Uterocervical angle in predicting spontaneous preterm birth: a systematic review and meta-analysis

Michael Jeffrey Goldstein, MD; Jessica Marie Bailer, MD; Veronica Mayela Gonzalez-Brown, MD

OBJECTIVE: This study aimed to compare the uterocervical angles in term and spontaneous preterm birth cohorts and to compare the test characteristics of the uterocervical angle and cervical length in the prediction of spontaneous preterm birth.

DATA SOURCES: A systematic search of published literature from January 1, 1945, to May 15, 2022, was performed using the following databases: PubMed, Cochrane Central Register of Controlled Trials, Embase, World Health Organization International Clinical Trials Registry Platform, Web of Science, and ClinicalTrials.gov. The search was not restricted. The references of all relevant articles were reviewed.

STUDY ELIGIBILITY CRITERIA: Randomized control trials, nonrandomized control trials, and observational studies were evaluated for primary comparisons. Included studies compared the uterocervical angles in term and spontaneous preterm birth cohorts and compared the uterocervical angle with cervical length in the prediction of spontaneous preterm birth.

METHODS: Of note, 2 researchers independently selected studies and evaluated the risk of bias with the Newcastle-Ottawa Scale for cohort and case-control studies. Mean differences and odds ratios were calculated using a random effects model for inclusion and methodological quality. The primary outcomes were uterocervical angle and successful prediction of spontaneous preterm birth. Moreover, posthoc analysis comparing the uterocervical angle and cervical length together was performed.

RESULTS: A total of 15 cohort studies with 6218 patients were included. The uterocervical angle was larger in the spontaneous preterm birth cohorts (mean difference, 13.76; 95% confidence interval, 10.61−16.91; $P<.00001$; $I^2=90\%$). Sensitivity and specificity analyses demonstrated lower sensitivities with cervical length alone and uterocervical angle plus cervical length than with uterocervical angle alone. Pooled sensitivities for uterocervical angle and cervical length alone were 0.70 (95% confidence interval, 0.66−0.73; $I^2=90\%$) and 0.46 (95% confidence interval, 0.42−0.49; $I^2=96\%$), respectively. Pooled specificities for uterocervical angle and cervical length were 0.67 (95% confidence interval, 0.66−0.68; $I^2=97\%$) and 0.90 (95% confidence interval, 0.89−0.91; $I^2=99\%$), respectively. The areas under the curve for uterocervical angle and cervical length were 0.77 and 0.82, respectively.

CONCLUSION: Uterocervical angle alone or with cervical length was not superior to cervical length alone in predicting spontaneous preterm birth.

Key words: adverse pregnancy outcomes, cervical length, sonographic predictors of spontaneous preterm birth, spontaneous preterm birth, ultrasound, uterocervical angle

Introduction

Spontaneous preterm birth (sPTB) continues to be the leading cause of perinatal morbidity and mortality in developed countries and occurs in 11% to 13% of births globally and in the United States.[1,2] Given the associated risks of death and both short- and long-term adverse consequences,[3] efforts to predict sPTB more accurately and reliably have led to various biochemical and imaging methods. The current

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Patient consent is not required because no personal information or detail is included.

The opinions and assertions expressed herein are those of the authors and do not reflect the official policy or position of the Uniformed Services University of the Health Sciences or the Department of Defense.

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Why was this study conducted?

Measuring cervical length (CL) is standard practice in stratifying the likelihood of spontaneous preterm birth (sPTB); however, since its widespread adoption, research has questioned its usefulness and reliability. The uterocervical angle (UCA) has been increasingly researched as an alternative.

Key findings

This review demonstrated that although UCA is significantly increased in women who ultimately experience sPTB, its test characteristics in the prediction of sPTB are poor, particularly compared with CL.

What does this add to what is known?

This is the largest and most in-depth systematic review and meta-analysis on this issue, comparing multiple subgroup analyses regarding differences in UCA in singleton and multiple pregnancies and in asymptomatic pregnancies and those showing symptoms of preterm labor. In addition, this review directly compared the test characteristics of UCA and CL.

practice to measure the cervical length (CL) using transvaginal ultrasound (US) is based on data demonstrating it to be a reproducible predictor of sPTB.[4–6]

Despite its widespread use, studies over the subsequent years have demonstrated poor sensitivity and suggested poor reliability in the prediction of sPTB.[7,8] Alternative sonographic measurements have been proposed, including uterocervical angle (UCA).[9] A recent systematic review and meta-analysis demonstrated a significant difference in UCA between sPTBs and term births.[10]

Objective

This study aimed to compare UCA in sPTBs and term births and to compare the test characteristics between UCA alone, CL alone, and UCA and CL together in the prediction of sPTB through a formal systematic review and meta-analysis.

Methods

Search strategy

A systematic review and meta-analysis were undertaken following the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines for observational studies. The review was registered in the International Prospective Register of Systematic Reviews on May 20, 2022 (registration number: CRD42022331509). A systematic search of published literature from January 1, 1945, to May 15, 2022, was performed on May 31, 2022, using the following databases: PubMed, Cochrane Central Register of Controlled Trials, Embase, the World Health Organization (WHO) International Clinical Trials Registry Platform (ICTRP), Web of Science, and ClinicalTrials.gov. The search was not limited by language or year of publication. The search was performed using the terms found in Appendix A. The reference lists were reviewed for additional studies that may have been included based on the eligibility criteria.

Inclusion and exclusion criteria

The inclusion criteria for this review included randomized controlled trials (RCTs), non-RCTs, cohort studies, and case-control studies that compared UCA in sPTBs and term births and test characteristics of UCA and CL in the prediction of sPTB. The test characteristics of UCA and CL together were included in a posthoc fashion from already included studies. Included studies evaluated the weighted mean differences (MDs) in UCA between sPTBs and term births in at least 1 of the following: symptomatic or asymptomatic and singleton or twin pregnancies. The exclusion criteria included case reports, case series, cross-sectional studies, reviews, abstracts, book chapters, editorials, animal studies, and basic science articles.

Titles and abstracts were screened independently by 2 authors with training in medical database searching (M.J.G. and J.M.B.) who reviewed the manuscripts for eligibility. Full-text articles were reviewed independently, excluding studies lacking complete data, lacking comparison groups, or not addressing the outcomes. Disagreements were discussed, and consensus was reached at each stage of the review process. In cases where full texts or complete data were unavailable, interlibrary loans were used, and attempts to contact the authors were made when appropriate.

Data extraction and definitions

Data extraction was performed by 1 author and reviewed for accuracy by another. The following were extracted: first author name, publication year, country performed, study design, comparison groups, group sizes, singleton or twin pregnancies, US method, symptomatic or asymptomatic preterm labor, gestational age (GA) at the time of the study and delivery, study criteria for preterm birth (PTB), UCA and CL measurements, and outcomes. During the data extraction process of this review, the following definitions and categorizations were used:

1. sPTB: traditionally defined as commencement of labor and birth at or after 20 0/7 weeks of gestation and before 37 0/7 weeks of gestation; however, several included studies defined alternate criteria for what was considered PTB, ranging from 28 weeks of gestation to the accepted definition.
2. Symptomatic preterm labor: regular contractions producing cervical change at or after 20 0/7 weeks of gestation and before 37 0/7 weeks of gestation.
3. Asymptomatic pregnancies: pregnancies in which there was no sign or symptom of spontaneous preterm labor at the time of US.

