A Review of Factors Associated With Dystocia and Cesarean Section in Nulliparous Women

Nancy K. Lowe, CNM, PhD

The primary indication for cesarean section in nulliparous women continues to be clinical diagnoses that fall under the rubric of dystocia. These diagnoses account for approximately two-thirds of all cesareans experienced by otherwise healthy nulliparous women. Contemporary research evidence suggests that this clinical phenomenon is complex and multifactorial. This review explores factors associated with the phenomenon of dystocia in the context of a conceptual model that considers women's physical and psychological characteristics, fetal factors, intrapartum care and interventions, assessments and clinical decision-making of health care providers, the sociopolitical environment, and the social and physical environment of childbirth. Clinical recommendations include emphasis on the maintenance of normal weight and weight gain during pregnancy, delaying the admission of nulliparous women to the hospital until active labor is established, avoiding elective induction for nulliparous women, keeping women well-hydrated and well-fed during labor, providing high-quality supportive care during labor, staying the course with effective treatment when dystocia is encountered, and a renewed emphasis on the psychobehavioral preparation of nulliparous women for the realities of labor. J Midwifery Womens Health 2007;52:216–228 © 2007 by the American College of Nurse-Midwives.

keywords: cesarean section, dystocia, nulliparous

INTRODUCTION

In approximately two-thirds of the cases of cesarean section in nulliparous women, the only indication for cesarean is dystocia, or abnormal labor.[1] Clinically, dystocia incorporates the diagnoses of failure to progress, arrest of dilatation, fetopelvic or cephalopelvic disproportion, prolonged active phase, secondary arrest of dilatation, arrest of descent, and malposition. Nulliparous women are particularly vulnerable to a diagnosis of dystocia for reasons that remain obscure. More than a decade ago, Heilbrunn and Park[2] noted that the proportion of women diagnosed with lack of progress during labor more than tripled from 3.8% to 11.6% between 1970 and 1989. In a 2000 report, the American College of Obstetricians and Gynecologists (ACOG) noted that across the United States, the greatest variation in primary cesarean section rates occurs among nulliparous women with term singleton fetuses in vertex presentations without complications.[3] The ACOG report further concluded that there is no evidence that higher cesarean section rates in these low-risk nulliparous women result in improved outcomes.

A primary obstetric care objective of Healthy People 2010[4] is to reduce cesarean births among healthy low-risk women giving birth for the first time. Low-risk is defined as a full term pregnancy with a singleton fetus in a vertex presentation in the absence of maternal complications. For nulliparas who are low risk, the 2010 cesarean birth target is a 15% reduction from a baseline rate of 18% in 1998. Unfortunately, the cesarean section rate for this population of women in the United States has continued to rise rather than decline, with national rates rising from 19% in 2000 to 25% in 2004.[5] As illustrated in Figure 1, at the current increase in annual rate, the national cesarean birth rate in the United States for healthy women giving birth for the first time can be projected at more than 30% by 2010, double the Healthy People 2010 target.

MODEL FOR CONCEPTUALIZING THE OUTCOME OF CESAREAN SECTION FOR DYSTOCIA

Although cesarean section for dystocia is a clearly identifiable outcome, the factors that may be causally interrelated to the chain of events that result in this outcome are less clearly defined. In Figure 2, the author has conceptually identified six broad areas that may be involved in the etiology of cesarean section for dystocia in healthy *n*ulliparous women at *t*erm with a *s*ingleton fetus in a *v*ertex presentation (NTSV) in contemporary US health care. These conceptual areas include: 1) individual physical and psychological characteristics of women that may influence their psychophysiologic function during labor; 2) fetal factors including weight, presentation, and position; 3) assessments and clinical decision-making of health care providers that depend on the beliefs, attitudes, knowledge, and skill of individual providers as well as local definitions of types of dystocia and adequate trial of labor, and local expectations for intervention and action; 4) intrapartum care and interventions that may affect labor progress; 5) the sociopolitical environment including availability of provider types, medical–legal influences, third-party payer influences, licensure and interdisciplinary turf issues, the social

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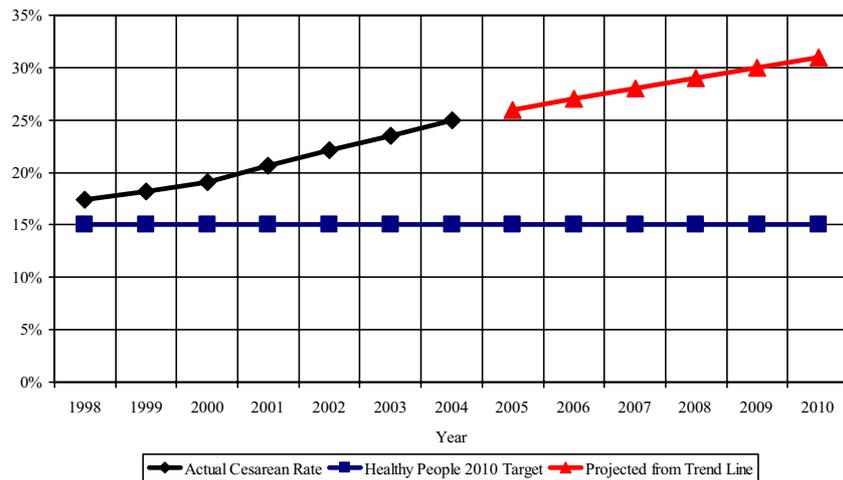
Figure 1. Projected national cesarean rate for healthy US first-time mothers at term with a singleton fetus in a cephalic presentation.

acceptability of various forms of care and women's behavior during labor, institutional norms and regulations; and 6) the social and physical environment including family and friends, the location of labor and birth, and the physical characteristics of the birthing environment. The purpose of this model is to visually depict the complexity of the influences and events that may interact to eventually lead to the outcome of a dystocia diagnosis and eventual cesarean section in NTSV.

