving when reimbursement for this care is $1153 or less, whereas doula support costing $1153 to $1808 would remain cost-effective. This amount includes the full cost of professional doula care, including several prenatal visits, doula support

Table 4. Outcomes of 2 Births in a Theoretical Cohort of 1.6 Million Nulliparous Term Births in the United States Associated with Professional Doula Support Versus No Doula During the First Birth Only

Outcomes	Doula	No Doula	Difference[a]
First birth			
Cesarean births	172,477	303,030	−130,553
Maternal death	52	71	−19
Second birth			
Cesarean births	144,581	216,565	−71,984
Maternal death	69	96	−26
Uterine rupture	131	230	−99
Cesarean hysterectomy after uterine rupture	34	61	−26
Total cost (in millions)	$31,949	$31,764	+$185
Total QALYs[b] (effectiveness)	41,917,334	41,909,717	+7617

Abbreviation: QALY, quality-adjusted life year.
[a]Numbers may not add up because of rounding.
[b]Utilities are a measure of disease burden and are frequently used in economic analyses to assess individual's valuation of outcomes. Such utilities can then be applied over time to create estimated QALYs. One QALY is equal to one year of life multiplied by the utility of the outcome. Utilities define quality-of-life measures for different states of well-being, ranging from 0 for death to 1 for optimal health. In this model, utilities were used to represent the final health state at each terminal branch of the decision analysis tree, which included the utility for mode of birth, maternal death, and hysterectomy, when applicable.

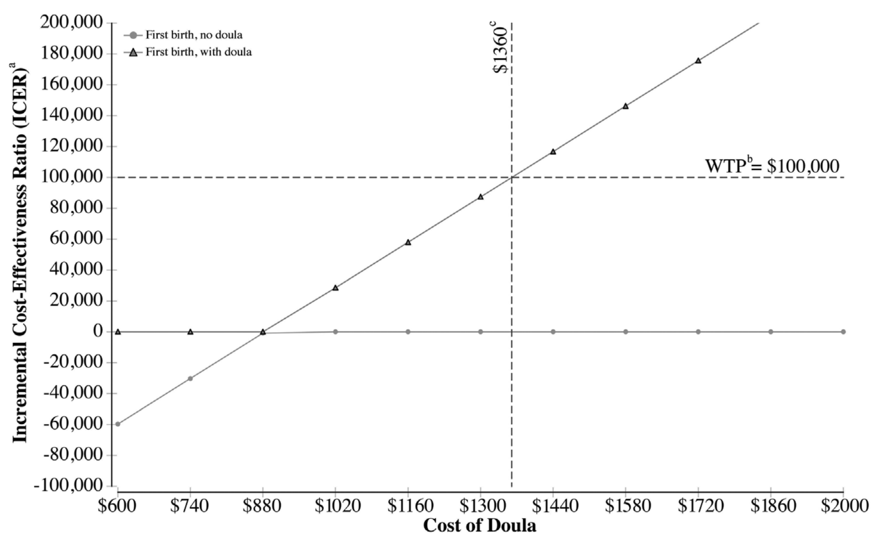

Figure 2. Univariate Sensitivity Analysis
The vertical axis displays the ICER, and the horizontal axis displays the cost of having a professional doula in the first birth only, varied from $600 to $2000. This figure demonstrates a professional doula is cost-effective up to $1360 for the cost of the doula, at a WTP threshold of $100,000 per quality-adjusted life year (QALY).

Abbreviations: ICER, incremental cost-effectiveness ratio; WTP, willingness to pay.
[a]The ICER is used to compare 2 strategies (continuous support by a professional doula vs no doula), which represents the average incremental cost in relation to one additional QALY.
[b]The WTP threshold represents the maximum price society will pay in order to gain one additional QALY or one year of perfect health.
[c]In this model, informed by both the ICER and WTP threshold, doula care during a woman's first labor is cost-effective up to $1360 for the cost of the doula.

during labor and birth, a number of postpartum visits, and phone and email availability during the first 6 weeks postpartum.