4. UCA: a US marker of the angle between the lower uterine segment and the cervical canal as measured by a line from the external os to the internal os regardless of the curvature of the cervical canal.
5. CL: a US marker of the length of the cervical canal measured either by drawing a direct line regardless of curvature or by drawing a series of lines to approximate the curve of the cervical canal.

Quality of included studies

Of note, 1 author performed quality appraisals, which were independently reviewed for accuracy by a second author. The Newcastle-Ottawa Scale (NOS) was used for cohort and case-control studies.

Data synthesis

All analyses were performed in Review Manager (RevMan; version 5.4.1; Cochrane Training, London, United Kingdom) using non-Cochrane mode and Meta-DiSc (version 1.4; Ramón y Cajal Hospital, Madrid, Spain). A random effects model was used to conduct the meta-analysis in RevMan of UCA in sPTB and term birth using the inverse variance method for weighted MD. Pooled sensitivities and specificities and summary receiver operating characteristic (SROC) plots were generated using the DerSimonian-Laird random effects model in Meta-DiSc comparing UCA, CL, and UCA and CL together. Small effect and publication biases were assessed using funnel plots. Sensitivity analysis was performed by grouping studies using the aforementioned definitions. A P value of <.05 was considered significant.

For continuous outcomes, MD and standard deviation (SD) were used. If median and range or median and interquartile range were reported, the methods described by Wan et al[11] were used to estimate the mean and SD. Because of this, some reported results may differ from the values reported in the original articles. To compare test characteristics, diagnostic odds ratios (dORs) were used to quantify the effects.

Results

Study selection and characteristics

The MOOSE flow diagram is shown in Figure 1. A total of 192 articles were retrieved from PubMed, Embase, the Cochrane database, WHO ICTRP, Web of Science, and ClinicalTrials.gov and through manual search. After excluding duplicates and ineligible studies, 22 studies were included in the qualitative analysis, including 11 prospective cohort studies,[13−23] 7 retrospective cohort studies,[24−30] and 4 case-control studies.[31−34] Of note, 1 study was not included in the meta-analysis because of incomplete data.[28]

The characteristics of all studies included in the systematic review and meta-analysis are shown in Table 1. Publications ranged from 2016 to 2022. Of the 22 studies included in the review, 4 were conducted in the United States, 4 in Spain, 3 in Turkey, 2 in Germany, 2 in Thailand, 2 in Egypt, and 1 each in Belgium, China, India, Venezuela, and Chile. A total of 7071 patients were included, of which 5542 were term, 910 were preterm, 418 were delivered after 7 days, 121 were delivered in <7 days, 53 were delivered after 10 days, and 27 were delivered in <10 days.

Risk of bias and quality of evidence

The quality of the included studies as evaluated by the NOS is illustrated in Table 2. All studies with 1 exception scored between 7 and 9 of 9 stars, indicating a low risk of bias. The remaining study scored 6 of 9 stars, indicating an elevated risk of bias. Heterogeneity was significant in both the overall and subgroup analyses. Studies varied in GA cutoffs for PTB, whether pregnancies were symptomatic or asymptomatic, and whether pregnancies were singleton, twin, or both. Funnel plot analysis demonstrated low concern for small effect bias, as illustrated in Supplemental Figure 1.

Synthesis of results

Compared with term births, UCA in PTB groups is significantly larger except for a subgroup analysis of studies evaluating UCA in pregnancies complicated by symptomatic preterm labor. The test characteristics of UCA and CL alone differed in that CL demonstrated significantly higher specificity, whereas UCA demonstrated higher sensitivity. UCA and CL together demonstrated test characteristics similar to CL alone, and dORs showed statistically significant differences between all 3 groups.

Uterocervical angle

All 22 studies included in the qualitative analysis compared UCA in sPTB and term births, with 18 studies showing a statistically significant difference[13,15,16,18−25,27,29−34] and 4 studies showing no difference.[14,17,26,28] Of note, 21 studies were included in the quantitative analysis, as shown in Figure 2.[13−27,29−34] Of the 6895 patients included, UCA was significantly larger in the sPTB group than in the term birth controls (MD, 13.76; 95% confidence interval [CI], 10.61−16.91; P<.00001; I^2=90%). There was significant heterogeneity in GA cutoffs for PTB, GA at the initial US, and both number of gestations and whether patients had symptoms of preterm labor.