This article reviews concepts relevant to the diagnosis of dystocia in NTSV, explores factors related to three areas of this complex etiological model (characteristics of women, fetal factors, and intrapartum care), and concludes with specific practice recommendations.

The English midwifery literature was searched for articles that targeted the occurrence of dystocia, the relationship of dystocia to cesarean section rates, factors related to observed rates of cesarean section for dystocia, and the effects of interventions on dystocia and cesarean section in this population. MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and the Cochrane Database of Systematic Reviews were searched from 1990 forward using various combinations of the terms dystocia, failure to progress, arrest of dilatation, cephalopelvic disproportion, arrest of descent, nulliparous or nullipara, parity, and cesarean section. This is not a systematic review; rather, it is an integrated review of a broad body of literature relevant to this critical issue in contemporary midwifery and obstetric practice.

DYSTOCIA IN NULLIPAROUS WOMEN AT TERM

Definition and Diagnosis

Dystocia is a general term used to signify abnormal labor resulting from abnormalities primarily involving uterine contractions or maternal expulsive efforts (power); the position, size, or presentation of the fetus (passenger); the maternal pelvis or soft tissues (passage); or combinations of these factors.[6] The precise criteria and terminology for the diagnosis of abnormal labor were previously defined based primarily on the work of Friedman more than four decades ago, and were adopted by the American College of Obstetricians and Gynecologists (ACOG).[7] In this classification scheme, labor problems were categorized as either protraction disorders (slower than normal) or arrest disorders (complete cessation of progress) in relation to specific characteristics of two labor parameters over time: cervical dilatation and fetal descent in the maternal pelvis. For nulliparous women, these criteria included cervical dilatation at a minimum of 1.2 cm per hour in active labor.

The most recent ACOG Practice Bulletin on dystocia[6] no longer specifies these strict diagnostic parameters, referring simply to the slower than normal (protraction) or complete cessation of progress (arrest) labels. Importantly, the diagnosis of dystocia cannot be made until the latent phase of labor has been completed, active labor has commenced, and an adequate trial of labor has occurred. The definitions of what is normal progress and what constitutes an adequate trial of labor remain clinically challenging.

Parameters of Normal Labor in Nulliparous Women

More recent analyses of labors in nulliparous women have demonstrated a significantly longer average duration of normal labor than the Friedman labor norms in women whose labors were managed by midwives[8,9] and by physi-

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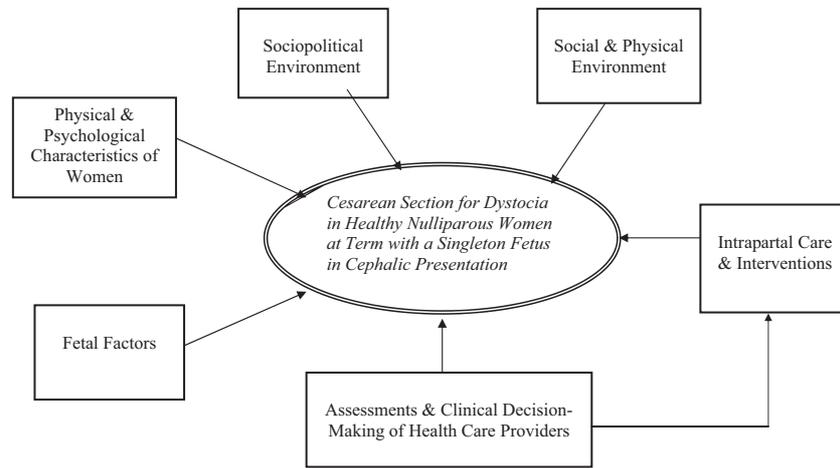
Figure 2. Conceptual model of factors affecting the occurrence of cesarean section for dystocia in healthy nulliparous women.

cians.[10] In these series, the length of active labor for NTSV who were in spontaneous labor was substantially greater than the Friedman norm of 2.5 hours from 4 to 10 cm of dilatation. Albers[9] found a mean length of active labor of more than 7 hours, while Zhang et al.[10] found an average of 5.5 hours in this population. The outside range of normal (interpreted as 2 standard deviations greater than the mean, consistent with Friedman's work) was 19.4 hours and 17.5 hours, respectively, in the two reports by Albers et al.[8,9] It is important to note than in the Albers' samples, women who received oxytocin augmentation during labor were excluded from the analysis, while 50% of the women in the Zhang et al.[10] study received oxytocin.

Active Management of Labor Protocols

Although it has long been recognized that a woman's first labor is often her longest, the introduction of "active management" in the early 1970s[11,12] marked the beginning of the now rather widespread belief in the tendency toward "inefficiency" of labor in nulliparous women. As commonly defined, a process that is inefficient does not produce a desired effect in a given amount of time or with a reasonable expenditure of effort or work. The method of active management was specifically developed for and restricted to NTSV, the population of interest for Healthy People 2010 goals.

The basic premise of active management is strict criteria for the diagnosis of labor and aggressive response to myometrial dysfunction ineffective in promoting cervical dilatation, according to preset partogram criteria based on a 12-hour limit from admission to delivery.[12] The clinical protocol includes prospective diagnosis of spontaneous labor that commits a woman to delivery within 12 hours, early amniotomy, early recognition of uterine inefficiency (dystocia), and treatment with intravenous oxytocin in a standard dosage regimen, in the context of one-to-one midwifery care.

The Irish experience is that active management has kept the total length of in-hospital labor under 12 hours for the majority of nulliparous women and the cesarean section rate significantly lower than rates in the United States for nulliparas.[12,13] Although one meta-analysis of 18 studies found that active management of labor is associated with a 34% decrease in the rate of cesarean delivery for dystocia in nulliparas,[14] others suggested that the effect was much more modest, and that the primary effective ingredient was supportive care during labor rather than the amniotomy or oxytocin administration.[15] In their retrospective analysis of 500 consecutive nulliparous women in spontaneous labor, Impey et al.[16] reported the outcomes of an active management protocol in the United Kingdom and found a mean cervical dilatation on admission of 1.7 cm, a mean duration of labor from admission to delivery of 6.1 hours, a 47% incidence of oxytocin administration during labor, and a 5.4% cesarean rate, 52% of these for dystocia. All but 2.8% of these women delivered within 12 hours of admission, and two-thirds delivered by 7 hours. Interestingly, all 27 cesareans occurred in women who were diagnosed "in labor" at less than or equal to 2-cm cervical dilatation.

