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ORIGINAL ARTICLE

Routine transabdominal cervical length screening in mid-pregnancy for the prevention of preterm birth: Is it good enough to use as a screening test?

Michelle K Pedretti[1,2], Jan E. Dickinson[1,3], Dorota A. Doherty[1] and John P. Newnham[1]

[1]Division of Obstetrics and Gynaecology, The University of Western Australia, Perth, Western Australia, Australia

[2]Department of Ultrasound, King Edward Memorial Hospital, Perth, Western Australia, Australia

[3]Maternal Fetal Medicine Service, King Edward Memorial Hospital, Perth, Western Australia, Australia

Correspondence: Dr Michelle K. Pedretti, Division of Obstetrics and Gynaecology, The University of Western Australia, M550, 35 Stirling Highway, Crawley, WA 6008, Australia. Email: michelle.pedretti@health.wa.gov.au

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Background: Preterm birth (PTB) is a major pregnancy complication. There is evidence that a short cervical length in mid-pregnancy may predict women at increased risk of PTB.

Aims: To evaluate the utility of population-based, transabdominal cervical length (TACL) measurement screening in mid-pregnancy for PTB prediction in women.

Materials and Methods: A transabdominal approach was initially performed, with a transvaginal (TVCL) approach offered when the TACL was <35 mm, could not be accurately measured, or the pregnancy had risk factors for PTB. TACL was compared to the directly related TVCL, when both were performed at the same assessment. Women with risk factors of PTB were included when they had both TACL and TVCL measurements performed at the same visit.

Results: Data were provided for 9355 singleton pregnancies from 13 participating imaging centres. A transabdominal approach was used in 9006 (96.3%), including 682 (7.3%) TVCL combined with TACL. There were 349 (3.7%) women who had TVCL only. The median TACL was longer (40 mm) than the TVCL (38 mm). In 682 paired TACL and TVCL measurements, TACL <35 mm correctly identified 96.2% of pregnancies with TVCL <25 mm, compared with 65.4% of cases when using a TACL <30 mm. A TVCL <25 mm occurred in 59 (0.6%) women. A TACL <35 mm was associated with birth <37 weeks of gestation in 12.1% of women and birth <32 weeks of gestation in 3.9%.

Conclusions: Universal TACL is a feasible option for population screening of cervical length in a low-risk population, progressing to TVCL if the TACL is <35 mm or the cervix cannot be transabdominally accurately measured.

KEYWORDS

cervical length, population screening, preterm birth, screening, transabdominal ultrasound

INTRODUCTION

Prior history alone is a poor discriminator of preterm birth (PTB) risk, with 50% of spontaneous preterm births (sPTB) occurring in nulliparous women.[1,2] There is an inverse relationship between PTB and cervical length (CL) in mid-pregnancy: the shorter the CL, the higher the risk of PTB.[3,4] Ultrasound imaging is the primary screening tool for CL assessment, with a transvaginal cervical

length (TVCL) measurement <25 mm considered short, thereby placing the pregnancy at an increased risk for PTB.[4]

Progesterone is recommended for women at risk of sPTB, particularly with a TVCL <25 mm at the mid-pregnancy assessment. Universal screening has been promoted to identify women with a TVCL <25 mm, given the association between a short CL and sPTB and the efficacy of progesterone to reduce this risk.[5,6] We classified women as 'low risk' who had no perceived risk factors for PTB at the beginning of their current pregnancy.

TVCL screening is considered the gold standard for CL assessment with most professional obstetric societies promoting TVCL screening, either universally or selectively.[4,6–8] Routine CL measurement is included as part of mid-pregnancy ultrasound imaging guidelines in many countries, including Australia and New Zealand.[9] TVCL measurement of the entire obstetric population in mid-pregnancy, however, is a logistical challenge compared with the simpler methodology of transabdominal cervical length (TACL) screening. Therefore, TACL is an attractive option for screening the low-risk pregnant population. The Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) has supported the implementation of universal mid-pregnancy TACL screening for low-risk women.[6] Their guideline recommends progression to TVCL assessment in cases with a TACL <35 mm, if the cervix cannot be adequately visualised with TACL or for women who are at high risk of PTB. Whether TACL is an effective screening test in a non-selected obstetric population warrants further evaluation.

