The duration of spontaneous active and pushing phases of labour among 75,243 US women when intervention is minimal: A prospective, observational cohort study

Ellen L. Tilden,[a,b,c] Jonathan M Snowden,[b,d] Marit L. Bovbjerg,[b,e] Melissa Cheyney,[b,f] Jodi Lapidus,[d,g] Jack Wiedrick,[d,g] and Aaron B. Caughey[a,c]*

[a]Department Nurse-Midwifery, School of Nursing, Oregon Health and Science University , 577, 3181 SW Sam Jackson Park Rd., Portland, OR 97214, USA
[b]UpLift Lab, Oregon State University, Corvallis, OR, USA
[c]Department of Obstetrics and Gynecology, School of Medicine, Oregon Health and Science University, Portland, OR, USA
[d]Oregon Health and Science University/Portland State University School of Public Health, Portland, OR, USA
[e]College of Public Health and Human Sciences, Oregon State University, Corvallis, OR, USA
[f]Department of Anthropology, Oregon State University, Corvallis, OR, USA
[g]Oregon Health and Science University Biostatistics and Design Program, Portland, OR, USA

eClinicalMedicine 2022;48: 101447
Published online 22 May 2022
https://doi.org/10.1016/j.eclinm.2022.101447

Summary

Background Friedman's curve, despite acknowledged limitations, has greatly influenced labour management. Interventions to hasten birth are now ubiquitous, challenging the contemporary study of normal labour. Our primary purpose was to characterise normal active labour and pushing durations in a large, contemporary sample experiencing minimal intervention, stratified by parity, age, and body mass index (BMI).

Methods This is a secondary analysis of the national, validated Midwives Alliance of North America 4·0 (MANA Stats) data registry (n = 75,243), prospectively collected between Jan 1, 2012 and Dec 31, 2018 to describe labour and birth in home and birth center settings where common obstetric interventions [i.e., oxytocin, planned cesarean] are not available. The MANA Stats cohort includes pregnant people who intended birth in these settings and prospectively collects labour and birth processes and outcomes regardless of where birth or postpartum care ultimately occurs. Survival curves were calculated to estimate labour duration percentiles (e.g. 10th, 50th, 90th, and others of interest), by parity and sub-stratified by age and BMI.

Findings Compared to multiparous women (n = 32,882), nulliparous women (n = 15,331) had significantly longer active labour [e.g., median 7.5 vs. 3.3 h; 95th percentile 34.8 vs. 12.0 h] and significantly longer pushing phase [e.g., median 1.1 vs. 0.2 h; 95th percentile 5.5 vs. 1.1 h]. Among nulliparous women, maternal age >35 was associated with longer active first stage of labour and longer pushing phase, and BMI >30 kg/m^2 was associated with a longer active first stage of labour but a shorter pushing phase. Patterns among multiparous women were different, with those >35 years of age experiencing a slightly more rapid active labour and no difference in pushing duration, and those with BMI >30 kg/m^2 experiencing a slightly longer active labour but, similarly, no difference in pushing duration.

Interpretation Nulliparous women had significantly longer active first stage and pushing phase durations than multiparous women, with further variation noted by age and by BMI. Contemporary US women with low-risk pregnancies who intended birth in settings absent common obstetric interventions and in spontaneous labour with a live, vertex, term, singleton, non-anomalous fetus experienced labour durations that were often longer than prior characterizations, particularly among nulliparous women. Results overcome prior and current sampling limitations to refine understanding of normal labour durations and time thresholds signaling 'labour dystocia'.

Funding OHSU Nursing Innovation and OHSU University Shared Resources.

*Corresponding author at: Department Nurse-Midwifery, School of Nursing, Oregon Health and Science University , 577, 3181 SW Sam Jackson Park Rd., Portland, OR 97214, USA.
E-mail address: tildene@ohsu.edu (E.L. Tilden).

Keywords: Labour progress; Labour dystocia; Labour duration; Prolonged labour

Research in context

Evidence before this study

Clinical science in the 1950s aimed to characterise normal labour length and proposed thresholds dividing normal vs. prolonged duration. This information was used to create partograms for identifying normal vs. prolonged labours and widely disseminated into clinical care. This science and translation of this science, despite acknowledged limitations, has greatly influenced labour management, including cesarean birth for 'prolonged labour'. Further, interventions to hasten birth are now ubiquitous, challenging the contemporary study of normal labour. We searched PubMed for articles published between January 1, 1950 and January 15, 2022 with the MeSH term set [Female; Gravidity; Humans; Labour, Labor; Maternal; Obstetric; Dystocia; Pregnancy]. We looked for observational or experimental studies assessing duration of time in the active phase or second stage of labour. None of the publications included a large, contemporary sample of women birthing in high-resource countries and intending delivery in settings absent routine intrapartum interventions.

Added value of this study

Findings suggest that normal nulliparous labour duration may have been greatly underestimated in prior research. Our results offer novel information regarding the normal duration of the active first stage of labour and during pushing in the second stage of labour. These results are novel because the majority of people in this cohort did not receive pharmacological or surgical interventions intended to hasten labour progress and/or birth. By providing counterfactual (to modern practice) estimates for normal labour duration, this information may help to overcome decades of uncertainty about how to define normal labour progress.

Implications of all evidence available

When pharmacological or surgical interventions intended to hasten labour progress and/or birth are rarely used, the duration of active first stage of labour and pushing in the second stage of labour may be longer than previously estimated. Future researchers might use our study findings to examine the hypothesized relationship between labour durations at and beyond the 95th percentile and risk for poor maternal/foetal/neonatal outcomes. Such research should lead to a decrease in unnecessary use of intervention, and iatrogenic sequelae, during childbearing.

Introduction

There is longstanding belief that labour duration is important for differentiating normal from abnormal labour patterns and that detecting 'prolonged labour' is critical for determining when intervention is warranted. Clinical science in the 1950s aimed to characterise normal labour length and proposed thresholds dividing normal vs. prolonged duration. There are four key concerns with this prior body of work.[1,2] Cohorts used for this research: (1) were small ($n < 500$); (2) experienced high rates of intervention to hasten birth [e.g., 55%ile of nulliparous women delivered via forceps]; and (3) included high-risk fetuses and neonates, some of whom were deceased prior to labour onset. Furthermore, systematic reviews have failed to show consistent association between traditional definitions of prolonged labour and poor maternal/child outcomes.[3] Despite these concerns, characterisation of normal vs. abnormal labour duration from the 1950s has: (1) widely shaped partographs that directly impact labour care and rates of intervention for millions of birthing people worldwide[4,5]; and (2) contributed to a labour care culture normalising intervention to the extent that it is difficult to identify a sufficiently large cohort of people birthing without intervention in order to perform less biased labour progress research.