Despite widespread adoption of some principles of active management in US hospitals, the cesarean section rate for nulliparous women at term has continued to increase, and the promise of active management to keep the cesarean section rate for dystocia low has not been realized in this country. A primary reason for this failure may be the absence of midwifery care for all but a small minority of women in the United States. In addition, Dublin active management is conducted in one large maternity institution where a systematic approach to diagnosis, ongoing assessment, and intervention to the care of women in spontaneous labor has been institutionalized and is reinforced through regular outcome monitoring in the context of collaborative midwifery/obstetrical care. There are few US institutions in which care practices and intervention criteria are so closely

defined and consistently monitored for all providers in the institution.

Adequate Trial of Labor

As pointed out by Impey et al.,[16] "the perception that long labor is unacceptable has had an important effect on the rising cesarean delivery rate since the 1970s." According to ACOG's Practice Bulletin "Dystocia and Augmentation of Labor,"[6] minimal uterine activity to advance labor is 3 contractions in 10 minutes with an intensity of 25 mm Hg greater than baseline. ACOG further states that adequate treatment for protraction or arrest disorders is evidenced by a maximum of 5 contractions in 10 minutes with cervical dilatation. Although the quantification of uterine activity via intrauterine pressure catheter and calculation of Montevideo units has been used to determine "adequacy" of the uterine effort (e.g., minimum of 4 hrs of contraction pattern >200 Montevideo units),[17] Rouse et al.[18] showed that oxytocin-augmented labor proceeds at a significantly slower pace than spontaneous labor using Friedman criteria. Their data indicated that the vaginal delivery rate significantly increased with no increase in morbidity when 4 hours of adequate contractions were allowed before cesarean section for failure to progress was performed versus the conventional 2-hour limit. ACOG has also pointed out that there is no convincing evidence demonstrating lower rates of cesarean or improved perinatal outcomes with the use of intra-uterine pressure catheters compared to external tocodynamometry for the evaluation of uterine activity.

In their recent review, Lin and Rouse[19] proposed a definition of failed induction "as the inability to achieve a cervical dilatation of 4 cm and 90% effacement, or at least 5 cm (regardless of effacement) after a minimum of 12 to 18 hours of membrane rupture and oxytocin administration." Although this definition is limited to suggested parameters for induced labor, it may provide some guidance for management of dystocia, particularly when augmentation of labor has begun before the minimum dilatation and effacement criteria proposed.

PHYSICAL AND PSYCHOSOCIAL CHARACTERISTICS OF WOMEN

Maternal Age

A number of maternal factors known before labor have been linked to dystocia in otherwise low-risk women. Increasing maternal age, particularly ages above 35 years, has been consistently associated with an increased risk of dystocia and subsequent cesarean section (Table 1). Regardless of absolute cesarean rates at the time of study, nulliparous women in this age bracket generally experience cesarean delivery at twice the rate of their younger counterparts.[20–23] This relationship is particularly important in light of the increasing mean age at first birth from 21.4 years in 1970 to 25.2 years in 2003

and 2004.[24] Overall, these studies indicate that first-time mothers over the age of 35 are more likely to be white, married, and have private insurance, and are at increased risk for dystocia, use of oxytocin during labor, and cesarean section delivery, but have no increased incidence of adverse neonatal outcomes. Two retrospective studies of large cohorts of nulliparous women divided into 5-year age brackets showed that the incidence of failure to progress, fetal distress, and cesarean section during labor increased progressively in each age bracket after age 25 with large increases seen after age 35 and 40 respectively.[21,22] Some investigators[23] have suggested that a progressive, age-related deterioration in myometrial function may partially explain these observations, although other maternal characteristics and provider behaviors also may be important. No biological evidence for the hypothesis of age-related deterioration in myometrial function was found in the literature.

Genetic Predisposition

A potential genetic mechanism in dystocia was proposed in a population-based Swedish study of mother–daughter, sister–sister, and twin sister pairs[25] and a study of mother–daughter pairs in Utah[26] (Table 2). In both studies, the mothers' history of dystocia and operative vaginal or abdominal delivery significantly increased daughters' risk of a similar occurrence with a similar sister-to-sister effect in the Swedish study. The Swedish researchers acknowledged that the increased incidence of dystocia diagnosis from 2.2% in the maternal cohort to 12.5% in the daughter cohort may reflect revised diagnostic classifications adopted during the intervening years rather than a real increase in the incidence of dystocia. Although a genetic tendency toward inefficient labor may be responsible for these observations, the psychological mechanism of self-fulfilling prophecy as well as intergenerational changes in obstetric care cannot be excluded as factors responsible for these observed familial associations.

Maternal Height

Short stature is associated with an increased risk of cesarean section, particularly when maternal height is less than or equal to 150 cm.[27,28] As summarized in Table 3, these studies suggest that maternal height under 150 cm (approximately 5 feet) is associated with an approximate 2-fold or greater increased risk of cesarean delivery in nulliparous women. McGuinness and Trivedi[28] pointed out that the risk of cesarean increased gradually as maternal height decreased, with the absolute risk of cesarean not reaching 30% until women were less than 140 cm (4 feet, 6 inches) tall. The likelihood of normal vaginal delivery was still more than 80% at modest levels of short stature.

