BMJ Open

Portable ultrasound technologies for estimating gestational age in pregnant women: a scoping review and analysis of commercially available models

Alexander John Eggleston ,[1] Elise Farrington ,[2] Steve McDonald ,[3] Samia Aziz [4]

To cite: Eggleston AJ, Farrington E, McDonald S, *et al*. Portable ultrasound technologies for estimating gestational age in pregnant women: a scoping review and analysis of commercially available models. *BMJ Open* 2022;**12**:e065181. doi:10.1136/bmjopen-2022-065181

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-065181).

Received 08 June 2022
Accepted 03 October 2022

Check for updates

[1]Global Women's and Newborn's Health Group, Burnet Institute, Melbourne, Victoria, Australia
[2]Medical Department, Western Health, Footscray, Victoria, Australia
[3]School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia
[4]Department of Public Health, Independent University, Bangladesh, Dhaka, Dhaka District, Bangladesh

Correspondence to
Dr Alexander John Eggleston; alex.eggleston05@gmail.com

ABSTRACT

Objectives To identify all available studies assessing the use of portable ultrasound devices for pregnant women, with the specific aim of finding evidence for devices used to determine gestational age and their validity when compared with conventional ultrasound machines. We also wanted to determine what portable ultrasound models are commercially available for obstetric use.

Design Systematic scoping review.

Primary and secondary outcome measures Extracted variables included study design, population, method of ultrasound measurement, devices used and whether studies formally validated accuracy against conventional ultrasound.

Results We searched four databases—Medline, Embase, CINAHL and Maternal and Infant Care. In total 56 studies from 34 countries were identified; most were observational studies. Across all studies, 27 different portable ultrasound models (from 17 manufacturers) were evaluated. Twenty-one studies assessed use of portable ultrasound for evaluating fetal characteristics or estimating gestational age, and 10 of these were formal validation studies. In total, six portable devices have been validated for gestational age estimation against a conventional ultrasound comparator. The web searches identified 102 portable devices (21 manufacturers). These were a mix of handheld devices that connected to a phone or computer, or laptop-style portable ultrasound devices. Prices ranged from US\$1190 to US\$30 000 and weight ranged from 0.9 kg to 13.0 kg.

Conclusion While the number of commercially available portable ultrasound devices continues to grow, there remains a lack of peer-reviewed, quality evidence demonstrating their accuracy and validity when compared with conventional ultrasound machines. This review identified some models that may be useful in gestational age estimation in low-resource settings, but more research is required to help implement the technology at scale.

Trial registration number Registered via Open Science Framework (DOI: 10.17605/OSF.IO/U8KXP).

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ We applied a detailed and tailored search strategy to a wide range of data sources to identify as many relevant studies as possible, including a variety of medical databases.
- ⇒ The screening and data extraction processes were completed by two independent reviewers, with any conflicts resolved by a third reviewer.
- ⇒ The findings from our formal scoping review were augmented by additional web searches of ultrasound manufacturers.
- ⇒ We acknowledge that scoping reviews do not take into account the integrity or accuracy of individual studies identified.
- ⇒ We acknowledge that some studies may have been published outside of the databases and websites we searched.

BACKGROUND

The WHO recommends that all pregnant women should receive at least one ultrasound scan before 24 weeks' gestation to estimate gestational age, improve detection of fetal anomalies and multiple pregnancies, reduce induction of labour for post-term pregnancy, and improve a woman's pregnancy experience.[1] An ultrasound scan for gestational age estimation is most accurate when it is performed in the first trimester of pregnancy.[2] Several antenatal interventions recommended by WHO confer benefit when used at specific gestational ages—such as antenatal corticosteroids for women at risk of preterm birth prior to 34 weeks' gestation,[3] aspirin for women at increased risk of pre-eclampsia prior to 20 weeks' gestation[4] and induction of labour for post-term pregnancy[5]—and hence the safe and appropriate use of these interventions can be affected by accuracy of gestational age estimation. WHO's antenatal care recommendations emphasise the need for effective and reliable antenatal ultrasound services to be available to all pregnant women, in order to optimise maternal and newborn health outcomes.[6] However, in many low-/middle-income countries (LMICs), women's access to reliable antenatal ultrasound is often limited or only available in certain contexts, such as tertiary hospitals or in private health services.[7 8] Resource constraints and limited infrastructure in rural health facilities further impact the ability to implement traditional or conventional ultrasound machines in these settings.

Recent years have seen the development of portable, wireless, compact or mobile-based ultrasound systems for obstetric use.[9] If such portable ultrasound devices are as accurate as conventional, cart-based ultrasound systems—as well as being easy to use, affordable and acceptable to women and their healthcare providers—they could help improve pregnant women's access to antenatal ultrasound, and thus increase coverage. A 2016 systematic review explored available research on the use of portable ultrasound devices in the triage, diagnosis and management of adult patients in LMICs, and found 36 studies describing their use in cardiac screening, abdominal assessment, obstetric dating, and in rapid triage in rural areas or emergency settings.[9] While that review identified only three studies related to portable ultrasound use in pregnancy, a number of new portable ultrasound models have become commercially available since that review was conducted, including several models intended specifically for pregnant women.

We therefore aimed to conduct a scoping review to identify all available studies assessing the use of portable ultrasound devices for pregnant women, as well as aiming to identify what portable ultrasound models are currently commercially available. We did this review to help identify which (if any) devices would be useful for improving access to antenatal ultrasound for women in LMICs.

METHODS

Study design

Scoping reviews are a useful methodology for examining the range and nature of existing literature on a topic.[10 11] They are well suited to addressing relatively broad questions, as they can create a map of the existing literature in a reproducible and transparent manner.[12] Scoping reviews can provide insights into how a topic has been studied, and whether knowledge gaps exist. This scoping review was conducted in accordance with the Joanna Briggs Institute Methodology for Scoping Reviews, and is reported as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews standards.[10 11] We first developed a review protocol which was registered online via the Open Science Framework website.[13] As a systematic review of publicly available data, ethics approval was not required. No patients or members of the public were involved in the design or conduct of this review.

Patient and public involvement

No patient's or members of the public were involved in the design, conduction, or dissemination of results for this paper.

Eligibility criteria

For the scoping review, eligible studies were primary research studies that used any study design, conducted in any country, setting or language, provided that the study involved the use of a portable ultrasound device (variably described as point-of-care, wireless, compact, or mobile-based ultrasound devices) in pregnant women. We also included studies that pertained to training healthcare providers in the use of portable ultrasound devices for pregnancy-related indications. Studies were included regardless of the comparator used. We searched the literature from 1 January 2000 onwards, considering that portable ultrasound devices are a relatively new technology. While the aim of the review was to identify portable ultrasound devices specifically for gestational age estimation, we decided to use eligibility criteria that captured any study assessing the use of a portable ultrasound device for any pregnancy-related indication, to ensure that no eligible devices or data were missed. This was also because some ultrasound devices might have multiple uses (such as gestational age estimation, assessing position of the placenta, or detecting fetal anomaly). Studies that related to the use of conventional ultrasound systems only (ie, cart-based ultrasound devices), or studies that assessed portable ultrasound use in clinical contexts outside of obstetric applications were not included. Conference abstracts, case reports, case series, study protocols and editorial letters were also not eligible. Systematic reviews were not considered eligible but were checked for any studies not identified through our searches.

Literature searching and assessment of eligibility

We searched four databases—Medline, Embase, CINAHL and Maternal and Infant Care—on 29 July 2021. With support from two information specialists, search strategies were constructed for each database, combining relevant synonyms and search terms for pregnancy (including terms related to foetal biometry and GA estimation) and portable ultrasound devices (online supplemental tables S1–S4). Identified citations were collated and deduplicated in Endnote,[14] before uploading to Covidence for screening.[15] Two reviewers independently screened and assessed titles and abstracts of all retrieved citations for potential eligibility. For potentially eligible studies, full texts were retrieved and assessed by two independent reviewers according to the review's eligibility criteria. Disagreements during both stages were resolved either through discussion or consultation with a third author.

Separate to the searches of these four databases, we used Google searches to identify portable ultrasound devices that were commercially available at the time of searching. These searches used structured search terms and synonyms to identify manufacturers of portable ultrasound systems (online supplemental table S5). We also searched individual websites of ultrasound manufacturers to identify what (if any) portable ultrasound systems were currently available (online supplemental table S6). Once the scoping review was completed, we updated these searches to ensure that manufacturers identified in the included studies were also included in these web searches.