Recognising these concerns and the profound impact that these definitions of normal vs. abnormal labour duration have had on intrapartum care, research teams have worked to define contemporary estimates of normal vs. abnormal labour durations.[6,7] One critical barrier to this work is that large, contemporary populations of labouring people frequently receive interventions to hasten birth [e.g. synthetic oxytocin, artificial rupture of membranes]. In large part because the early clinical science proposing to characterise normal vs. abnormal labour duration was so widely adopted into contemporary labour care practice from the 1950s on, it is now difficult to find adequately powered samples with minimal intervention that could be used to refine characterisation of normal vs. abnormal labour duration. Some researchers have overcome these sampling limitations through use of data from populations where there may be barriers to accessing obstetric interventions.[8] Findings from these studies can be challenging to apply to populations birthing in higher-resource countries, such as in the UK or the USA, where interventions are commonly used. The state of labour progress science has real world consequences: labour dystocia ('prolonged labour') is the most common indication for primary caesarean in the US,[4] and the prevalence of primary caesarean rates among spontaneously labouring women with term, vertex fetuses is beyond WHO recommendations in many high-resource countries.[9,10]

The purpose of this paper is to characterise, by parity, the duration of the active first stage of labour and the pushing phase of labour using contemporary data that contains observations from a large number of undisturbed labours and births. There is evidence that women at and beyond 35 years of age (vs. younger)[11] and with body mass index (BMI) at and beyond 30 kg/m^2 (vs. lower)[12] may have longer labours. Thus, a secondary aim was to compare labour durations for older vs. younger women (< 35 years) and by BMI less than vs. at or over 30 kg/m^2.

Methods

Study design and participants

This was a cohort study using the Midwives Alliance of North America 4·0 data (MANA Stats), n = 75,243. These data were prospectively collected by maternity care providers in all 50 US states between Jan 1, 2012 and Dec 31, 2018. Individuals in this cohort intended to labour and birth in settings where common obstetric interventions [e.g., synthetic oxytocin, caesarean] are not available.[13,14] Importantly, these data also include outcomes among those who transferred to the hospital during labour or in the immediate postpartum period. This offers the opportunity to characterise labour progress in settings absent common obstetric interventions without excluding those who transitioned to an intervention-rich setting, who would disproportionately be the more medically complex patients.

After receiving informed consent from cohort participants, maternity care providers used the MANA 4·0 web-based data collection system to enter demographic and health characteristics of pregnant people they cared for during pregnancy, labour, and after birth up until 6 weeks postpartum. Few who were eligible declined participation, with approximately 97%ile agreeing to inclusion [approximately 3%ile either declined to participate or transferred to a different prenatal care provider before consenting].[13] Multiple supports bolstered providers' correct data entry, including: (a) training in MANA Stats web-based data collection; (b) clear written instructions for logging and data collection procedures; (c) lists of variable definitions; and (d) access to 'data doulas' trained to help address questions about data entry uncertainties.[13]

Procedures

Data collection systems flagged data that were missing or outside of the expected ranges. These flags required providers entering data to reconcile (or explain) potential errors before submitting. Individual record data review by trained researchers helped ensure data consistency and accuracy. All records were reviewed if: (a) any values in the record were flagged as possibly out of range (in which case the data reviewer read the midwife's explanation and either agreed the value was reasonable, or contacted the midwife for further details, after which the record was possibly corrected), (b) transfer into the hospital setting; or (c) any report of miscarriage, stillbirth, or maternal or newborn death. For transfers and deaths, again, the data reviewer read through all available data and notes, contacted the midwives for further information if necessary, and corrected any mistakes in data entry (e.g., the miscarriage cutoff is 20 weeks in MANA stats, but some midwives would call 22 weeks a miscarriage because that is the rule for vital statistics in their state; data reviewers would correct this to "fetal loss, IUFD"). All data are encrypted and stored on a secure server. Data validation demonstrated a high degree of agreement between original data entry and data checks. Further details about MANA Stats data consenting, development, and validation is available.[13,14]

This secondary analysis using deidentified data was determined to be not human subjects research by the Oregon Health & Science University Research Integrity Office.

Upon receiving IRB approval from Oregon Health & Science University, we received and stored the de-identified MANA 4·0 data set. We selected our inclusion and exclusion criteria to define an explicitly low-risk population, as the majority of labours in the MANA cohort are low-risk. To further probe the possibility that the distribution of labour durations may be driven by risk factors not identified before the start of labour, for sensitivity analyses we also defined subcohorts excluding labours associated with transfer to hospital care or unforeseen poor outcomes. We included labours for singleton pregnancies that were not induced and ended within the term pregnancy period (37 0/7 to 41 6/7 weeks or 259 to 293 days gestation, inclusive); 58,885 of the labours recorded in MANA Stats met these criteria. We then excluded 8224 observations complicated by pre-pregnancy maternal diabetes, hypertension, genital herpes, oligo- or polyhydramnios, placenta previa, placental abruption, intrauterine growth restriction, congenital foetal anomaly, a history of uterine surgery, preterm premature rupture of the membranes, or nonvertex presentation. 1888 records were excluded due to missing key variables required for analysis (i.e., complete case analysis). The final cohort included 48,773 spontaneous, term maternal/child labour and birth observations among those with singleton, vertex, low-risk pregnancies for analysis.

Outcomes

Maternal characteristics included self-identified race or ethnicity [Asian/Oceanian, Black, Latina, Multiracial, Other, and White], age, height, BMI, pregnancy weight gain, group beta streptococcus colonisation in the third trimester, gestational age at delivery, maternal education level [less than high school diploma, high school diploma, more than high school diploma], marital or partnered status, and eligibility for Medicaid (health insurance for low-income Americans). Planned birth place, as well as actual birth place [home, birth center, hospital, other], neonatal birth weight [small for gestational age (<10th%ile), normal gestational age (10th −90th%ile), and large for gestational age (>90th%ile)] were also included. Mode of delivery [spontaneous vaginal, vacuum or forceps, caesarean] were included for competing risks analyses (see below).

We defined active-phase duration and pushing phase duration using three time variables in the data. Date and time of onset of the active phase of labour was determined by the attending provider. The MANA Stats system provides a suggested definition for active labor onset, but we recognize there will be variability in practice. These slight inconsistencies will reduce the precision of our estimates; however, at the same time, they allow for easier translation of our research to numerous other, diverse practice settings. This registry captures duration of pushing during second stage but not onset of full cervical dilation; therefore, pushing phase was described. The time and date that continuous pushing during second stage began marked the termination of active labour and the onset of the pushing phase of labour. The time and date of birth marked termination of the second stage of labour.

The small fraction (4%ile) of women missing labour durations for either the first stage only or the pushing phase only were treated as right-censored observations, with censoring at 1 min into the labour. These missing observations included a small number of labour durations originally recorded as: (a) negative values, (b) active labour times in excess of five days, or (c) pushing phase labour times in excess of 16 h. Observations with these characteristics were viewed as incorrect then replaced with missing values (and thus ultimately treated as right-censored observations). A small number (142 [0·3%ile]) of observations had an unexpected spike in the distribution of pushing phase times at just past 12 h. These observations were clustered near the Canadian border where midwives report caring for women in both Canada, where military-time is common, and the US, where military-time is less common. These records were adjusted to correct the likely time miscoding.

Finally, we conducted sensitivity analyses to see whether the extreme right skew of the empirical labour durations would be lessened in a cohort that did not transfer to the hospital setting. Sensitivity analyses involved first excluding all caesarean or assisted births (which occur only following intrapartum transfer from the community setting to a hospital) and then additionally excluding any birth associated with a significant maternal, foetal, or neonatal morbidity. We found that the extreme right skew persisted even in completely transfer-free and complication-free labours, supporting the robustness of our labour duration estimates.