The primary aims of this study were to determine the effectiveness of mid-pregnancy TACL screening in predicting the frequency of a short CL when measured by progression to TVCL, and to evaluate the relationships between CL and obstetric outcomes in singleton pregnancies.

MATERIALS AND METHODS

This was a retrospective study conducted in Western Australia, between January 2015 and May 2017, performed under the umbrella of the Western Australian Preterm Birth Prevention Initiative.[5,10] The data collection coincided with the commencement of the state-wide initiative and encompassed the roll-out of CL screening. Images of CL measurements (either TACL or TVCL), routinely performed at mid-pregnancy (18–22 weeks gestation) ultrasound examinations at 13 participating practices were included. Participating practices included a private women's imaging practice where the authors (MP, JD) worked and had access to the images, and publicly funded sites including King Edward Memorial Hospital and Fiona Stanley Hospital (the state tertiary obstetric referral centres), secondary metropolitan and rural sites including: Osborne Park Hospital, Geraldton Hospital, Fremantle Hospital, Rockingham Hospital, Hedland Health Campus, Swan Districts Hospital, Exmouth Hospital, Broome Hospital, Carnarvon Hospital and Royal Perth Hospital. These publicly funded sites were all public hospitals where imaging was stored on the public Picture Archiving and Communications System (PACS) and the Radiology Information System (RIS). The CL was measured according to local imaging protocols and the CL was cited in the imaging report.[11] Images were reviewed in the PACS RIS for the CL and imaging approach was taken for cases where data were missing in the reports. Where there was a significant discrepancy/typographical error between the CL on the image and the CL in the report, the CL on the image was used. Where multiple CL measurements were recorded for the pregnancy, the CL measurement obtained closest to 20 weeks gestation was used. Where the CL was measured by transvaginal and transabdominal approaches at the same examination, these measurements were both recorded and considered 'paired'. Any multiple pregnancies that may have been incorrectly captured, as well as singleton pregnancies where the mid-pregnancy CL was not available, and abortions between 20 and 24 weeks gestation were excluded prior to analysis. All CL measurements were recorded in millimetres.

The CL measurements were merged with pregnancy data recorded in the Western Australian Midwives Notification System (MNS) by the Western Australian Data Linkage System (WADLS) (https://www.datalinkage-wa.org.au/). The MNS receives and maintains data from midwives on all births in Western Australia where the gestation is ≥20 weeks or birthweight >400 g for pregnancies of unknown gestation. Information from the MNS included maternal characteristics, medical and obstetric history, pregnancy complications, labour and birth outcomes, including mode of delivery, gestation at delivery, location of birth, and live or stillborn status. History of PTB (present, absent or unknown) was derived using consecutive pregnancies reported in the MNS from 1999.

This study was a component of the 'Implementation of a state-wide cervical length screening program' and 'Monitoring the impact if the Western Australian Preterm Birth Prevention Initiative on preterm births', which were approved by the Women and Newborn Health Service Human Research Ethics Committee (2015028EW) RGS0000002660 and (2016027EW) RGS 0000002677, and the Health Department of Western Australia (EC00422) RGS0000000704.

Statistical analysis

Continuous data were summarised using medians, interquartile ranges and ranges or means and standard deviations, and categorical data were summarised with frequency distributions. Univariate comparisons of continuous outcomes between groups were conducted using Mann–Whitney and Kruskal–Wallis nonparametric tests, and Fisher exact or χ^2 tests for categorical data. Operating characteristics of TACL <35 mm as a screening test for TVCL <25 mm, including sensitivity, specificity and positive and negative predictive values and were obtained for TACL and TVCL paired data (n = 682) after its first implementation to examine the utility of 35 mm cut-off within the limitations of partial data.