Data collection and analysis

For the scoping review, data extraction was conducted using a customised Google Sheet, which was pretested and refined on five eligible studies. For each included study, we extracted data on: study title, author, year of publication, country and region where the study was conducted, study design, population, setting, stage of pregnancy, method of measurement (transabdominal, transvaginal, and/or transperineal), device used and what parameters were assessed. By parameters, we mean whether the study reported on accuracy, effects on health outcomes, feasibility, whether training programmes were used, and whether they compared findings to conventional ultrasound devices. The country where a study was conducted was classified into income levels using 2021 World Bank categories.[16]

Study designs were classified according to the Centre for Evidence-Based Medicine's published hierarchies of evidence,[17] while those studies that self-described as pilot, field or validation studies were classified as 'other primary research design'. We also classified each study based on its main objective—for example, whether the study used portable ultrasound primarily for: gestational age estimation, confirming pregnancy, routine antenatal ultrasound scans, identifying ectopic pregnancy, identifying or monitoring placental abnormalities, congenital anomaly screening, monitoring labour progress, or emergency/trauma applications for pregnant women (online supplemental table S7). For those studies that formally validated a portable device against a conventional ultrasound system for gestational age estimation, the findings of that validation analysis were reported. As a scoping review, quality assessment of individual studies was not performed. Data were analysed descriptively. For the purposes of reporting review findings, the term "portable ultrasound" was used to mean any point-of-care, wireless, compact or mobile-based ultrasound device, as distinct from conventional (non-portable) or cart-based ultrasound devices.

For the web searches to identify commercially available portable ultrasound devices, we extracted available data on country of manufacture, countries of registration, intended use and user, what training is provided or available, and the device characteristics. This included the device's power supply, battery life, transducers, obstetric software presets, estimated lifetime, drop and waterproof standards, weight, dimensions, accessories, screen resolutions, software requirements, storage, data export options, price and warranty. In 2018, WHO published a policy brief on their antenatal care recommendations, identifying eight suggested requirements that obstetric ultrasound equipment should meet for antenatal care (box 1). We assessed all identified ultrasound systems against these eight requirements.[6]

Box 1 Suggested equipment capacity for obstetric ultrasound (US; reproduced with permission from the WHO's recommendations on antenatal care for a positive pregnancy experience)[6]

- ⇒ Real-time, grayscale capabilities
- ⇒ Transabdominal transducer (3–5 MHz)
- ⇒ Transvaginal US transducer to help detect placental abnormalities and extrauterine pregnancies
- ⇒ Adjustable acoustic power output controls with output display standards
- ⇒ Freeze-frame capabilities and electronic callipers
- ⇒ Obstetric presets (software) to estimate gestational age
- ⇒ Capacity to print or store images
- ⇒ Regular maintenance and servicing, important for optimal equipment performance

In general, service delivery settings that will only conduct routine basic obstetric ultrasound will not require a machine with additional features such as Doppler or 3-D/4-D imaging.

A transvaginal transducer may also be useful in some examinations where an experienced provider is unable to visualise anatomy with a transabdominal transducer.

RESULTS

Literature searches for the scoping review identified 2770 citations, of which 793 duplicates were removed. Title and abstract screening of the remaining 1977 unique citations identified 269 citations which were potentially eligible. After reviewing full texts, 56 studies were included for analysis (figure 1). The most common reasons for exclusion included conference abstracts (86 studies), ultrasound device was not described (34 studies), or studies using an ineligible intervention (such as conventional ultrasound devices only) (26 studies). Six full texts were unable to be located. All data used in the results are publicly available online.[18]

Characteristics of included studies

Included studies were published between 2005 and 2021. Studies were conducted in 34 different countries across six regions (2 studies were conducted in multiple countries). High-income countries accounted for 24 studies (42.9%), lower middle income countries for 13 studies (23.2%), upper middle income for 9 studies (16.1%) and low-income countries for 8 studies (14.3%) (table 1). In terms of geographical regions, 16 studies (28.6%) were from sub-Saharan African countries, followed by Latin American and Caribbean countries (13 studies, 23.2%). The country with the highest number of studies was the USA (10 studies, 17.9%).

Cross-sectional study designs were most common (15 studies, 26.8%), followed by prospective or retrospective cohort studies (11 studies, 19.6%) and a single study using a case-control study design. The remaining 29 studies were pilot, field or validation studies. Studies were most commonly using portable ultrasound devices for transabdominal assessment (36 studies, 64.3%). Other studies related to training programmes for portable ultrasound

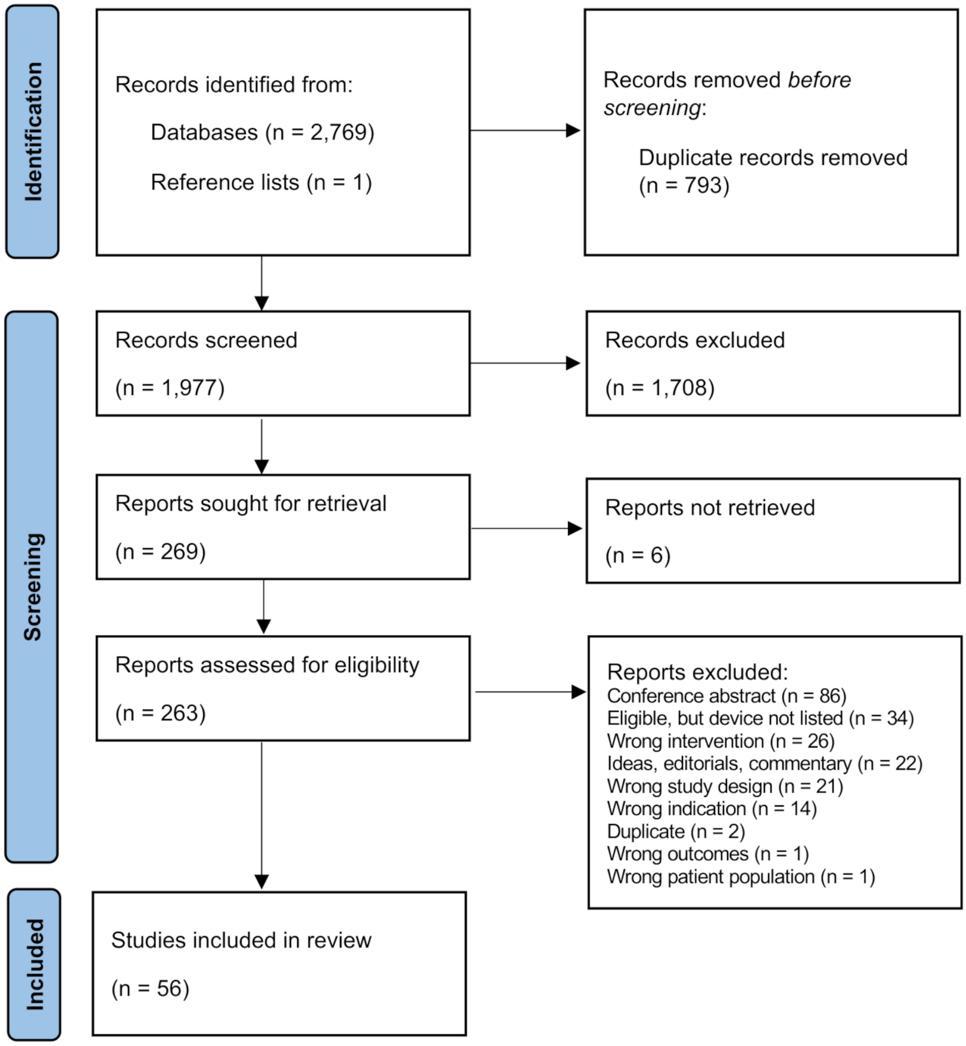

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart of the screening process for scoping review.

use in pregnancy-related indications (9 studies, 16.1%), using portable devices with transvaginal ultrasound only (8 studies, 14.3%), and studies where existing ultrasound devices were modified, such as attaching a motor to a probe to allow for remote control of an ultrasound device (3 studies, 5.4%). In total, 21 studies related to assessment of fetal characteristics or performing gestational dating (37.5%). Other studies used portable ultrasound for routine antenatal scans or clinical observations (13 studies, 23.2%) and ultrasound use in emergency/trauma situations involving pregnant women (10 studies, 17.9%) (figure 2).

Table 1 Number of studies per World Bank (2021) income level

Income level	Number of studies	% of total studies
High income	24	42.9
Upper middle income	9	16.1
Lower middle income	13	23.2
Low income	8	14.3
Multiple*	2	3.6
Total	**56**	**100.0**

*Both studies categorised under multiple were across countries classified as high income and upper middle income.

