Fetal Heart Rate and Amniotic Fluid Volume Measurements with a Home Ultrasound Device

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Abstract

Objective Pulsenmore ES is a self-scanning ultrasound (US) system for remote fetal assessment. It comprises a handheld transducer that serves as a smartphone cradle coupled with an application and clinician's web-viewer dashboard. Recently, a novel capability was added to the system allowing offline fetal heart rate (FHR) and maximal vertical pocket (MVP) measurements. The aim of this study was to evaluate these tools for usability and accuracy.

Study Design A prospective, non-randomized, non-blinded clinical study design was used. Pulsenmore ES scans were obtained by non-professional laypersons in app-guided (AG) mode (user follows video tutorials in the application) or clinician-guided (CG) mode (user is guided by a health care professional in a real-time telemedicine visit). The scans were stored on a cloud for later interpretation by a health care professional. Each self-scan was immediately followed by a standard US scan performed by a clinician. The asynchronous FHR and MVP measurements made on the AG and CG scans through the designated dashboard were analyzed and compared with the real-time, in-clinic (INC) measurements.

Results The cohort included 28 women. Rates of successful utilization of the Pulsenmore tool for measurement of FHR were 84.7 ± 11.24% of scans made in AG mode and 96.3 ± 6.35% of scans made in CG mode. Corresponding values for MVP were 91.7 ± 2.31% and 95.0 ± 1.73%. FHR accuracy (difference from INC values) was 10.8 ± 7.5 beats per minute (bpm; 7.2%) in AG mode and 5.8 ± 5.1 bpm (4%) in CG mode. MVP accuracy was 1.3 ± 1.4 cm (22%) and 0.9 ± 0.8 cm (14%), respectively. Sensitivity (87.5% and 100% in AG and CG modes, respectively) and specificity (95% and 95.5% in AG and CG modes, respectively) were established for MVP.

Conclusion FHR and MVP measurements obtained from scans captured by the self-operated Pulsenmore ES ultrasound platform are highly accurate and reliable for clinical use relative to standard INC measurements.

Keywords
- ultrasound
- home
- mobile
- fetal heart rate
- amniotic fluid volume
- maximal vertical pocket

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Key Points

- Pulsenmore ES is a self-scanning US system for remote fetal assessment.
- FHR and MVP can be accurately and remotely measured from home.
- Home US can play a critical role in remote antenatal surveillance.

Ultrasound (US) technology plays an essential role in prenatal care. Novel handheld US devices allow point-of-care assessment of various fetal parameters. The expansion of telehealth, particularly during the coronavirus disease 2019 (COVID-19) pandemic, highlighted the need for remote fetal surveillance guided by health care professionals, as recently addressed by the American College of Obstetricians and Gynecologists (ACOG).[1]

The Pulsenmore ES system (Pulsenmore Ltd., Omer, Israel) enables prenatal US imaging for fetal surveillance from home. It consists of a handheld portable US transducer coupled with a user smartphone application and a clinician web-viewer dashboard. The user's smartphone is connected to the cradle on the transducer to serve as a probe, utilizing its power, processing, and communication capabilities (►**Fig. 1**). The device operates in two modes. (1) In the application-guided (AG) mode (►**Video 1**), the user is guided by video tutorials (►**Videos 2**–**6**), and the scans are uploaded to the cloud where they are reviewed asynchronously by a health care professional for qualitative parameters of fetal cardiac activity, amniotic fluid volume (AFV), and fetal movements.[2] (2) In the clinician-guided (CG) mode (►**Video 7**), the user is guided in a real-time virtual telehealth visit in which audio and video communication facilitates live guidance and online interpretation.[3]

Video 1

Application-guided mode. The user is guided by video tutorials, and the scans are uploaded to the cloud where they are reviewed asynchronously by a health care professional for qualitative parameters of fetal cardiac activity, amniotic fluid volume, and fetal movements. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2469-0887.

Video 2

Fetal presentation and lie. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2469-0887.

Video 3

Fetal cardiac activity. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2469-0887.

Video 4

Number of fetuses. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2469-0887.

Video 5

Placental location and position. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2469-0887.

Video 6

Estimation of amniotic fluid volume. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2469-0887.

Video 7

Clinician-guided mode. The user is guided in a real-time virtual telehealth visit in which audio and video communication facilitates live guidance and online interpretation. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2469-0887.