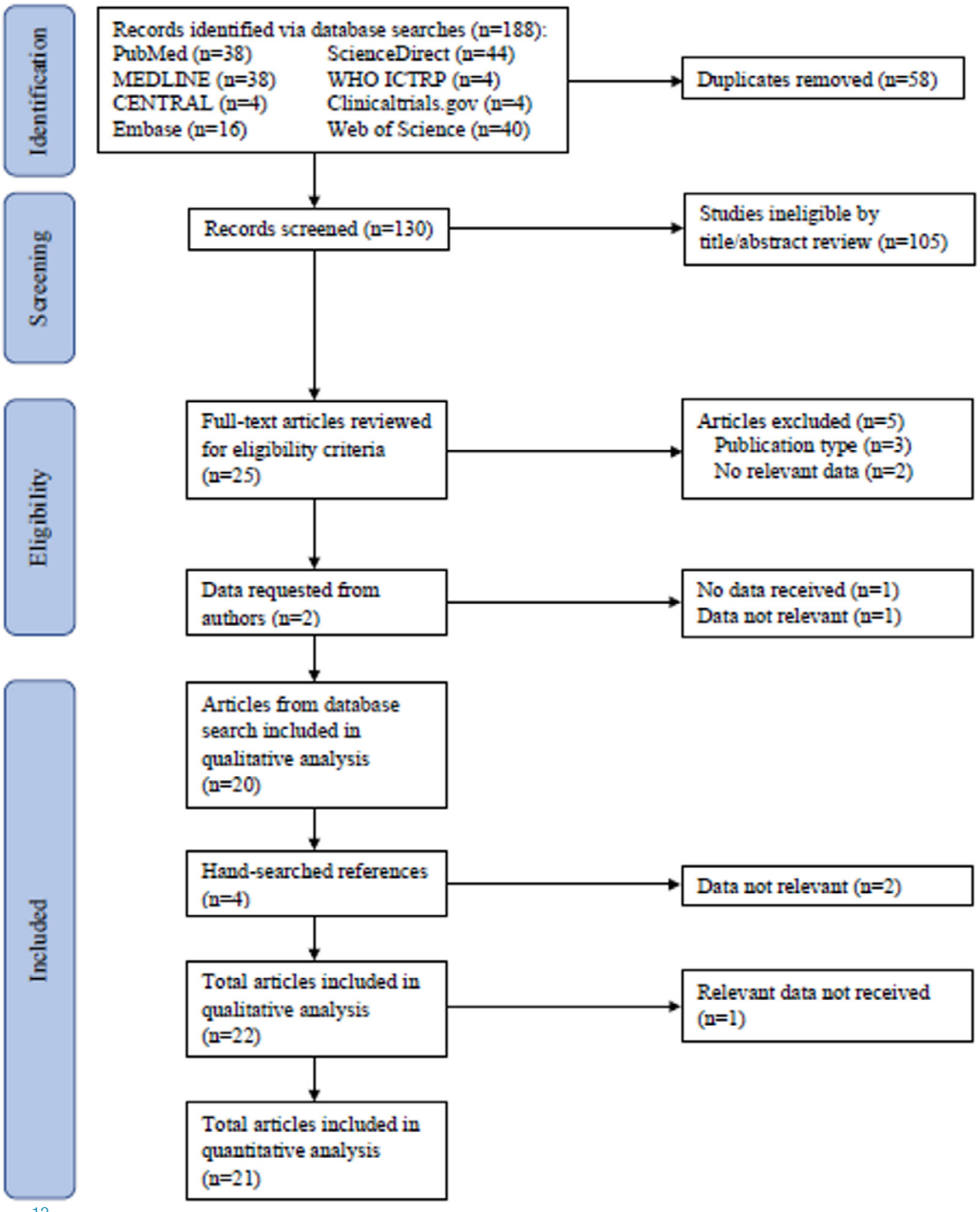
Singleton pregnancies

Of note, 16 studies included in the qualitative analysis compared UCA in sPTBs and term births in singleton pregnancies,[13−16,18,19,21−23,26,28,30−34] with 14 studies showing a statistically significant difference[13−16,18,19,21−23,26,28,30−34] and 2 studies showing no difference.[14,26] Of the 16 studies, 15 were included in the quantitative analysis, as shown in Figure 3.[13−16,18,19,21−23,26,28,30−34] Of the 5749 patients included, UCA was significantly larger in the sPTB group than in the term birth controls (MD, 12.87; 95% CI, 8.82−16.92; P<.00001; I^2=91%). There was significant heterogeneity in GA cutoffs for PTB, GA at the initial US, and whether patients had symptoms of preterm labor.

Twin pregnancies

Of note, 5 studies included in the qualitative analysis compared UCA in sPTBs and term births in twin pregnancies, with all 5 studies showing a significant difference.[20,24,25,27,29] All 5 studies were included in the quantitative analysis, as

FIGURE 1
MOOSE flow diagram for new systematic reviews of observational studies



Adapted from Stroup.[12]

ICTRP, International Clinical Trials Registry Platform; *MOOSE*, Meta-analysis of Observational Studies in Epidemiology; *WHO*, World Health Organization.

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shown in Figure 4. Of the 1037 patients included, UCA was significantly larger in the sPTB group than in the term birth controls (MD, 18.21; 95% CI, 13.64−22.77; $P<.00001$; $I^2=68\%$). There was moderate to substantial heterogeneity in GA cutoffs for PTB, GA at the initial US, and whether patients had symptoms of preterm labor.

Symptomatic women

Of note, 6 studies included in the qualitative analysis compared UCA in sPTBs and term births in pregnancies complicated by signs and symptoms of preterm labor,[14,15,17,23,26,33] with 3 studies showing a significant difference[15,23,33] and 3 studies showing no difference.[14,17,26] All 6 studies were included in the quantitative analysis, as shown in Figure 5. Of the 970 patients

TABLE 1
Summary of included studies

Author, year of publication	Location	Study design	Comparison	Definition of term	sPTB (n)	Term (n)	US type	Number of gestations	Symptomatic	GA at US
Vielba et al,[25] 2022	Spain	RetC	UCA vs CL	28 wk	6	171	TVUS	Twins	No	2T
Khamees et al,[13] 2022	Egypt	ProC	UCA vs CL	37 wk	44	123	TVUS	Singleton	No	3T
Wagner et al,[26] 2021	Germany	RetC	UCA vs CL	Delivery at >7 d	46	167	TVUS	Singleton	Yes	3T
Vielba et al,[24] 2021	Spain	RetC	UCA vs CL	28 wk	12	412	TVUS	Twins	No	2T
Luechathananon et al,[14] 2021	Thailand	ProC	UCA vs CL	37 wk	43	117	TVUS	Singleton	Yes	3T
Ercan et al,[15] 2021	Turkey	ProC	UCA vs CL	Delivery at >10 d	27	53	TVUS	Singleton	Yes	2T
Yenigul and Ercan,[16] 2021	Turkey	ProC	UCA vs CL	37 wk	24	36	TVUS	Singleton	No	2T
Makled et al,[21] 2021	Egypt	ProC	UCA vs CL	37 wk	53	144	TVUS	Singleton	No	2T
Gründler et al,[17] 2020	Germany	ProC	UCA vs CL	37 wk	36	73	TVUS	All	Yes	2T
Farràs Llobet et al,[18] 2020	Spain	ProC	UCA vs CL	37 wk	52	1358	TVUS	Singleton	No	2T
Sawaddisan et al,[19] 2020	Thailand	ProC	UCA	37 wk	31	325	TVUS	Singleton	No	2T
Lynch et al,[27] 2020	United States	RetC	UCA vs CL	37 wk	57	57	TVUS	Twins	No	2T
van der Merwe et al,[20] 2020	Belgium	ProC	UCA vs CL	37 wk	27	36	TVUS	Twins	No	2T
Reyna-Villasmil et al,[33] 2020	Venezuela	Case-control	UCA vs CL	Delivery at >7 d	75	251	TVUS	Singleton	Yes	2T
Farràs Llobet et al,[31] 2018	Spain	Case-control	UCA	Delivery at <34 wk vs delivery at >37 wk	34	241	TVUS	Singleton	No	2T
Knight et al,[29] 2018	United States	RetC	UCA vs CL	36 wk	116	143	TVUS	Twins	No	2T
Shi et al,[34] 2018	China	Case-control	UCA vs CL	37 wk	84	980	TPUS	Singleton	No	2T
Bafalı et al,[23] 2018	Turkey	PE	UCA vs CL	37 wk	32	50	TVUS	Singleton	Yes	2T
Lynch et al,[28] 2017	United States	RetC	UCA vs CL	37 wk	64	112	TVUS	Singleton	No	2T
Sepúlveda-Martínez et al,[32] 2017	Chile	Case-control	UCA	34 wk	93	225	TVUS	Singleton	No	2T
Sur et al,[22] 2017	India	ProC	UCA	37 wk	18	51	TVUS	Singleton	No	2T
Dziadosz et al,[30] 2016	United States	RetC	UCA vs CL	37 wk	84	888	TVUS	Singleton	No	2T

2T, second trimester; *3T*, third trimester; *CL*, cervical length; *PE*, prospective empirical; *ProC*, prospective cohort study; *RetC*, retrospective cohort study; *TPUS*, transperineal ultrasound; *TVUS*, transvaginal ultrasound; *UCA*, uterocervical angle; *US*, ultrasound.