The 56 studies used 27 different portable ultrasound models, from 17 manufacturers (table 2). Nearly half used a device produced by SonoSite, with the most common being the SonoSite M-Turbo (10 studies, 17.9%) followed by the General Electric (GE) VScan (8 studies), SonoSite Titan and Micromaxx (4 studies each), and GE Voluson i (three studies). One device, the Enlace Hispano Americano de Salud Healthy Pregnancy Kit device, was described in two studies but does not appear to be commercially available.[19 20]

Of the 56 studies, 47 (83.9%) primarily focused on pregnant women as participants, and 9 studies (16.1%) collected data related to staff members who participated in portable ultrasound training programmes. The 47 studies involved pregnant women without specific

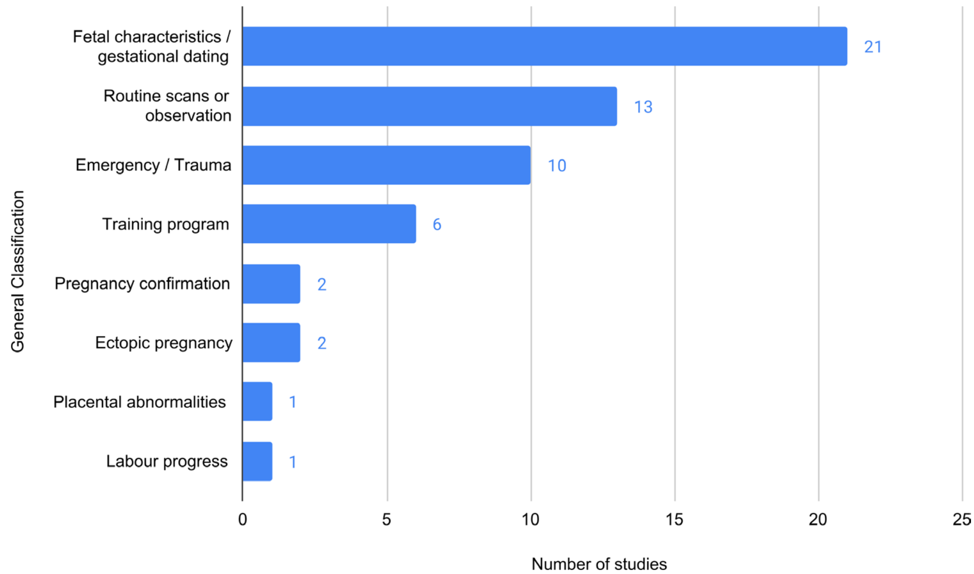

Figure 2 Studies classified by their main objective in using a portable ultrasound.

restrictions (32 studies), pregnant women who presented with vaginal bleeding (5 studies) or women with ectopic or clinically high-risk pregnancies (10 studies). For the nine studies that reported data on staff members being trained in portable ultrasound use, these involved multiple groups of health professionals (four studies), physicians only (two studies), nurses/midwives only (two studies) and medical students (one study).

Most studies (53 studies, 94.6%) were conducted in the antenatal period, though 2 were intrapartum and 1 was both antenatal and intrapartum. Of those 53 studies in the antenatal period, 10 were in the first trimester only, 5 in the second trimester only, 5 in the third trimester only and 5 across both second and third trimesters (the remaining 28 studies did not specify the pregnancy term period). Studies were conducted in outpatient antenatal care settings (30 studies, 53.6%), inpatient (24 studies, 42.9%) and community settings, such as local marketplaces or 'field investigations' (8 studies, 14.3%). One study assessed portable ultrasound in the context of telemedicine, and one study did not describe the setting.

Accuracy of portable ultrasound devices

A total of 21 studies related to portable ultrasound use for assessment of fetal characteristics and/or gestational age estimation, though only 10 of these formally validated a portable device against a conventional ultrasound. Findings from these 10 studies—including study design, objective, devices used and key findings—are presented in table 3. The devices used in these 10 studies were the GE VScan (4 studies); GE Logiq i (1 study); Konted Gen 1 C10R (1 study); Mindray DP-10 (1 study); Siemens Accuson 10 (1 study); SonoSite M-Turbo (1 study); and SonoSite Titan (1 study). These validation studies investigated device accuracy with regards to fetal biometric measurements such as biparietal diameter and femur length, as well as fetal number, fetal lie, gestational age, placental location, small or large for gestational age. The studies were conducted with women across a range of gestational ages. Of these 10 studies, 9 reported that the portable ultrasound device was partially or fully validated.

Commercially available portable ultrasounds

Web searches identified 106 portable ultrasound devices made by 26 different manufacturers (online supplemental table S8). The majority were produced in China, and prices ranged from US$1190 to US$30 000. Devices ranged in weight from 0.9 kg to 13.0 kg and battery life was from 40 min up to 8 hours. Identified devices were a mix of handheld devices with either wired or wireless connection to a user's device (typically a phone or computer), or laptop-style portable ultrasound devices.

Where sufficient data were available, we compared available devices against the requirements identified in WHO's antenatal care recommendations for ultrasound devices (box 1). Though we did not have complete data on all identified devices, it was common for identified devices to have a transabdominal transducer, greyscale imaging capabilities, adjustable acoustic power output controls, freeze-frame capabilities, the capacity to store and print images and obstetric presets. For most devices, information was not available on whether regular servicing and maintenance was offered, and it was less common for transvaginal transducers to be available.

DISCUSSION

Summary of main findings

This scoping review identified 56 studies related to the use of portable ultrasound devices in obstetric care, more than half of which were in LMICs. The review found that 27 portable ultrasound devices (from 17 manufacturers) had been formally evaluated in the peer-reviewed literature. These studies most commonly related to abdominal assessment using a portable ultrasound device, though studies relating to transvaginal ultrasound assessment and

Table 2 Number of studies, stratified by manufacturer and model of portable ultrasound device

Manufacturer	Portable ultrasound device model	Number of studies	% total studies
Enlace Hispano Americano de Salud	Healthy Pregnancy Kit specific[19 20]	2	3.6
General Electric	Logiq e[23]	1	1.8
	Logiq I[24]	1	1.8
	Voluson I[25–27]	3	5.4
	VScan[28–35]	8	14.3
Healcerion	SONON 300C[36]	1	1.8
Konted	Gen 1 C10R[21]	1	1.8
Lequio	US-304[37]	1	1.8
Mindray	DP-10[38]	1	1.8
	DP-20[39 40]	2	3.6
Phillips	Lumify[41]	1	1.8
	VISIQ[42]	1	1.8
Primedic	Handyscan[43]	1	1.8
Siemens	Accuson 10[44]	1	1.8
Signostics	Signos[45]	1	1.8
SONON	300 L[46]	1	1.8
Sonoscanner	Orcheo Lite[47 48]	2	3.6
SonoScape	S2[49]	1	1.8
SonoSite	180[50 51]	2	3.6
	180 Plus[52]	1	1.8
	Edge[53]	1	1.8
	M-Turbo[54–62]	9	16.1
	Micromaxx[63–65]	3	5.4
	Micromaxx OR M-Turbo[66]	1	1.8
	S180[67]	1	1.8
	Titan[68–71]	4	7.1
	Model not specified[72]	1	1.8
Sony	Model not specified[73]	1	1.8
Toshiba	SSA-510 A[74]	1	1.8
Whale Imaging	Sigma P5[75]	1	1.8

training programmes for healthcare workers on using portable ultrasound were also identified. Our results found that only 10 studies formally validated portable ultrasound devices against a conventional ultrasound device. Four studies assessed accuracy of gestational age estimation, while six studies assessed accuracy of selected fetal biometry measures, which can be used in estimating gestational age. These 10 studies incorporated 7 devices, with which only 6 were described as valid compared with their conventional counterpart. By comparison, 102 portable ultrasound devices are currently commercially available. While many of the available devices are promising in terms of function, portability and affordability, we identified no validation studies for the majority of commercially available devices.

Strengths and limitations

This review was conducted in accordance with a prespecified protocol, and in line with current scoping review methodological guidance.[10–12] We searched a wide range of sources using robust search strategies, and studies were screened and extracted in duplicate and verified. The scoping review was augmented by additional web searches of ultrasound manufacturers, providing useful corollary information on the commercial availability of portable devices. However, some limitations must be acknowledged. Despite our best efforts, we were unable to locate six potentially eligible studies, which may have impacted the findings of this review. Also, some of the included studies required extensive discussions in the review team regarding the study design, intervention and what fetal measurements had been evaluated. We aimed to mitigate this through using operational definitions for study classification and data extraction, though this was challenging for some studies that were poorly reported. While nine studies were identified in which portable ultrasound devices were determined to be valid, it is possible that validation studies in other settings or populations may find different results. Also, sample sizes for these studies were not large—up to 251 women, and including a proof-of-concept study in a single woman.[21] Hence, we consider it likely that further studies will be required for these devices also. It is important to acknowledge that ultrasound manufacturers may have conducted formal validation for portable ultrasound devices, but that these may not be available in the public domain. However, we consider it critical that any such studies should be made publicly available in the peer-reviewed literature, so that clinicians, administrators and policy-makers can appropriately scrutinise their accuracy and reliability.