Statistical analysis

Observed labour times were used to estimate the sample-wide distribution of labour durations. We calculated an empirical survival curve of time (in hours) for two events: (a) the end of the active phase of labour; and (b) the end of the pushing phase of labour. The survival curves were modeled semi-parametrically using natural cubic splines with 8 degrees of freedom for time to allow flexible fitting to the empirical curve shape. Caesarean and assisted vaginal deliveries were treated as competing risks (< 2%ile of included labours). Competing risk propensity weights were calculated separately within strata defined by indicators for any intrapartum complications or intrapartum transfer to the hospital. The survival curve model was used to estimate labour time percentiles (5th, 10th, 50th, 75th, 85th, 90th, and 95th) and their standard errors for each phase, by parity. We used the same survival curve model approach for sub-analyses of each parity group to explore potential differences in outcomes by maternal age and BMI; due to small counts at the extreme labour time durations in these sub-analyses, we focused on estimating labour time percentiles at the median, 75th%ile, and 90th%ile, but also calculated estimates of the 10th and 25th%iles for these subcohorts.

Role of the funding source

Neither funding source was involved with any aspect of data collection, analysis, interpretation, trial design, recruitment, manuscript writing, decision to submit for publication, or any other aspect of conducting this research. All authors had full access to all the data in the study and accept responsibility for the decision to submit for publication.

Results

Sample

In this sample, multiparas were about twice as common as nulliparas [nulliparous: 15,522; multiparous: 33,251] (Table 1). 83·4%ile of the nulliparous sample and 87·4%ile of the multiparous sample identified as White. Almost all people in this sample were either married or partnered [91·7%ile of nulliparous; 96·4%ile of multiparous]. 81·1%ile of nulliparous women and 77·5%ile of multiparous women in this sample had completed at least some college training. And about one-quarter [nulliparous: 23·4%ile; multiparous: 22·7%ile] of this cohort were eligible for Medicaid.

	NULLIPAROUS	MULTIPAROUS
Total, n	15,522	33,251
Race, n (%ile)		
White	12,949 (83·42)	29,055 (87·38)
Black	322 (2·07)	533 (1·60)
Latina	1084 (6·98)	1886 (5·67)
Asian/Oceanian	505 (3·25)	728 (2·19)
Multiracial	524 (3·38)	831 (2·50)
Other	76 (0·49)	133 (0·40)
White	12,949 (83·42)	29,055 (87·38)
Unreported	62 (0·40)	85 (0·26)
Married or partnered, n (%ile)	14,230 (91·68)	32,055 (96·40)
Education level, n (%ile)		
Less than HS diploma	705 (4·54)	2376 (7·15)
HS diploma	2025 (13·05)	4819 (14·49)
More than HS diploma	12,589 (81·10)	25,764 (77·48)
Unreported	203 (1·31)	292 (0·88)
Medicaid eligible, n (%ile)	3631 (23·39)	7549 (22·70)
Maternal age, mean ± SD (years)	28·7 ± 5·0	31·3 ± 4·7
Maternal age ≥ 35 years, n (%ile)	1958 (12·61)	8550 (25·71)
Maternal height, mean ± SD (m)	1·7 ± 0·1	1·7 ± 0·1
Maternal Body Mass Index (BMI), mean ± SD (kg/m^2)	23·3 ± 4·3	24·1 ± 4·9
Underweight (BMI < 18·5 kg/m^2), n (%ile)	783 (5·04)	1406 (4·23)
Normal weight (BMI in [18·5,25 kg/m^2)), n (%ile)	10,132 (65·28)	19,954 (60·01)
Overweight (BMI in [25,30 kg/m^2)), n (%ile)	2543 (16·38)	6318 (19·00)
Obese (BMI ≥ 30 kg/m^2), n (%ile)	1049 (6·76)	3585 (10·78)
Unreported, n (%ile)	1015 (6·54)	1988 (5·98)
Pregnancy weight gain, mean ± SD (kg)	15·3 ± 5·3	14·3 ± 5·1
Group B Streptococcal (GBS) vaginal colonization, n (%ile)	1598 (10·30)	3345 (10·06)
Gestational age (GA) at delivery, mean ± SD (days)	280·5 ± 6·8	280·2 ± 6·6
Early term (37 - 38 6/7 weeks), n (%ile)	2028 (13·07)	4258 (12·81)
Term (39 - 40 6/7 weeks), n (%ile)	10,340 (66·62)	23,225 (69·85)
Late term (41 - 41 6/7 weeks), n (%ile)	3154 (20·32)	5768 (17·35)
Delivery setting, n (%ile)		
Home	8377 (53·97)	24,319 (73·14)
Birth center	5038 (32·46)	8278 (24·90)
Hospital	2056 (13·25)	520 (1·56)
Other	51 (0·33)	134 (0·40)
Birthweight, mean ± SD (g)	3479·3 ± 426·5	3651·3 ± 451·6
Small for GA (< 10th%ile), n (%ile)	1746 (11·25)	1838 (5·53)
Normal for GA (in [10th, 90th]%iles), n (%ile)	12,277 (79·09)	25,187 (75·75)
Large for GA (> 90th%ile), n (%ile)	1380 (8·89)	6182 (18·59)
Unreported, n (%ile)	119 (0·77)	44 (0·13)
Mode of delivery, n (%ile)		
Spontaneous vaginal	14,633 (94·27)	33,138 (99·66)
Assisted (vacuum or forceps)	231 (1·49)	34 (0·10)
Caesarean overall	658 (4·24)	79 (0·24)
Caesarean for labor dystocia	349 (2·25)	33 (0·10)

***Table 1*: Demographics, health, and birth characteristics.**

12·6%ile of nulliparous women (vs. 25·7%ile of multiparous women) were age 35 or older. Maternal height, BMI, pregnancy weight gain, rates of GBS vaginal colonization, and gestational age at delivery were quite similar between the nulliparous and multiparous samples. Nulliparas more frequently birthed a neonate that was small for gestational age [nulliparous: 11·3%ile vs. multiparous: 5·5%ile], and in contrast, multiparas more frequently birthed a neonate that was large for gestational age [multiparous: 18·6%ile vs. nulliparous: 8·9%ile].

Multiparous women more often birthed in their intended setting, with only 1·6%ile transitioning to the hospital during labour, birth, or postpartum. 13·5%ile of nulliparous women transitioned to the hospital during labour, birth, or postpartum. Almost all people in this sample birthed vaginally, without operative intervention: 94·3%ile of nulliparas and 99·7%ile of multiparas experienced spontaneous vaginal birth. 2·3%ile of nulliparous women and 0·1%ile of multiparous women delivered by caesarean indicated for dystocia.

Duration of the active phase of labour

Nulliparous (vs. multiparous) women experienced significantly longer active phases of labour on average [mean 11·9 vs. 4·6 h; median 7·5 vs. 3·3 h, $p < 0·0001$] (Table 2) and by proportion still laboring in each three- hour interval, up to 120 h (Table 3). 90%ile of nulliparas completed the active phase of labour before 21 h, whereas 90%ile of multiparas completed the active phase of labour before 9 h (Table 3, Figures. 1 and 2). More nulliparous women had active labours that extended beyond 24 h, compared to multiparous women.