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TABLE 2
Newcastle-Ottawa Scale for quality assessment of cohort and case-control studies

Author, year	Selection 1 2 3 4	Comparability of groups 5	Outcome 6 7 8	Total
Vielba et al,[24] 2022	****		***	7
Khamees et al,[13] 2022	****		***	7
Wagner et al,[26] 2021	****		***	7
Vielba et al,[24] 2021	****		***	7
Luechathananon et al,[14] 2021	****		***	7
Ercan et al,[15] 2021	****		***	7
Yenigul and Ercan,[16] 2021	****		***	7
Makled et al,[21] 2021	****		***	7
Gründler et al,[17] 2020	****	**	***	9
Farràs Llobet et al,[18] 2020	****	**	***	9
Sawaddisan et al,[19] 2020	****		***	7
Lynch et al,[27] 2020	****	**	***	9
van der Merwe et al,[20] 2020	****		***	7
Reyna-Villasmil et al,[33] 2020	****		***	7
Farràs Llobet et al,[31] 2018	****		***	7
Knight et al,[29] 2018	****	*	***	8
Shi et al,[34] 2018	***		***	6
Bafalı et al,[23] 2018	****		***	7
Lynch et al,[28] 2017	****		***	7
Sepúlveda-Martínez et al,[32] 2017	***	**	***	8
Sur et al,[22] 2017	****		***	7
Dziadosz et al,[30] 2016	****	**	***	9

Selection: 1 = representativeness of exposed cohort; 2 = selection of nonexposed cohort; 3 = ascertainment of exposure; and 4 = demonstration that outcome was not present at start of the study. Comparability of groups: 5 = comparability of groups based on design or analysis (may be awarded 2 stars by controlling for ≥2 factors). Outcome: 6 = assessment of outcomes; 7 = adequate length of follow-up; and 8 = adequacy of follow-up.

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included, UCA was significantly larger in the sPTB group than in the term birth controls (MD, 7.60; 95% CI, 1.28−13.93; P=0.02; I^2=88%). This difference was no longer present when 3 studies comparing delivery within 7 to 10 days were excluded (MD, 2.26; 95% CI, −3.66 to 8.17; P=0.045; I^2=38%).[15,26,33] There was significant heterogeneity present when all 6 studies were included. Subgroup analysis, excluding the 3 studies comparing delivery within 7 to 10 days, demonstrated minimal heterogeneity.

Asymptomatic women

Of note, 16 studies included in the qualitative analysis compared UCA in sPTBs and term births in pregnancies without symptoms of preterm labor, with all 16 studies showing a significant difference.[13,16,18−22,24,25,27−32,34] Of the 16 studies, 15 were included in the quantitative analysis, as shown in Figure 6.[13,16,18−22,24,25,27−32,34] Of the 5925 patients included, UCA was significantly larger in the sPTB group than in the term birth controls (MD, 16.29; 95% CI, 13.38−19.20; P<.00001; I^2=78%). There was significant heterogeneity in GA cutoffs for PTB, GA at the initial US, and number of gestations.

Uterocervical angle compared with cervical length

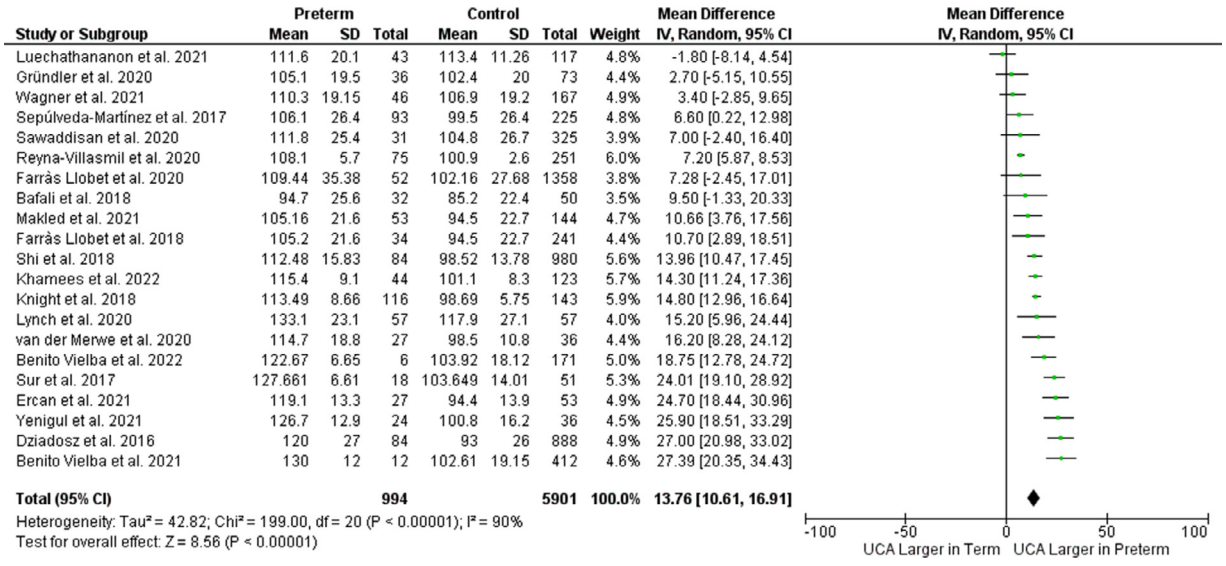
Of note, 15 studies included in the quantitative analysis provided data on test characteristics for UCA and CL alone in the prediction of sPTB, as shown in Figure 7.[13,14,16,18,20,21,23−25,27,29−31,33,34] Pooled sensitivities for UCA and CL alone were 0.70 (95% CI, 0.66−0.73; I^2=90%) and 0.46 (95% CI, 0.42−0.49; I^2=96%), respectively. Pooled specificities for UCA and CL were 0.67 (95% CI, 0.66−0.68; I^2=97%) and 0.90 (95% CI, 0.89−0.91; I^2=99%), respectively. Pooled dORs for UCA and CL alone were 6.21 (95% CI, 3.71−10.38; I^2=84%) and 9.56 (95% CI, 4.60−19.88; I^2=88%), respectively, as shown in Figure 8. SROC plots are shown in Figure 9. The area under the curve (AUC) for UCA and CL were 0.77 and 0.82, respectively.

Subgroup analysis of studies comparing UCA and CL alone in women with symptoms consistent with preterm labor included 3 studies,[14,23,33] as shown in Supplemental Figure 2. Pooled sensitivities for UCA and CL were 0.56 (95% CI, 0.50−0.62; I^2=95%) and 0.71 (95% CI, 0.65−0.77; I^2=97%), respectively. Pooled specificities for UCA and CL were 0.83 (95% CI, 0.81−0.86; I^2=92%) and 0.89 (95% CI, 0.86−0.91; I^2=99%), respectively. Pooled negative likelihood ratios (LRs) for ruling out sPTB in symptomatic patients were 0.53 (95% CI, 0.24−1.19; I^2=96%) for UCA and 0.46 (95% CI, 0.05−4.18; I^2=99%) for CL, as shown in Supplemental Figure 3.

Uterocervical angle and cervical length together

Of note, 4 studies included in the quantitative analysis provided data on test characteristics for UCA and CL together in the prediction of sPTB, as shown in Figure 10, A.[13,14,27,30] Pooled sensitivity

FIGURE 2
Mean differences in UCA, comparing sPTBs and term pregnancies



CI, confidence interval; *SD*, standard deviation; *sPTB*, spontaneous preterm birth; *UCA*, uterocervical angle.

