

## Guidelines for clinical practice

### Oxytocin administration during spontaneous labor: guidelines for clinical practice. Chapter 1: Definition and characteristics of normal and abnormal labor

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## Summary

Since the mid-1950s, the definitions of normal labor set forth by E. Friedman have guided obstetric practices in maternity units across the globe. But recent work is challenging these definitions, now considered too restrictive and thought to induce excessive interventionism by medical professionals. The objective of this chapter of these Clinical Practice Guidelines is to redefine the structure and duration of normal labor, as well as the criteria defining abnormal labor. Based on a systematic review of the literature, we make various recommendations. In the first place, the diagnosis of labor dystocia is inappropriate during the latent phase. The active phase of the first stage of labor begins at a cervical dilation between 5 and 6 cm. On the other hand, a speed of dilation  $< 1 \text{ cm}/4 \text{ h}$  at the beginning of the active phase of the first stage is considered abnormal, as is a speed  $< 1 \text{ cm}/2 \text{ h}$  above 7 cm dilation. The maximum duration of the descent phase of the second stage of labor cannot be determined from the literature, but the risk-benefit balance becomes less favorable after 3 hours. Finally, the literature does not justify any recommendation about the maximum duration of the expulsion phase. These new guidelines should make it possible to reduce the rates of oxytocin use and of cesareans for labor dystocia.

**Key words:** pregnancy, obstetric labor, dystocia, professional guidelines

## Introduction

Since the 1950s, the labor curves compiled by Friedman have defined the diverse phases of labor and the duration considered "normal" for each of them worldwide. Most maternity units around the world have long based their intervention strategies for correcting labor that is abnormally protracted or appears arrested (labor dystocia) on Friedman's work. Nonetheless, during the past two decades, several publications have challenged the relevance of the Friedman curves [1–4], in view of trends in both population characteristics and obstetric practices that can influence the course of labor [5]. For example, since Friedman's analyses, women's age at delivery has risen, together with the proportion of obese women and infant birth weights, in France [6] and elsewhere, including the United States [5]. Similarly, some obstetric practices that may influence the duration of different phases of labor have also changed. We note in particular the rising use of induction of labor and oxytocin during labor as well as the routine practice of amniotomies and epidural analgesia (although the influence of the latter factor remains controversial in the literature).

Recent studies among more contemporary populations and using more sophisticated mathematical methods suggest that the normal duration of labor is longer than that described by Friedman [3,7]. They also call for a redefinition of the different phases of labor, insofar as too restrictive a definition of labor can result in inappropriate management (oxytocin administration, and operative vaginal and cesarean deliveries) and induce unnecessary (and thus by definition, excessive) morbidity in women and their babies. In a survey conducted at the turn of the century among North American maternity departments (Canadian, US, and Mexican), with 89 responding among the 500 contacted, 35% no longer used the Friedman

standards because they considered them out-of-date and 88% believed that they should be redefined [8].

In a literature review, Spong et al. (2012) described the different causes of cesareans during the first stage of labor [9]. Listed among the key points that could help to reduce the prevalence of these cesareans in the US were better definitions of failure of induction and of labor dystocia as well as better monitoring of fetal status and more frequent external cephalic version.

Our objective was to review and synthesize recent data about the normal duration of labor and the criteria required to justify intervention in labor considered abnormal. This article also deals with the definition, causes and consequences of labor dystocia.

## Material and methods

This study is a review of the literature. The articles selected for our research bibliography were identified in the Medline database from the following search algorithm: "*non-progressive labor*" [tiab] OR "*augmented labor*"[tiab] OR "*labor dystocia*"[tiab] OR "*labour dystocia*"[tiab] OR "*non progressive labour*"[tiab] OR "*augmented labour*"[tiab] OR "*labor progress*"[tiab] OR "*labour progress*"[tiab] OR "*labor progression*"[tiab] OR "*labour progression*"[tiab] OR "*labor curve*"[tiab] OR "*labor pattern*" [tiab] OR "*labor patterns*"[tiab] OR "*labor norms*" [tiab]. On October 30, 2015, this algorithm identified 473 articles, listed at the following link: <http://www.ncbi.nlm.nih.gov/sites/myncbi/18e3vo1UNjr5r/collections/48394990/public/>.

Our analysis covers only articles concerning human births, written in French or English, and considered relevant. Case reports, letters, and comments to editors were excluded, as were reviews of the literature that provided no new information.

The final selection of relevant articles for this analysis included several stages. First, each author read the titles and abstracts of the initial 473 articles selected by the algorithm to choose articles to be read in full (n=140). The authors then excluded articles that did not appear relevant on full reading. They next discussed articles selected by only one of them, one by one, until they reached a consensus. Overall, 83 of the initial 473 articles (18%) were selected for this review. Thirty additional articles were subsequently identified through reading the 83 selected (see Figure 1).

We also consulted guidelines from various international learned societies, including the American College of Obstetricians and Gynecologists (ACOG) and the Society of Maternal and Fetal Medicine (SMFM), as well as those of the National Institute of Clinical Excellence (NICE).

When we say that something should or should not be done, we mean to say that it is a recommendation unless a specific reason based on the clinician's experience, the patient's individual characteristics, or the organization of care overrides it. *Should* essentially means *must* unless there is a strong reason not to, and *should not* means *do not*, unless there is a strong reason to do it.

What are the structure and the duration of normal labor?

### **What is the structure of normal labor?**

The different phases of labor that have been the international reference in obstetrics for the past 60 years were defined from two samples, of 100 and then 500 women [10,11]. Presenting his observations on graph paper (duration of labor along the X axis and cervical dilation on the Y axis), Friedman described an S-shaped curve for the first stage of labor, that is, the period of cervical dilation). He distinguished two phases: one latent and the other active. The latter was itself composed of three steps (an acceleration phase, a stable one, and a decelerating one), each different in terms of their speed of dilation (LE3). Friedman also described a second stage of labor that extended from complete cervical dilation to birth of the fetus. It should be noted that the sample of 500 women was a consecutive series of nulliparas, mainly singleton pregnancies, but also 4% twin pregnancies and one fetus in breech presentation. Most of the women entered labor spontaneously (96%), 9% received oxytocin, and only 8% had epidural analgesia. These results were later confirmed in the 1970s by work conducted on a population of 10,000 women, in an early computerized analysis of labor [12].

Since the report by Zhang et al. in 2002, most of the studies questioning the current relevance of Friedman's curves have found that the speed of dilation during the active phase of the first stage is not constant and that the prolongation of the duration of labor relative to these reference data concerns mainly this first phase of labor. Although dilation speed appears to accelerate at 4-5 cm, neither the stable phase nor the deceleration phase identified by Friedman was found among the nulliparas in Zhang's sample (1162 nulliparas admitted before 7 cm, with singleton pregnancies, at term, in cephalic presentation and delivered vaginally) [3] (LE2). The dilation curve followed an exponential model that did not resemble the S-shaped curve suggested by Friedman (Figure 2).

An older study of grand multiparas ( $> 5$ ) made similar observations. In a series of 500 women who gave birth in the US in 1978–1981, Petrikovsky et al. described an exponential dilation curve, with no deceleration phase and the transition from the latent to the active phase occurring around 5-6 cm [13]. They provided little information about their methods, other than that they used various "nonlinear models."

A first explanation for this discordance between curves may therefore be linked to the statistical approach used. Since Zhang et al., the principal publications have applied more appropriate and more modern analytic approaches, such as survival analysis with censored intervals to calculate the median duration of labor (overall or for each cm of dilation), or modeling the labor curves with polynomial functions (used to model dilation curves according to their mean). The deceleration phase described by Friedman may actually have been due to an artefact, because the examination was performed only at set regular intervals and dilation was measured only up to 10 cm. For example, if dilation increased from 9 to 10 cm in 30 minutes and then stayed at full dilation for 30 minutes until the next examination, the dilation speed recorded would be 1 cm in an hour rather than in 30 minutes [14,15].