Table 1. Results of Referenced Studies Reporting the Relationship Between Maternal Age in Nulliparous Women and Cesarean Section for Dystocia

Study (Year)	Design, Setting, and Subjects	Potential Confounders	Findings
Adashek et al.[20] (1993)	Prospective, descriptive in one Level III hospital in Illinois: 275 nulliparas, 20–29 years, and 74 nulliparas, ≥35 years, with term, singleton pregnancies, cephalic presentations in spontaneous labor	No differences between groups in gestational age, pregnancy weight gain, or BMI; older nulliparas more likely to be white, cared for by private physicians, and have a higher prepregnancy weight	Older nulliparas more than twice as likely to experience cesarean section (OR, 2.4; 95% CI, 1.2–5.1); dystocia (arrest of dilatation or descent) accounted for 90% or more of the cesareans in both groups
Ecker et al.[21] (2001)	Retrospective, descriptive in one Level III hospital in Massachusetts; 3715 nulliparas with term pregnancies	Sample included women with multiple gestations as well as those with prelabor cesareans for malpresentation, prior myomectomy, etc.	In those women (n = 3428) who labored (spontaneously or induced), the rate of cesarean section rose continuously from 8.3% for nulliparas <25 years to 31.6% for those ≥40 years; from age 25, the risk for cesarean was higher during induced compared to spontaneous labor
Main et al.[22] (2000)	Retrospective, descriptive in one Level III hospital in California; 8496 nulliparas with term, singleton pregnancies, cephalic presentation in spontaneous labor; divided into six different 5-year age group brackets	Proportion of each cohort identified as other than white or Hispanic decreased as maternal age increased; use of epidural anesthesia and birth weight increased as age increased	Cesarean section rate increased significantly per age cohort beginning at age 25, with continuous increase in rates of cephalopelvic disproportion or failure to progress (dystocia) from age 25; compared to the younger age groups, the risk of cesarean section rose significantly by age cohort: ≥30 to <35 [OR, 2.18; (CI, 1.20–3.96)]; ≥35 to <40 [OR, 2.97; (CI, 1.62–5.45)]; ≥40 [OR 4.68 (CI 2.43–9.04)]
Rosenthal and Paterson-Brown[23] (1998)	Prospective, descriptive in one London teaching hospital; 6410 nulliparas with term, singleton pregnancies, cephalic presentations of all ages	Age treated as a continuous variable	Rates of induction of labor, prelabor cesarean section, and instrumental vaginal delivery and cesarean section during spontaneous and induced labor increased significantly with increasing maternal age (P < .001); with each additional year of age, the risk of cesarean section during labor increased (OR, 1.08; CI, 1.06–1.11)

CI = confidence interval; OR = odds ratio.

Weight and Pregnancy Weight Gain

Both maternal overweight (body mass index [BMI] ≥25) and obesity (BMI ≥29) before pregnancy have been consistently linked to increased risk of dystocia and cesarean section, even in the absence of other complications[27,29–32] (Table 3). Regardless of prepregnancy BMI, maternal pregnancy weight gain in excess of 35 to 40 pounds also is associated with increased risk of dystocia and cesarean delivery.[30–33] Nuthalapaty et al.[34] found that for each 10-kg weight increment in nulliparous women, the rate of cervical dilatation significantly slowed, and the duration of labor and the risk of cesarean increased during induction of labor.

In their study of women attended by certified nurse-midwives (CNMs), Kaiser and Kirby[35] found that regardless of pregnancy weight gain, short stature, maternal age, parity, or intrapartum complications, maternal obesity was associated with a significantly increased risk of cesarean delivery. Although these and other studies of mixed parity samples consistently link maternal prepregnancy overweight and obesity as defined by BMI to increased cesarean risk for dystocia, Vahratian et al.[31] point out that when a more statistically conservative multivariate risk ratio (RR) is calculated, the risk of cesarean for dystocia is less than previously reported in obese nulliparas and insignificant for overweight nulliparas.

Stress

The catecholamine-mediated maternal stress response to the psychological and physical demands of labor has been implicated as a potential factor in the development of dystocia in nulliparas. The clinical hypothesis is that exaggerated production of catecholamines, particularly epinephrine, in response to pain and stress, disrupts coordinated uterine contractions by binding with beta-adrenergic receptors on the myometrial smooth muscle cells. The proposed link between the catecholamines norepinephrine (NEP) and epinephrine (EPI) and dystocia is through the effect of high levels of EPI on beta-adrenergic receptors of the uterine musculature. Similar to other primates, the human myometrium is richly supplied with beta-adrenergic receptors whose stimulation by EPI or other beta-sympathomimetic agents is associated with decreased uterine contractility.[36]

Although a growing body of research supports an independent link between psychosocial stress and adverse pregnancy outcomes, such as preterm birth,[37] research on the stress-related aspects of difficulties that arise during labor at term in otherwise healthy women is sparse. This lack of

Table 2. Results of Referenced Studies Reporting a Potential Genetic Link in Dystocia

Study (Year)	Design, Setting, and Subjects	Potential Confounders	Findings
Berg-Lekas et al.[25] (1998)	Swedish Medical Birth Registry from 1973–1990; 9852 mother–daughter pairs, 2916 sister–sister pairs, and 40 twin sister pairs	Multiple births excluded; mother–daughter pairs included only when the eldest daughter was the mother's first child; sister–sister and twin sister pairs included only when both were first births	Nulliparous eldest daughter of a mother who experienced dystocia had OR 1.7 (CI, 1.2–2.4) for dystocia and OR 1.8 (CI, 1.0–3.1) for operative vaginal or abdominal delivery; nulliparous younger sister of an elder sister who experienced dystocia had OR 2.0 (CI, 1.5–2.7) for dystocia and OR 3.5 (CI, 2.1–5.8) for operative vaginal or abdominal delivery; rate of dystocia 75% in nulliparas whose twin sister had dystocia (unadjusted OR, 24.0; CI, 1.5–794.5)
Varner et al.[26] (1996)	Utah birth certificates between 1947–1957 (maternal cohort) and 1970–1991 (daughter cohort); "cases" were female children of the maternal cohort who had at least one live birth in the daughter cohort and delivered by cesarean, midforceps, or high forceps or had sisters who experienced these outcomes; "controls" were female children of the maternal cohort who had at least one live birth in the offspring cohort and delivered spontaneously or by low forceps	Controls identified on a 2:1 ratio to cases and matched for maternal age, birth county, and parity	Women born by cesarean for dystocia had an OR 2.11 (CI, 1.38–3.24) for delivering by cesarean section themselves; however, because of dramatically different overall rates of cesarean section in the generational cohorts, 96.5% of the women who experienced cesarean in the daughter cohort were themselves born vaginally

CI = confidence interval; OR = odds ratio.

knowledge has impeded the development and acceptance of intrapartum care practices designed to minimize stress and optimize the outcomes of labor and birth for healthy women and their infants.