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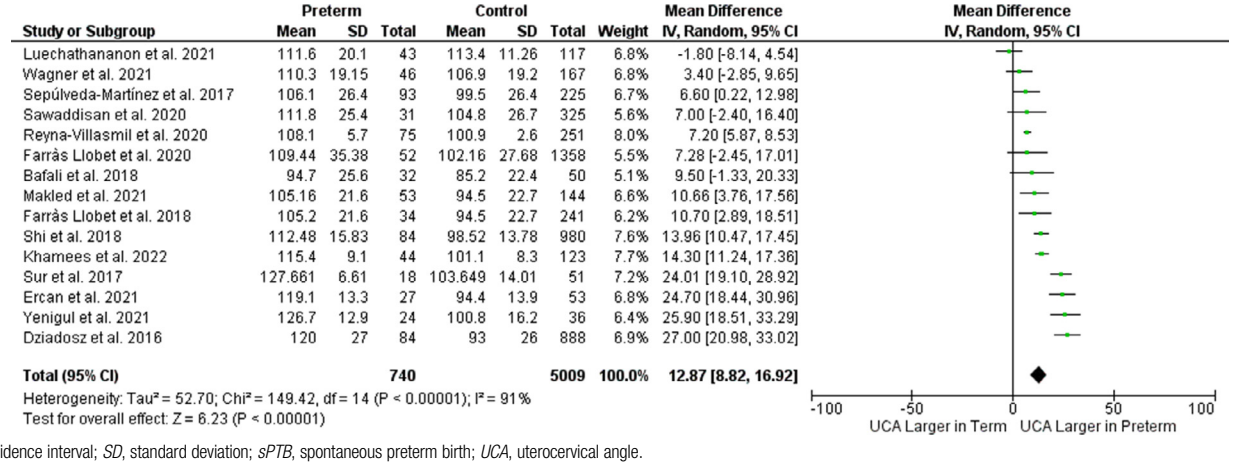
FIGURE 3
Mean difference in UCA, comparing sPTB and term singleton pregnancies



CI, confidence interval; *SD*, standard deviation; *sPTB*, spontaneous preterm birth; *UCA*, uterocervical angle.

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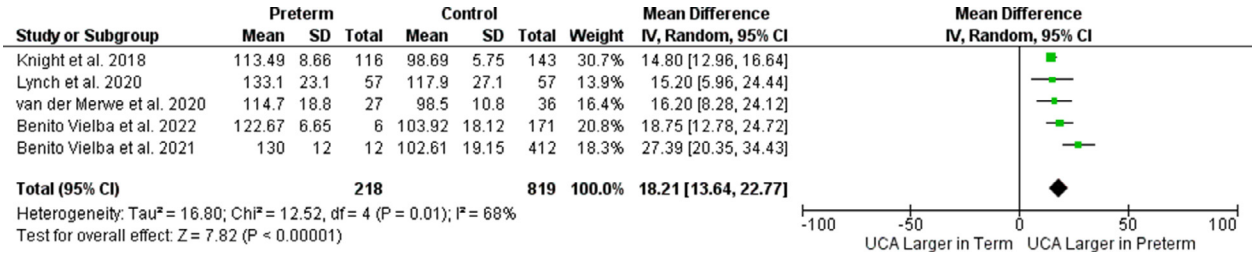
and specificity were 0.22 (95% CI, 0.17−0.28; I^2=87%) and 0.95 (95% CI, 0.94−0.96; I^2=98%), respectively. The pooled dOR was 4.69 (95% CI, 1.95−11.29; I^2=70%), as shown in Figure 10, B. SROC plot is shown in Figure 10, C. The AUC for UCA and CL together was 0.74.

Comment

Main findings

Looking at the MDs, the UCA was significantly larger in the sPTB group than in the term birth controls. This difference was present across all pregnancy types evaluated except for pregnancies complicated by symptomatic preterm labor. This was in agreement with the most recent systematic review and meta-analysis on this topic.[10] This reproducible difference has driven the suggestion that UCA may be a useful tool in predicting sPTB in at-risk women. However, direct comparisons between UCA and

FIGURE 4
Mean difference in UCA, comparing sPTB and term twin pregnancies



CI, confidence interval; *SD*, standard deviation; *sPTB*, spontaneous preterm birth; *UCA*, uterocervical angle.

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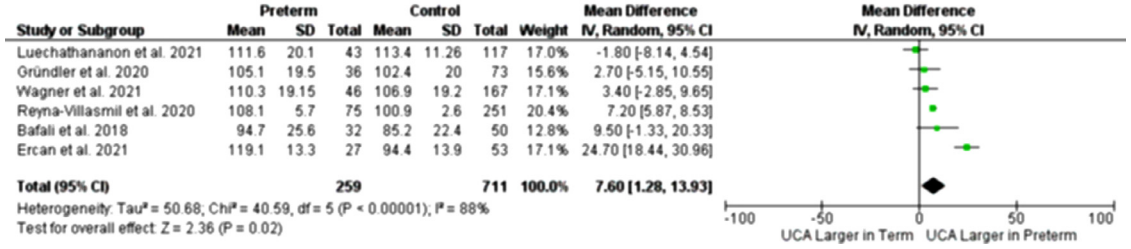
FIGURE 5
Mean difference in UCA, pregnancies complicated by symptomatic preterm labor



CI, confidence interval; *SD*, standard deviation; *sPTB*, spontaneous preterm birth; *UCA*, uterocervical angle.

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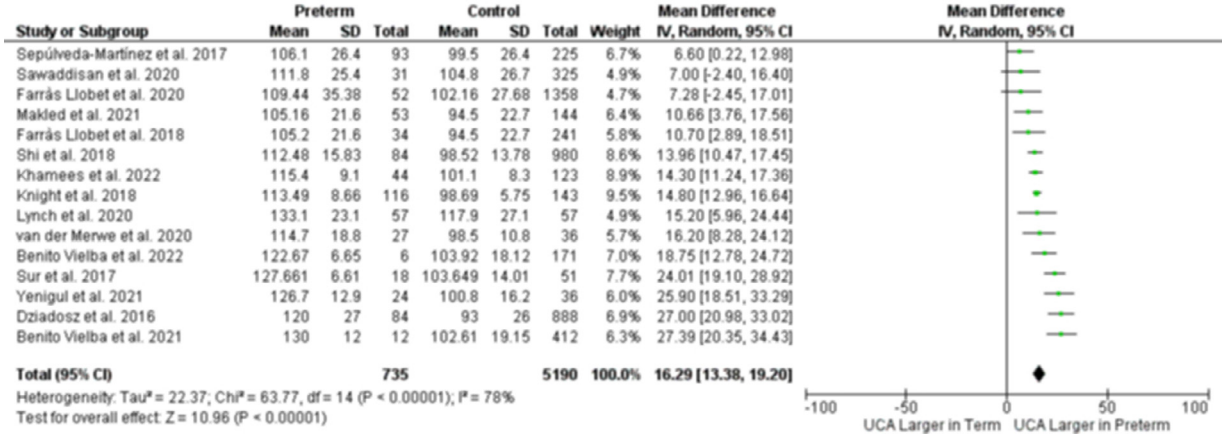
FIGURE 6
Mean difference in UCA, pregnancies without symptoms of preterm labor