Cohen and Friedman considered that the disappearance of this deceleration phase may have been associated not only with examinations spaced too far apart, but also with a selection bias in the studies, linked to the exclusion of cesareans during labor: the deceleration phase may have been more marked in cases with difficulties in engagement [16]. Nonetheless, Zaki et al. and Leftwich et al., who used the modern statistical techniques described above in large populations, did not identify a deceleration phase although they did not exclude cesareans from their sample [17,18].

**Overall, we recommend using the following definitions: the first stage of labor corresponds to the period of cervical dilation up to 10 cm (full dilation) and the second stage of labor extends from complete cervical dilation to the baby's birth (professional consensus).**

### **The first stage of labor: latent and active phases**

The beginning of the active phase is generally distinguished by an acceleration of dilation speed. Two points make it difficult to define the latent phase in the literature: first, its threshold seems to vary between women, and second, cervical dilation does nonetheless occur during this phase. The onset of labor is generally defined by the presence of painful and regular uterine contractions, associated with cervical dilation. In most studies, the threshold defining the transition between the latent and active phases is set at 4 cm of dilation; other studies place it at 3 cm instead or describe the latent phase based on the dilation speed rather than a threshold of dilation.

Peisner and Rosen, in a quite old study (1979-1982) of 1699 women in spontaneous labor with a singleton fetus in cephalic presentation (including 1060 nulliparas), showed that the threshold of transition between the latent and active phase is probably situated at a dilation  $> 3$  cm [19] (LE3). Relying on Friedman's definition of normal labor to define the active phase ( $> 1.2$  cm/h for nulliparous and  $> 1.5$  cm/h for parous women, including both primiparous and multiparous women), 50% of women were in the active phase at 4 cm, 74% at 5 cm, and 89% at 6 cm. After secondarily excluding women with protracted or stopped labor, the authors calculated that 60% were in the active phase at 4 cm, and 89% at 5 cm (LE3). These results



appeared similar in nulliparous and parous women. Some women (1%) even gave birth without ever reaching the dilation speed threshold defining the active phase.

Laughon *et al.* compared data from two cohorts of women from which the speed of labor has been estimated, that is, the Collaborative Perinatal Project (CPP) and the Consortium for Safe Labor (CSL). The CPP is a multicenter prospective cohort from 12 US hospitals that collected information on the labor of 44,669 women recruited from 1959 through 1965. The CSL is a multicenter retrospective cohort representative of the general population of US women; it covers more than 200,000 women who gave birth between 2002 and 2008 in 19 hospitals. The women in the (more recent) CSL cohort were on average significantly older, had a higher BMI, received both epidural analgesia and oxytocin during labor more often, and had longer first and second stages of labor than those in the CPP cohort [5] (LE2).

From a sample of 62,415 parturients in the CSL cohort, Zhang *et al.* found that the inflection point of dilation speed was around 6 cm. They thus defined the beginning of the active phase of labor at 6 cm [7] (LE2).

In a separate study reanalyzing the CPL data, Zhang *et al.* found an inflection point for the dilation curves that suggested that the active phase of labor begins around 5 cm for parous women and 5.5 cm for the nulliparas, although Friedman had suggested a transition around 3-4 cm in his work covering the same periods [20]. The closeness of the dilation curves analyzed by Zhang's group in the CSL (2004-2008) and CPP (1959-1965) data tends to show that the differences between the results of Zhang and Friedman for the 1950s are more strongly related to differences in their methods of statistical analysis than to changes in either

population characteristics or obstetric practices. The inflection point appeared less marked for the nulliparas, probably because of their greater interindividual variability.

Nonetheless, reliance on dilation curves to define the transition between the latent and active phase can produce biased conclusions, insofar as these curves are based on mean rather than median speeds. The clinical impact nonetheless remains limited (the rest of this paragraph contains the technical explanations). There is strong variability in the 4-6 cm range, visible from the median data and the 95th percentiles, and due to the fact that some of these patients were not in labor (see Peisner and Rosen [19]). To the extent that the dilation speed has a left-censored log-normal distribution (many subjects with low values and a few with much longer durations), the range of the duration probably influenced the mean dilation speed, shifting it away from the median. Concretely, this variability is probably responsible for flattening the curves by shifting the mean. When this variability is reduced, after 6 cm, the mean catches up with the median and thus creates the impression of a point of inflection that is located at the end of the transition from latent to active labor and not at the center. Detailing the median dilation speed more precisely, centimeter by centimeter (not influenced by the minimum and maximum values), we see that it increased most rapidly around 5 cm, rather than at 6 cm, for both the nulliparous and parous women (Tables 1, 2 and 3). The exclusion of cesareans for dystocia may also affect this speed, if these women have protracted latency phases more frequently (some might have had cesareans because they were incorrectly considered to be in the active phase).

**Overall, the latent and active phases of the first stage of labor should be differentiated (grade B). The beginning of the latent phase is defined by the presence of regular uterine contractions associated with cervical modifications (professional consensus). The active**

**phase begins between 5 and 6 cm of cervical dilation and is accompanied by regular uterine contractions (LE2).**

### **What is the normal duration of the first stage of labor?**

According to Friedman, the latent phase lasts a mean of 8.6 hours for nulliparas and 5.3 hours for parous women, while the active phase (acceleration, stability, and decelerations) lasts respectively 4.9 and 2.2 hours. He described dilation speed as going from 1.2 to 3 cm/h for the nulliparas and 1.5 to 5.7 cm/h for the others [11]. These data were confirmed by a subsequent analysis of 10,293 women [12] (LE3). Friedman defined "normal" dilation speed during the active phase as greater than 1.2 cm/h, based on the mean duration of labor + 2 standard deviations (SD). Following these studies, partograms and the concept of directed pushing were developed with the aim of reducing the duration of labor and limiting the frequency of cesarean for labor dystocia. The standard management became an early amniotomy associated with oxytocin administration once the dilation speed during the active phase exceeded the threshold of 1 cm/h [4].

At the beginning of the 1990s, Perl and Hunter observed slightly different results [21]. In a retrospective series reviewing the records of 505 nulliparas who spontaneously reached the active phase of labor, defined as 3 cm of cervical dilation, the authors sought to assess the relevance of a threshold of 1 cm/h for dilation speed. Overall, 21% of the nulliparas in their study did not reach this threshold dilation speed (mean speed <1 cm/h) and 10% had a mean dilation speed <0.5 cm/h. Only 7% received oxytocin. The other characteristics of this population were not known (LE3).

In a single-center study (1991-1994) by Albers et al., the population (n=1473) was restricted to women in labor without any epidural analgesia, or induction, or oxytocin, all considered factors that could slow down labor [1]. Overall, 20% were classified in protracted labor according to Friedman's criteria. The mean duration of the active phase (4-10 cm) was 7.7 for nulliparas and 5.7 h for parous women (19.4 and 13.7 at +2 SD). In a second single-center study of 2511 women who gave birth in 1996 without either an epidural or oxytocin during labor, Albers found a very similar mean duration of the active phase: 7.7 hours for the nulliparas and 5.6 for the parous women (17.5 and 13.8 at +2 SD) [22]. Jones et al., in an exclusively Hispanic population (240 women who gave birth between 1995 and 1998 in New York, found a slightly shorter active phase, but it always remained longer than the duration proposed by Friedman: 6.2 hours for nulliparas and 4.4 for the others (13.4 and 11.6 at +2 SD) [23]. Nonetheless, the analyses included only women with cervical dilation < 4 cm on arrival at the maternity ward. Excluding the women with more advanced dilation on arrival at the maternity ward (women with a potentially faster dilation speed) can result in overestimating the duration of labor.

Inversely, Kilpatrick et al. reported a mean duration for the first stage of labor (without distinguishing between the latent and active phases) shorter than in Friedman's series, in a population of 6991 US women (1976–1987, single-center study) [24]. In the absence of epidural analgesia, the mean duration was 8.1 hours for nulliparas in the first stage of labor (latent and active phases combined) and 5.7 hours for parous women (16.6 and 12.5 at +2 SD), while women with epidurals had mean durations respectively of 10.2 and 7.4 hours (19.0 and 14.9 at +2 SD). In a single-center study (1991–1996) limited to a population of 1006 recent Chinese immigrants to the USA, Sills et al. reported a mean duration for the first stage

of labor of 5.4 hours (+2 SD: 11.6 h), in the absence of epidural analgesia, oxytocin, and prostaglandins [25].