The idea that the maternal emotional stress may be linked to the development of dysfunctional labor patterns and dystocia originated in articles published more than 40 years ago[38–40] and subsequently in the work of Lederman et al.[41–43] Heavily cited in the obstetric literature, Lederman's findings from a single prospective study of 32 NTSVs showed that: 1) plasma NEP and EPI levels were no different during the third trimester of pregnancy compared to those in similar nonpregnant women; 2) that NEP and EPI levels were significantly higher during labor at 3 to 5 cm cervical dilation, 9 to 10 cm, and immediately after delivery than during pregnancy; and that 3) NEP and EPI independently and progressively rose during labor.[41] During active labor, EPI was positively correlated to state anxiety scores ($r = .60$; $P < .01$) and to total length of labor ($r = .60$; $P < .01$), negatively correlated to uterine function as measured in Montevideo units ($r = -.71$; $P < .01$), but unrelated to NEP or cortisol levels.[42] Plasma cortisol was positively correlated with state anxiety ($r = .59$; $P < .01$), negatively correlated to uterine function ($r = -.55$, $P < .01$), but unrelated to length of labor. NEP levels were unrelated to EPI, cortisol, state anxiety, or length of labor. Data from psychological measures obtained during late pregnancy showed that higher stress scores related to pregnancy and motherhood, partner and family relationships, and fears of labor were significantly

related to less efficient uterine function during labor, higher state anxiety during labor, higher plasma EPI levels, and longer length of labor.[43]

These general patterns of significant increases in EPI, NEP, and cortisol from late pregnancy to labor were subsequently confirmed in a study of 50 nulliparous Swedish women using hourly urine and salivary measures.[44] These researchers also found substantial individual variation in stress response during labor with a moderate but significant decrease in NEP and EPI after the administration of epidural analgesia. Overall, the magnitude of increase of EPI and cortisol was in excess of 500%, while the increase in NEP was much more modest, which suggests that mental stress whether positive or negative is more dominant than physical stress during labor.[45]

Pregnancy-specific Psychological Attributes

In a stress and coping framework, women's beliefs and attitudes about themselves and the world are potential moderators of their thought processes about childbirth and its outcomes. Childbirth is acknowledged as a life event that is potentially threatening and stressful because of the likelihood of pain and the risk of injury or even death for mother and child.[46] Conceptualized as pregnancy-specific psychological attributes, both fear of childbirth and the social-cognitive construct of self-efficacy for childbirth have been related to the experience and course of labor.

Research findings show that many women have substantial fear of childbirth, and that fear can be related to

Table 3. Results of Referenced Studies Reporting the Relationship Between Maternal Height, Weight, and Pregnancy Weight Gain in Nulliparous Women and Cesarean Section for Dystocia

Study (Year)	Design, Setting, and Subjects	Potential Confounders	Findings
Baeten et al.[29] (2001)	Retrospective, population-based cohort study from Washington state birth certificates: 96,801 nulliparous women who had singleton births in 1992–1996 and for whom a BMI could be calculated (categorized as lean, normal, overweight, or obese)	Age, education, martial status, smoking, prenatal care, pregnancy weight gain, and obstetrical complications	Overall cesarean section rate of 12.6% for lean to 32.0% for obese women; cesarean risk increased progressively for overweight and obese women in the absence of other complications; adjusted OR for cesarean section by BMI category: overweight (BMI 25–29.9) OR 1.5 (CI, 1.0–2.3); obese (BMI ≥30) OR 2.0 (CI, 1.2–3.1)
Cnattingius et al.[27] (1998)	Retrospective population-based from Swedish Birth Register; 92,623 nulliparous women with known mode of delivery for 1992 and 1993	Variables considered included maternal age, maternal height, prepregnancy BMI, education, place of birth, type of hospital, smoking habits, cohabitation with baby's father	Overall cesarean section rate of sample was 11.9%; cesarean risk increased progressively with increasing maternal age, decreasing maternal height, and increasing prepregnancy BMI; adjusted OR for cesarean section in nulliparous women by characteristic: age ≥35 yrs (OR, 4.4; CI, 3.8–5.2); height 155–164 cm (OR, 2.0; CI, 1.8–2.2); height <154 cm (OR, 4.5; CI, 3.9–5.2); overweight (BMI 25.0–29.9; OR, 1.8; CI, 1.6–1.9); obese (BMI >30; OR, 2.4; CI, 2.1–2.7); cesarean rate of 11% among tall (≥175 cm) obese nulliparas compared to 36% among obese nulliparas <155 cm in height
Dietz et al.[32] (2005)	Retrospective population-based data from the PRAMS from 19 states; 24,423 nulliparous women with single, term infants born between 1998–2000	Age, education, race, marital status, Medicaid recipient, height, pregnancy weight gain, infant birth weight, gestational age, diabetes, hypertension during pregnancy, and complications of labor and delivery	Overall cesarean section rate of sample was 22.0%; incidence of cesarean section increased from 14.3% for lean women (BMI <19.8) to 42.6% for very obese women (BMI ≥35); adjusted RR for cesarean section for nulliparous women without complications: overweight (BMI 26.1–29.0; RR, 1.4; CI, 1.0–1.8); obese (BMI 29.0–34.9; RR, 1.5; CI, 1.1–2.1); very obese (BMI ≥35; RR, 3.1; CI, 2.3–4.8)
Kaiser and Kirby[35] (2001)	Retrospective, descriptive from CNM practice in academic, inter-city hospital in Wisconsin; 1881 women of mixed parity who delivered between 1994 and 1998; managed by CNMs	Pregnancy weight gain, height, advanced maternal age, parity, and intrapartum complications	Overall cesarean rate was 5.1% (4.1% for women with normal BMI and 7.7% for obese women) for this mixed parity sample; adjusted OR for cesarean section was 3.99 (CI, 2.0–7.9) for obese (BMI ≥29.0) women
McGuinness and Trivedi[28] (1999)	Retrospective, descriptive from a large regional hospital in New Zealand; nulliparous, singleton pregnancies who delivered 1994–1998 and grouped according to normal vaginal delivery (n = 997) and emergency cesarean section for dystocia (n = 81)	No matching for other risk factors	Mean height of women who delivered vaginally was 164.6 cm (SD = 7.27) and of those who delivered by cesarean section 161.0 cm (SD = 7.32); logistic regression showed that the OR for cesarean gradually increased with decreasing height; risk of cesarean increased from about 5% at 170 cm to 10% at 160 cm, 17.5% at 150 cm, and 30% at 140 cm
Nuthalapaty et al.[34] (2004)	Secondary analysis of data from a prospective observational study of a labor induction protocol in a Level III hospital in Alabama; 509 women (360 nulliparous) at term with a singleton pregnancy, cephalic presentation with induction medically indicated	Age, birth weight, initial cervical dilation, and diabetes	Overall cesarean section rate of 28.3% for nulliparous women; the odds of cesarean for nulliparas increased by 25% for each 10-kg increase in maternal weight; the cesarean rate ranged from 15% for nulliparas in the lowest weight quartile (47–72 kg) to 37% for those in the highest weight quartile (103–103 kg)
Stotland et al.[33] (2004)	Retrospective cohort study of women at a Level III university hospital in California; 9788 nulliparous women with term, singleton pregnancies, cephalic presentations without diabetes that delivered between 1976–2001	Age, prepregnancy BMI, gestational age, ethnicity, smoking, birth weight, and date of delivery	Overall cesarean section rate of 17% with 50% performed for "failure to progress"; nulliparas gaining excessive weight according to Institute of Medicine guidelines had an adjusted OR 1.40 (CI, 1.22–1.59) for cesarean section