Logistic regression analysis was used to examine the effects of short CL on the likelihood of PTB with adjusted odds ratios (aOR) together with their 95% confidence intervals (CI) reported to summarise their effects. Other covariates used to adjust for the probability of preterm birth included maternal age, maternal body mass index (BMI), nulliparity, smoking during pregnancy, history of PTB, history of stillbirth and pregnancy complications, including pre-eclampsia, and gestational diabetes.

SPSS statistical software (IBM SPSS Statistics for Windows (version 29)) was used for data analysis. All *P*-values were two-sided and *P*-values <0.05 were considered statistically significant.

RESULTS

Study population

Between January 2015 and May 2017, 82 976 singleton births were reported in the MNS. These births included 9355 pregnancies (with latest expected delivery date 31 May, 2017) where CL measurements were recorded in mid-pregnancy at the 13 participating centres, after the exclusion of multiple pregnancies incorrectly captured ($n = 62$) or singleton pregnancies without CL measurements at 18–22 weeks gestation ($n = 12$). These 9355 pregnancies (Fig. 1) represented 11.3% of all singleton pregnancies recorded in the MNS during the study period.

The demographic and obstetric characteristics at the mid-pregnancy ultrasound for the 9355 women with a CL recorded at participating practices and those in practices where the CL images were not available ('non-participating practices') are shown in Table S1. Women with a CL recorded were less likely to smoke or have a BMI >25 kg/m^2 and were more likely to have pre-existing medical conditions, a history of PTB or prior stillbirth. Additionally, they had a higher rate of both pregnancy complications and PTB (9.5% vs 7.0%).

Among women from participating practices, the median maternal age was 32 years and 43.9% were nulliparous. Smoking in pregnancy was reported in 6.4% ($n = 599$) (4.6% of nulliparous and 7.8% of multiparous women). A prior history of PTB was recorded for 13.3% of multiparous women and 4.7% had a prior stillbirth. Of the 9355 women, 9.5% ($n = 888$) delivered at <37 weeks gestation, with 2.2% ($n = 208$) delivering at <32 weeks gestation (Table S1). A summary of the CL measurements, stratified by parity, is presented in Table 1.

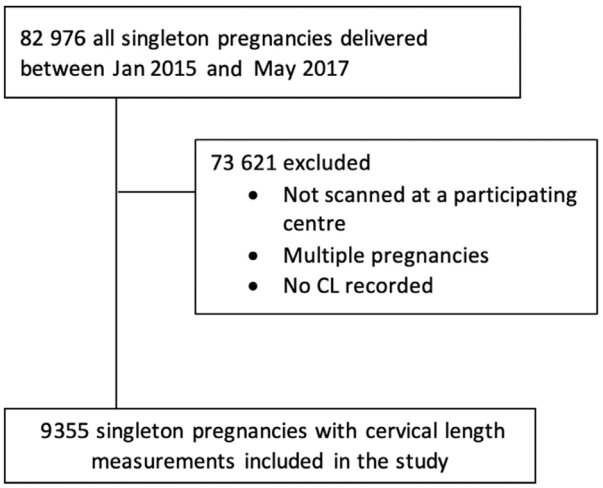

FIGURE 1 Participant flow chart.CL, cervical length.

CL measurements in mid-pregnancy

The median gestation at the time of the ultrasound examination was 19.6 weeks (interquartile range (IQR) 19.3–20, range 18–22.9 weeks gestation). The median TACL was 40 mm (IQR 36.6–44 mm), and the median TVCL was 38 mm (IQR 33.3–45.2 mm). The median TACL was longer in multiparous (40.4 mm) than nulliparous women (39.6 mm) ($P < 0.001$). These medians were reversed for TVCL measurements at 38.4 mm (nulliparous) and 37.7 mm (multiparous) (Table 1).