CI, confidence interval; *SD*, standard deviation; *sPTB*, spontaneous preterm birth; *UCA*, uterocervical angle

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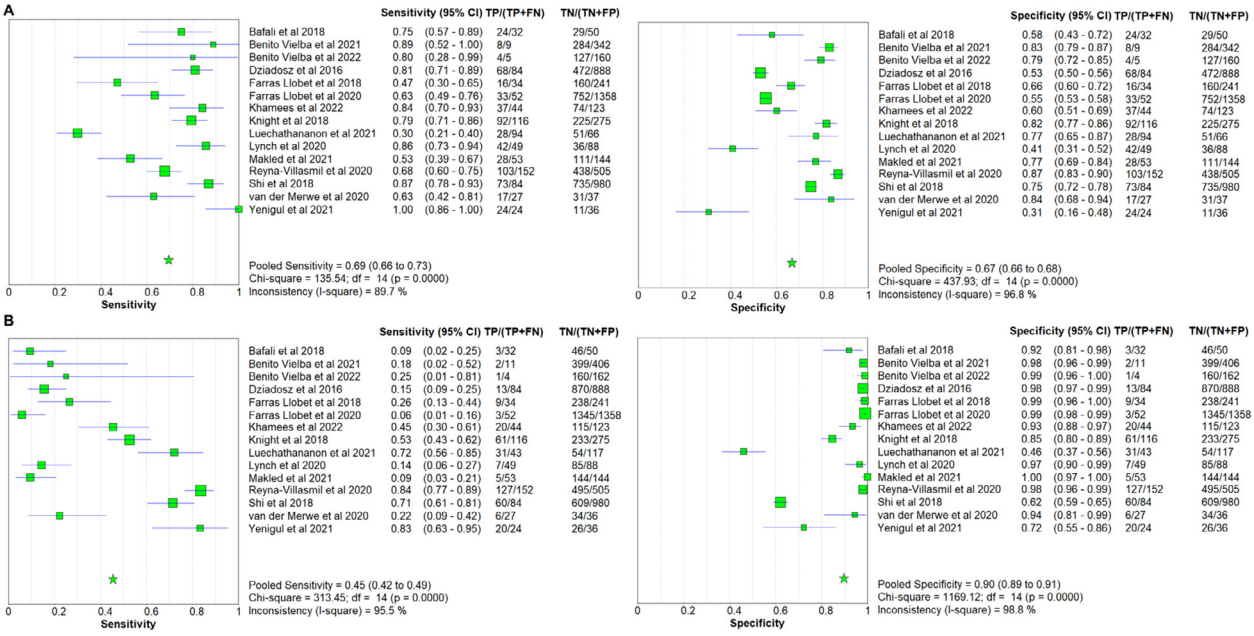
FIGURE 7
Forest plots showing test characteristics of UCA and CL alone



A, Sensitivities and specificities for UCA alone. **B,** Sensitivities and specificities for CL alone.

CI, confidence interval; *CL*, cervical length; *UCA*, uterocervical angle.

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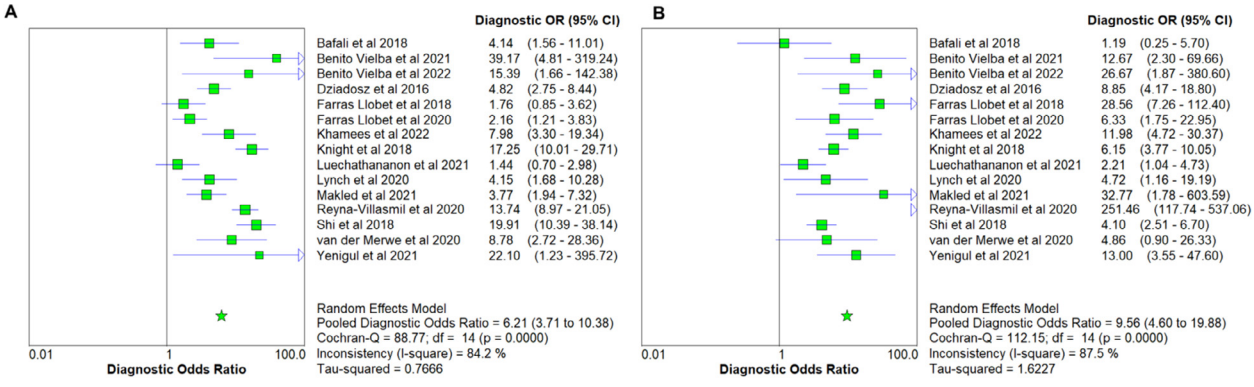
CL revealed a more complicated picture.

UCA alone had a significantly greater sensitivity than CL but demonstrated a significantly lower specificity. In addition, the dOR and AUC were greater for CL. This implies that although UCA is a more useful tool to reassure against sPTB, CL performs better at identifying which patients are likely to experience sPTB. Given the sensitivity and specificity picture demonstrated in Figure 7, we searched through our existing literature to identify any studies that evaluated the use of UCA and CL together. Only 4 of the studies in our review included such a comparison, and the results demonstrated a lower sensitivity and higher specificity with a significantly lower dOR than either UCA or CL alone. This may be due to the small number of studies available that evaluated UCA and CL

FIGURE 8
Forest plots showing dORs for UCA and CL alone

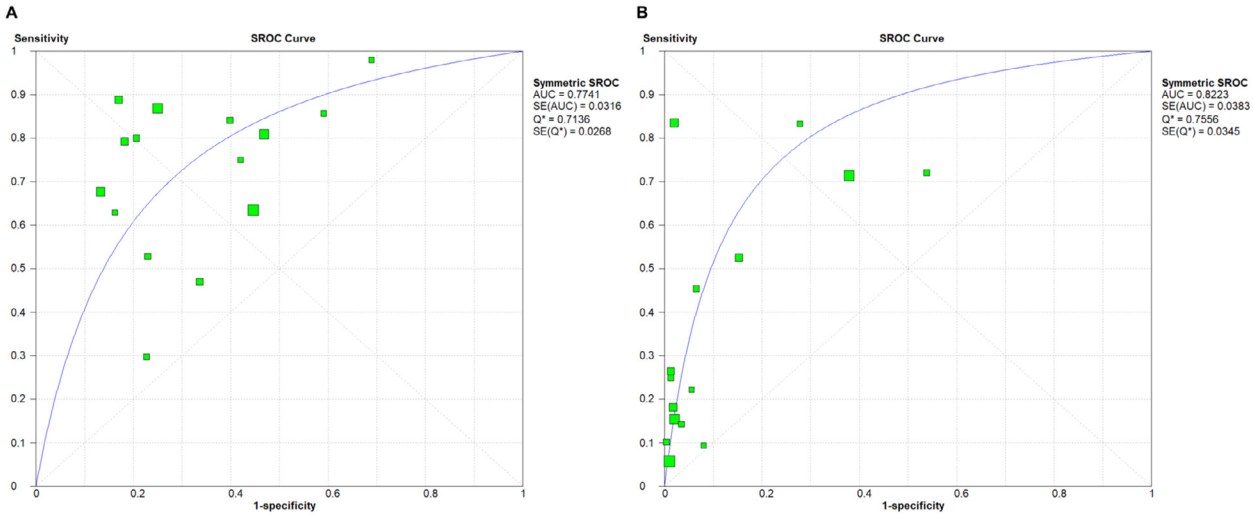


A, dORs for UCA alone. **B,** dORs for CL alone.