Zhang et al. used data from 1162 women with a vaginal delivery between 1992 and 1996 in a level-3 hospital to propose new standards for a normal dilation speed for nulliparas [3]. The mean duration of labor in that study was again longer than that reported by Friedman (5.5 h vs 2.5 h for dilation of 4 to 10 cm). In a study of 1119 nulliparas, Incerti et al. reported similar results, with a median duration of 5.5 h (95th percentile: 12.5 h) for the active phase of the first stage of labor (4 to 10 cm), for a mean dilation speed of approximately 1.5 cm/h (95th percentile: 0.5 cm/h) [26].

Among a selection of 62,415 women in the CSL database, Zhang et al. found a similar median duration of dilation for nulliparous and parous women before 6 cm dilation, but it accelerated for the latter above this threshold (Table 1, Figure 3) [7].

Note that the strong selection of the populations in the studies of Zhang et al. does limit the generalizability of their results. The women are young (mean age 23-24 years for nulliparas and 27-30 years for the others) and represent essentially a particular subpopulation of women at low obstetric risk (cephalic presentation, at term, without induction). These methodological choices can have important consequences on the population's dilation speed. Tables 2 and 3 present the duration of dilation reported by different studies, all conducted in the same population (Consortium of Safe Labor, 2002-2008), but with different selection criteria. We note in particular that labor was slower when they included women with cesareans, inductions of labor, and preterm births, or when specific adjustments were made to the population. Similarly, it must be remembered that these cohorts report data collected in hospitals that

applied protocols based on Friedman's work. The women with longer labor were therefore more likely to have had cesareans during labor. Accordingly, data for the longer labors are truncated, which resulted in underestimating the mean and median durations of labor, as well as the dilation speed (especially when cesareans are excluded). Excluding cesareans performed for labor dystocia from descriptions of the duration of labor for "normal" women is debatable under these circumstances.

Few studies describe the duration of the latent phase. Moreover, they generally describe the mean duration since arrival at the maternity ward and not since onset of the latent phase. They do so because as a general rule, it is difficult to determine the duration of this latent phase, especially as women arrive at the hospital at different, and sometimes advanced, stages of dilation, so that it is difficult to estimate precisely when cervical modification began.

**Overall, the duration of the first stage of labor differs according to parity and is longer in nulliparas (LE2). Sufficient data to determine the normal duration of the latent phase are not currently available. The median duration of the active phase (from 5 to 10 cm) of the first stage has not been defined for normal labor. Available data reporting a median duration of the progression of cervical dilation between 4 and 10 cm estimate it at 5.5 hours for nulliparas and 3 hours for the others (LE2).**

### **What are the structure and duration of the second stage of normal labor?**

The second stage of labor extends from full cervical dilation to expulsion (birth) of the fetus. It is essential to distinguish here the practices in North America and in France. The former

generally begin "**immediate pushing**" at complete cervical dilation and consider the second stage to begin then and extend through a single phase to the child's birth. In France, where "**delayed pushing**" is practiced, the second stage includes a (passive) descent phase through the birth canal and an expulsion phase, with active descent of the fetus due to maternal pushing. The data from the literature are thus based on two sets of studies: those conducted in North America, which examine principally the duration of the second stage of labor as a whole, without distinguishing between the descent and expulsion phases, and several studies performed in France that focus more especially on the duration of the expulsive efforts.

*Second stage of labor: immediate pushing vs delayed pushing*

Around the turn of this century, several randomized controlled trials studied the effect of immediate compared with delayed pushing. The PEOPLE trial in Canada, which included more than 1800 nulliparas, is one of the largest on this topic [27]. The group of women with delayed pushing (waiting  $\geq 2$  h after full dilation) had a longer median duration of the second stage of labor than the group with early pushing (187 vs 123 min,  $P < 0.001$ ), but a shorter median duration of expulsive efforts (68 vs 110 min,  $P < 0.001$ ) and fewer instrumental or cesarean deliveries (relative risk (RR) 0.79, 95% confidence interval (CI): 0.66-0.95) (LE1). Inversely, in a trial of 178 nulliparas, delayed pushing (here a delay of 1 h) did not show any advantages in terms of mode of delivery, neonatal outcome, or perineal outcome (all  $P > 0.05$ ) [28]. Vause et al. reported similar results for 135 nulliparas [29]. Nonetheless, these two studies probably lacked the power to identify these types of morbidity.

Four meta-analyses have compiled the data from randomized trials comparing early or immediate (at the beginning of the second stage, i.e., at full dilation) with delayed pushing. For Menez-Orieux et al. and Tuuli et al., the probability of spontaneous vaginal compared

with operative vaginal or cesarean delivery was significantly higher in the women with delayed pushing (respectively, RR 1.09, 95% CI 1.01-1.17) and RR 1.09, 95% CI 1.03-1.15) [30,31] (LE3). For Roberts et al., delayed pushing was associated with a lower frequency of rotational or high forceps (RR 0.69, 95% CI: 0.55-0.87), but had no statistically significant effect on the risk of cesarean (RR 0.77, 95% CI: 0.55-1.08) [32] (LE3). The meta-analysis of Boog et al. found that neither method was superior to the other for perineal outcomes. Finally, Lemos et al. analyzed 13 studies and did not find either method superior to the other, for either mother or baby [33].

In summary, the data from the literature do not clearly show that either of these approaches is superior to the other (LE3).

#### *Data on the second-stage duration with early pushing*

In his work on 500 white women during the 1950s, Friedman reported that the mean duration of the second stage of labor was  $57 \pm 0.8$  minutes. In the 1980s, Kilpatrick et al. studied the duration of the entire second stage in a population of 6991 women among whom this duration was not limited [24]. This absence of obstetric intervention makes this study a useful model for studying the real normal duration of the second stage. In the absence of epidural analgesia, the authors reported a mean second-stage duration of 54 minutes in nulliparas and 19 minutes in parous women (+2 SD: 132 and 61 min respectively). Among women with epidural analgesia, the mean duration was 79 minutes for the nulliparas and 45 minutes for the others (+2 SD: 185 and 131) (LE2). Albers et al. found a similar median second-stage duration without epidural analgesia, induction, or oxytocin augmented labor: 53 minutes for the nulliparas and 17 minutes for parous women (+2 SD: 147 and 57 min) [1] (LE2). Similar results were also observed by Jones et al. with a mean duration of 54 minutes for nulliparas



and 22 minutes for the others (+2 SD: 140 and 77 min), but they provided no information about epidural use [23]. Finally, in a single-center series of 15,759 nulliparas (1976-2001) in California, Cheng et al. found one nullipara in five (18%) had a second-stage duration > 3 hours [34].

The most recent work from the CSL (Tables 2 and 3) also detailed the duration of the second stage according to different population selection criteria, with and without epidural analgesia. Without epidural analgesia, the median duration was around 40 minutes for nulliparous and 10-15 minutes for parous women (95th percentile: approximately 2-3 h and 1 h, respectively) (LE2). With epidurals, this median duration extended to approximately 1 hour for nulliparas, and 20-25 minutes for parous women (95th percentile: 3-3.5 h and 1-2 h) (LE2). We must nonetheless recall that the US guidelines then in effect recommended that this stage not exceed 3 hours for nulliparas and 2 hours for other women.

Nonetheless, overall, these studies do not distinguish between the descent phase and the final delivery phase, in view of the practices that encourage pushing to begin at full dilation. Moreover, given the long interval between digital cervical examinations (generally every 2 h), the time spent at full dilation is probably underestimated.

#### *Data on duration of the second stage of labor with delayed pushing (France)*

The literature includes the results of secondary analyses of two French randomized trials — PREMODA (3330 women from the control group, with singleton term pregnancies at low obstetric risk, from 138 maternity units in 2001-2002) and Pithagore 6 (analysis of data for 4000 nulliparas with a vaginal delivery in 106 maternity units in 2004-2006) [35,36]. In the PREMODA trial, the median duration of the descent phase was 30 minutes (interquartile

range, IQR 10-60) and 90% of the women had a descent phase < 120 minutes (note that 62% received oxytocin during labor) [35] (LE2). In both studies, the median duration of the expulsion phase for nulliparas ranged from 18 (IQR: 10-27) to 23 minutes (IQR: 14-32). This duration was < 40 minutes for nearly 90% (LE2).