Most cervical measurements were obtained transabdominally ($n = 9006$, 96.3%) with a higher rate of the transabdominal only approach among multiparous women (89.8% vs 88.0% $P = 0.005$) (Table 1). A few women ($n = 349$, 3.7%) had TVCL measurements only, higher among nulliparous women (4.3% vs 3.3%, $P = 0.009$). The incidence of TACL <35 mm without progression to TVCL was 10.1% ($n = 944$) and included 103 cases of transabdominally obtained measurements <30 mm. For women with a TACL measurement ($n = 9006$), the incidence of progression to TVCL was 14.4% ($n = 1294$). When reviewing women ($n = 682$) who had paired TACL and TVCL measurements, the incidence of those progressing to TVCL, based on a TACL <35 mm, was 51.4%.

In paired TACL and TVCL measurements, the median TACL was 34.6 mm and the median TVCL was 38.6 mm. There was a 2.7 mm difference between TACL and TVCL for those women who had both measurements performed at the same visit (Table 2). This difference was 1.8 mm in the tertiary hospital population and 3.9 mm in the specialist women's imaging practice. The difference increased in nulliparous women to 4.9 mm and decreased to 1.3 mm in the multiparous women.

The incidence of a TVCL <25 mm was 0.6% ($n = 59$). This incidence was 0.7% in nulliparous and 0.6% in multiparous women and was highest (1.8%) at the tertiary hospital. Of those with a short TVCL, 16 had a cervical cerclage *in situ* at the time of the examination, of whom 51.9% were nulliparous.

Women with a short TVCL were more likely to have experienced a prior PTB (16.9% vs 7.6%, $P = 0.012$; 10/59 vs 638/8352) (Table S1). Women with a short TVCL were also more likely to have preterm prelabour rupture of membranes (13.6% vs 1.9%, $P < 0.001$; 8/59 vs 158/8352), and experienced preterm labour (10.2% vs 2.6%, $P < 0.001$; 6/59 vs 220/8352) in the current pregnancy.

For the 682 women who had both TACL and TVCL performed, 350 (51.4%) had a TACL <35 mm and required TVCL measurements, with 26 cases of TVCL <25 mm. The sensitivity of TACL <35 mm predicting a TVCL <25 mm was 96.2% (95% CI 80.4–99.9%)

TABLE 1 Cervix length measurements in mid-pregnancy

Characteristic	All (*n* = 9355)	P0 (*n* = 4108)	P1+ (*n* = 5247)
Gestation at cervical measurements median (IQR, range (R)), weeks	19.6 (IQR 19.3–20.0, R 18.0–22.9)	19.6 (IQR 19.3–20.0, R 18.0–22.9)	19.6 (IQR 19.3–20.0, R 18.0–22.9)
TA median *N* = 9006 (IQR, range)	40.0 (IQR 36.6–44.0, R 3.0–150.0)	39.6 (IQR 36.0–43.3, R 0–83.6)	40.4 (IQR 37.0–44.6, R 0–150.0)
	40.6 ± 6.5	39.9 ± 6.4	41.1 ± 6.6
<35 mm	1294 (13.8)	660 (16.1)	634 (12.1)
TV median *N* = 1031 (IQR, range)	38.0 (IQR 33.3–42.5, R 0–62.0)	38.4 (IQR 34.1–42.9, R 0–59.1)	37.7 (IQR 32.7–42.2, R 0–62.0)
Mean ± SD	37.4 ± 8.3	37.8 ± 8.2	37.0 ± 8.6
<25 mm	60 (0.6)	27 (0.7)	32 (0.6)
Only TA measured	8324 (89.0)	3613 (88.0)	4711 (89.8)
Both TA and TV measured	682 (7.3)	318 (7.7)	364 (6.9)
Only TV measured	349 (3.7)	177 (4.3)	172 (3.3)
Short cervix			
No	8353 (89.3)	3607 (87.8)	4745 (90.4)
TV <25 mm	59 (0.6)	27 (0.7)	32 (0.6)
TA <35 mm, no TV	944 (10.1)	474 (11.5)	470 (9.0)
TA <35 mm, no TV†			
30 mm < TA < 35 mm	840 (9.0)	429 (10.4)	412 (7.9)
TA <30 mm	103 (1.1)	45 (1.1)	58 (1.1)

†Percentages based on *n* = 9355.
P0, nulliparous; P1+, multiparous; IQR, interquartile range; TA, transabdominal; TV, transvaginal.