(Continued)

Table 3. Continued

Study (Year)	Design, Setting, and Subjects	Potential Confounders	Findings
Vahratian et al.[31] (2005)	Secondary analysis of data from the Pregnancy, Infection, and Nutrition Study in North Carolina (1995–2002); 641 nulliparous women with term, singleton pregnancies	Height, education, pregnancy weight gain, and labor induction	The adjusted risk ratio for cesarean section: overweight women (RR, 1.2; CI, 0.8–1.8); obese women (RR, 1.5; CI, 1.05–2.0)
Young and Woodmansee[30] (2002)	Retrospective analysis of data from a large private obstetric practice in Florida; 3383 nulliparous women who delivered between February 1993 and June 2001	Age, height, birth weight, and gestational age	Overall cesarean rate for sample of 21.8%; risk of cesarean increased consistently and significantly with increasing BMI; primary diagnoses were cephalopelvic disproportion and failure to progress; nulliparas with BMI ≥30 had OR 6.5 (CI, 6.2–6.9) for cesarean section; the effect was compounded by excessive pregnancy weight gain

BMI = body mass index; CI = confidence interval; CNM = certified nurse midwife; OR = odds ratio; PRAMS = Pregnancy Risk Assessment Monitoring System; RR = relative risk; SD = standard deviation.

a negative birth experience and alterations in the physiology of labor.[47–50] Fears of childbirth have been associated with increased pain and distress during labor,[44,51] increased risk of prolonged labor and cesarean section,[50] and increased risk of significant postpartum emotional dysphoria.[52–54] In the developed world, where fear of childbirth has been primarily evaluated, clinical fear of childbirth complicates approximately 20% of pregnancies and fear may be severe in 6% to 10% of pregnancies.[55]

Additionally, the fear of childbirth may be a factor in maternal request for cesarean section before labor.[55,56] In their review of research on the effects of anxiety during pregnancy, Johnson and Slade[57] concluded that specific types of anxiety (psychosocial stress, family functioning, or fear of childbirth) may be associated with prolonged labor or cesarean section delivery.

FETAL FACTORS

In nulliparous women with vertex presentations, the fetal factors associated with dystocia caused by failure of descent and subsequent cesarean delivery are increased fetal weight, persistent occipitoposterior (OP) position, and unengaged fetal head at the onset of active labor. In a report of more than 8000 low-risk first pregnancies, 8% of the newborns had birth weights of 4000 to 4499 grams, and 1% were greater than 4500 grams.[58] Although the rate of cesarean section was less than 20% when the fetal weight was less than 4000 grams, it rose to more than 30% at 4000 to 4499 grams and 60% at more than 4500 grams in this single series.

Persistent OP position is reported to occur in 2.4% to 7.2% of nulliparous women and is associated with a 3- to 7-fold increase in the incidence of third and fourth degree perineal laceration, a 2- to 3-fold increase in the rate of operative vaginal delivery, and a 3- to 4-fold increase in the rate of cesarean section for failure to progress.[59–61]

In an observational study of nulliparous women using serial ultrasound confirmation of fetal position during labor, Lieberman et al.[62] found that 36% of nulliparas had a fetus in the OP position on at least one ultrasound exam, final fetal position was not established until late in labor, and only 31% of nulliparas with a fetus in the OP position at birth had an OP position at the initial labor ultrasound examination. Finally, in nulliparas with a vertex presentation, an unengaged fetal head at the onset of labor has been linked to a 3-fold increase in the rate of cesarean section, an association that persisted at a 50% level when fetal weight was controlled.[63]