Fig. 1 Pulsenmore ES device with and without a cradled smartphone.

Several small-scale clinical trials have demonstrated the system's usability for basic fetal monitoring[2,4] and high-risk pregnancy surveillance.[3,5] The system has also been found to reduce anxiety in women with an unfavorable obstetric history.[6] Currently, it is available as a real-life, high-volume, asynchronous service of Clalit, the largest health maintenance organization in Israel.[7] At present, the device provides the clinician with visualization to confirm fetal cardiac activity, to subjectively determine if the AFV is normal, and to detect fetal movements.

Recently, Pulsenmore developed M-mode capability for offline fetal heart rate (FHR) measurements (►**Fig. 2**), and calipers, for offline maximal vertical pocket (MVP) measurements (►**Fig. 3**). FHR and MVP can be assessed from the cloud-stored scans via a designated web viewer. The aim of this study was to validate these tools and compare them for accuracy with standard-of-care US measurements.

Materials and Methods

A prospective, non-randomized, non-blinded, clinical study was conducted at a tertiary medical center. FHR and MVP measurements derived from Pulsenmore ES US scans that were obtained by non-professional laypersons, and stored on the cloud for access through a designated web viewer, were compared with measurements obtained from scans made with a conventional, commercially available, US machine by health care professionals in real time.

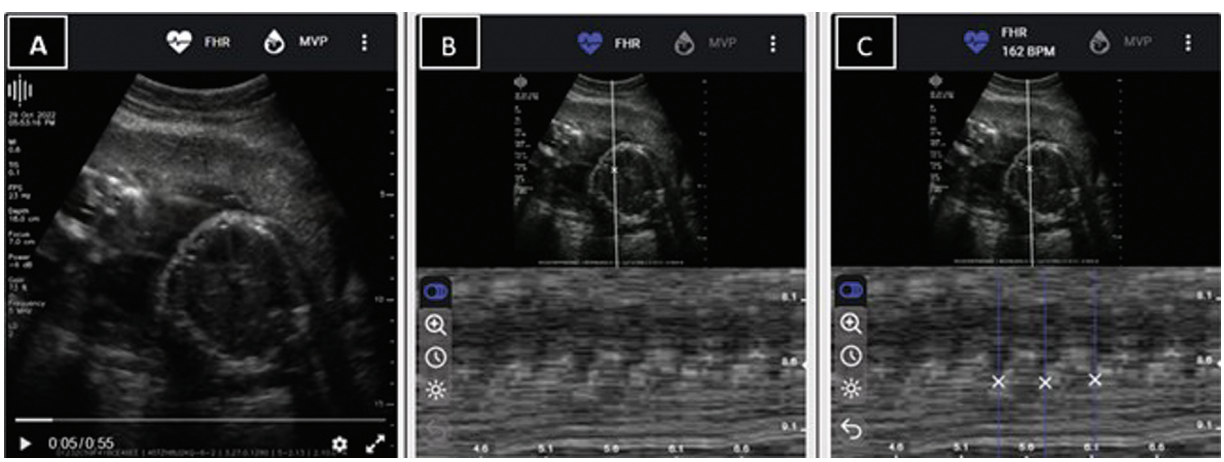

Fig. 2 Demonstration of the fetal heart rate (FHR) measurement tool available on the Pulsenmore web viewer. The health care professional should allocate the best view of the fetal heart. Then, the video is paused, and the video cursor is slowly dragged to have a satisfactory image of the fetal heart. The FHR measurement tool icon is clicked; this changes the mouse cursor to a vertical line to mark the desired location of the M-mode image of the fetal heart. (**A**) M-mode image is presented, centered around the clinician annotation of the fetal heart. The health care professional places the line so it clearly runs through the fetal heart paused image with the pointer exactly on the heart (**B**). Once clicked, an M-mode of the selected location appears below the paused video and the health care professional should identify a beat pattern; and mark three points at two consecutive heartbeat pulses. For consistency, the valleys between two consecutive heartbeats should always be selected. Once the appropriate valleys are chosen, a value of the actual heartbeat rate will appear next to the FHR icon (**C**). MVP, maximal vertical pocket.