These results are consistent with those from data from the French AUDIPOG perinatal network (200,000 women between 2008 and 2011, unpublished data). Overall, 95% of the women had a descent phase lasting < 120 minutes (130 for the nulliparous and 100 for the parous women) and an expulsion phase < 40 minutes (45 and 26, respectively).

**Overall, it is recommended that the descent and expulsion phases be distinguished in analyzing the second stage of labor (professional consensus). The descent phase corresponds to fetal descent through the pelvis under the influence of uterine contractions, while the expulsion phase also involves maternal pushing (expulsive efforts) (professional consensus). The data from the North American literature do not allow a precise determination of the normal duration of each of these phases. In France, the descent phase lasts less than 2 hours and the expulsion phase less than 40 minutes in more than 90% of cases (LE3).**

### **What factors may influence the duration of labor?**

The results and discussions of these different points are presented elsewhere [37].

**Overall, some factors are likely to modulate the duration of labor. The latent phase appears to be prolonged in the case of maternal obesity. Inversely, preterm delivery is associated with a shorter latent phase (LE2). Twinning and some hypertensive disorders are associated with a prolongation of the active phase of the first stage of labor (by up to 2 h) (LE2).**

## Dynamic characteristics of abnormal labor

Table 4 summarizes the principal individual risk factors for labor dystocia identified in the literature. The results and discussions of these different points are detailed elsewhere [37]. The effects of professional practices on the duration of labor are discussed in two other texts [38,39].

### **The first stage of labor**

Labor dystocia is generally defined as a labor that is abnormally long or as interruption of cervical dilation (for a duration that varies between definitions). It can be mechanical or dynamic: mechanical dystocia is associated with a defect in the fit of the descending fetus or fetopelvic disproportion; dynamic dystocia, which is one form of what is more generally referred to in English-speaking countries as labor dystocia, is associated with a defect in the intensity, frequency, or duration of uterine contractions. The distinction is not always obvious either clinically or in the literature. Accordingly, for this section, when the studies do not specify the type of dystocia, we use the generic term "dystocia" to characterize a general defect or problem in rate of progress per centimeter of cervical dilation.

As Neal et al. explained, the threshold of  $< 1.2$  cm/h proposed by Friedman was based only on the stable phase (that is, the phase with the maximum slope), and not on the entire active phase (acceleration, stability, and deceleration phases) [4]. According to these studies, applying the median +2 SD for these three phases together appears to produce a threshold on the order of 0.6 cm/h. Neal et al. also calculated the mean dilation speed during the active phase for the populations studied by Albers et al. [1], Albers [22], and Jones et al. [23]. The mean dilation speed in these studies varied from 0.8 to 1 cm/h and the mean speed at +2 SD from 0.3 to 0.5 cm/h. Nonetheless, considering that the dilation speed is not linear and that it tends to increase as labor progresses, the authors suggest a norm  $< 0.5$  cm/h at the beginning of the active phase and  $> 0.5$  cm/h at its end. They argue that continued application of a threshold dilation speed of 1 cm/h creates a risk of overdiagnosis of dystocia.

Zhang et al. also underlined the nonlinear nature of labor and reported that dilation of 0.25 cm/h before 6 cm was frequent (< 95th percentile) for nulliparas, while dilation of 0.5 cm/h exceeded the 95th percentile after 6 cm, for both nulliparous and parous women [7,20]. Based on these data, the authors suggest that the concept of normal labor should be adjusted as labor advances and that dilation speed < 1 cm/4 h should be considered abnormal before 6 cm dilation [7].

Rouse et al. studied a population of 542 women with arrest of progress in dilation, defined as dilation > 4 cm and unchanged for more than 2 hours [2]. In their study, arrest continued for 27% of the nulliparous and 18% of the parous women 2 hours after oxytocin administration, compared with only 9% and 6% 4 hours after oxytocin administration. The authors thus recommend that if dilation stops progressing the duration of the perfusion should be extended to 4 hours rather than 2, before recourse to cesarean delivery. Nonetheless, according to Peisner et al., 50% of women are still in the latent phase at 4 cm of dilation [19]. The effect observed might therefore be linked to progression into the active phase, and not to an effect of oxytocin administration. The absence of a control group prevents us from ruling out this bias.

In developing countries, where medical care and access to cesarean deliveries are much more limited, the consequences of labor dystocia can be severe for mother and child. A prospective study of 266,723 women living in 6 countries with a low to intermediate level of income (Argentina, Guatemala, India, Kenya, Pakistan, and Zambia in 2010-2013) showed that the risk of maternal death within 42 days of giving birth doubles for women with labor dystocia (RR 1.9, 95% CI 1.4-2.4) [40]. The authors also showed an excess risk of maternal (RR 1.8, 95% CI 1.5-2.2) and fetal (RR 1.2, 95% CI 1.1-1.3) infection and postpartum hemorrhage (PPH) (RR 2.4, 95% CI 1.8-3.3) (LE3). These data must of course be related to the care

capacity of the countries concerned and cannot be applied directly to France. They nonetheless help to justify the focus on the diagnosis of labor dystocia.

Various studies have looked at the impact of dystocia during the first stage of labor on maternal and fetal morbidity in the most industrialized countries. Based on a case-control study (311 cases of dystocia and 1169 controls) in Sweden in 2000-2001, Selin et al. (2008) reported an excess risk of severe PPH ( $> 1000$  mL) (OR 1.9, 95% CI 1.2-3.1) and of third- and fourth-degree perineal lesions (OR 2.9, 95% CI 1.6-5.2) associated with labor dystocia [41]. Both trends persisted after adjustment for parity, birth weight, and epidural analgesia, although they were no longer statistically significant (OR 1.5, 95% CI 0.9-2.4 and 1.6 95% CI 0.8-3.0, respectively) (LE3). Data from the French Pithagore 6 study also suggest an association between the duration of the active phase of the first stage of labor and the risk of PPH. The proportion of woman with an active phase  $> 6$  hours rose from 20.2% in the control subjects ( $n=2414$ ) to 34.3% in those with PPH ( $n=9364$ ) and 38.1% in those with severe PPH ( $n=2494$ ;  $P < 0.001$ ) [42]. An Israeli study of 240,189 women who gave birth between 1988 and 2009 showed a higher prevalence of labor dystocia in the 138 women with uterine rupture than with other women (in the first stage of labor: 9.4% vs 1.8%, OR 5.7, 95% CI 3.2-10.0; in the second stage: 13% vs 1.6%, OR 9.5, 95% CI 5.8-15.6) [43]. Nonetheless, the lack of statistical adjustment prevents ruling out potential confounding factors, and the definition of labor dystocia was not specified (LE4). Harper et al. looked at neonatal outcomes in a population of 5388 American women in a single-center study that took place from 2004 to 2008) [44]. Those with a duration of labor  $> 90$ th percentile had a higher proportion of infants transferred to neonatal special care units (OR  $\sim 2.5$ ;  $P < 0.01$ ).

Overall, the data from the literature do not allow us to define a normal duration for the latent phase of the first stage of labor. The threshold between the latent and the active phase varies from woman to woman (LE2). The progression of dilation from one centimeter to the next is not constant during the active phase (LE2). To define dynamic dystocia, the duration since the last cervical modification should be considered rather than total duration since the onset of labor (grade B), regardless of uterine activity.

Labor dystocia should not be diagnosed before 5-6 cm of cervical dilation, that is, before the end of the latent phase of the first stage of labor (professional consensus). Consequently, the term "early labor dystocia" (in French, *dystocie de démarrage*) should no longer be used (professional consensus). Dilation speed should be considered abnormal if it is slower than 1 cm/4 h at the beginning of the active phase of the first stage and less than 1 cm/2 h after 7 cm of dilation (Grade B).