Interpretation

This is the first review specifically examining the use of portable ultrasound devices for use in pregnant women. A 2016 review by Becker *et al* investigated portable ultrasound use across multiple health topics, identifying only three studies on pregnancy-related indications.[9] Our review identified a higher number of studies, probably reflecting that a number of portable devices have entered the market since 2016, with an associated increase in research interest. It was noteworthy that over half of identified studies were conducted in LMICs, likely reflecting that this innovative technology is promising for limited-resource settings.

The large number of devices commercially available is consistent with expansion of this technology in recent years. However, only 27 of these devices have had been formally evaluated through some form of peer-reviewed

Table 3 Characteristics and findings from studies comparing portable ultrasound devices against conventional ultrasound for assessing fetal characteristics and gestational age estimation

Author	Year	Country	Study design	Sample size	Gestational age	Portable ultrasound device used	Comparator	Key findings	Review team assessment
Dougherty *et al*[24]	2021	USA	Quality assurance and improvement protocol	113 pregnant women	14–26 weeks	GE Logiq i	A diagnostic obstetric ultrasound scan performed with Voluson E8 system by a trained sonographer	For biometric measures and calculations of estimated gestational age, inter-reader reliability ranged from 0.79 to 0.85 for all parameters except femur length. Over 94% of the obstetric sweep protocol ultrasound ages were within 7 days of the corresponding gold-standard age	Study demonstrates validity for these measures
Galjaard *et al*[30]	2014	Belgium	Cohort study (prospective)	51 pregnant women	'Third trimester' (range not indicated)	GE VScan	Comparison to routine scan performed by an experienced ultrasonographer on a Voluson E730 Expert	Regarding fetal growth measurements, there was very good agreement for measurements of biparietal diameter (BPD) and good agreement for femur length (FL) and trans-cerebellar diameter (TCD)	Study demonstrates validity for these measures
Haragan *et al*[31]	2015	USA	Diagnostic accuracy study	251 pregnant women	24–40 weeks	GE VScan	Formal growth ultrasound by registered diagnostic medical sonographers (device not specified)	Authors found a highly significant correlation between handheld and formal ultrasound measurements of abdominal circumference (R=0.939; p<0.001). Handheld ultrasound was also found to be viable for screening for Fetal Growth Restriction and Large for Gestational Age	Study demonstrates validity for these measures
Lausin *et al*[44]	2009	Croatia	Diagnostic accuracy study	100 pregnant women	16–41 weeks	Siemens Accuson 10	Larger, traditional ultrasound devices used at the studies clinic (devices not specified)	Portable ultrasound device was found to be effective for measuring the following: quantity of amniotic fluid, position of the placenta, position of the fetus and fetal heartbeat. Regarding biometrical measurements, BPD was determined in 97% of patients, FL in 73% and AC in only 67%.	Study demonstrates validity for some measures, but not for others
Maraci *et al*[21]	2020	UK	Proof-of-concept evaluation	1 pregnant woman	Not indicated	Konted Gen 1 C10R	1)Sonographer performed manual estimation of TCD on scan; and 2) clinical hospital scan TCD measurement on the same subject made using a high-end ultrasound machine (GE Voluson E8)	TCD automated measurement (26.2 mm) was an underestimation compared with manual measurement (34.9 mm) and the hospital measurement (36.2 mm). It is not known whether this is a fault of the scan being from a portable device, or from the automated system itself.	Study did not demonstrate validity of a machine learning algorithm for TCD measurement, though sample size is small (n=1)
Saul *et al*[71]	2012	USA	Cross-sectional study	68 pregnant women	'First trimester' (range not indicated)	SonoSite Titan	Gestational age estimated by ultrasound performed in the department of radiology (device not specified)	Excluding cases with no fetal pole, the median discrepancy between emergency-physician performed and radiology department gestational age estimation was 2 days. The correlation coefficient was 0.978	Study demonstrates validity for these measures

Continued

Table 3 Continued

Author	Year	Country	Study design	Sample size	Gestational age	Portable ultrasound device used	Comparator	Key findings	Review team assessment
Sayasneh *et al*[34]	2012	UK	Cohort study (prospective)	204 women	Group 1: 'early pregnancy' (range not indicated) Group 2: >14 weeks Group 3: Not applicable	GE VScan	Transvaginal and/or transabdominal examination depending on the clinical indication, using a Voluson E8 Expert	In group 1, there was good to very good agreement or identifying presence or absence of embryo, gestational sac, fetal heart motion, pregnancy location and final diagnostic outcome. In group 2, there was good to very good agreement for fetal presentation, placental location, and placental position. In group 3, there was very good agreement for final diagnosis and type of ovarian mass. For continuous variables, there was close agreement for CRL, mean sac diameter, FL and mean diameter of an ovarian mass	Study demonstrates validity for these measures
Shah *et al*[61]	2010	USA	Cross-sectional study	96 ultrasound examinations on 38 pregnant women	14–40 weeks	SonoSite M-Turbo	Formal sonography by an ultrasound technician using Accuvix XQ ultrasound machine	When comparing physician-performed measurements with true gestational age measurements, BPD had a correlation coefficient of 0.947 and FL had a correlation coefficient of 0.957. Physician's determination of fetal viability had an overall accuracy of 96% when using ultrasound	Study demonstrates validity for these measures
Toscano *et al*[38]	2021	Peru	Single-centre pilot study	126 pregnant women	'Second or third trimester' (range not indicated)	Mindray DP-10	Concurrently performed standard of care ultrasound obtained and interpreted by an experienced ultrasonographer	Telediagnostic system with ultrasound protocol showed excellent agreement with standard of care ultrasound allowing identification of number of fetuses, fetal presentation, placental location and assessment of amniotic fluid volume. Intraclass correlation was good or excellent for all fetal biometric measurements—including kappa coefficient of 0.95 for estimated gestational age	Study demonstrates validity for these measures
Troyano *et al*[35]	2013	Spain	Pilot study	80 women	11–13 weeks	GE VScan	The same measurements performed with a traditional US device (Voluson 730 Expert)	When comparing to the conventional ultrasound findings, there was high Pearson's correlation coefficient for BPD, gynaecological measurements and overall correlation	Study demonstrates validity for these measures

research regarding their accuracy, feasibility, reliability or acceptability. In their 2019 commentary on medical device regulation, Charlesworth and van Zundert argued that while medical device manufacturers may posit that it is too costly, time-consuming, and impractical to generate evidence on devices from large studies, primary research is undeniably critical to ensuring that large-scale implementation will be beneficial.[22] Relatedly, a major finding from this review is that further research on portable ultrasound devices—in particular their accuracy and acceptability when used in antenatal care contexts—are needed to guide decision-making around selection and procurement of ultrasound models.

Since 2016, WHO has recommended that all women should have an ultrasound prior to 24 weeks' gestation; however, the coverage of ultrasound use remains limited in many countries.[7 8] Findings of this review can be useful to maternity care clinicians, programme administrators and policy-makers who are seeking to identify reliable, affordable and portable ultrasound systems to use in their settings. However, available information was insufficient for most models, and only 10 had been formally validated for fetal biometry measures. In order to respond to this knowledge gap, and the growing number of commercially available devices, further peer-reviewed studies into portable ultrasound devices for obstetric use are required. These studies would ideally be independent (free from any financial bias or incentives from device manufacturers); use a diagnostic accuracy design (or similar) for routine fetal biometry measures; assess promising handlhed devices against a standard control; and be peer reviewed and publicly available. It is hoped that these studies would demonstrate convincingly that handheld devices perform as well as conventional ultrasound systems used in obstetrics.

CONCLUSION

A large number of portable ultrasound devices for obstetric use are commercially available; however, there is limited peer-reviewed research that has formally assessed how these devices perform against conventional ultrasound machines. Findings from this review, combined with future studies that assess the accuracy and validity of new technologies, can help support safe and effective implementation of portable devices, particularly for limited-resource settings where access to obstetric ultrasound is limited.

Acknowledgements Lorena Romero (an information specialist) helped with the initial design of the search strategy. Anna Shalit and Lauren Vallely (medical students) helped with the initial title/abstract screening.