Duration of the pushing phase of labour

Pushing phase durations were also significantly longer for nulliparous (vs. multiparous) women on average [mean 1·9 vs. 0·4 h; median 1·1 vs. 0·2 h, $p < 0·0001$] (Table 4) and by the proportion still laboring, comparing 1 h intervals up to 15 h (Table 5). Similar to the duration of active phase, nulliparous women pushed for longer than multiparous women; 90%ile of nulliparas completed the second stage by just over 3 h, while 90%ile of multiparas completed the second stage in less than 45 min (Table 5, Figures. 3 and 4).

Duration of the active phase of labour by maternal age

On average, younger nulliparous women [<35 years] completed the active phase of labour more than one hour earlier than those who were 35 and older [7·3 h vs. 8·6 h] (Table 6). Differences between these nulliparous groups were wider at the 90th%ile, with younger people completing active labour approximately 11·5 h earlier than older nulliparous people. This was reversed among multiparous women, but with much less time difference. At both the median and at the 90th%ile, younger multiparas' active phase of labour was 18 min longer than multiparas 35 and older.

	NULLIPAROUS	*MULTIPAROUS*
Total, n nonmissing (%)	15,331 (98·77)	32,882 (98·89)
First stage active labourduration, hours		
mean ± SD	11·9 ± 15·4	4·6 ± 5·6
5th percentile ± SE	2·2 ± 0·031	0·8 ± 0·010
10th percentile ± SE	2·9 ± 0·034	1·2 ± 0·011
50th percentile ± SE	7·5 ± 0·066	3·3 ± 0·020
75th percentile ± SE	12·6 ± 0·125	5·4 ± 0·035
85th percentile ± SE	16·7 ± 0·198	7·1 ± 0·051
90th percentile ± SE	20·9 ± 0·360	8·7 ± 0·075
95th percentile ± SE	34·8 ± 1·205	12·0 ± 0·125

***Table 2*: Duration of first stage active labour in hours, by parity, at multiple points of distribution.**

	NULLIPAROUS	*MULTIPAROUS*
Total, n nonmissing (%ile)	15,331 (98·77)	32,882 (98·89)
Continuing active labour, n (%ile)		
>3h	13,709 (89·42)	18,289 (55·62)
>6h	9404 (61·34)	6798 (20·67)
>9h	6056 (39·50)	3037 (9·24)
>12h	4007 (26·14)	1701 (5·17)
>15h	2780 (18·13)	1008 (3·07)
>18h	1960 (12·78)	550 (1·67)
>21h	1384 (9·03)	341 (1·04)
>24h	973 (6·35)	227 (0·69)
>30h	667 (4·35)	145 (0·44)
>36h	334 (2·18)	62 (0·19)
>42h	172 (1·12)	34 (0·10)
>48h	100 (0·65)	15 (0·05)
>54h	52 (0·34)	7 (0·02)
>60h	33 (0·22)	4 (0·01)
>66h	20 (0·13)	3 (0·01)
>72h	15 (0·10)	1 (0·00)
>96h	2 (0·01)	0 (0·00)
>120h	0 (0·00)	0 (0·00)

***Table 3*: Counts and percentage of those continuing active labour, by parity, every three hours up to 24 h and then every 6 h after 24 h.**

Duration of the pushing phase of labour by maternal age

Pushing-phase duration age-related findings were also significantly different (Table 6). Nulliparous women <35 (vs. ≥ 35) birthed, on average, 18 min earlier and nearly 2 h earlier at the 90th%ile. There were no differences between older and younger multiparous women in pushing phase durations at the median or 90th%ile.

Duration of the active phase of labour by BMI

Nulliparous active labour duration trends, stratified by BMI, showed that those with BMI < 30 kg/m^2 completed the active phase on average 12 min earlier than those with BMI ≥ 30 (Table 6). Differences were wider at the 90th%ile, with nulliparous women with higher BMIs (vs. lower BMIs) needing 9 h more time to complete the first stage of labour. BMI-associated

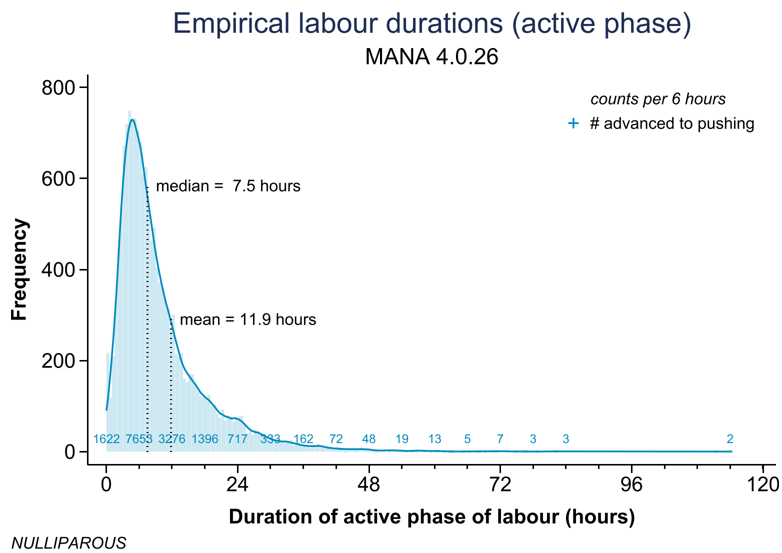

Figure 1. Frequency of nulliparous women progressing to pushing during active second stage by active first stage of labour duration, in hours.

Black lines on the x-axis mark active first stage of labour duration in 6 h intervals Blue numbers on the x-axis denote the number of observations and points of active phase of labour duration, in hours, when pushing began. Numbers from 0 to 800 on the y-axis denote the frequency count.

differences among multiparous women were less clinically relevant, with approximately 6 min of difference in active phase duration at the median and approximately 30 min of difference in active phase duration at the 90th%ile.

Duration of the pushing phase of labour by BMI

Interestingly, nulliparas with BMI < 30 kg/m^2 had slightly longer pushing phase durations at the mean (1 h and 6 min vs. 54 min) and at the 90th%ile (3 h and 12 min vs. 3 h), compared to those with BMI ≥ 30 kg/m^2

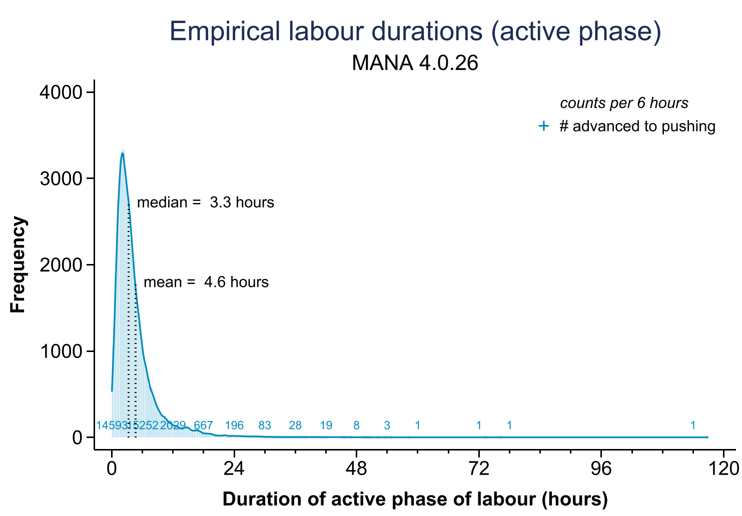

Figure 2. Frequency of multiparous women progressing to pushing during active second stage by active first stage of labour duration, in hours.