### **Second stage of labor**

Here again, studies conducted in North America (and practicing immediate pushing) should be distinguished from French (delayed pushing) studies.

#### ***Consequences of a prolonged second stage of labor in North American practices***

Allen et al. reported one of the largest series on maternal-fetal morbidity associated with the duration of the second stage of labor; it included a population of 129,517 Canadian women who gave birth between 1988 and 2006 [45]. In nulliparas, the authors found a statistically significant and gradual (after adjustment) increase in the risk of maternal (chorioamnionitis,

PPH, and respiratory distress) and neonatal (transfer to neonatal special or intensive care) complications when the duration of the second stage of labor exceeded 2 hours. In parous women, a significant excess risk of both maternal (obstetric injuries, PPH, and fever) and neonatal (respiratory distress, 5-min Apgar score  $< 7$  and transfer to neonatal special or intensive care) complications appeared with second-stage durations  $> 1$  hour. Although some associations persisted after adjustment for various confounding factors, the dose-response effect disappeared in parous women. In this study, 14.8% of the nulliparas had a second stage of labor  $> 3$  h and 3.2% of the others a second stage  $> 2$  hours (LE2).

The study by Cheng et al. of 15,759 Californian nulliparas also indicated a gradual increase in the risk of PPH with the duration of the second stage, with rates rising from 7.1% (0-1 h) to 30.9% ( $> 4$  h) [34]. After adjustment for mode of delivery and episiotomy, the relation reached statistical significance when the second stage  $> 3$  hours (adjusted OR 1.48, 95% CI 1.24-1.78). A similar trend was observed for third- and fourth-degree perineal lacerations and chorioamnionitis. On the other hand, the incidence of neonatal morbidity did not increase (LE2). A subsequent study of 5,158 multiparas observed a clearly higher cesarean rate once the second stage of labor  $> 3$  hours (1.3-7.5% before 3 h; 26.3% after 3 h) [46]. Similarly, the rate of operative vaginal delivery rose substantially after 2 hours (from 5-10% to  $> 30\%$ ). The rates of PPH and chorioamnionitis grew gradually for each additional hour (for PPH: 13.5% for 0-1 h, 16.7% for 1-2 h, 23.3% for 2-3 h, and 34.1% for  $\geq 3$  h; for chorioamnionitis: 2.5%, 4.6%, 14.2%, and 23% respectively). For the newborns, the frequency of an arterial pH  $< 7$ , Apgar score  $< 7$ , and transfer to the neonatal intensive care units tended to increase when the second stage of labor exceeded 2 hours, but not consistently (LE2). In a study of 4126 American nulliparas, the proportion of vaginal deliveries fell drastically (cesarean rate of 13, 38, 48, and 70% for a second stage of 2-3 h, 3-4 h, 4-5 h, and  $\geq 5$  h, respectively), while for



each additional hour, the risk of chorioamnionitis increased by 60% (OR adjusted for mode of delivery = 1.60, 95% CI 1.40-1.83), uterine atony by 31% (ORa 1.31, 95% CI 1.14-1.51), and third and fourth-degree perineal lacerations by 44% (ORa 1.44, 95% CI 1.29-1.60) [47]. No notable excess risk was found for the fetus (LE2). The Canadian PEOPLE trial (1,800 nulliparas with singleton pregnancies, at term) reported an excess risk of PPH when the duration of active pushing exceeded 3 h (reference < 1 h; ORa 2.5, 95% CI 1.4-4.1). On the other hand, no excess risk of severe (third- and fourth-degree) perineal lesions or neonatal complications was associated with a longer duration of expulsive efforts [48] (LE3).

To our knowledge, the literature includes only one randomized trial on the subject, conducted in a US maternity ward in 2014-2015 [49]. In this trial, the 78 women had a descent period lasting as long as 1 hour, during which they were offered delayed pushing. Women allocated to the "usual care" group (n=37) then had 2 h of delayed pushing if they had epidural analgesia (and 1 h for those without it); those allocated to the extended care (n=41) had an additional hour of pushing (3 h for women with and 2 h for those without epidurals). Although these results must be considered with prudence in view of the absence of blinding, lack of power, and probable bias (due to posterior positions), they nonetheless indicate a lower risk of cesarean for the women with delayed pushing (RR 0.45, 95% CI 0.22-0.93), with no excess risk of maternal or neonatal complications (maternal infection, perineal lesions, and PPH, neonatal outcomes) (LE3).

At least two studies have suggested an increased risk of shoulder dystocia in cases with an extended second stage of labor. The first examined a population of 240,000 Israeli women who gave birth between 1988 and 2010 and found an increased risk (OR 2.4, 95% CI 1.5-3.7) after adjustment for various factors including macrosomia and maternal obesity, but not for

duration of labor [50]. Despite the excess risk, the prevalence of shoulder dystocia in women with a prolonged second stage remained low, at 4.9% (LE3). Mehta et al. reported similar results in a more modest case-control study conducted in the US between 1996 and 2001 (65 nulliparas with shoulder dystocia/65 controls) [51] (LE3). Although the causal link between dystocia (failure to progress) during the second stage of labor and shoulder dystocia remains questionable, the clinical association is clear, and a prolonged second stage may potentially be interpreted as a warning sign of shoulder dystocia.

Finally, a literature review of observational studies reported that a protracted second stage of labor is associated with excess maternal risks of infection and hemorrhage, but not with excess neonatal morbidity (defined by either 5-min Apgar score or transfer for neonatal care) [52]. Nonetheless, in a recent article, Leveno et al. noted that the studies that failed to show any excess risks of neonatal complications in the case of a prolonged second stage had generally adjusted their results for mode of delivery (cesarean or vaginal delivery), contrary to the studies that have identified an excess neonatal risk [53]. These authors note that cesareans are often performed because of fetal heart rate (FHR) changes, to prevent the risk of neonatal asphyxia, and therefore that adjustment for mode of delivery essentially results in underestimating unfavorable neonatal outcome.

#### *Consequences of a prolonged second stage of labor in French practices*

In a study conducted in 2004–2005 at the maternity ward of the University of Tours Hospital (1,191 nulliparas), Naime-Alix et al. reported that the frequency of PPH increased when the second stage of labor grew longer (>3 h vs <1 h: 14.8% vs 4.1%;  $P < 0.001$ ) [54]. They found similar results for chorioamnionitis (3.1% vs 1.2%,  $P = 0.01$ ). More globally, an excess risk of maternal morbidity (PPH, chorioamnionitis, and third- and fourth-degree perineal lacerations)

was shown for each additional hour of second-stage labor (ORa 1.78, 95% CI 1.59-1.97). These analyses were adjusted for maternal BMI and age, birth weight, and duration of labor. On the other hand, no excess risk of neonatal complications was observed (LE3).

The secondary analysis of the PREMODA trial data, described above, also showed an excess risk of severe PPH (> 1000 mL) for nulliparas in the case of prolonged pushing (14.3% severe PPH in the group with "50 minutes or more" vs 1.2% in the "less than 10 min" group: ORa 10.6, 95% CI 2.8-40.3). On the other hand, a prolonged descent phase was no longer at risk of severe PPH (2.3% for a duration > 2 h vs 1.9% for < 1 h: crude OR 1.2, 95% CI 0.5-2.9) [55]. No excess risk of unfavorable neonatal outcome was reported in the women with prolonged pushing [56]. The secondary analysis of the data from the PITHAGORE 6 trial (presented above) confirms these results; they show an excess risk of severe PPH in nulliparas for the group with expulsive efforts > 37 min compared with the group with expulsive efforts ≤ 37 min (ORa 1.59, 95% CI 1.06-2.39). The association was close to significance for all PPH (OR 1.39, 95% CI 0.99-1.96) [36]. In this study, oxytocin administration, operative vaginal delivery, and episiotomy were also associated with an increased risk of severe PPH.