CI, confidence interval; *CL*, cervical length; *dOR*, diagnostic odds ratio; *OR*, odds ratio; *UCA*, uterocervical angle.

Goldstein. Uterocervical angle in predicting spontaneous preterm birth. Am J Obstet Gynecol Glob Rep 2023.

FIGURE 9
SROC curves comparing UCA and CL alone

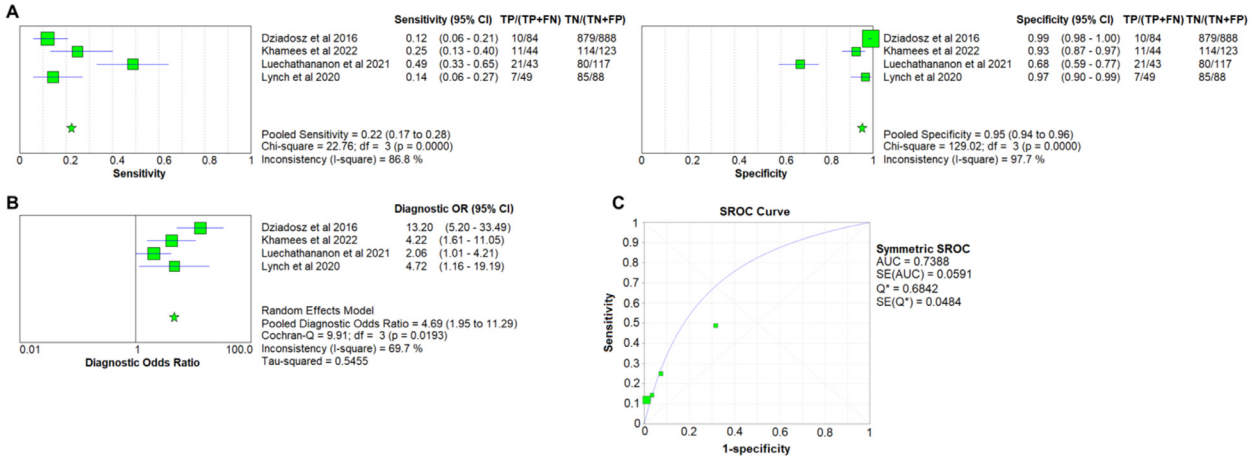


A, SROC curve for UCA alone. **B,** SROC curve for CL alone.

AUC, area under the curve; *CL*, cervical length; *SROC*, summary receiver operating characteristics; *UCA*, uterocervical angle.

Goldstein. Uterocervical angle in predicting spontaneous preterm birth. Am J Obstet Gynecol Glob Rep 2023.

FIGURE 10
Test characteristics of UCA and CL together



A, Sensitivities and specificities of UCA and CL together. **B,** dORs for UCA and CL together. **C,** SROC curve for UCA and CL together.

AUC, area under the curve; *CI*, confidence interval; *CL*, cervical length; *dOR*, diagnostic odds ratio; *SROC*, summary receiver operating characteristics; *UCA*, uterocervical angle.

Goldstein. Uterocervical angle in predicting spontaneous preterm birth. Am J Obstet Gynecol Glob Rep 2023.

together, but the overall pattern demonstrated in Figure 9, A, is similar to that of UCA and CL alone.

A subgroup analysis of studies evaluating pregnancies complicated by symptoms of preterm labor revealed 3 studies that compared UCA with CL.[14,23,33] There was a statistically significant difference in pooled sensitivities, favoring CL alone. However, the negative LRs were similar and associated with a minimal to small decrease in pretest probability that lacked significance. The lack of a significant difference in negative LR may be due to the small number of studies available for the subgroup analysis.

Strengths and limitations

The major strengths of this systematic review and meta-analysis are the extensive literature review, strict methodology following the MOOSE guidelines, scoring of studies, and the subgroup analyses of studies based on the number of gestations and symptomatology. Several limitations need to be considered.

First, 4 studies required the conversion of crude data for inclusion in the meta-analysis, resulting in discrepancies between the original articles and those in this review. Most studies included data not requiring conversion, and studies requiring conversion did not generate significantly skewed data. Regardless, this must be kept in mind when interpreting the results of this meta-analysis. Heterogeneity and variations in data reporting are also limitations, as heterogeneity was significant. However, the presence of heterogeneity is not necessarily problematic. Although it may represent poor study design in included studies, it may also indicate a high degree of clinical diversity.[35] Given the quality assessments performed on the included studies, it is more likely that the high heterogeneity in our analysis is due to the diversity in the populations and the variable definitions of preterm and term deliveries rather than poor study design. All studies included in this review were observational; however, nearly half of the studies were prospective. Finally, the small number of studies available for some subgroup analyses made evaluating publication bias and generalization of results difficult.

Comparison with existing literature

Despite sPTB being the leading cause of perinatal morbidity and mortality in developed countries[1,2] with several studies evaluating UCA and CL as potential sonographic markers for predicting sPTB, only 1 systematic review and meta-analysis has been conducted on the subject.[10] The authors concluded that UCA was significantly larger in sPTB and may be a valuable tool in the prediction of sPTB. That review and meta-analysis looked solely at the MD in UCA in sPTB and term birth without performing subgroup analysis by number of gestations and presence of symptoms. In addition, no comparison to CL was made. This systematic review and meta-analysis was an extensive analysis of UCA and evaluated studies comparing UCA with CL alone and UCA and CL together.

Conclusion and implications

sPTB is the leading cause of perinatal morbidity and mortality. The current sonographic marker for predicting sPTB is CL, although recent data have called its reliability into question. Despite various studies and a systematic review and meta-analysis demonstrating a significantly wider UCA in sPTBs compared with term births, comparison to CL alone did not show significant improvement in the prediction of sPTB. Similarly, UCA and CL together failed to show improvement vs CL alone, although the number of studies that included that comparison was small. More prospective studies are required to determine whether UCA and CL used together have any benefit vs CL alone. ■

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.xagr.2023.100240.

REFERENCES

1. Goldenberg RL, Culhane JF, Iams JD, Romero R. Epidemiology and causes of preterm birth. Lancet 2008;371:75–84.

2. Walani SR. Global burden of preterm birth. Int J Gynaecol Obstet 2020;150:31–3.

3. Beck S, Wojdyla D, Say L, et al. The worldwide incidence of preterm birth: a systematic review of maternal mortality and morbidity. Bull World Health Organ 2010;88:31–8.

4. Crane JM, Hutchens D. Transvaginal sonographic measurement of cervical length to predict preterm birth in asymptomatic women at increased risk: a systematic review. Ultrasound Obstet Gynecol 2008;31:579–87.