Black lines on the x-axis mark active first stage of labour duration in 6 h intervals Blue numbers on the x-axis denote the number of observations and point of active phase of labour duration, in hours, when pushing began. Numbers from 0 to 800 on the y-axis denote the frequency count.

	NULLIPAROUS	MULTIPAROUS
Total, n nonmissing (%ile)	14,693 (97·08)	32,538 (98·02)
Pushing phase duration, hours		
mean ± SD	1·9 ± 2·8	0·4 ± 0·6
5th percentile ± SE	0·2 ± 0·004	0·0 ± 0·000
10th percentile ± SE	0·3 ± 0·005	0·1 ± 0·001
50th percentile ± SE	1·1 ± 0·009	0·2 ± 0·001
75th percentile ± SE	1·9 ± 0·016	0·4 ± 0·003
85th percentile ± SE	2·5 ± 0·023	0·6 ± 0·004
90th percentile ± SE	3·1 ± 0·043	0·7 ± 0·006
95th percentile ± SE	5·5 ± 0·176	1·1 ± 0·012

***Table 4*: Duration of pushing during the second stage of labour in hours, by parity, at multiple points of distribution.**

	NULLIPAROUS	MULTIPAROUS
Total, n nonmissing (%ile)	14,693 (97·08)	32,538 (98·02)
Continuing pushing, n (%ile)		
>1h	11,754 (81·09)	6149 (18·92)
>2h	4909 (33·87)	756 (2·33)
>3h	2093 (14·44)	225 (0·69)
>4h	1012 (6·98)	121 (0·37)
>5h	542 (3·74)	81 (0·25)
>6h	320 (2·21)	54 (0·17)
>7h	208 (1·43)	40 (0·12)
>8h	152 (1·05)	32 (0·10)
>9h	109 (0·75)	25 (0·08)
>10h	73 (0·50)	23 (0·07)
>11h	41 (0·28)	18 (0·06)
>12h	22 (0·15)	13 (0·04)
>13h	9 (0·06)	4 (0·01)
>14h	5 (0·03)	0 (0·00)
>15h	0 (0·00)	0 (0·00)

***Table 5*: Counts and percentage of those continuing pushing during the second stage of labour, by parity, every hour.**

(Table 6). BMI was not associated with differences in pushing phase of labour duration among multiparous women.

Discussion

This study used contemporary US data collected from low-risk birthing people predominantly from settings where routine perinatal interventions are not available. Consistent with prior US literature on those intending home or birth center births ['community births'], this sample contained more young (< 35 years), married or partnered, lower BMI (<30 kg/m^2), White women with college education and access to private medical insurance, compared with the broader US childbearing population.[13,14] The majority of people in this sample birthed in the community setting. Nulliparous women had significantly longer active first stage and pushing phase durations than multiparous women. Maternal age >35 was associated with longer active first stage of labour and longer pushing phase among nulliparous women. BMI >30 kg/m^2 was associated with longer active first stage of labour but shorter pushing phase among nulliparous women. Patterns among multiparous women were different, with those >35 experiencing a slightly more rapid active labour and no difference in pushing duration, and those with BMI >30 kg/m^2 experiencing a slightly longer active labour but, similarly, no difference in pushing duration. These study findings offer new active first stage and pushing phase labour duration estimates that are not confounded by interventions to hasten or terminate labour.

Regarding a comparison of current estimates with selected prior estimates, it may be useful to consider these results within a selected historical context. There is longstanding clinical and clinical-science interest in labour duration as a key factor in determining risk.[25] Though several clinical-scientists prior to Friedman published on these topics, Friedman's labour progress research was the most widely translated to the clinical setting.[26] There has also been extensive critique of Friedman's widely influential work from multiple, contemporary labour progress scientists.[6,7,8,15,17] This science has importantly advanced both understanding of labour duration norms and also greatly influenced changes to clinical care supporting more patience with labour progress.[27] The current study seeks to build on this prior research with data offering a new opportunity: characterization of labour duration when there is little to no medical interference with physiologic birthing processes. This raises interest in comparison of current labour duration estimates vs. prior labour duration estimates. Because prior labour duration science is voluminous, we chose to compare current study findings against six published labour duration studies from a range of author teams, design, methodologic approaches, and publication years (1955 – 2018). We acknowledge that the choice of comparison studies is not comprehensive and represents those that are well-known and have been commonly referenced over the years.

The most striking comparisons relate to new estimates of nulliparous active phase of labour duration. Study findings indicate that the median duration of nulliparous active labour may be nearly twice as long, and the 95th%ile duration more than three times as long, when compared to earlier estimates [e.g., median: 7·5 vs. 4·0 h; 95th%ile: 34·8 vs. 11·7 h][2] (Table 7). Given well-established trends showing higher rates of intervention for 'labour dystocia' among nulliparous (vs. multiparous) women,[4] this finding is of particular importance. It seems that labours we are labelling as "pathologically too long" (dystocia) solely because they exceed the 95th%ile of earlier labour duration estimates might well be within the reasonable range of normal, for nulliparous women in particular.

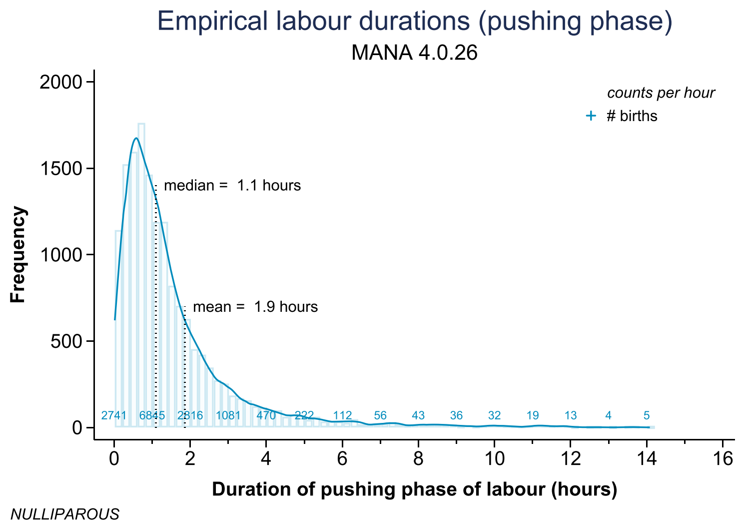

Figure 3. Frequency of nulliparous women progressing to birth by pushing during active second stage of labour duration, in hours. Black lines on the x-axis mark pushing duration in 1 h intervals. Blue numbers on the x-axis denote the number of observations and point of pushing duration, in hours, when birth occurred. Numbers from 0 to 2000 on the y-axis denote the frequency count.

Our estimates of multiparous active phase of labour duration were more consistent with selected prior estimates. While our results suggest that the median multiparous active labour duration is longer than earliest estimates [3·3 vs. 1·8 h],[1] 3·3 average hours of active labour duration is within the range of prior characterisations.[15] Interestingly, multiparous active duration at the 95th%ile was approximately 1, 2 h shorter than noted in several prior estimates (Table 7).