INTRAPARTUM CARE AND INTERVENTIONS

Admission to the Hospital

Jackson et al.[64] reported that in low risk nulliparous women, hospital admission at greater than or equal to 4-cm cervical dilatation was associated with a 26% greater incidence of spontaneous vaginal delivery compared to admission before dilatation to 4 cm. Later hospital admission was linked to collaborative care by teams of nurse-midwives and physicians rather than care by physicians alone. Similarly, Holmes et al.[65] found a 10.3% cesarean section rate in low-risk nulliparous women admitted in spontaneous labor at 0 to 3 cm dilatation compared to a 4.2% rate for those admitted at greater than or equal to 4 cm. Further, a study of "standard risk" pregnancies from 30 hospitals in two US states showed that 69% of cesarean sections were performed for lack of progress (dystocia); however, 16% of these women were less than 3 cm dilated and 24% were less than 4 cm dilated at the time of surgery.[1] A cervical dilatation of less than 4 cm is defined as latent labor, a period during which the diagnosis of protraction and arrest disorders (dystocia) is not possible. Therefore, it is reasonable to hypothesize that nulliparous women admit-

ted during latent labor are more vulnerable to a diagnosis of labor dystocia and to subsequent cesarean section.

McNiven et al.[66] randomized women (n = 209) to either early labor assessment wherein they were encouraged to walk or go home if found to be in the latent phase of labor or direct admission on presentation to the labor ward.[66] They found significant decreases in clinical indicators of dystocia (duration of labor, use of epidural analgesia, and use of oxytocin for augmentation) in nulliparas assigned to the early labor assessment group when compared to women assigned to direct admission, although no differences in frequency of cesarean or operative vaginal delivery were found. Women assigned to the early labor assessment intervention evaluated their labor and birth experience more positively than did women admitted directly to hospital.

Supportive Care

The concept of supportive care during labor extends the idea of social support as a moderator of stress. Supportive labor care can be viewed as a type of enacted support from a social support framework and has been described as including components of emotional support and advocacy, information and advice, and comfort measures.[67] In a recent Cochrane review of 15 trials involving 12,791 hospitalized women in 11 countries under a wide range of clinical circumstances, women who had continuous one-to-one support during labor were less likely to have any analgesia or anesthesia (RR, 0.87; CI, 0.79–0.96), a cesarean (RR, 0.90; CI, 0.82–0.99) or operative vaginal delivery (RR, 0.89; CI, 0.83–0.96), and less likely to be dissatisfied with their childbirth experience (RR, 0.73; CI, 0.65–0.83).[68] Unlike previous reviews on supportive care during labor, these investigators provided an important analysis of subgroup findings from the 15 trials. This analysis suggested that policies in the birth setting, type of supportive care provider, and the timing of the onset of supportive care might enhance or reduce the effectiveness of labor support. Specifically, the routine availability of epidural analgesia appears to limit the effectiveness of labor support on the incidence of spontaneous vaginal birth and cesarean delivery; supportive care by non-staff individuals that begins before the active phase of labor is generally more effective than support by institutional staff or support that begins later in labor.

In a separate review of the 11 randomized clinical trials that only included first-time mothers, Scott, Berkowitz, and Klaus[69] concluded that continuous labor support significantly shortens labor (weighted mean difference, –1.64 hrs; CI, –2.3 –0.96 hours) and decreases the use of oxytocin augmentation of labor (OR, 0.29; CI, 0.20–0.40), analgesia (OR, 0.64; CI, 0.49–0.85), operative vaginal delivery (OR, 0.43; CI, 0.28–0.65), and cesarean delivery (OR, 0.49; CI, 0.37–0.65). These findings indirectly suggest a decreased incidence of

dystocia in women with continuous labor support. This analysis also showed that, compared to continuous labor support, intermittent support had no effect on these outcomes.

There are no studies of supportive care during labor that specifically examine the woman's evaluation of supportive care provided by multiple individuals involved in her labor care, nor the moderating effects of that support on the relationship between psychosocial stress and personal resources and the development of labor dystocia. However, in the recently released Listening to Mothers II[70] national survey by Childbirth Connections, new mothers gave doulas the highest ratings for quality of support compared to supportive care provided by family member/friend, husband/partner, physician, midwife, or nurse.

Induction of Labor

Induction of labor is one of the fastest growing medical procedures in the United States.[71] Induction of labor is clearly associated with an increased risk of a diagnosis of dystocia and cesarean section delivery in nulliparous women.[72–81] Across these studies using large samples from various states in the United States and abroad, nulliparous healthy women at term with a singleton, cephalic pregnancy with elective induction of labor are at 1.5- to 2.5-fold greater risk of delivering by cesarean section than women in spontaneous labor, even when maternal age, birth weight, and gestational age are controlled. The primary indication for cesarean delivery in these women is failure to progress or dystocia. Although a favorable cervix as determined by a Bishop Score or the need for cervical ripening at the time of induction may moderate the relationship of induction to cesarean risk in nulliparous women,[81,82] evidence suggests that a significant risk of dystocia and eventual cesarean section remains for women whose labors are induced.[75,78]

Epidural Analgesia

The use of epidural analgesia/anesthesia for the management of labor pain has received considerable research attention over the past 15 years as a potential factor in the development of dystocia in nulliparous women. This extensive body of both prospective and retrospective research has been differentially interpreted by experts in the field as evidenced by two simultaneously published systematic reviews.[83,84] Although there is disagreement about whether epidural causes cesarean delivery or whether observed associations between epidural and cesarean are caused by differences between women who do or do not choose epidural and/or differences in epidural protocols, there is general agreement that the reason for cesarean deliveries associated with epidural is failure to progress or dystocia.[84] A Cochrane review

concluded that although cesarean section rates for dystocia may not be increased with epidural, the evidence suggests significant increases in the need for oxytocin augmentation of labor, the incidence of intrapartum fever, the length of second-stage labor, and the need for operative vaginal delivery.[85] Lieberman's recent investigation of fetal position found that while nulliparous women with epidural analgesia during labor did not have more fetuses in the OP position at labor onset, the incidence of OP position was higher at birth in women with (12.9%) compared to those without (3.3%) epidural.[62]