Contributors AJE developed the review protocol and data extraction tools. AJE and SM (an information specialist) developed the search strategy. AJE, EF and SA conducted title/abstract and full-text screening and data extraction—conflicts were resolved by either EF or SA depending on which was not involved in the initial decision. AJE prepared the first draft of the analysis, which was reviewed by all authors and revised following their input. AJE is responsible for the overall content as guarantor for this review. All named authors contributed to the writing of this manuscript. The authorship team is comprised of medical doctors, a maternal and public health researcher, and an information specialist.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

ORCID iDs
Alexander John Eggleston http://orcid.org/0000-0001-7458-7092
Elise Farrington http://orcid.org/0000-0001-8710-4360
Steve McDonald http://orcid.org/0000-0003-2832-5205
Samia Aziz http://orcid.org/000-0002-7670-1116

REFERENCES

1 World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience. Geneva World Health Organization; 2016.
2 Whitworth M, Bricker L, Mullan C, *et al*. Ultrasound for fetal assessment in early pregnancy. *Cochrane Database Syst Rev* 2015;2015.
3 World Health Organization. WHO recommendations on interventions to improve preterm birth outcomes. Geneva World Health Organization; 2015.
4 World Health Organization. WHO recommendations on antiplatelet agents for the prevention of pre-eclampsia. Geneva, Switzerland WHO; 2021.
5 World Health Organization. WHO recommendations: induction of labour at or beyond term. Geneva, Switzerland World Health Organization; 2018.
6 World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience: ultrasound examination. Geneva, Switzerland WHO; 2018.
7 Shah S, Bellows BA, Adedipe AA, *et al*. Perceived barriers in the use of ultrasound in developing countries. *Crit Ultrasound J* 2015;7:11.
8 Franklin HL, Mirza W, Swanson DL, *et al*. Factors influencing referrals for ultrasound-diagnosed complications during prenatal care in five low and middle income countries. *Reprod Health* 2018;15:204.
9 Becker DM, Tafoya CA, Becker SL, *et al*. The use of portable ultrasound devices in low- and middle-income countries: a systematic review of the literature. *Trop Med Int Health* 2016;21:294–311.
10 Tricco AC, Lillie E, Zarin W, *et al*. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018;169:467–73.
11 Peters MD, Godfrey C, McInerney P, *et al*. *Scoping reviews*. Joanna Briggs Institute reviewer's manual, 2017: 408–46.
12 Peters MDJ, Marnie C, Tricco AC, *et al*. Updated methodological guidance for the conduct of scoping reviews. *JBI Evid Synth* 2020;18:2119–26.
13 Eggleston AV J. Point-Of-Care ultrasound technologies for gestational age dating: rapid scoping review: OSF registries 2021.

14 Web of Science Group. EndNote USA: Clarivate, 2020. Available: https://endnote.com/
15 Covidence. About Covidence Australia, 2020. Available: https://www.covidence.org/ [Accessed 14 Oct 2020].
16 World Bank Group. The world bank USA, 2021. Available: https://www.worldbank.org/
17 CEBM. Centre for evidence based medicine, 2020. Available: https://www.cebm.net/
18 Data from: portable ultrasound technologies for estimating gestational age in pregnant women: a scoping review and analysis of commercially available models 2022.
19 Crispín Milart PH, Diaz Molina CA, Prieto-Egido I, *et al*. Use of a portable system with ultrasound and blood tests to improve prenatal controls in rural Guatemala. *Reprod Health* 2016;13:110.
20 Crispín Milart PH, Prieto-Egido I, Díaz Molina CA, *et al*. Detection of high-risk pregnancies in low-resource settings: a case study in Guatemala. *Reprod Health* 2019;16:80.
21 Maraci MA, Yaqub M, Craik R, *et al*. Toward point-of-care ultrasound estimation of fetal gestational age from the trans-cerebellar diameter using CNN-based ultrasound image analysis. *J Med Imaging* 2020;7:1.
22 Charlesworth M, van Zundert AAJ. Medical device regulation: the need for clinical vigilance and oversight. *Anaesthesia* 2019;74:693–5.
23 Kawooya MG, Nathan RO, Swanson J, *et al*. Impact of introducing routine antenatal ultrasound services on reproductive health indicators in Mpigi district, central Uganda. *Ultrasound Q* 2015;31:285–9.
24 Dougherty A, Kasten M, DeSarno M, *et al*. Validation of a telemedicine quality assurance method for point-of-care obstetric ultrasound used in low-resource settings. *J Ultrasound Med* 2021;40:529–40.
25 Di Lieto A, De Falco M, Pontillo M. The wireless tele-ultrasonography in prenatal telemedicine. *Giornale Italiano di Ostetricia e Ginecologia* 2011;33:158–62.
26 Rijken MJ, de Wit MC, Mulder EJH, *et al*. Effect of malaria in pregnancy on foetal cortical brain development: a longitudinal observational study. *Malar J* 2012;11:222.
27 Rijken MJ, Moroski WE, Kiricharoen S, *et al*. Effect of malaria on placental volume measured using three-dimensional ultrasound: a pilot study. *Malar J* 2012;11:5.
28 Bruns RF, Menegatti CM, Martins WP, *et al*. Applicability of pocket ultrasound during the first trimester of pregnancy. *Med Ultrason* 2015;17:284–8.
29 Dalmacion GV, Reyles RT, Habana AE, *et al*. Handheld ultrasound to AVERT maternal and neonatal deaths in 2 regions of the Philippines: an iBuntis® intervention study. *BMC Pregnancy Childbirth* 2018;18:32.
30 Galjaard S, Baeck S, Ameye L, *et al*. Use of a pocket-sized ultrasound machine (PUM) for routine examinations in the third trimester of pregnancy. *Ultrasound Obstet Gynecol* 2014;44:64–8.
31 Haragan AF, Hulsey TC, Hawk AF, *et al*. Diagnostic accuracy of fundal height and handheld ultrasound-measured abdominal circumference to screen for fetal growth abnormalities. *Am J Obstet Gynecol* 2015;212:820.e1–820.e8.
32 Mbuyita S, Tillya R, Godfrey R, *et al*. Effects of introducing routinely ultrasound scanning during Ante Natal Care (ANC) clinics on number of visits of ANC and facility delivery: a cohort study. *Arch Public Health* 2015;73:36.
33 Pedersen JK, Sira C, Trovik J. Handheld transabdominal ultrasound, after limited training, may confirm first trimester viable intrauterine pregnancy: a prospective cohort study. *Scand J Prim Health Care* 2021;39:123–30.
34 Sayasneh A, Preisler J, Smith A, *et al*. Do pocket-sized ultrasound machines have the potential to be used as a tool to triage patients in obstetrics and gynecology? *Ultrasound Obstet Gynecol* 2012;40:145–50.
35 Troyano Luque JM, Ferrer-Roca O, Barco-Marcellán MJ, *et al*. Modification of the hand-held Vscan ultrasound and verification of its performance for transvaginal applications. *Ultrasonics* 2013;53:17–22.
36 Kim J, Kim S, Jeon S, *et al*. A longitudinal study investigating cervical changes during labor using a wireless ultrasound device. *J Matern Fetal Neonatal Med* 2018;31:1787–91.
37 Kodaira Y, Pisani L, Boyle S, *et al*. Reliability of ultrasound findings acquired with handheld apparatuses to inform urgent obstetric diagnosis in a high-volume resource-limited setting. *Int J Gynaecol Obstet* 2021;153:280–6.
38 Toscano M, Marini TJ, Drennan K, *et al*. Testing telediagnostic obstetric ultrasound in Peru: a new horizon in expanding access to prenatal ultrasound. *BMC Pregnancy Childbirth* 2021;21:328.
39 Amoah B, Anto EA, Osei PK, *et al*. Boosting antenatal care attendance and number of hospital deliveries among pregnant women in rural communities: a community initiative in Ghana based on mobile phones applications and portable ultrasound scans. *BMC Pregnancy Childbirth* 2016;16:141.
40 Anto EA, Amoah B, Crimi A. Segmentation of ultrasound images of fetal anatomic structures using random forest for low-cost settings. *Annu Int Conf IEEE Eng Med Biol Soc* 2015;2015:793–6.
41 Straily A, Malit AO, Wanja D, *et al*. Use of a tablet-based system to perform abdominal ultrasounds in a field investigation of Schistosomiasis-Related morbidity in Western Kenya. *Am J Trop Med Hyg* 2021.
42 Vinayak S, Sande J, Nisenbaum H, *et al*. Training midwives to perform basic obstetric point-of-care ultrasound in rural areas using a tablet platform and mobile phone transmission Technology-A WFUMB COE project. *Ultrasound Med Biol* 2017;43:2125–32.
43 Busch M. Portable ultrasound in pre-hospital emergencies: a feasibility study. *Acta Anaesthesiol Scand* 2006;50:754–8.
44 Lausin I, Kurjak A, Miskovic B, *et al*. Sonoscope, fiction or reality? *Gynaecologia et Perinatologia* 2009;18:30–3.
45 Shorter M, Macias DJ. Portable handheld ultrasound in austere environments: use in the Haiti disaster. *Prehosp Disaster Med* 2012;27:172–7.
46 Choi MJ, Lim CM, Jeong D, *et al*. Efficacy of intraoperative wireless ultrasonography for uterine incision among patients with adherence findings in placenta previa. *J Obstet Gynaecol Res* 2020;46:876–82.
47 Arbeille P, Zuj K, Blouin J. Remote echography & Doppler using tele-operated compact motorised probes & portable echograph. Application to 200 isolated patient in rural areas. *Angeiologie* 2016;68:23–34.
48 Arbeille P. 2074546 Tele-Operated Echograph and Motorised probe transducer for remote echography in isolated environment. Application to space exploration and isolated medical centre. *Ultrasound Med Biol* 2015;41:S28.
49 Lindgaard K, Riisgaard L. 'Validation of ultrasound examinations performed by general practitioners'. *Scand J Prim Health Care* 2017;35:256–61.
50 Bentley S, Hexom B, Nelson BP. Evaluation of an obstetric ultrasound curriculum for midwives in Liberia. *J Ultrasound Med* 2015;34:1563–8.
51 Kimberly HH, Murray A, Mennicke M, *et al*. Focused maternal ultrasound by midwives in rural Zambia. *Ultrasound Med Biol* 2010;36:1267–72.
52 Blaivas M, Kuhn W, Reynolds B, *et al*. Change in differential diagnosis and patient management with the use of portable ultrasound in a remote setting. *Wilderness Environ Med* 2005;16:38–41.
53 Shah S, Adedipe A, Ruffatto B, *et al*. BE-SAFE: bedside sonography for assessment of the fetus in emergencies: educational intervention for late-pregnancy obstetric ultrasound. *West J Emerg Med* 2014;15:636–40.
54 Varner CB, Borgundvaag D.;, McLeod B.;, *et al*. Correction: fetal outcomes following emergency department point-of-care ultrasound for vaginal bleeding in early pregnancy. *Can Fam Physician* 2016;62:628.
55 Bailey C, Carnell J, Vahidnia F, *et al*. Accuracy of emergency physicians using ultrasound measurement of crown-rump length to estimate gestational age in pregnant females. *Am J Emerg Med* 2012;30:1627–9.
56 Chiem AT, Chan CH-Y, Ibrahim DY, *et al*. Pelvic ultrasonography and length of stay in the ED: an observational study. *Am J Emerg Med* 2014;32:1464–9.
57 Hall EA, Matilsky D, Zang R, *et al*. Analysis of an obstetrics point-of-care ultrasound training program for healthcare practitioners in Zanzibar, Tanzania. *Ultrasound J* 2021;13:18.
58 Mbonyizina C, Ntirushwa D, Bazzett-Matabele L, *et al*. Point of care ultrasound: does the presence of ascites in severe pre-eclampsia correlate with poor maternal and neonatal outcome? *Trop Med Int Health* 2019;24:1018–22.
59 Osborne B, Thoirs K, Parange N. The effectiveness of simulation training in the teaching of skills required for sonographic fetal assessment in mid-trimester pregnancy to novices: a pilot study. *Australas J Ultrasound Med* 2016;19:147–53.
60 Reynolds TA, Amato S, Kulola I, *et al*. Impact of point-of-care ultrasound on clinical decision-making at an urban emergency department in Tanzania. *PLoS One* 2018;13:e0194774.
61 Shah S, Teismann N, Zaia B, *et al*. Accuracy of emergency physicians using ultrasound to determine gestational age in pregnant women. *Am J Emerg Med* 2010;28:834–8.