TABLE 2 Summary of paired transabdominal and transvaginal cervical length measurements from TVCL, on average 2.7 mm (*P* < 0.001)

	Centiles					Centiles		
	Min	10th	25th	Median	Mean (SD)	75th	90th	Max
All (*n* = 682)								
TACL, mm	4.5	25.6	30.0	34.6	35.3 (8.2)	40.4	45.9	62.7
TVCL, mm	0	29.2	33.8	38.6	38.0 (7.8)	42.9	46.5	59.9
TACL-TVCL, mm	−27.1	−13.1	−8.4	−2.7	−2.7 (8.5)	2.4	8.1	34.8
Nulliparous (*n* = 271)†								
TACL, mm	4.5	25.3	29.6	33.2	34.4 (8.0)	39.7	44.4	62.7
TVCL, mm	0	30.9	35.9	39.6	39.4 (7.4)	43.9	47.8	59.1
TACL-TVCL, mm	−27.1	−15.2	−9.0	−5.0	−4.9 (8.0)	0.2	5.1	18.9
Multiparous (*n* = 334)†								
TACL, mm	8.0	27.3	31.1	36.1	36.7 (8.1)	41.2	47.4	62.7
TVCL, mm	0	29.1	33.4	38.6	37.9 (7.6)	42.7	46.1	59.9
TACL-TVCL, mm	−24.1	−10.9	−6.6	−1.4	−1.3 (8.3)	4.0	9.9	34.8

†Women from a private specialist women's imaging practice (*n* = 321) and specialist tertiary obstetric hospital (*n* = 284) are included (*n* = 605).
TACL, transabdominal cervical length; TVCL, transvaginal cervical length.

and specificity 50.4% (95% CI 46.5–54.3%), with a positive predictive value of 7.1% (95% CI 6.4–7.9%), and a negative predictive value of 99.7% (95% CI 98.0–99.9%). If the TACL cut-off was changed from <35 to <30 mm, using the sample of paired CL measurements (*n* = 682), the sensitivity to predict a TVCL <25 mm was reduced from 96.15 to 65.4% (Table 3).

Relationships between a short CL and obstetric outcomes

A short TVCL remained a significant predictor of PTB in multivariable logistic regression (adjusted odds ratio (aOR) = 2.89, 95% CI 1.54–5.41, *P* < 0.001) with adjustments

TABLE 3 Operating characteristics of TACL detecting TVCL <25 mm with cut offs of 30 and 35 mm

	TACL <30 mm		TACL <35 mm	
Characteristic	**% or ratio**	**95% CI**	**% or ratio**	**95% CI**
Sensitivity	65.38	44.33–82.79	96.15	80.36–99.90
Specificity	77.71	74.33–80.84	50.38	46.48–54.28
Positive likelihood ratio	2.93	2.14–4.02	1.94	1.74–2.16
Negative likelihood ratio	0.45	0.26–0.76	0.08	0.01–0.52
Positive predictive value	10.43	7.84–13.75	7.11	6.42–7.86
Negative predictive value	98.26	97.08–98.97	99.70	97.98–99.96
Accuracy	77.24	73.90–80.34	52.12	48.29–55.93

TACL, transabdominal cervical length; TVCL, transvaginal cervical length.

for other maternal factors. A TACL <35 mm alone, without the corresponding TVCL <25 mm, was not associated with increased risk of PTB (aOR = 1.19, 95% CI 0.95–1.49, $P = 0.133$). Of the 59 women with a TVCL <25 mm, 22 (37.3%) delivered at <37 weeks gestation. This incidence decreased to 9.2% in cases of TACL between 30 and 35 mm and in whom a TVCL had not been recorded, and 16.5% with a TACL <30 mm with no TVCL. Women with a TVCL <25 mm had the highest numbers of preterm births at 20–36 weeks gestation ($n = 8$; 24.2%).