Hydration and Nutrition

The relationship between inadequate maternal hydration and the development of dystocia in nulliparous women at term who are denied access to oral intake (NPO) was suggested in a randomized trial that compared a 250 mL/hour intravenous (IV) protocol to the traditional 125 mL/hour approach.[86] The higher rate of IV fluid administration was associated with trends toward a lower frequency of oxytocin administration for labor dystocia and fewer cesarean deliveries, although neither finding was statistically significant. A recent randomized clinical trial of the effect of unrestricted oral carbohydrate intake during labor on the incidence of dystocia (defined as dilatation less than 0.5 cm/hr for 4 hrs after 3 cm cervical dilatation) in low-risk nulliparous women failed to show a significant effect, although there also was no significant difference in the incidence of adverse maternal or neonatal outcomes.[87]

DISCUSSION

As conceptualized by the model in Figure 1, the occurrence of dystocia and eventual cesarean section in an individual nulliparous woman at term with a singleton fetus in a cephalic presentation is the product of a complex equation. Many of the factors reviewed, although associated with the incidence of dystocia and subsequent cesarean section, cannot be considered causative. Their effects may be mediated through changes in perception and decision-making that influence eventual diagnoses and operative intervention.

In addition, this review has not considered the complex sociopolitical, social, and physical environmental factors, or the processes of clinical decision-making by health care providers that are critical aspects of the reality of an individual woman's labor experience and eventual outcomes. These factors are broad, powerful, and far-reaching in their abilities to affect the outcomes for an individual woman and her fetus. Sociopolitical factors include societal views of women and the process of labor and birth, issues of liability (real or perceived), institutional philosophies and standards of practice, and local opinion leaders who influence the operational definitions of risk and normal including what is an "adequate trial of labor," to name a few.

The clinical decision-making of health care providers is dynamically influenced by a host of factors including sociopolitical and environmental factors and disciplinary paradigms, knowledge, experience, perceived personal liability risks, fatigue, pressure for bed space, etc. With no clear scientific evidence or measures for what is an adequate trial of labor and when "enough is enough," providers and women under their care make intervention decisions based often on beliefs and values about the phenomenon of labor and birth.

Clinical Recommendations for Practice

Despite these limitations, a number of clinical recommendations seem reasonable for midwifery practice from the literature that has been reviewed.

Maternal BMI and Weight Gain During Pregnancy Are Important Modifiable Risk Factors

Maintenance of a normal BMI is not only in the interest of women's long-term health but also is important to the process of labor and birth. Midwives should take every opportunity to not only discuss the health risks of overweight and obesity with women but also provide intervention and referrals for weight loss and healthy weight maintenance as needed. While a singular focus on weight gain during pregnancy is not a woman-centered approach to prenatal care, directed nutritional intervention to foster recommended weight gain by BMI category is a proactive strategy to reduce the likelihood of dystocia during labor.

Do Not Admit Nulliparous Women Until Active Labor

In the hospital environment where most midwives attend births, do not admit nulliparous women until active labor if at all possible. The midwifery practice of supporting and monitoring labor by outpatient or home visits, telephone, etc. prior to hospital admission is an important and critical component of reducing the likelihood of a diagnosis of dystocia. The skill of supporting labor during its early phases is an art that requires focused attention, development and additional research.

Do Not Electively Induce Nulliparous Women

This perspective is increasingly being abandoned under pressures from a variety of sources, including women themselves. The principle of non-intervention in normal processes,[88] a central tenet of the midwifery philosophy, is at the heart of the debate surrounding elective induction. Induction should be considered only when the benefits of delivery outweigh the potential maternal and fetal risks of intervention.[89]

Keep Women Well-hydrated and Well-fed During Labor

This does not require intravenous intervention. Additional research is needed to establish prescriptive parameters for what constitutes adequate oral intake to support the physiology of normal labor.

Provide Supportive Care

It is essential that midwives seriously examine their own practices to determine their capabilities to provide true supportive care. Supportive care that has been shown to be effective is that provided on a one-to-one continuous basis throughout the entire process of labor. Because midwives frequently have more than one woman under their care in hospital-based practices, doula care should be considered for women cared for by midwives who cannot guarantee one-to-one midwifery support.

Stay the Course, Using Amniotomy and Oxytocin Judiciously to Treat Dystocia

A second part of this recommendation is to avoid the adoption of rigid rules of adequacy of labor augmentation. Further, the need for oxytocin augmentation of labor should be anticipated when epidural analgesia is used during labor. Labor in all likelihood is no longer physiologic with epidural pain relief and a different care pathway can be expected.[90]

Preparing Nulliparous Women for the Realities of Labor Is Important and Significant Work

The author believes that renewed attention to the preparation of women for labor (real childbirth educational and behavioral preparation) is a critical aspect of midwifery practice. Midwives must seize the responsibility for building a new culture and system of care for the support of normal childbirth. Although this can be done one woman at a time, the need to radically change the basic system of care for childbearing women in the United States and elsewhere is paramount.

Underlying these recommendations is the assumption that midwifery-led care during labor is optimal care for healthy childbearing women. An important document for all midwives is the Evidence Based Guidelines for Midwifery-led Care in Labour published by the Royal College of Midwives.[90] In these guidelines, principles of care to promote normalcy and optimal outcomes are delineated as supported by available evidence.

CONCLUSION

The problem of labor dystocia remains an ill-defined phenomenon that may be labeled with a variety of clinical diagnoses. There is, however, no question that nulliparous women are vulnerable to these diagnoses and that these diagnoses account for a substantial portion of the rising number of cesarean sections performed each year in the United States on NTSVs. Continued research is needed to advance knowledge about the complex intrinsic and extrinsic mechanisms leading to these diagnoses and about care to optimize normal spontaneous vaginal delivery and mitigate the need for surgical intervention.

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