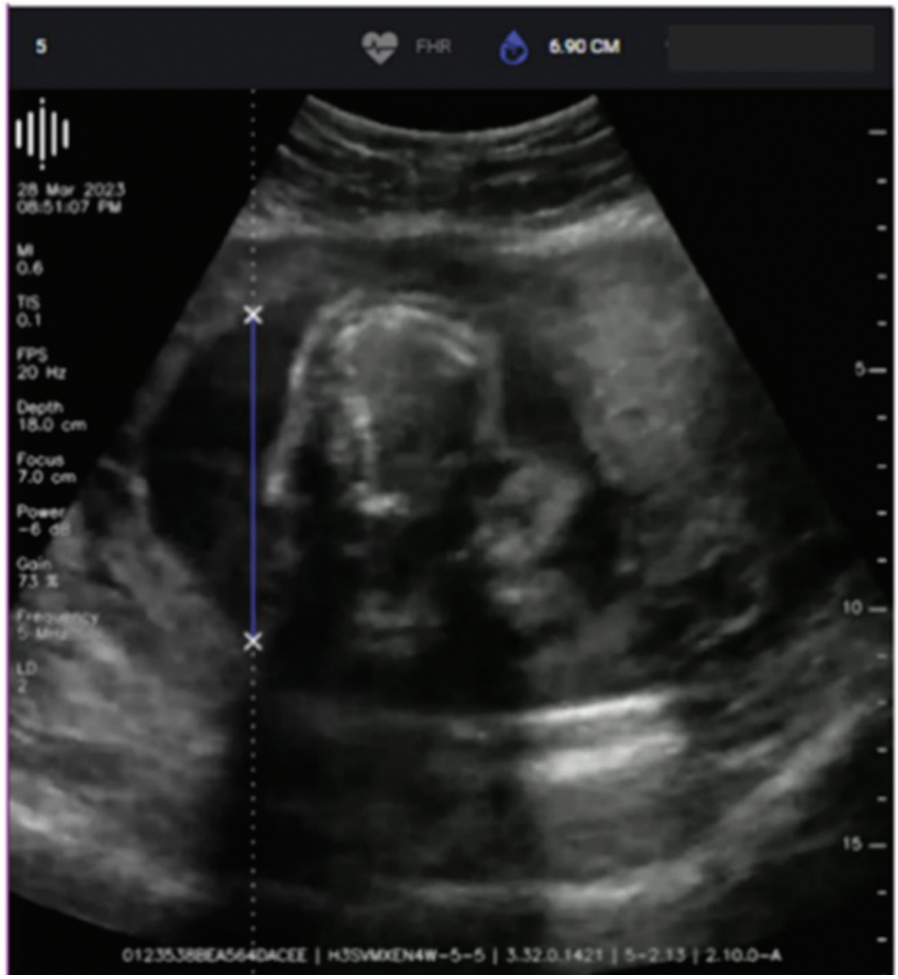

Fig. 3 Demonstration of the maximal vertical pocket (MVP) measurement tool, available on the Pulsenmore web viewer. The health care professional should identify the largest visible pocket of amniotic fluid, as visible throughout the scan, and pause the video at the appropriate time. Then the health care professional should click on the MVP tool to perform a simple measurement, obtained with two calipers. The health care professional places them vertically, perpendicular to the horizon, avoiding fetal parts.

Study Population

Pregnant women aged ≥18 years who were hospitalized in the maternal–fetal medicine ward or attending the maternal–fetal medicine ambulatory clinic were eligible for the study. Other inclusion criteria were singleton viable fetus $14^{0/7}$ to $40^{0/7}$ gestational weeks, first trimester-confirmed gestational age, and no prior experience with the Pulsenmore device. Women with multiple gestations, known fetal anatomic malformations or genetic aberrations, body mass index (BMI) >40 kg/m^2, or abdominal skin conditions (rash, wounds, and cuts) were excluded, as were those with possible allergy to the probe's materials or US gel.

Study Procedure

Each participant underwent four abdominal US scans: two self-scans with the Pulsenmore ES device, one in AG mode and one in CG mode, and two standard in-clinic (INC) scans. The Pulsenmore scans were performed in a separate room occupied solely by the participant, without additional face-to-face guidance. After the first scan was completed, the participant was asked to remain in the same recumbent position, and a clinician immediately entered the room to perform a scan using a standard system (Voluson P6, General Electric). This procedure was then repeated. Real-time FHR and MVP measurements were made during the two INC scans. The AG, CG, and INC scans were also uploaded to the cloud with the Pulsenmore scans for offline reading and interpretation with the web viewer. The two INC scans (INC1 and INC2) served as the gold standard reference for the corresponding AG and CG scans.