In a recent report, Korb et al. compared women who pushed for more than 45 min (n=124) with those who had an operative vaginal delivery before 45 minutes for failure of labor to progress (and no FHR-related indication) (n=95) [57]. This study took place in 2013 in a Parisian maternity unit that applied no time limit to pushing and compared two groups with similar general characteristics. Nulliparas accounted for 91% of this population. In the group that pushed > 45 minutes, 61% of the women finally had spontaneous vaginal deliveries. Women with an operative vaginal delivery for nonprogression < 45 minutes had a much higher risk of third- and fourth-degree perineal lacerations than the others (ORa 6.5, 95% CI

1.1-40.1) (LE3). These analyses were adjusted for the duration of labor before 5 cm, the time to full dilation and onset of expulsive efforts, episiotomy, manual rotation, and birth weight. An indication bias could not be totally excluded.

In summary, most of the data found in the international literature appear to report an excess risk of maternal complications (principally chorioamnionitis and PPH) when the duration of the second stage of labor > 3 hours in nulliparas and 2 hours in others. Results about the effect of this duration on neonatal outcome are divergent, and most studies have found no statistically significant associations. The studies conducted in France report results predominantly similar to those of the other international studies. Nonetheless, for PPH, the French data tend to suggest a potential excess risk that appears to be more specifically associated to the expulsive phase (ranging from more than 37 to 50 min, depending on the study).

Generally, the absence or slightness of an excess risk of fetal/neonatal morbidity in the studies of a prolonged second stage of labor can be explained by conditions enabling effective monitoring that enable immediate intervention at the least sign of hypoxia. Women are only allowed to continue laboring as long as their fetuses have a satisfactory heart rhythm; the more fragile fetuses are delivered rapidly. This situation artificially increases the frequency of fetal morbidity in the groups of women with shorter labor.

Finally, although giving parturients more time during the second stage of labor reduces the number of cesareans (and their associated maternal-fetal risk) by allowing more women to have vaginal deliveries, the probability of vaginal delivery diminishes gradually with time, at the same time as maternal risk rises. Nonetheless, the current data in the literature do not

allow us to identify a clear limit to the duration of the second stage of labor at which point the global risk makes cesarean delivery preferable to expectant management.

**Overall, extension of the second stage of labor appears to be associated with excess maternal risk. As long as fetal monitoring is appropriate, neonatal risk does not appear to increase (LE2).**

**The current data do not justify setting a firm second-stage time limit that should not be exceeded, but maternal risks do increase especially from 3 hours onward. The current data do not allow the recommendation of a maximum duration to be recommended for the active pushing phase.**

### **What are the guidelines abroad?**

Synthesis of the Guidelines of the American College of Obstetricians and Gynecologists (2014):

In 2014, the American College of Obstetricians and Gynecologists and the (American) Society of Maternal-Fetal Medicine (SMFM) jointly recommended a definition of labor divided into 2 stages, with the first stage subdivided into a latent (or passive) phase and an active phase [58]. This consensus statement does not propose time thresholds to define protracted or arrested labor, but it does suggest that neither can be diagnosed before 6 cm of dilation, considered to be the beginning of the active phase of the first stage. Dilation that stops before 6 cm must not be an indication for a cesarean, nor is labor that is progressing, but slowly. It is suggested that cesareans be limited to women with no progress after 4 h of oxytocin, if uterine activity is satisfactory and the amniotic sac ruptured, or after 6 h of

oxytocin without adequate uterine activity and no change in dilation. Before a diagnosis of lack of progress during the second stage, it is appropriate to authorize (if maternal and fetal conditions permit) 2 hours of pushing for parous and 3 hours for nulliparous women. Extension of this period may be envisioned on a case-by-case basis when appropriate (for all of these elements, the recommendations are strong, and the quality of evidence moderate).

## Conclusion

Recent studies show clearly that the definitions developed by Friedman in the 1950s are inappropriate today and can lead to excessive and potentially iatrogenic interventionism by obstetrics professionals. This change is explained simultaneously by trends in population characteristics and in professional practices, but also by the use of more appropriate statistical tools for constructing curves. Analysis of the data from the literature allows us to recommend new definitions of normal labor as well as new criteria for characterizing labor as dystocic. The implementation of these guidelines should enable us to reduce oxytocin use and cesarean deliveries for labor dystocia and accordingly to avoid unnecessary iatrogenic harm to a portion of the population of women having babies.

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**Table 1.** Median duration of labor from one centimeter of dilation to the next

Cervical dilation (cm)	Median duration, in hours (95 <sup>th</sup> percentile)		
	Parity 0 (n=25,624)	Parity 1 (n=16,755)	Parity 2 (n=16,219)
3-4 cm	1.8 (8.1)	-	-
4-5 cm	1.3 (6.4)	1.4 (7.3)	1.4 (7.0)
5-6 cm	0.8 (3.2)	0.8 (3.4)	0.8 (3.4)
6-7 cm	0.6 (2.2)	0.5 (1.9)	0.5 (1.8)
7-8 cm	0.5 (1.6)	0.4 (1.3)	0.4 (1.2)
8-9 cm	0.5 (1.4)	0.3 (1.0)	0.3 (0.9)
9-10 cm	0.5 (1.8)	0.3 (0.9)	0.3 (0.8)
2 <sup>nd</sup> stage of labor (without epidural analgesia)	0.6 (2.8)	0.2 (1.3)	0.1 (1.1)
2 <sup>nd</sup> stage of labor (with epidural analgesia)	1.1 (1.8)	0.4 (2.0)	0.3 (2.6)

*Adapted from Zhang et al. 2010 [7]. Results based on 62,415 women from the Consortium of Safe Labor cohort (200,000 women who gave birth between 2004 and 2008 in 19 US hospitals) with all of the following characteristics: spontaneous singleton pregnancy, cephalic presentation, at term, vaginal delivery.*

Table 2. Median duration of labor in nulliparas, from different studies of the *Consortium of Safe Labor* cohort (2002-2008)

Source (first author + publication year)	Timofeev 2012 (59)	Zhang 2010 [7]	Zaki et al. 2013* [17]	Leftwich et al. 2013 [18]	Leftwich et al. 2013 [18]
<b>Cervical dilation</b>	Median duration, in hours (90th percentile)	Median duration, in hours (95th percentile)	Median duration, in hours (95th percentile)	Median duration, in hours (95th percentile)	Median duration, in hours (95th percentile)
3-4 cm	1.5 (4.3)	1.8 (8.1)	3.4 – 5.1 (7.4 – 11.0)	4.8 (10.6)	5.2 (11.2)
4-5 cm	1.1 (3.6)	1.3 (6.4)	2.8 – 3.6 (6.5 – 8.7)	3.5 (8.4)	3.8 (8.9)
5-6 cm	0.6 (2.3)	0.8 (3.2)	1.9 – 2.4 (4.3 – 5.7)	2.4 (5.9)	2.6 (6.4)
6-7 cm	0.4 (1.7)	0.6 (2.2)	1.5 – 1.6 (3.1 – 3.7)	1.7 (4.0)	1.8 (4.3)
7-8 cm	0.3 (1.3)	0.5 (1.6)	1.2 – 1.4 (2.6 – 3.1)	1.3 (3.0)	1.4 (3.2)
8-9 cm	0.2 (1.1)	0.5 (1.4)	1.1 – 1.2 (2.2 – 2.4)	1.2 (2.6)	1.3 (2.8)
9-10 cm	0.6 (1.9)	0.5 (1.8)	1.1 – 1.2 (2.1 – 2.6)	1.2 (2.6)	1.4 (2.9)
4-10 cm	5.3 (10.8)	NA	7.4 – 8.5 (15.1 – 17.2)	8.8 (18.0)	9.6 (18.4)
2 <sup>nd</sup> stage of labor (without epidural analgesia)	0.7 (2.2)	0.6 (2.8)	0.6 – 1.1 (2.3 – 4.1)	NA	NA
2 <sup>nd</sup> stage of labor (with epidural analgesia)	1.0 (2.9)	1.1 (3.6)	1.0 – 1.5 (3.1 – 5.2)	NA	NA
<b>Population characteristics</b>			>37 weeks (adjusted)	<b>&gt;34 - 42 WEEKS</b>	<b>&gt;34 weeks (adjusted)</b>
Gestational age	37 - 42 weeks	37 - 42 weeks	No limitation	No limitation	<b>Adjusted</b>
Maternal age	No limitation	No limitation	Included	Included	<b>Adjusted</b>
Rapid cervical dilation (<3 h)	Included	Included	<b>Adjusted</b>	No limitation	<b>Adjusted</b>
Birth weight	No limitation	No limitation			

Induction of labor	<b>Exclusion</b>	Included	<b>Adjusted</b>	Included	Included
Cesarean during labor	<b>Exclusion</b>	<b>Exclusion</b>	Included	Included	Included
Prolonged labor	Included	Included	Included	Included	Included
Labor dystocia	Included	Included	Included	Included	Included

\* population stratified in 4 age subgroups (maximum and minimum durations are presented when they differ). The cohort included 200,000 women who gave birth between 2004 and 2008 in 19 US hospitals.