Our study suggests that nulliparous women experienced, on average, slightly longer second-stage than in prior estimates (Table 8). However, it is important to remember that the data used for this analysis did not include time prior to pushing during second stage, while some previous estimates marked the beginning of second stage by full cervical dilation alone. Thus, our pushing phase findings are likely shorter than they would have been if second stage onset had been marked

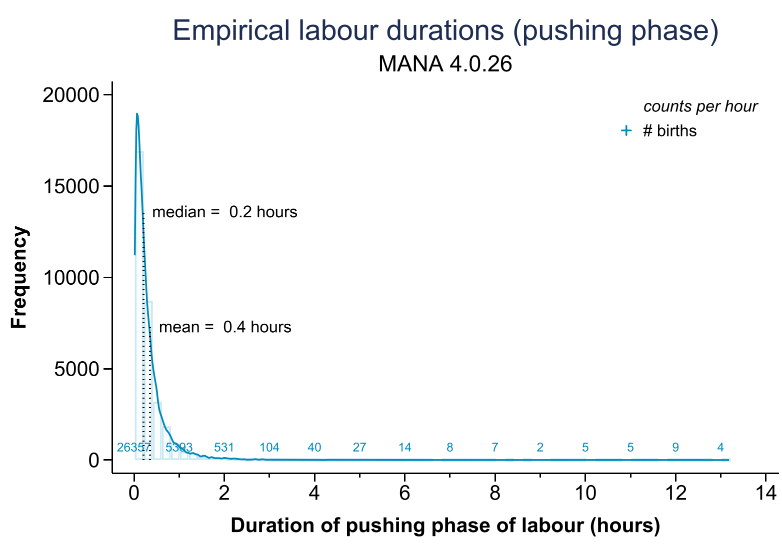

Figure 4. Frequency of multiparous women progressing to birth by pushing during active second stage of labour duration, in hours. Black lines on the x-axis mark pushing duration in 1 h intervals. Blue numbers on the x-axis denote the number of observations and point of pushing duration, in hours, when birth occurred. Numbers from 0 to 2000 on the y-axis denote the frequency count.

	NULLIPAROUS				MULTIPAROUS			
	Age < 35	**Age ≥ 35**	**BMI < 30 kg/m²**	**BMI ≥ 30 kg/m²**	**Age < 35**	**Age ≥ 35**	**BMI < 30 kg/m²**	**BMI ≥ 30 kg/m²**
Total, n nonmissing (%ile)	13,389 (87·33)	1937 (12·63)	13,300 (86·75)	1036 (6·76)	24,419 (74·26)	8459 (25·73)	21,130 (64·26)	9786 (29·76)
Active phase of labour duration, hours								
10th percentile ± SE difference [95% CI]	2·9 ± 0·039	3·1 ± 0·095	2·9 ± 0·042	3·2 ± 0·105	1·2 ± 0·015	1·1 ± 0·020	1·2 ± 0·014	1·2 ± 0·032
	0·175 [−0·031, 0·381]		0·252 [0·025, 0·479]		−0·130 [−0·180, −0·079]		−0·025 [−0·094, 0·045]	
25th percentile ± SE difference [95% CI]	4·5 ± 0·052	5·0 ± 0·144	4·6 ± 0·055	5·0 ± 0·174	2·0 ± 0·019	1·9 ± 0·027	2·0 ± 0·018	2·0 ± 0·044
	0·505 [0·199, 0·810]		0·411 [0·046, 0·776]		−0·178 [−0·244, −0·111]		0·005 [−0·091, 0·100]	
50th percentile ± SE difference [95% CI]	7·3 ± 0·081	8·6 ± 0·244	7·4 ± 0·086	8·2 ± 0·308	3·4 ± 0·027	3·1 ± 0·042	3·3 ± 0·026	3·4 ± 0·068
	1·285 [0·770, 1·800]		0·712 [0·072, 1·352]		−0·240 [−0·340, −0·139]		0·080 [−0·066, 0·226]	
75th percentile ± SE difference [95% CI]	12·3 ± 0·142	15·0 ± 0·429	12·5 ± 0·153	13·6 ± 0·501	5·5 ± 0·047	5·2 ± 0·071	5·4 ± 0·045	5·6 ± 0·115
	2·700 [1·797, 3·603]		1·107 [0·059, 2·156]		−0·289 [−0·459, −0·119]		0·230 [−0·017, 0·478]	
*90th percentile ± SE difference [95% CI]	19·6 ± 0·398	31·2 ± 1·721	21·2 ± 0·378	30·2 ± 2·590	8·7 ± 0·097	8·4 ± 0·139	8·6 ± 0·094	9·1 ± 0·220
−0·332 [−0·672, 0·008]	0·533 [0·054, 1·012]		9·006 [3·772, 14·241]		−0·332 [−0·672, 0·008]		0·533 [0·054, 1·012]	
	NULLIPAROUS				MULTIPAROUS			
Total, n nonmissing (%)	12,903 (87·82)	1786 (12·16)	12,774 (86·94)	960 (6·53)	24,180 (74·31)	8354 (25·67)	27,107 (83·31)	3486 (10·71)
Pushing phase duration, hours								
10th percentile ± SE difference [95% CI]	0·3 ± 0·005	0·4 ± 0·015	0·3 ± 0·006	0·2 ± 0·015	0·1 ± 0·001	0·1 ± 0·001	0·1 ± 0·001	0·0 ± 0·001
	0·051 [0·019, 0·083]		−0·094 [−0·126, −0·062]		−0·003 [−0·005, 0·000]		−0·008 [−0·011, −0·005]	
25th percentile ± SE difference [95% CI]	0·6 ± 0·007	0·7 ± 0·025	0·6 ± 0·009	0·5 ± 0·023	0·1 ± 0·001	0·1 ± 0·002	0·1 ± 0·001	0·1 ± 0·003
	0·141 [0·090, 0·193]		−0·133 [−0·181, −0·084]		−0·003 [−0·007, 0·002]		−0·018 [−0·023, −0·012]	
50th percentile ± SE difference [95% CI]	1·1 ± 0·011	1·4 ± 0·039	1·1 ± 0·013	0·9 ± 0·041	0·2 ± 0·002	0·2 ± 0·003	0·2 ± 0·002	0·2 ± 0·005
	0·307 [0·226, 0·389]		−0·171 [−0·256, −0·085]		0·001 [−0·007, 0·009]		−0·029 [−0·039, −0·019]	
75th percentile ± SE difference [95% CI]	1·8 ± 0·020	2·4 ± 0·059	1·9 ± 0·021	1·7 ± 0·070	0·4 ± 0·004	0·4 ± 0·007	0·4 ± 0·004	0·4 ± 0·010
	0·562 [0·438, 0·687]		−0·166 [−0·313, −0·020]		0·013 [−0·003, 0·028]		−0·043 [−0·064, −0·022]	
90th percentile ± SE difference [95%ile CI]	3·0 ± 0·045	4·9 ± 0·344	3·2 ± 0·074	3·0 ± 0·196	0·7 ± 0·008	0·7 ± 0·014	0·7 ± 0·009	0·7 ± 0·018
	1·990 [1·296, 2·685]		−0·192 [−0·612, 0·227]		0·036 [0·004, 0·069]		−0·058 [−0·099, −0·018]	

***Table 6*: Active phase of labour and pushing durations, stratified by parity, maternal age, and Body Mass Index (BMI) at multiple points of distribution.**

* Model-based standard errors were incalculable for some 90th percentiles due to sparse counts; in those cases, CIs based on bootstrapping are reported instead.