Importantly, several safety features ensure minimal exposure, as dictated by the As Low As Reasonably Achievable (ALARA) principle. The system supports only low-frequency wavelengths (2–5 MHz) and provides 2D (B-mode) imaging, without Doppler, only for anatomical imaging. Each scan is enabled only upon medical professional approval. A predefined scan protocol ensures an optimized procedure, and the duration of each self-scan, in the AG mode, is limited to 3 minutes, and up to the health care professional in the CG mode. The acoustic output limits are a mechanical index of 0.4 and a thermal index of 0.03, well below the limit of 1.0.

Data Analysis

FHR and MVP were quantitatively measured from the self-made scans by three independent, blinded readers (two board-certified OBGYN clinicians, and one sonographer technician) using the novel measurement tools in the web viewer. All readers were highly experienced in the use of the Pulsenmore system and had undergone further, specific training in the use of the FHR and MVP tools for the purpose of this study.

To evaluate the usability of the device, two parameters were calculated: rate of detection of cardiac activity, defined as the average percentage of participants for whom each reader could detect cardiac activity, and the average percentage of participants for whom each reader could measure FHR and MVP.

To evaluate the accuracy of the measurements, the average FHR and MVP values measured on the Pulsenmore scans (in AG or CG mode) by the three readers were averaged and the differences from the real-time INC measurements were calculated by averaging the absolute differences between each pair of scans: AG versus INC1 and CG versus INC2. The calculation considered only self-scans on which FHR or MVP values could be obtained.

Intrareader differences (the degree of variation among repeated FHR values obtained by a single reader) were calculated as the average of the reader's standard deviations. For MVP, no intrareader values were available because only one MVP value was measured by each reader. Interreader differences (reflecting the degree of variation between readers) were calculated as the standard deviation of the average of FHR or MVP values obtained by each reader. The percent error was calculated by dividing the average difference by the average value of FHR or MVP. *p*-values were calculated against the predefined primary outcome measure. A *p*-value <0.05 was considered significant.

The qualitative MVP measurement together with the subjective assessment of AFV by the readers was used to determine the sensitivity (correct evaluation of abnormal AFV) and specificity (correct evaluation of normal AFV) of the device relative to real-time INC scanning. For the qualitative evaluation, AFV of 2 to 8 cm was considered normal and AFV <2 or >8 cm was considered abnormal.

Data Collection

In addition to information collected for eligibility, the following data were obtained from the medical records of each participant: demographics (ethnicity, education level), BMI, medical background, obstetrical history (gravidity, parity), and current pregnancy course (gestational age, fetal and maternal complications).

Outcome Measures

The primary outcome measure was the proportion of scans in which FHR or MVP values generated by the Pulsenmore ES device in AG and CG modes were in agreement with the standard-of-care measurements.[8] For FHR, agreement was defined as a difference between measurements of <32 beats per minute (bpm) for gestational age <28 weeks and <37 bpm for gestational age ≥ 28 weeks. For MVP, agreement was defined as a difference between measurements within $\pm 20\%$.

Ethics

The study was approved by the local Institutional Review Board (approval number 0062-23-RMC; June 7, 2023). Written informed consent was obtained from each participant prior to any study procedures.

Results

Thirty-one participants were recruited, of whom two were excluded from the analysis because of missing data (scans were not recorded and real-time, in-clinic FHR and MPV measurements were not performed for technical reasons). In addition, one withdrew consent prior to the onset of the study.

Baseline characteristics of the participants are shown in ►Table 1. The final cohort consisted of 28 pregnant women with a mean age of 33.5 ± 6.1 years and an average BMI of $27.6 \pm 4.9\,kg/m^2$; 7 (25%) had a BMI of $>30\,kg/m^2$. Ten women (36%) had ≤ 12 years of schooling. More than half the participants were considered high risk because of relevant medical history or complications in the current pregnancy. Prior to study recruitment, nine women (32%) were diagnosed with abnormal AFV: five oligohydramnios and four polyhydramnios.