Several studies have assessed the outcomes and costs associated with having a professional doula during labor and birth, demonstrating a reduction in costs due to a reduced number of cesarean births, decreased use of epidural analgesia, and fewer instrumental vaginal births.[7,8,10] Nevertheless, no prior studies have examined the influence of doula care during a woman's first birth on the cost-effectiveness and outcomes of both her first and second births. This cost-effectiveness model includes maternal outcomes, specifically maternal death, uterine rupture, and cesarean hysterectomy as a result of prior cesarean birth, not considered in prior studies. Although many initiatives and studies seeking to improve maternity care outcomes are emerging,[33] it is worth noting that professional doula care in labor has long-standing evidence of effectiveness without incurring additional risk. Findings from this theoretical model demonstrating the cost-effectiveness of professional doula care highlight doula

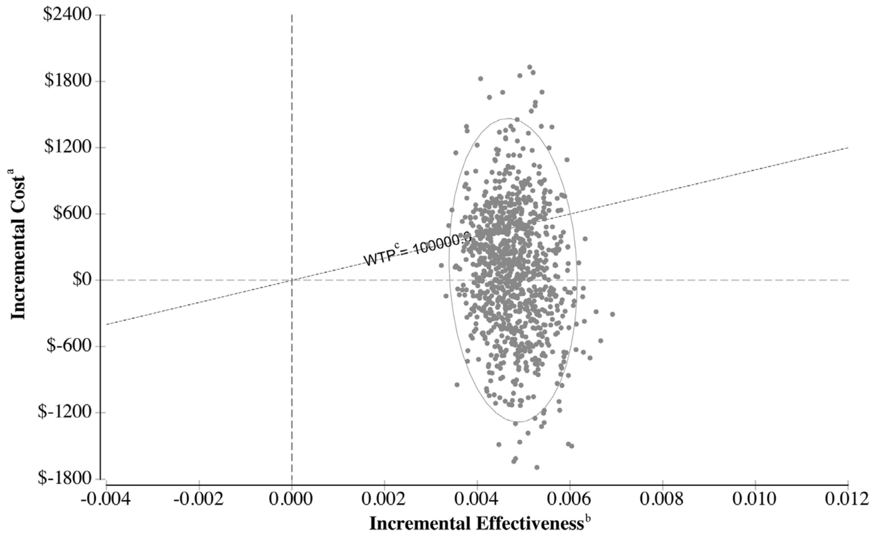

Figure 3. Multivariable Sensitivity Analyses
This is a Monte Carlo simulation analysis, which simulates the outcomes of 1000 low-risk nulliparous women given the option to labor. The vertical axis displays the incremental cost, and the horizonal axis displays the incremental effectiveness. The dashed line indicates a WTP threshold of $100,000 per quality-adjusted life year (QALY). Each dot represents the results of a single trial (the calculated incremental cost-effectiveness ratio [ICER]), and the ellipse represents the 95% confidence ellipse of outcomes. The ICER is used to compare 2 strategies (continuous support by a professional doula vs no doula), which represents the average incremental cost in relation to one additional QALY, and is calculated by dividing the incremental cost by the incremental effectiveness for each simulation through the model.

Abbreviation: WTP, willingness to pay.
[a]The incremental cost represents the incremental cost of having a professional doula compared with no doula. In other words, it is the total cost of one simulation of having a professional doula minus the total cost of one simulation through the model without a professional doula.
[b]The incremental effectiveness represents the incremental QALYs of having a professional doula compared with no doula. In other words, it is the final QALYs calculated for one simulation of having a professional doula minus the final QALYs of one simulation through the model without a professional doula.
[c]The WTP threshold represents the maximum price society will pay in order to gain one additional QALY or one year of perfect health.

support as a maternity care strategy with promise to achieve optimal care with minimal to no risk as well as cost savings. The combination of these factors makes doula care worthy of consideration for wider incorporation into standard US maternity care.

There is evidence that doula care may be underutilized in the United States.[11] The 2013 Listening to Mothers survey found that only 6% of laboring women use doula care.[34] This survey also found that women insured by Medicaid were more likely to have an unmet desire for doula support during labor compared with privately insured women.[34] These findings suggest that there are important barriers to accessing doula care in the United States. Another barrier to continuous doula care is the result of poor integration of doulas into the maternity care team. Currently, very few hospital systems have a hospital-based doula program, and a majority of doula services are paid directly by the woman.[4] This is most likely attributable to limited financial resources, low reimbursement for doula care, discouragement of some health care providers from using doula services, and lack of knowledge about doula care.[3,35–37]

Initiatives to expand access to professional doula care during labor are emerging in health policy as well as within maternity health care systems. Policy efforts include state-level legislative initiatives (Oregon and Minnesota) to acquire Medicaid reimbursement for doula support.[4] Several hospital-based models that integrate doulas into the broader maternity care team have recently emerged, including labor and birth units that employ doulas.[11,35] Dissemination of best practices for incorporating routine access to professional doulas within hospital-based maternity care teams is an important direction for future research.