62 Vyas A, Moran K, Livingston J, *et al*. Feasibility study of minimally trained medical students using the rural obstetrical ultrasound triage exam (ROUTE) in rural Panama. *World J Emerg Med* 2018;9:216–22.
63 Dean AJ, Ku BS, Zeserson EM. The utility of handheld ultrasound in an austere medical setting in Guatemala after a natural disaster. *Am J Disaster Med* 2007;2:249–56.
64 MacVane CZ, Irish CB, Strout TD, *et al*. Implementation of transvaginal ultrasound in an emergency department residency program: an analysis of resident interpretation. *J Emerg Med* 2012;43:124–8.
65 Shah SP, Epino H, Bukhman G, *et al*. Impact of the introduction of ultrasound services in a limited resource setting: rural Rwanda 2008. *BMC Int Health Hum Rights* 2009;9:4.
66 Wang R, Reynolds TA, West HH, *et al*. Use of a β-hCG discriminatory zone with bedside pelvic ultrasonography. *Ann Emerg Med* 2011;58:12–20.
67 Wylie B, Mawindo P, Nyirenda O, *et al*. Accuracy of gestational dating in an observational pregnancy malaria cohort in Malawi: an ultrasound demonstration project. *American Journal of Tropical Medicine and Hygiene* 2010;83:287.
68 Adhikari S, Blaivas M, Lyon M. Diagnosis and management of ectopic pregnancy using bedside transvaginal ultrasonography in the ED: a 2-year experience. *Am J Emerg Med* 2007;25:591–6.
69 Adler D, Mgalula K, Price D, *et al*. Introduction of a portable ultrasound unit into the health services of the Lugufu refugee cAMP, Kigoma district, Tanzania. *Int J Emerg Med* 2008;1:261–6.
70 Kolbe N, Killu K, Coba V, *et al*. Point of care ultrasound (POCUS) telemedicine project in rural Nicaragua and its impact on patient management. *J Ultrasound* 2015;18:179–85.
71 Saul T, Lewiss RE, Rivera MDR. Accuracy of emergency physician performed bedside ultrasound in determining gestational age in first trimester pregnancy. *Crit Ultrasound J* 2012;4:22.
72 Goodman A, Black L, Briggs S. Obstetrical care and women's health in the aftermath of disasters: the first 14 days after the 2010 Haitian earthquake. *Am J Disaster Med* 2014;9:59–65.
73 Ndiaye P, Aris FB, Diedhiou A, *et al*. Annual assessement of a mobile ultrasonography service in the region of Ziguinchor, Senegal]. *Bilan d'activite annuel de l'echographie en strategie avancee dans la region de Ziguinchor* 2007;67:38–42.
74 Dimassi K, Douik F, Ajroudi M, *et al*. Ultrasound fetal weight estimation: how accurate are we now under emergency conditions? *Ultrasound Med Biol* 2015;41:2562–6.
75 Sibbald CA, Nicholas JL, Chapnick M, *et al*. Fetal brain ultrasound measures and maternal nutrition: a feasibility study in Ecuador. *Am J Hum Biol* 2021;33:e23467.

SUPPLEMENTARY TABLE S1. Search strategy for Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions(R) <1946 to July 29, 2021>, conducted on 29 July 2021

#	Query
1	exp Pregnancy/
2	exp Pregnancy Trimesters/
3	Prenatal Care/
4	exp Pregnancy Complications/
5	Pregnancy Outcome/
6	exp Pregnancy Tests/
7	Obstetrics/
8	Gestational Age/
9	exp Fetal Monitoring/
10	pregnan*.ti,ab,kf.
11	((fetal or foetal or fetus* or foetus*) adj3 (grow* or anomal* or abnormal* or malform* or disorder* or disease* or distress or biomet* or develop* or weight* or bodyweight* or macrosomia or size* or sizing or anatom* or aneuploid* or body proportion* or proportion* or wellbeing or well-being or matur* or organ matur*or status* or movement* or assess* or nutrition* or malnutrition*)).ti,ab,kf.
12	((AGA or SGA or LGA or FGR or IUGR or small or large) adj3 (fetus* or foetus*)).ti,ab,kf.
13	((fetal or foetal or fetus* or foetus*) adj3 (percentile* or centile* or z-score* or growth centile* or crown-rump or limb-volume)).ti,ab,kf.
14	(gestation* age* or gestation* time* or "week* gestation*" or "week* of gestation*").ti,ab,kf.
15	(trimester adj (growth* or development*)).ti,ab,kf.
16	((intrauterine or intra-uterine) adj (growth or development)).ti,ab,kf
17	or/1-16
18	exp Ultrasonography/
19	(ultraso* or scan* or ultra-sound* or ultra-sonogr* or ultra-sonic* or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler).ti,ab,kf.
20	18 or 19
21	Point-of-Care Systems/