Nulliparous active labour duration					
	Study results	Friedman 19,55[2]	Albers 1996[16]	Zhang 2010[17]	Abalos 2018[a15]
Sample size	15,331	500	556	8690	75,081
mean	11·9	4·9	7·7	..	..
median	7·5	4·0	..	3·7	3·7 — 5·9
95th%ile	34·8	11·7	19·4	16·7	14·5 — 16·7
Multiparous active labour duration					
	Study results	Friedman 19561	Albers 1996[16]	Zhang 2010[17]	Abalos 2018[a15]
Sample size	32,882	500	917	11,765	117,829
mean	4·6	2·2	5·7	..	..
median	3·3	1·8	..	2·2	2—5
95th%ile	12·0	13·6	13·7	14·2	11 - 14

***Table 7*: Active labor duration at the mean, median, and 95th%ile, in hours, vs. selected prior estimates.**
.. not reported.
[a]ranges reported in this systematic review.

by full cervical dilation rather than pushing onset, as there is often a lag between full cervical dilation and the urge to push. It is interesting to note that the results showing 5·5 h of second stage duration at the 95th%ile among nulliparous women is more than twice as long as some prior characterisations (Table 8). It is possible that this is related to hospital-based policies and culture and/or clinician perceptions of risk leading to earlier second stage intervention, and thus shorter labor times, in prior samples. Also of note, our population did not have ready access to epidurals which have been shown to further increase the length of the second stage by two hours or more at the 95th%ile.[28]

Median pushing during second stage duration of labour findings among multiparous women are the same as earliest published estimates [e.g., median is 0·2 h in our study and also in Friedman's 1956 study].[1] And current multiparous estimates at the mean, median, and 95th%ile are within the ranges estimated from earlier characterisations (Table 8). Our study findings thus increase confidence in the normal duration patterns of multiparous second stage of labour by corroborating prior multiparous second stage duration research. Findings further lend confidence that measuring the onset of the second stage by the start of pushing may be comparable to prior methods of measuring second stage duration.

Older maternal age (≥ 35 vs. < 35) was associated with longer active and second stage labour durations among nulliparous women. This pattern was reversed among older multiparous women whose active labour durations were shorter and second stage labour durations were equivalent to those <35 years. These age-related findings are consistent with some, but not all, prior research.[11,18] Regardless of parity, those with higher (≥ 30 kg/m² vs. <30 kg/m²) BMI experienced longer active labour. But this trend reversed during second stage, as those with BMI ≥ 30 kg/m² had shorter

Nulliparous second stage labour duration					
	Study results[a]	Friedman 19,55[2]	Albers 1996[16]	Zhang 2010[7]	Abalos 2018[b15]
Sample size	14,693	500	556	27,170	75,081
mean	1·9	0·95	53 m	..	..
median	1·1	0·8	..	36 m	14—66 min
95th%ile	5·5	2·5	2 h, 45 m	2 h, 48 m	65—138 min
Multiparous second stage labour duration					
	Study results[a]	Friedman 19,56[1]	Albers 1996[16]	Zhang 2010[7]	Abalos 2018[b15]
Sample size	32,538	500	917	35,245	117,829
mean	0·4	0·29	17 m	..	..
median	0·2	0·2	..	9 m	6—12 min
95th%ile	1·1	0·83	57 m	72 m	58 — 76 min

***Table 8*: Pushing duration at the mean, median, and 95th%ile, in hours, vs. Second stage of labor duration of selected prior estimates.**
..not reported.
[a] those in our sample were actively pushing.
[b] ranges reported in this systematic review.

(nulliparous) or equivalent (multiparous) pushing durations, compared to those with BMI < 30 kg/m^2. These findings are consistent with prior research.[19,20] Differences by maternal age, BMI, and parity signal important directions for future study that might also examine whether maternal age modifies the relationship between first stage labour duration and BMI.[12] Given repeated evidence that normal labour durations vary widely,[15] that each labouring individual has multiple health and demographic characteristics, and that the effect of these characteristics varies, in turn, by other characteristics, unless future nomograms become exceedingly individualized, greater patience in labour, with less focus on time, may be prudent.

A strength of this study is the sample, which provided the opportunity to study labour progress in a large, contemporary, low-risk, and undisturbed cohort. By overcoming prior sampling concerns, our study findings provide critical new insight regarding the duration of normal active phase and pushing phase of labour when interventions to hasten birth are not routinely used. There are also several limitations. The onset of active labour in the MANA cohort is identified by the attending midwife and routinely, but not always, included cervical examination. This practice of defining active labour by contraction frequency, duration, and regularity likely differs from other birth settings where cervical examinations may occur more routinely. An additional limitation is that most women in moderate- to high-resource countries intend hospital birth at the start of labour. There are known demographic differences, and likely values and preference differences, among those who choose community birth that may affect length of labour, such as a greater tolerance for longer labour before using intervention. Community birth models of care also usually offer continuity of care along with continuous labour support, and these may have important consequences for maternal (and thus foetal) ability to tolerate longer durations of labour and pushing. For these reasons, findings may not be generalizable to all childbearing populations. Importantly, we believe that this study comes as close as is feasible and ethical to providing counterfactual (to modern practice) estimates for normal labour duration during the active first stage of labour and pushing during second stage. This information may help to overcome decades of uncertainty about normal labour progress absent intervention and time thresholds signaling labour dystocia.

We recommend replication studies using other community birth (or similarly low-intervention) samples. Before findings can be generalized to wider childbearing populations, research should estimate similar outcomes among those with more granular variation in parity, age, size, and socioeconomic circumstances. Future research must explore these questions in more racially, ethnically, and geographically diverse samples. Because it is unknown if labour time thresholds at points of statistical distribution are related to risk, we also believe it is critical that future research examine the association between labour duration and risk for poor maternal/child outcomes. Only after the evidence base on these topics is stronger do we recommend incremental and well-studied translation of these findings. Similar to prior research that compared the effect of waiting 2 vs. 4 h with active phase arrest,[21,22] future research might consider the effects of allowing one to two more hours of supportive care,[23,24] vs. immediate intervention, especially after nulliparous active labour reaches a duration traditionally defined as 'labour dystocia'.

Despite longstanding belief in the relevance of labour duration for intrapartum clinical decision making, there are widely acknowledged limitations to how normal labour and birth have been characterised and to how labor dystocia has been defined. Clinical translation of early labour duration research has led to widespread use of interventions intended to hasten labor, thus creating difficulty in obtaining a large, undisturbed sample to characterise normal patterns of labour progress. Findings of this study offer new estimates for active labour and pushing phase durations during low-risk childbearing.

Contributors

ET conceptualized and led the study; made substantial contributions to the study design and data acquisition; substantially contributed to the analysis and interpretation; led the initial draft and all draft revisions; approved the final manuscript; is accountable for all aspects of the work; has confidence in the integrity of all co-authors' contributions; had full access to all the data in the study; and accepts responsibility to submit for publication. JS and AC substantially contributed to conceptualizing the study; made substantial contributions to the study design; substantially contributed to the analysis, interpretation, the initial draft, and all draft revisions; approved the final manuscript; is accountable for all aspects of the work; has confidence in the integrity of all co-authors' contributions; had full access to all the data in the study; and accepts responsibility to submit for publication. MC and MB verified the underlying data; substantially contributed to conceptualizing the study; made substantial contributions to the study design and data acquisition; substantially contributed to the analysis, interpretation, the initial draft, and all draft revisions; approved the final manuscript; is accountable for all aspects of the work; has confidence in the integrity of all co-authors' contributions; had full access to all the data in the study; and accepts responsibility to submit for publication. JL and JW made substantial contributions to the study design and data acquisition; substantially contributed to the analysis, the initial draft, and all draft revisions; approved the final manuscript; is accountable for all aspects of the work; has confidence in the integrity of all co-authors' contributions; had full access to all the data in the study; and accepts responsibility to submit for publication.