5. Honest H, Bachmann LM, Coomarasamy A, Gupta JK, Kleijnen J, Khan KS. Accuracy of cervical transvaginal sonography in predicting preterm birth: a systematic review. Ultrasound Obstet Gynecol 2003;22:305–22.

6. To MS, Skentou C, Chan C, Zagaliki A, Nicolaides KH. Cervical assessment at the routine 23-week scan: standardizing techniques. Ultrasound Obstet Gynecol 2001;17:217–9.

7. Melamed N, Hiersch L, Meizner I, Bardin R, Wiznitzer A, Yogev Y. Is measurement of cervical length an accurate predictive tool in women with a history of preterm delivery who present with threatened preterm labor? Ultrasound Obstet Gynecol 2014;44:661–8.

8. Guerby P, Fillion A, Pasquier JC, Bujold E. Evaluation of midtrimester cervical length thresholds for the prediction of spontaneous preterm birth. J Gynecol Obstet Hum Reprod 2022;51:102287.

9. Daskalakis G, Theodora M, Antsaklis P, et al. Assessment of uterocervical angle width as a predictive factor of preterm birth: a systematic review of the literature. BioMed Res Int 2018;2018:1837478.

10. Hessami K, Kasraeian M, Sepúlveda-Martínez Á, et al. The novel ultrasonographic marker of uterocervical angle for prediction of spontaneous preterm birth in singleton and twin pregnancies: a systematic review and meta-analysis. Fetal Diagn Ther 2021: 1–7.

11. Wan X, Wang W, Liu J, Tong T. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. BMC Med Res Methodol 2014;14:135.

12. Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. JAMA 2000;283:2008–12.

13. Khamees RE, Khattab BM, Elshahat AM, Taha OT, Aboelroose AA. Uterocervical angle versus cervical length in the prediction of spontaneous preterm birth in singleton pregnancy. Int J Gynaecol Obstet 2022;156:304–8.

14. Luechathananon S, Songthamwat M, Chaiyarach S. Uterocervical angle and cervical length as a tool to predict preterm birth in threatened preterm labor. Int J Womens Health 2021;13:153–9.

15. Ercan F, Yenigul NN, Baser E. Measurement of the uterocervical angle for predicting the latent period in pregnancy exhibiting premature membrane rupture. Gynecol Obstet Invest 2021;86:200–8.

16. Yenigul NN, Ercan F. The efficacy and efficiency of uterocervical angle measurements to predict preterm labor in idiopathic polyhydramnios patients: a prospective cohort study. Z Geburtshilfe Neonatol 2021;225:129–33.

17. Gründler K, Gerber B, Stubert J. Uterocervical angle as a predictor of preterm birth on a high-risk collective between 20 and 31 weeks of gestation: a cohort analysis. Acta Obstet Gynecol Scand 2020; 99:1527–33.

18. Farràs Llobet A, Higueras T, Calero IZ, et al. Prospective evaluation of the uterocervical angle as a predictor of spontaneous preterm birth. Acta Obstet Gynecol Scand 2020; 99:1511–8.

19. Sawaddisan R, Kor-Anantakul O, Pruksanusak N, Geater A. Uterocervical angle measurement for preterm birth prediction in singleton pregnant women with no history of preterm birth and normal cervical length: a prospective cohort study. Eur J Obstet Gynecol Reprod Biol 2020;252:30–5.

20. van der Merwe J, Couck I, Russo F, et al. The predictive value of the cervical consistency index to predict spontaneous preterm birth in asymptomatic twin pregnancies at the second-trimester ultrasound scan: a prospective cohort study. J Clin Med 2020;9:1784.

21. Makled A, Abuelghar W, Shabaan M, Kamel O. Relationship between uterocervical angle and prediction of spontaneous preterm birth. EBWHJ 2021;11:256–63.
22. Sur B, Misra S, Dash S. Evaluation of the anterior cervical angle of the uterus to predict spontaneous preterm birth. Int J Reprod Contracept Obstet Gynecol 2017;6:2323.
23. Bafalı O, Kıyak H, İnce O, Başkıran Y, Gedikbasi A. The prediction of preterm birth threat by uterocervical angle. Perinat J 2018;26:11–7.
24. Benito Vielba M, de Bonrostro Torralba C, Álvarez Sarrado L, Tajada Duaso M, Campillos Maza JM, Castán Mateo S. Uterocervical angle at 20 weeks: a promising predictor of spontaneous preterm birth in twin pregnancies. Eur J Obstet Gynecol Reprod Biol 2021;260:131–6.
25. Benito Vielba M, de Bonrostro Torralba C, Espiau Romera A, Roca Arquillue M, Campillos Maza JM, Castán Mateo S. Uterocervical angle as a predictor of spontaneous preterm birth in twin pregnancies. J Matern Fetal Neonatal Med 2022;35:1878–85.
26. Wagner P, Schlechtendahl J, Hoopmann M, Prodan N, Abele H, Kagan KO. Measurement of the uterocervical angle for the prediction of preterm birth in symptomatic women. Arch Gynecol Obstet 2021;304:663–9.
27. Lynch TA, Szlachetka K, Seligman NS. Second trimester uterocervical angle and spontaneous preterm birth in twins. J Matern Fetal Neonatal Med 2020;33:3125–31.
28. Lynch TA, Szlachetka K, Seligman NS. Ultrasonographic change in uterocervical angle is not a risk factor for preterm birth in women with a short cervix. Am J Perinatol 2017;34:1058–64.
29. Knight JC, Tenbrink E, Onslow M, Patil AS. Uterocervical angle measurement improves prediction of preterm birth in twin gestation. Am J Perinatol 2018;35:648–54.
30. Dziadosz M, Bennett TA, Dolin C, et al. Uterocervical angle: a novel ultrasound screening tool to predict spontaneous preterm birth. Am J Obstet Gynecol 2016;215:376.. e1–7.
31. Farràs Llobet A, Regincós Martí L, Higueras T, et al. The uterocervical angle and its relationship with preterm birth. J Matern Fetal Neonatal Med 2018;31:1881–4.
32. Sepúlveda-Martínez A, Díaz F, Muñoz H, Valdés E, Parra-Cordero M. Second-trimester anterior cervical angle in a low-risk population as a marker for spontaneous preterm delivery. Fetal Diagn Ther 2017;41:220–5.
33. Reyna-Villasmil E, Mejía-Montilla J, Reyna-Villasmil N, Torres-Cepeda D, Rondón-Tapia M, Briceño-Pérez C. Ángulo uterocervical o longitud cervical en la predicción de parto pretérmino inminente en pacientes sintomáticas. Rev Peru Ginecol Obstet 2020;66:4.
34. Shi W, Qin J, Ding Y, et al. The predictive role of transperineal ultrasound measuring anterior uterocervical angle and cervical length on preterm birth. Int J Clin Exp Med 2018;11:5980–5.
35. Sandercock P. The authors say: 'the data are not so robust because of heterogeneity' - so, how should I deal with this systematic review? Meta-analysis and the clinician. Cerebrovasc Dis 2011;31:615–20.