22	(point-of-care or point-of-patient-care or point-of-service or point-of-need).ti,ab,kf.
23	(bedside or pocket-sized or handheld or hand-held or wireless or wire-less or compact or mobile or portable or POCUS).ti,ab,kf.
24	21 or 22 or 23
25	20 and 24
26	(((ultrasound or ultra-sound or ultrason*) adj10 (portab* or hand held or handheld or point-of-care or mobile or POC or bedside or bed-side or pocket-sized or wireless or wire-less or rapid or emergency or compact)) or POCUS).ti,ab,kf.
27	or/25-26
28	17 and 27
29	exp animals/ not humans/
30	28 not 29
31	limit 30 to yr="2000 -Current"

SUPPLEMENTARY TABLE S2. Search strategy for Embase database via Ovid, conducted on 29 July 2021

#	Query
1	fetus outcome/ or fetus risk/ or fetus weight/ or gestation period/ or gestational age/ or fetus control/
2	prenatal growth/ or fetus growth/ or fetal biophysical profile/ or prenatal development/ or fetus development/ or fetal well being/ or fetus maturity/ or fetus movement/
3	fetus disease/ or prenatal disorder/ or fetal malnutrition/ or fetus distress/ or fetus malformation/ or macrosomia/ or oligohydramnios/ or premature fetus membrane rupture/
4	((fetal or foetal or fetus* or foetus*) adj3 (grow* or anomal* or abnormal* or malform* or disorder* or disease* or distress or biomet* or develop* or weight* or bodyweight* or macrosomia or size* or sizing or anatom* or aneuploid* or body proportion* or proportion* or wellbeing or well-being or matur* or organ matur*or status* or movement* or assess* or nutrition* or malnutrition*)).mp.
5	((AGA or SGA or LGA or FGR or IUGR or small or large) adj3 (fetus* or foetus*)).mp.
6	((fetal or foetal or fetus* or foetus*) adj3 (percentile* or centile* or z-score* or growth centile* or crown-rump or limb-volume)).mp.
7	(gestation* age* or gestation* time* or "week* gestation*" or "week* of gestation*").mp.
8	(trimester adj (growth* or development*)).mp.
9	((intrauterine or intra-uterine) adj (growth or development)).mp.
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11	"point of care ultrasound"/
12	((point-of-care or point-of-patient-care or point-of-service or point-of-need) adj3 (US or ultraso* or scan* or ultra-sound* or ultra-sonogr* or ultra-sonic* or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler*)).mp.
13	((bedside or pocket or pocket-size* or handheld or hand-held or wireless or wire-less or compact or mobile or portable or POC) adj3 (US or ultraso* or scan* or ultra-sound* or ultra-sonogr* or ultra-sonic* or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler*)).mp.
14	pocus.mp.
15	11 or 12 or 13 or 14
16	10 and 15

17	ultrasound/
18	echography/ or a scan/ or b scan/ or doppler ultrasonography/ or gray scale echography/ or real time echography/ or transvaginal echography/
19	echograph/ or cardiotocograph/ or doppler device/ or echocardiograph/ or ultrasound scanner/
20	doppler echo/ or doppler probe/
21	duplex doppler ultrasonography/ or pulsed doppler ultrasonography/
22	(ultraso* or scan* or ultra-sound* or ultra-sonogr* or ultra-sonic* or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler).mp.
23	17 or 18 or 19 or 20 or 21 or 22
24	portable equipment/
25	(point-of-care or point-of-patient-care or point-of-service or point-of-need).mp.
26	(bedside or pocket-sized or handheld or hand-held or wireless or wire-less or compact or mobile or portable or POCUS).mp.
27	24 or 25 or 26
28	10 and 23 and 27
29	fetus echography/ or nuchal translucency measurement/
30	fetal ultrasound monitor/ or fetal doppler/ or obstetric ultrasound transducer/
31	((fetal or foetal or fetus* or foetus* or prenatal or obstetric) adj3 (ultraso* or scan* or ultra-sound* or ultra-sonogr* or ultra-sonic* or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler)).mp.
32	29 or 30 or 31
33	27 and 32
34	16 or 28 or 33
35	pregnancy/ or adolescent pregnancy/ or first trimester pregnancy/ or mother fetus relationship/ or multiple pregnancy/ or second trimester pregnancy/ or third trimester pregnancy/ or unplanned pregnancy/ or unwanted pregnancy/ or multiple pregnancy/ or quadruplet pregnancy/ or quintuplet pregnancy/ or superfetation/ or triplet pregnancy/ or twin pregnancy/
36	prenatal care/ or prenatal diagnosis/ or prenatal screening/ or noninvasive prenatal testing/
37	(pregnan* or superfetation or trimester* or first trimester* or first-trimester* or second trimester* or second-trimester* or third trimester* or third-trimester* or mid-trimester* or

	expectant mother* or expectant female* or prenatal or pre-natal or antenatal or ante-natal).mp.
38	35 or 36 or 37
39	15 and 38
40	23 and 27 and 38
41	39 or 40
42	34 or 41
43	(exp animal/ or nonhuman/) not exp human/
44	42 not 43
45	limit 44 to yr="2000 -Current"

SUPPLEMENTARY TABLE S3. Search strategy for CINAHL database via EBSCO, conducted on 29 July 2021

#	Query
1	(MH "Fetus") OR (MH "Fetal Heart") OR (MH "Placenta") OR (MH "Embryo") OR (MH "Fetal Membranes") OR (MH "Umbilical Cord") OR (MH "Umbilical Arteries") OR (MH "Umbilical Veins") OR (MH "Fetal Abnormalities") OR (MH "Fetal Diseases") OR (MH "Fetal Growth Retardation") OR (MH "Fetal Macrosomia") OR (MH "Fetal Distress") OR (MH "Fetus") OR (MH "Fetal Weight") OR (MH "Fetal Development") OR (MH "Fetal Movement") OR (MH "Fetal Well-Being") OR (MH "Fetal Monitoring") OR (MH "Fetal Biophysical Profile") OR (MH "Fetal Monitoring, Electronic") OR (MH "Cardiotocography")
2	((fetal or foetal or fetus* or foetus*) N3 (grow* or anomal* or abnormal* or malform* or disorder* or disease* or distress or biomet* or develop* or weight* or bodyweight* or macrosomia or size* or sizing or anatom* or aneuploid* or “body proportion*” or proportion* or wellbeing or well-being or matur* or “organ matur*” or status* or movement* or assess* or nutrition* or malnutrition*))
3	((AGA or SGA or LGA or FGR or IUGR or small or large) N3 (fetus* or foetus*))
4	((fetal or foetal or fetus* or foetus*) N3 (percentile* or centile* or “z-score*” or “growth centile*” or “crown-rump” or “limb-volume”))
5	(“gestation* age*” or “gestation* time*” or "week* gestation*" or "week* of gestation*")
6	(trimester N1 (growth* or development*))
7	((intrauterine or “intra-uterine”) N1 (growth or development))
8	1 or 2 or 3 or 4 or 5 or 6 or 7
9	(MH "Point-of-Care Testing")
10	((“point-of-care” or “point-of-patient-care” or “point-of-service” or “point-of-need”) N3 (US or ultraso* or scan* or “ultra-sound*” or “ultra-sonogr*” or “ultra-sonic*” or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler*))
11	((bedside or pocket or “pocket-size*” or handheld or “hand-held” or wireless or “wire-less” or compact or mobile or portable or POC) N3 (US or ultraso* or scan* or “ultra-sound*” or “ultra-sonogr*” or “ultra-sonic*” or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler*))
12	(pocus)
13	9 or 10 or 11 or 12

14	8 and 13
15	(MH "Ultrasonography")
16	(MH "Ultrasound Technologists")
17	(MH "Ultrasonography, Doppler") OR (MH "Echocardiography, Doppler") OR (MH "Echocardiography, Doppler, Color") OR (MH "Echocardiography, Doppler, Pulsed") OR (MH "Ultrasonography, Doppler, Duplex") OR (MH "Ultrasonography, Doppler, Color") OR (MH "Ultrasonography, Doppler, Pulsed")
18	(ultraso* or scan* or "ultra-sound*" or "ultra-sonogr*" or "ultra-sonic*" or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler)
19	15 or 16 or 17 or 18
20	(MH "Portable Equipment")
21	("point-of-care" or "point-of-patient-care" or "point-of-service" or "point-of-need")
22	(bedside or "pocket-sized" or handheld or "hand-held" or wireless or "wire-less" or compact or mobile or portable or POCUS)
23	20 or 21 or 22
24	8 and 19 and 23
25	(MH "Ultrasonography, Prenatal") OR (MH "Nuchal Translucency Measurement")
26	((fetal or foetal or fetus* or foetus* or prenatal or obstetric) N3 (ultraso* or scan* or "ultra-sound*" or "ultra-sonogr*" or "ultra-sonic*" or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler))
27	25 or 26
28	23 and 27
29	14 or 24 or 28
30	(MH "Pregnancy") OR (MH "Pregnancy, High Risk") OR (MH "Pregnancy, Prolonged") OR (MH "Pregnancy, Multiple") OR (MH "Pregnancy, Quadruplet") OR (MH "Pregnancy, Quintuplet") OR (MH "Pregnancy, Triplet") OR (MH "Pregnancy, Twin") OR (MH "Superfetation") OR (MH "Pregnancy Trimesters") OR (MH "Pregnancy Trimester, First") OR (MH "Pregnancy Trimester, Second") OR (MH "Pregnancy Trimester, Third") OR (MH "Pregnancy, Unplanned") OR (MH "Pregnancy, Unwanted") OR (MH "Maternal-Fetal Exchange")
31	(MH "Obstetric Care") OR (MH "Prenatal Care") OR (MH "Prepregnancy Care") OR (MH "Noninvasive Prenatal Testing")