Of the 9355 women, 1096 (9.5%) delivered preterm with 2.2% ($n = 208$) delivering at <32 weeks gestation (Table 1). The majority of deliveries at >39 weeks gestation were in women with a mid-pregnancy CL >35 mm (Table 4). The PTB rate at <32 and <37 weeks gestation for the state (82 976) and the 9355 women was 1.2, 2.2 and 7.7, 9.5% respectively. Using a TACL <35 mm, the rate for a PTB at <32 weeks gestation was 3.9% and 12.1% for <37 weeks gestation. If a TACL <30 mm was used, these rates increased to 6.8 and 19.2% for PTB <32 and <37 weeks gestation, respectively (Table 4).

DISCUSSION

Our results confirm that a two-step approach to CL population screening, incorporating an initial TACL screening with a 35 mm cut-off, is an effective strategy in low-risk women, enabling it to be feasibly incorporated as a component of PTB prevention programs.[4–6,12,13] A TACL <35 mm will predict 96% of cases with a TVCL <25 mm, with 14.4% of women ($n = 1294$) needing to progress to TVCL. This increases to 21%, when women with no TACL measurement ($n = 944$) are included.

Access and financial aspects of CL screening

The costs involved with universal TVCL screening are not insignificant but need to be balanced against the financial burden of very early PTB (in Australia AUD$236 000/case up to 18 years of age[14]). Friedman *et al*.[15] reported a sensitivity of 98.8% for an initial TACL predicting a short cervix. Stamillo and Carlson[16] concluded that transvaginal ultrasound did not provide additional information in cases with an adequate transabdominal measurement (ie >35 mm).

TVCL remains the preferred screening approach for women at high risk, when the TACL is <35 mm or cannot be adequately transabdominally assessed.[17,18] Miller and Grobman[19] reported an initial TACL screening strategy was cost-effective when optimising the screening characteristics in lower-risk populations. TVCL screening adds approximately ten minutes to each examination and requires additional equipment (specialised transducer and high-level cleaning unit) and consumables.[8]

CL cut-off and prevalence of short CL

Our data confirm the association between sonographic CL and pregnancy duration. The prevalence of a short TVCL in our sample was low (0.6%), consistent with other publications of 0.45–6.2% (TVCL <25 mm).[6,17,20–22] There were women with an increased PTB risk in our study of whom some would have received vaginal progesterone based on prior history or mid-pregnancy CL. With no way of determining those prescribed progesterone, the ability to estimate the effectiveness of CL in the timing of birth is limited due to the potential treatment effect. The lack of understanding of the potential treatment effects in this group may also explain why the incidence of a short TVCL is at the lower end of the reported range.

Variable TACL 'cut-off' measurements have been reported, with a range of sensitivities and specificities. The TACL <35 mm cut-off has a reported sensitivity of 96.1–100% and specificity of 32.2–39.4%.[15, 17, 23] Decreasing the transabdominal cut-off to <30 mm, improves specificity (65.6–82.7%).[17,23] However, this significantly decreases sensitivity (38.5–72.4%) and positive predictive value of TACL as an initial screening test. Marren *et al*, reported that altering the TACL (full bladder) cut-off to <30 mm would result in 62% of cases with a short cervix being missed.[23]

Most professional societies agree that TVCL assessment remains the gold standard for CL screening in PTB prevention policies.[4,7,24–28] Universal TVCL screening is promoted but does not appear to be undertaken on a population basis, but rather

TABLE 4 Preterm birth outcomes overall, stratified by nulliparity and stratified by TACL and TVCL cervical length measurements