Additional reasons to move toward routinized access to professional doula care during labor relates to emerging evidence that doula care may help to mitigate social determinants of health that adversely affect US women who are most vulnerable to poor outcomes.[35,36] Given that black women more frequently desired but were unable to access doula support (vs white women), efforts to routinize professional doula care may be especially important for improving outcomes among these women and reducing health disparities.[34] As well, there is evidence supporting higher levels of patient satisfaction associated with doula care.[16,35] Thus, maternity care system changes that advance professional doula access for all US women in labor could improve outcomes among those who may derive the most benefit from this care while increasing overall maternity care satisfaction.

There are several limitations to this research. This model did not account for all outcomes related to intrapartum doula care. For example, previous research has demonstrated that continuous doula support is associated with decreased use of epidural analgesia, compared with no doula support.[6] Therefore, the cost-effectiveness estimates are likely conservative, and including a wider range of maternal and neonatal outcomes in such an analysis may provide additional support for this association.

Because of methodological limitations of cost-effectiveness analyses, this model is subject to uncertainty in the inputs for the selected probabilities, costs, and utilities. Inputs were chosen from the available evidence, but several of the studies used were subject to bias, low external validity, and the possibility of being underpowered. As an example, maternal mortality is a rare outcome and the estimates for death after a vaginal and cesarean birth were derived from a single large study.[17] In addition, a majority of the costs were derived from a study that gathered financial data from a single institution, which may not accurately reflect the costs of maternal health care in other parts of the United States.[23] Furthermore, assumptions were made for several of the cost calculations. When calculating the cost of labor time, although the length of labor was drawn from a large multicenter retrospective observational data set,[24] multiple assumptions were used to compare the length of labor between nulliparous and multiparous women. This suggests the estimated cost-effectiveness threshold may vary depending on the costs and maternal health practices at a specific institution, and the reported cost-effectiveness estimates in this study may be quite conservative. The authors were also limited by the number of randomized controlled trials assessing a professional doula versus no doula and maternal outcomes conducted in the United States; therefore, one study published in 1991 was used to determine the probability of cesarean in the model.[5] Another approach would have been to use the effect size from the available randomized controlled trials and apply it to known current rates of cesarean birth in the United States. This approach was applied as a sensitivity analysis and demonstrated that when including the baseline cost of a doula at $1000, but using today's cesarean birth rate of 26%, having a professional doula was found to be cost-saving (lower costs and higher QALYs). This is in contrast to the original model, which demonstrated that having a professional doula present was only cost-saving up to $884 per doula and was cost-effective (higher costs despite higher QALYs), at a baseline cost of $1000 per doula. This demonstrated that an approach utilizing the current cesarean birth rate actually biases the study toward greater cost-effectiveness of the intervention; therefore, the authors opted for the more conservative approach.

Even when considering these limitations, the univariate sensitivity analyses and Monte Carlo simulations suggest that the proposed strategy of nulliparous women receiving doula care is cost-effective as results remained robust across a wide and clinically plausible range. Thus, these theoretical model estimates indicate that professional doula care during nulliparous labor and birth may improve quality of life and lead to improved maternal outcomes.

In conclusion, estimates from this cost-effectiveness analysis add to the literature supporting the integration of a professional doula into a woman's labor care and signal the need for increased doula care reimbursement. Increasing low-risk women's access to professional doula support holds great promise to enhance the quality of US maternity care while remaining cost-effective.

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

ACKNOWLEDGMENTS

Dr. Ellen L. Tilden receives support from the Eunice Kennedy Shriver National Institute of Child Health and Human Development and National Institutes of Health Office of Research on Women's Health, Oregon BIRCWH (Building Interdisciplinary Research Careers in Women's Health) Scholars in Women's Health Research across the Lifespan (K12HD043488-14). This source of funding had no involvement in any aspects of the research presented in this article.

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