The usability of the FHR and MVP measurement tools is shown in ►Table 2. Fetal cardiac activity was successfully detected in $94 \pm 1.73\%$ of the scans done in AG mode and $98.7 \pm 2.31\%$ of scans done in CG mode. Corresponding rates of successful FHR measurement were $84.7 \pm 11.2\%$ and $96.3 \pm 6.4\%$. AFV was visualized on all scans. MVP measurement was accomplished in $91.7 \pm 2.31\%$ and $95 \pm 1.73\%$ of scans done in AG and CG mode, respectively.

The accuracy of FHR and MVP measurements on the Pulsenmore scans and inter- and intrareader variability are presented in ►Table 3. FHR could be measured by at least one reader on the AG scans of 27 participants and the CG scans of all 28 participants. The average difference from the INC scans was 10.8 ± 7.5 bpm for AG mode (7.2% of the average FHR) and 5.8 ± 5.1 bpm for CG mode (4% of the average FHR). Both differences were significantly lower than the predetermined primary outcome measures of 32 bpm before 28 weeks and 37 bpm after 28 weeks ($p < 0.001$ for both).

Intra- and interreader variabilities in FHR values were calculated for the 17 and 25 participants, respectively, for whom all FHR values were available on the AG and CG scans. Mean intrareader variability was 6.3 ± 2.6 bpm (4.2%) for the AG mode and 7.1 ± 2.2 bpm (5.0%) for the CG mode. Mean interreader variability rates were 6.1 ± 2.9 (4.0%) and 4.5 ± 2.8 bpm (3.1%), respectively.

MVP could be measured by at least one reader for all participants. The average difference in MVP values from the INC scans was 1.3 ± 1.4 cm (22%) for the AG mode and 0.9 ± 0.8 cm (14.6%) for the CG mode. The difference from the predetermined primary outcome measure of $\pm 20\%$

Table 1 Demographic and medical data of 28 study participants

Characteristics	*N*
Maternal age, years	33.5 ± 6.1
Body mass index, kg/m^2	27.6 ± 4.9
≤ 25	9 (32.1%)
25–29.9	12 (42.9%)
≥ 30	7 (25.0%)
Gravidity	3.8 ± 2.9
Parity	2.0 ± 1.79
Nulliparity	20 (71.4%)
Gestational age at recruitment, wk	33.46 ± 6.1
14–24	5 (17.9%)
25–33	15 (53.5%)
34–40	8 (28.6%)
Education level	
Less than 12 years	1 (3.6%)
High school diploma	9 (32.1%)
Bachelor's degree or higher	18 (64.3%)
Medical history	7 (25.0%)
Gastrointestinal: Crohn's disease, irritable bowel syndrome	2 (7.1%)
Respiratory: asthma	1 (3.6%)
Neurologic: epilepsy	1 (3.6%)
Chronic hypertension	1 (3.6%)
Endocrine: hypothyroidism	1 (3.6%)
Psychiatric: bipolar disorder	1 (3.6%)
Pregnancy complications, overall	15 (53.6%)
Oligohydramnios	5 (17.9%)
Polyhydramnios	4 (14.3%)
Preterm ruptured membranes with placental abruption	1 (3.6%)
Vaginal bleeding (first and second trimester)	1 (3.6%)
Arrested preterm labor	1 (3.6%)

Data are presented as mean ± standard deviation for continuous variables, and number (percentage) for category l variables.

achieved statistical significance for the CG mode ($p = 0.018$) but not the AG mode ($p = 0.16$). Interreader variability was 0.8 ± 0.7 cm (13%) for the AG mode and 0.8 ± 0.7 cm (14%) for the CG mode. No intrareader values were available for MVP because only one MVP value was measured.

Analysis of the subjective evaluation of AFV (-normal/abnormal) using Pulsenmore ES scans compared with INC scans yielded a sensitivity of 66.7% for both modes and a specificity of 86.7% for the AG mode and 78.3% for the CG mode. Analysis of the objective evaluation of AFV (MVP = 2–8 cm or <2 or >8 cm) according to the MVP measurements on the Pulsenmore ES scans compared with the INC scans yielded a sensitivity of 87.5% and 100% for the AG and CG modes, respectively, and specificity of 95% and 95.5%, respectively (►**Table 4**).