Data sharing statement

MANA Stat 4.0 data used for this secondary analysis was collected and is protected by the Midwifery Alliance of North America. Access to this data can be obtained through completing an application that includes a proposed study to the Midwifery Alliance of North America Division of Research. To learn more about the application and proposal processes for gaining permission to use this data, contact The Midwifery Alliance of North America Division of Research at: researchapplications@manastats.org

Declaration of interests

ET declares the following interests: Co-Owner and Chief Scientific Officer for CenterMom, Inc. She has stock ownership in this company. Consultant and Director of Maternity Care for Stork Club, Inc. She receives payment for her work with Stork Club. JS, MC, MB, JL, JW, and AC have nothing to disclose.

Acknowledgments

We gratefully acknowledge Ms. Leah Holmes for her help with manuscript formatting. We gratefully acknowledge the funding received to support this research from: (1) Oregon Health & Science University School of Nursing Innovation Grant; and (2) Oregon Health & Science University Shared Resources Grant.

Funding

OHSU Nursing Innovation and OHSU University Shared Resources.

References

1 Friedman EA. Labor in Multiparas: a graphicostatistical analysis. *Obstet Gynecol*. 1956;8(6):686–703.
2 Friedman EA. Primigravid labor; a graphicostatistical analysis. *Obstet Gynecol*. 1955;6(6):567–589.
3 Bonet M, Oladapo OT, Souza JP, Gulmezoglu AM. Diagnostic accuracy of the partograph alert and action lines to predict adverse birth outcomes: a systematic review. *BJOG*. 2019;126(13):1524–1533.
4 Caughey A, Cahill AG, Guise JM, Rouse DJ. Safe prevention of the primary cesarean delivery. *Am J Obstet Gynecol*. 2014;210:179–193.
5 Vogel JP, Betrán AP, Vindevoghel N, et al. Use of the Robson classification to assess caesarean section trends in 21 countries: a secondary analysis of two WHO multicountry surveys. *Lancet Glob Health*. 2015;3(5):e260–e270.
6 Hamilton E, Warick P, Collins K, Smith S, Garite TJ. Assessing first-stage labor progression and its relationship to complications. *Am J Obstet Gynecol*. 2016;214(358):e.1–e.8.
7 Zhang J, Landy HJ, Branch DW, et al. Contemporary patterns of spontaneous labor with normal neonatal outcomes. *Obstet Gynecol*. 2010;116(6):1281–1287.
8 Oladapo OT, Souza JP, Fawole B, et al. Progression of the first stage of spontaneous labour: a prospective cohort study in two sub-Saharan African countries. *PLoS Med*. 2018;15:(1) e1002492.
9 Zeitlin J, Durox M, Macfarlane A, et al. Using Robson's Ten-Group classification system for comparing caesarean section rates in Europe: an analysis of routine data from the Euro-Peristat study. *BJOG*. 2021;128(9):1444–1453.
10 Seijmonsbergen-Schermers AE, van den Akker T, Rydahl E, et al. Variations in use of childbirth interventions in 13 high-income countries: a multinational cross-sectional study. *PLoS Med*. 2020;17:(5) e1003103.
11 Greenberg MB, Cheng YW, Sullivan M, Norton ME, Hopkins LM, Caughey AB. Does length of labor vary by maternal age? *Am J Obstet Gynecol*. 2007;197(4):428.e1-7.
12 Lundborg L, Liu X, Aberg K, et al. Association of body mass index and maternal age with first stage duration of labour. *Sci Rep*. 2021;11(1):13843.
13 Cheyney M, Bovbjerg M, Everson C, Gordon W, Hannibal D, Vedam S. Development and validation of a national data registry for midwife-led births: the midwives alliance of North America statistics project 2.0 dataset. *J Midwifery Womens Health*. 2014;59(1):8–16.
14 Cheyney M, Bovbjerg M, Everson C, Gordon W, Hannibal D, Vedam S. Outcomes of care for 16,924 planned home births in the United States: the midwives alliance of North America statistics project, 2004 to 2009. *J Midwifery Womens Health*. 2014;59(1):17–27.
15 Abalos E, Oladapo OT, Chamillard M, et al. Duration of spontaneous labour in 'low-risk' women with 'normal' perinatal outcomes: a systematic review. *Eur J Obstet Gynecol Reprod Biol*. 2018;223:123–132.
16 Albers LL, Schiff M, Gorwoda J. The length of active labor in normal pregnancies. *Obstet Gynecol*. 1996;87(3):355–359.
17 Zhang J, Troendle J, Mikolajczyk R, Sundaram R, Beaver J, Fraser W. The natural history of the normal first stage of labor. *Obstet Gynecol*. 2010;115(4):705–710.
18 Zaki MN, Hibbard JU, Kominiarek MA. Contemporary labor patterns and maternal age. *Obstet Gynecol*. 2013;122(5):1018–1024.
19 Carlhall S, Kallen K, Blomberg M. Maternal body mass index and duration of labor. *Eur J Obstet Gynecol Reprod Biol*. 2013;171(1):49–53.
20 Shenouda C, Wijesooriya A, Toufeili A, Miller MR, Penava D, de Vrijer B. Labour progression in obese women: are women with increased body mass index having unnecessary cesarean sections? *J Obstet Gynaecol Can*. 2020;42(3):293–300.
21 Rouse DJ, Owen J, Hauth JC. Active-phase labor arrest: oxytocin augmentation for at least 4 h. *Obstet Gynecol*. 1999;93(3):323–328.
22 Henry DEM, Cheng YW, Shaffer BL, Kaimal AJ, Bianco K, Caughey AB. Perinatal outcomes in the setting of active phase arrest of labor. *Obstet Gynecol*. 2008;112(5):1109–1115.
23 Renfrew MJ, McFadden A, Bastos MH, et al. Midwifery and quality care: findings from a new evidence-informed framework for maternal and newborn care. *Lancet*. 2014;384(9948):1129–1145.
24 Betran AP, Temmerman M, Kingdon C, et al. Interventions to reduce unnecessary caesarean sections in healthy women and babies. *Lancet*. 2018;392(10155):1358–1368.
25 Cohen WR, Friedman EA. The assessment of labor: a brief history. *J Perinat Med*. 2018;46(1):1–8.
26 Philpott RH, Castle WM. Cervicographs in the management of labour in primigravidae I. The alert line for detecting abnormal labour. *J Obstet Gynaecol Br Commonw*. 1972;79(7):592–598.
27 *WHO Recommendations Intrapartum Care for a Positive Childbirth Experience*. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.
28 Cheng YW, Nicholson JM, Shaffer BL, Caughey AB. The second stage of labor and epidural use: a larger effect than previously suggested. *Obstet Gynecol*. 2014;123:527–535.