Table 3. Median duration of labor in parous women, from different studies of the Consortium of Safe Labor cohort (2002-2008)

Source (first author + publication year)	Timofeev 2012 (59)	Zhang 2010* [7]	Zaki et al. 2013** [17]	Leftwich et al. 2013 [18]	Leftwich et al. 2013 [18]
<b>Cervical dilation</b>	Median duration, in hours (90th percentile)	Median duration, in hours (95th percentile)	Median duration, in hours (95th percentile)	Median duration, in hours (95th percentile)	Median duration, in hours (95th percentile)
3-4 cm	1.5 (4.4)	NA	4.4 – 5.8 (9.5 – 11.5)	5.8 (12.3)	7.6 (14.4)
4-5 cm	1.0 (3.5)	1.4 (7.0 – 7.3)	2.7 – 3.9 (6.2 – 8.7)	3.5 (8.1)	4.2 (9.2)
5-6 cm	0.5 (2.2)	0.8 (3.4)	1.8 – 2.0 (4.5 – 4.9)	2.2 (5.6)	2.5 (6.3)
6-7 cm	0.3 (1.4)	0.5 (1.8 – 1.9)	1.3 – 1.6 (3.5 – 4.3)	1.5 (4.2)	1.7 (4.6)
7-8 cm	0.1 (0.9)	0.4 (1.2 – 1.3)	0.8 – 1.0 (1.8 – 2.7)	1.1 (3.0)	1.3 (3.5)
8-9 cm	0.1 (0.6)	0.3 (0.9 – 1.0)	0.8 – 0.9 (2.1 – 2.4)	1.0 (2.6)	1.1 (2.9)
9-10 cm	0.2 (0.9)	0.3 (0.8 – 0.9)	0.6 – 0.9 (1.4 – 2.4)	0.9 (2.3)	1.0 (2.6)
4-10 cm	3.2 (8.8)	NA	6.5 – 8.8 (14.1 – 17.6)	8.2 (17.4)	10.0 (18.7)
2 <sup>nd</sup> stage of labor (without epidural analgesia)	0.2 (0.6)	0.1 – 0.2 (1.1 – 1.3)	0.2 (1.0 – 1.3)	NA	NA

2 <sup>nd</sup> stage of labor (with epidural analgesia)	0.3 (1.0)	0.3 – 0.4 (1.6 – 2.0)	0.4 (1.5 – 2.3)	NA	NA
<b>Population characteristics</b>			>37 <b>(adjusted)</b>	WG <b>&gt;34 WG</b>	<b>&gt;34 WG (adjusted)</b>
Gestational age	37 - 42 WG	37 - 42 WG	No limitation	No limitation	<b>Adjusted</b>
Maternal age	No limitation	No limitation	Included	Included	<b>Adjusted</b>
Rapid cervical dilation (<3 h)	Included	Included	<b>Adjusted</b>	No limitation	<b>Adjusted</b>
Birth weight	No limitation	No limitation	<b>Adjusted</b>	Included	Included
Induction of labor	<b>Exclusion</b>	Included	<b>Adjusted</b>	Included	Included
History of cesarean	Included	<b>Exclusion</b>	<b>Exclusion</b>	Included	Included
Cesarean during labor	<b>Exclusion</b>	<b>Exclusion</b>	Included	Included	Included
Prolonged labor	Included	Included	Included	Included	Included
Labor dystocia	Included	Included	Included	Included	Included

\* population stratified according to 2 levels of parity, or \*\* according to 4 age groups (maximum and minimum durations are presented when they differ). The cohort included 200,000 women who gave birth between 2004 and 2008 in 19 US hospitals.

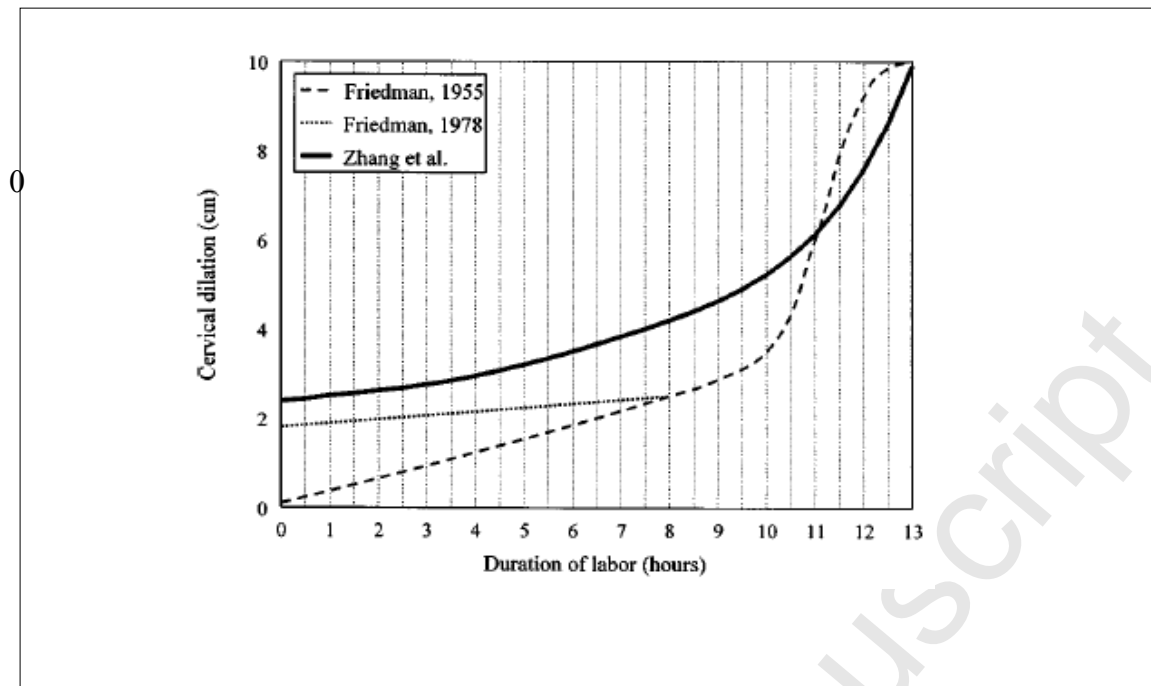
Table 4. Summary of the principal risk factors for labor dystocia identified in the literature

<b>Risk factor</b>	<b>Likely</b>	<b>Equivocal</b>	<b>Unlikely</b>
<b>Maternal</b>	<ul style="list-style-type: none"> <li>- Maternal obesity;</li> <li>- Higher maternal age;</li> <li>- Small size;</li> <li>- Nulliparity;</li> <li>- Great parity;</li> <li>- Birth spacing;</li> <li>- Post-term pregnancy;</li> <li>- History of cesarean/dystocia;</li> <li>- Diabetes;</li> <li>- Hypertensive disorders;</li> <li>- Fibromas/myomas</li> </ul>	<ul style="list-style-type: none"> <li>- Ethnicity (Asian);</li> <li>- Lower frequency of uterine contraction;</li> <li>- Biphasic uterine contraction</li> <li>-Violence / abuse</li> </ul>	
<b>Fetal</b>	<ul style="list-style-type: none"> <li>- Higher fetal weight;</li> <li>- Hydramnios;</li> <li>- Deflexed and posterior cephalic presentation</li> </ul>	<ul style="list-style-type: none"> <li>- gender of the fetus (masculin);</li> </ul>	<ul style="list-style-type: none"> <li>- Oligoamnios;</li> </ul>