Discussion

Principal Findings

This study sought to validate the quantitative measurement of FHR and MVP on scans generated by the novel self-operated Pulsenmore ES scanner and web viewer. The findings showed that both measurements were successfully captured by lay users compared with real-time INC measurements performed by physicians. The device showed both high sensitivity and high specificity for qualitative normal or abnormal MVP measurements.

Results

To obtain an accurate FHR measurement, at least 1.2 seconds of visualization of fetal cardiac activity are necessary to demonstrate three consecutive heartbeats in M-mode. In the AG mode, the woman is guided by video tutorials without real-time clinician involvement. This may explain the greater accuracy of CG than AG mode in the present study, as well as the relatively low number of self-scans in AG mode that were available for calculation of intra- and inter-reader variability. In only 17 cases (60%), all three readers provide three repeated FHR measurements. The AG mode is challenging because the users are unfamiliar with fetal heart anatomy and with US scanning procedures, and they are not expected to clearly recognize the fetal heart during scanning.

Nevertheless, FHR measurements were highly accurate. The average difference between FHR values obtained with the Pulsenmore device and those obtained from real-time scans ranged from 5 to 11 bpm, which fell within the same range as the intra- and interreader variability. Notably, these values were lower than the predefined endpoint of 32 to 37 bpm, demonstrating the reliability of FHR measurements across all scan types.

Table 2 Usability of measurement tools of the Pulsenmore ES device, by mode of operation

Parameters	App-guided mode	Clinician-guided mode
Successful detection of cardiac activity	94.0 ± 1.73%	98.7 ± 2.31%
Successful FHR measurement	84.7 ± 11.24%	96.3 ± 6.35%
Successful MVP measurement	91.7 ± 2.31%	95.0 ± 1.73%

Abbreviations: FHR, fetal heart rate; MVP, maximal vertical pocket.
Data are presented as mean ± standard deviation percent of total scans performed.

Table 3 Accuracy of fetal heart rate and maximal vertical pocket measurements on the Pulsenmore ES scans compared with real-time in-clinic scans, by mode of operation

	App-guided mode			Clinician-guided mode		
FHR accuracy	*N*	Bpm (*p*-value)	Percent error	*N*	Bpm (*p*-value)	Percent error
Difference	27	10.8 ± 7.5 ($p < 0.001$)[a]	7.2%	28	5.8 ± 5.1 ($p < 0.001$)[a]	4%
Intrareader variability	17	6.3 ± 2.6	4.2%	25	7.1 ± 2.2	5%
Interreader variability	17	6.1 ± 2.9	4%	25	4.5 ± 2.8	3.1%
MVP accuracy	*n*	Centimeters (*p*-value)	Percent error	*N*	Centimeters (*p*-value)	Percent error
Difference	28	1.3 ± 1.4 ($p = 0.16$)	22%	28	0.9 ± 0.8 ($p = 0.018$)[a]	14.5%
Interreader variability	28	0.8 ± 0.7	13%	28	0.8 ± 0.6	14%

Abbreviations: BPM, beats per minute; FHR, fetal heart rate; MVP, maximal vertical pocket.
FHR and MVP differences were calculated by averaging the absolute differences between each pair: app-guided (average of three readers) versus in-clinic, and clinician-guided (average of three readers) versus in-clinic.
The intrareader variability represents the degree of variation among repeated FHR values obtained by a single reader and is calculated as the average of the reader's standard deviations. For MVP, no intrareader values are available since only one MVP value was measured.
The interreader variability reflects the degree of variation between readers, calculated as the standard deviation of each reader's average.
The percent error was calculated by dividing the average difference by the average FHR value.
[a]Significant difference from predefined primary outcome measures of the protocol.

The MVP measurements on the Pulsenmore scans varied from the INC scans by 22% for the AG mode and 14.5% for the CG mode. The variability in CG mode was within the ±20% predefined threshold, and the variability in AG mode was very close to this threshold. It has been well-established that MVP measurements exhibit significant variability.[9–11] Hence, our results are reliable and comply with the protocol's endpoint.