		All (*n* = 9355)	Nulliparous (*N* = 4108)	Multiparous (*N* = 5247)
	GA at birth (weeks)	***n* (%)**	***n* (%)**	***n* (%)**
TVCL ≥25 mm		8352	3607	4745
	20–27	102 (1.2)	39 (1.1)	63 (1.3)
	28–31	59 (0.7)	30 (0.8)	29 (0.6)
	32–36	611 (1.9)	280 (7.8)	331 (7.0)
	<32	161 (1.9)	69 (1.9)	92 (1.9)
	<37	772 (9.2)	344 (9.7)	423 (8.9)
	37+	7580 (90.8)	3258 (90.3)	4322 (91.1)
TVCL <25 mm	*N*	59	27	32
	20–27	10 (16.9)	4 (14.8)	6 (18.8)
	28–31	6 (10.2)	4 (14.8)	2 (6.3)
	32–36	6 (10.2)	3 (11.1)	3 (9.9)
	<32	16 (10.2)	8 (29.6)	8 (25.0)
	<37	22 (37.3)	11 (40.7)	11 (34.4)
	37+	37 (62.7)	16 (59.3)	21 (65.6)
TACL <35 mm, no TVCL	*N*	944	474	470
	20–27	28 (3.0)	14 (3.0)	14 (3.0)
	28–31	3 (0.3)	3 (0.6)	-
	32–26	63 (6.7)	27 (5.7)	36 (7.7)
	<32	31 (3.3)	17 (3.6)	14 (3.0)
	<37	94 (10.0)	44 (9.3)	50 (10.6)
	37+	850 (90.0)	430 (90.7)	420 (89.4)
TACL <30 mm, no TVCL	*N*	103	45	58
	20–27	8 (7.8)	1 (2.2)	7 (12.1)
	28–31	–	–	–
	32–26	9 (8.7)	5 (11.1)	4 (6.9)
	<32	8 (7.8)	1 (2.2)	7 (12.1)
	<37	17 (16.5)	6 (13.3)	11 (19.0)
	37+	86 (83.5)	39 (86.7)	47 (81.0)

GA, gestational age; TACL, transabdominal cervical length; TVCL, transvaginal cervical length.

in particular institutions or for the basis of CL screening in a selected population.[29]

Strengths and limitations

A study limitation is that measurements were conducted by multiple operators, using various methods for both TACL and TVCL measurements. A standardised technique for TACL screening could add to the value of this approach. A TVCL >25 mm will be curved in >50% of cases,[30] straightening as it shortens. All cervices <16 mm will be straight.[31] A single straight-line measurement between the internal and external cervical os is promoted as the most reproducible CL measurement; however, this method will underestimate the CL in curved cervices. Although Kagan and Sonek[31] state this is of little clinical significance, in low-risk women it may increase anxiety, and a spline measurement may be more appropriate. While there is a standard for TVCL measurement, there are limited standards and protocols for TACL. We suggest the same imaging standards should be applied, regardless of approach (ie the entire cervical canal is identified and occupies 75% of the image, the closed CL is measured from internal to external os, along the canal). A straight-line measurement should be routinely used. We recognise this straight-line measurement may potentially increase the progression to TVCL. A spline measurement should be considered for those cervices that measure <25 mm on TACL and are acutely curved, to accurately represent the 'true' CL and minimise overtreatment.

In conclusion, our study supports a TACL <35 mm cut-off as part of a two-step approach utilising mid-pregnancy universal TACL screening for low-risk pregnancies. Progression to a TVCL assessment should the TACL be <35 mm, or if the cervix could not be adequately visualised, is a reasonable approach to

CL screening for the prevention of PTB. A TACL <35 mm cut-off should be used rather than a TACL <30 mm cut-off, for progression to TVCL, due to the improved sensitivity (sensitivity 96.2% vs 65.4%) of the detection of the TVCL short cervix and the reduced progression to TVCL rate. Pregnancies at increased risk of a short CL or PTB should have TVCL screening as the primary approach, as TVCL <25 mm at <24 weeks gestation remains the definition of a short cervix for the determination of increased risk of PTB.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Participants versus non-participants maternal and delivery characteristics, with participants additionally stratified by nulliparity.