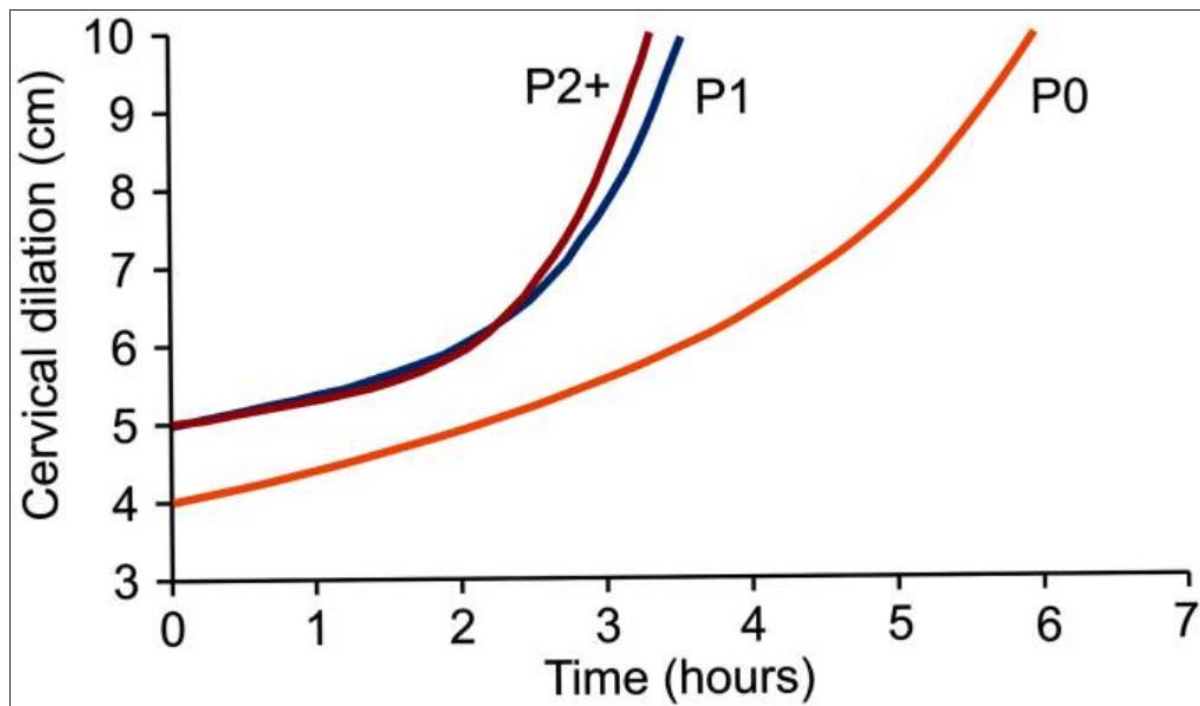
**Figure 1.** Inclusion of articles. \*Of the 283 articles considered "off-topic", 32 were excluded because they were dealt with specifically by other working groups (effect of obstetric management on dilation speed or risk of dystocia).

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**Figure 2.** Comparison between the dilation curves proposed by Friedman (1955; 1978) and by Zhang (2002). With permission of Elsevier from Zhang et al. 2002 [3].

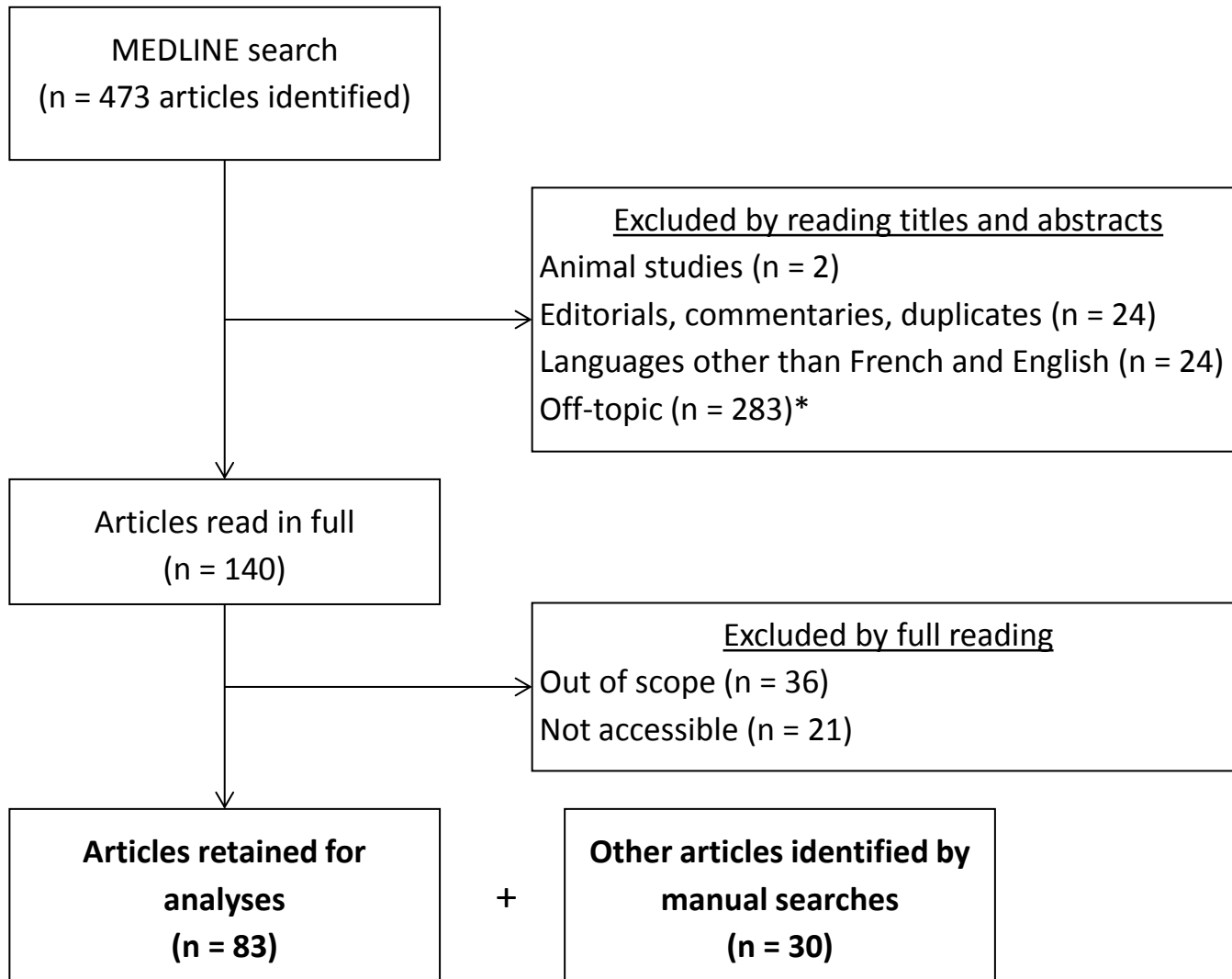


**Figure 3.** Zhang's dilation curves according to parity. Average labor curves based on 62,415 women from the Consortium of Safe Labor cohort (200,000 women who gave birth between 2004 and 2008 in 19 US hospitals) with all of the following characteristics: spontaneous singleton pregnancy, cephalic presentation, at term, vaginal delivery. Figure reprinted with permission of Wolters Kluwer from Zhang et al. 2010 [7]

Abbreviations: P0, nulliparous women; P1, women of parity 1; P2+, women of parity 2 or higher.

**Figure 4.** Structure of labo. The normal duration of the active phase is 5.5 h in nulliparous women and 3 h in parous women (grade B). Dystocia in the first stage of labor is defined by a dilation speed  $< 1 \text{ cm}/4 \text{ h}$  between 5 and 7 cm or a dilation speed  $< 1 \text{ cm}/2 \text{ h}$  after 7 cm (grade B).

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**1<sup>st</sup> stage of labor**

**2<sup>nd</sup> stage of labor**