The results of the sensitivity and specificity analysis of normal/abnormal AFV by subjective evaluation or qualitative MVP measurements were appropriate. Values were higher for the objective estimation, showing compatible specificity in the AG and CG modes, but superior sensitivity in the CG mode. Several studies compared ultrasound AFV estimation to actual AFV values determined during amniocentesis using the dye-dilution technique (considered the gold standard for AFV evaluation) or direct measurement at cesarean delivery. Overall, the US-based estimation was found to be moderately accurate if AFV was normal but poor if AFV was abnormal (oligohydramnios or polyhydramnios).[12] Moreover, a recent study estimated the capability of blind interpretation of scans performed with a portable US system (Butterfly IQ) by individuals with no prior formal US training, to diagnose common pregnancy complications. The US operators received a short training session and then scanned 168 pregnant women. The sensitivity of detecting an abnormal AFV was 56.9% and the specificity was 95.9%; the detection rate of cardiac activity was 99.6%.[13] Others compared subjective ultrasound AFV assessment to amniotic fluid index (AFI) measurement as the gold standard. One study of 886 pregnant women reported 58% sensitivity for oligohydramnios,[14] and another, including 420 pregnant women, reported 59% sensitivity for oligohydramnios and 50% for polyhydramnios, with >90% specificity for both.[15] These findings indicate that the sensitivity of AFV sonographic evaluation, either subjective or by AFI, is reduced in the presence of polyhydramnios and oligohydramnios. Together with our results, they point to the difficulty in evaluating abnormal AFV based on US scans.

The reported sensitivity and specificity values for subjective US-based evaluation of AFV are in the same range obtained in this study for scans captured by both modes of the Pulsenmore device. In general, the limited sensitivity in cases of abnormal AVF detection is due to the high variability of the scanning technique in addition to differences in maternal and fetal positions, fetal urine output, and maternal physiology, in addition to excess pressure on the maternal abdomen.[16] The present study was designed to reduce this variability by having the women perform the self-scans in close temporal proximity to the INC scans, with minimal

Table 4 Sensitivity and specificity of the Pulsenmore device for amniotic fluid volume assessment, either subjective or qualitative, with in-clinic scans as the reference

Assessment	Test accuracy indicator	*N*	App-guided mode	*N*	Clinician-guided mode
Subjective	Sensitivity	8	66.7%	5	66.7%
	Specificity	20	86.7%	23	78.3%
Objective (qualitative)	Sensitivity	8	87.5%	6	100%
	Specificity	20	95%	22	95.5%

movement of the women between the paired scans. The sensitivity of the subjective AFV evaluation was approximately 67%, and the specificity 80%, both acceptable values for AFV. Considering that the subjective evaluation was based on scans captured by a layperson, we may conclude that the sensitivity and specificity are similar to those obtained for scans performed by health care professionals. It is noteworthy that the MVP-based objective evaluation of AFV from scans captured by the women yielded a much greater sensitivity of 87.5% for the AG mode and 100% for the CG mode; specificity was 95% for both modes. These findings suggest that MVP measurement on Pulsenmore scans captured by a layperson is reliable and can be safely used in cases of suspected AFV abnormality.

Clinical Implications

This study successfully validates the FHR and MVP measurements made via the Pulsenmore web viewer from scan clips captured by laypersons using the Pulsenmore device in AG or CG mode. The results were adequate and reliable compared with real-time INC measurements performed by a health care professional using a conventional US system, appropriately indicating abnormal AFV levels in both operative modes. These findings have important clinical implications. The validated measurement tools can play a critical role in supporting advanced prenatal assessment procedures, biophysical profiles, and remote fetal surveillance of high-risk pregnancies.

Research Implications

Further research will focus on weaving these new tools into real-life prenatal care, in a manner that remote fetal surveillance will become a viable day-to-day procedure. Furthermore, additional advanced tools will need to be developed and validated, using the home US technology, such as fetal biometry, Doppler, and incorporation of artificial intelligence analysis.

Strengths and Limitations

The main strength of our study is the prospective design and strict methodology, along with the diverse population of participants, albeit limited in number. Moreover, the blinded readers were well-acquainted with the device and demonstrated high proficiency in reading the Pulsenmore-based scans. However, it is possible that the results may be less reliable with less experienced readers.

Conclusion

FHR and MVP measurements obtained from scans captured by the self-operated Pulsenmore ES ultrasound platform are highly accurate and reliable for clinical use, relative to standard INC measurements, and can be safely implemented in various telehealth settings, for remote fetal surveillance and antenatal care.

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Conflict of Interest

None declared.

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