32	(pregnan* or superfetation or trimester* or “first trimester*” or “first-trimester*” or “second trimester*” or “second-trimester*” or “third trimester*” or “third-trimester*” or “mid-trimester*” or “expectant mother*” or “expectant female*” or prenatal or “pre-natal” or antenatal or “ante-natal”)
33	30 or 31 or 32 Pregnancy terms
34	13 and 33
35	19 and 23 and 33
36	34 or 35
37	29 or 36
38	S29 or S36 - Limiters - Publication Year: 2000-2021
39	S29 OR S36 - Limiters - Publication Year: 2000-2021; Human

SUPPLEMENTARY TABLE S4. Search strategy for Maternity and Infant Care database, conducted on 29 July 2021

#	Query
1	((fetal or foetal or fetus* or foetus*) adj3 (grow* or anomal* or abnormal* or malform* or disorder* or disease* or distress or biomet* or develop* or weight* or bodyweight* or macrosomia or size* or sizing or anatom* or aneuploid* or body proportion* or proportion* or wellbeing or well-being or matur* or organ matur*or status* or movement* or assess* or nutrition* or malnutrition*)).mp.
2	((AGA or SGA or LGA or FGR or IUGR or small or large) adj3 (fetus* or foetus*)).mp.
3	((fetal or foetal or fetus* or foetus*) adj3 (percentile* or centile* or z-score* or growth centile* or crown-rump or limb-volume)).mp.
4	(gestation* age* or gestation* time* or "week* gestation*" or "week* of gestation*").mp.
5	(trimester adj (growth* or development*)).mp.
6	((intrauterine or intra-uterine) adj (growth or development)).mp.
7	or/1-6
8	((point-of-care or point-of-patient-care or point-of-service or point-of-need) adj3 (US or ultraso* or scan* or ultra-sound* or ultra-sonogr* or ultra-sonic* or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler*)).mp.
9	((bedside or pocket or pocket-size* or handheld or hand-held or wireless or wire-less or compact or mobile or portable or POC) adj3 (US or ultraso* or scan* or ultra-sound* or ultra-sonogr* or ultra-sonic* or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler*)).mp.
10	pocus.mp.
11	or/8-10
12	7 and 11
13	(ultraso* or scan* or ultra-sound* or ultra-sonogr* or ultra-sonic* or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler).mp.
14	(point-of-care or point-of-patient-care or point-of-service or point-of-need).mp.
15	(bedside or pocket-sized or handheld or hand-held or wireless or wire-less or compact or mobile or portable or POCUS).mp.
16	or/14-15
17	7 and 13 and 16

18	((fetal or foetal or fetus* or foetus* or prenatal or obstetric) adj3 (ultraso* or scan* or ultra-sound* or ultra-sonogr* or ultra-sonic* or echogram* or echoscope* or echosound* or echograph* or sonogram* or sonograph* or doppler)).mp.
19	16 and 18
20	12 or 17 or 19
21	(pregnan* or superfetation or trimester* or first trimester* or first-trimester* or second trimester* or second-trimester* or third trimester* or third-trimester* or mid-trimester* or expectant mother* or expectant female* or prenatal or pre-natal or antenatal or ante-natal).mp.
22	11 and 21
23	13 and 16 and 21
24	22 or 23
25	20 or 24
26	limit 25 to yr="2000 -Current"

SUPPLEMENTARY TABLE S5. Search terms used to identify portable ultrasound devices via Google searches

Portable device specific	**Ultrasound manufacturers and distributors**
Portable ultrasound device Handheld ultrasound device Compact ultrasound device Wireless ultrasound device	Ultrasound manufacturers Ultrasound distributors Ultrasound companies Ultrasound developers Medical supplies manufacturers Medical supplies distributors Medical supplies companies Medical device companies Medical device developers

SUPPLEMENTARY TABLE S6. List of manufacturers' websites searched for portable devices

Manufacturer
Butterfly
General Electric
Healcerion
Konted
Lequio
Mindray
Phillips
Primedic
Samsung
Siemens
Signostics
SONON
Sonoscanner
SonoScape
SonoSite
Sony
Toshiba
Whale imaging

SUPPLEMENTARY TABLE S7. Codes for each parameter extracted from eligible studies

Type of study	**Population**	**Setting**
Systematic review Randomised controlled trial Cohort study - Prospective or retrospective Cross-sectional study Case-control study Other primary research design	Pregnant women - Ectopic pregnancy Pregnant women - Vaginal bleed Pregnant women – Trauma Pregnant women - Caesarean section Pregnant women - High risk (multiple) Pregnant women - Pre-eclampsia Pregnant women – Malaria Pregnant women – multiple Pregnant women – Schistosomiasis Pregnant women – all Staff members – physicians Staff members - nurses/midwives Staff members - medical students Staff members – combination	Inpatient facility Outpatient facility Both inpatient and outpatient facility Community Home-based Population-based Both outpatient and community Multiple Other Unspecified Telemedicine
Intervention	**Stage of pregnancy**	**Classification of study objective**
Abdominal ultrasound Transvaginal ultrasound Abdominal and Transvaginal ultrasound	Antenatal – unspecified Antenatal - first trimester Antenatal - second trimester Antenatal - third trimester	Fetal characteristics / gestational dating Routine scans or observation Pregnancy confirmation

Transperineal ultrasound Training curriculum Automated systems Ultrasound modification Ultrasound protocol Tele-ultrasound Health systems strengthening	Antenatal - second and third trimester Intrapartum Postpartum All periods Multiple periods Unspecified Antenatal and Intrapartum Antenatal and Postpartum Intrapartum and Postpartum	Ectopic pregnancy Genetic screening Emergency / Trauma Placental abnormalities Labour progress Training program

[1] Other primary research designs included pilot studies, diagnostic accuracy studies, or field investigation/implementation studies

SUPPLEMENTARY TABLE S8. Results of online searches of ultrasound manufacturers

Manufacture	Model	Design	Country man	Facilitiy requ	Battery life	No. of probes
Butterfly	Butterfly iQ+	Handheld de	Not disclosed	Mobile devic	>= 2 hours co	1
Chison	Eco 3 expert	Laptop style	China	Electricity plu	2.5 hours con	7
Chison	Q5	Laptop style	Not disclosed	Electricty plu	Not disclosed	7
Chison	EBit30	Laptop style	China	Electricity plu	Not disclosed	10
Chison	Eco 5	Laptop style	China	Electricity plu	2.5 hours con	7
Chison	Eco 2	Laptop style	China	Electricity plu	2.5 hours con	7
Chison	SonoBook 9	Laptop style	China	Electricity plu	2 hours conti	27
Chison	SonoBook 6	Laptop style	China	Electricity plu	2 hours conti	10
Chison	SonoBook 8	Laptop style	China	Electricity plu	2 hours conti	13
Chison	SonoTouch 3	Tablet device	China	Electricity plu	Not disclosed	9
Chison	EBit50	Laptop style	China	Electricity plu	3 hours conti	10
Chison	EBit60	Laptop style	China	Electricity plu	2 hours conti	10
Chison	Eco 6	Laptop style	China	Electricity plu	1 hour "full c	8
Chison	SonoEye P5	Handheld de	China	Mobile devic	2.5 hours "di	1
Chison	Eco 1	Laptop style	China	Electricity plu	Not disclosed	6
Clarius	C3 HD	Handheld de	Not disclosed	Compatible r	60 minutes t	1
DRAMINSKI	BLUE	Tablet device	Poland	Electrciity plu	2.5 hours con	4
Edan	Acclarix AX4	Laptop style	China	Electricity plu	1 hour 15 mi	8
Edan	Acclarix AX8	Laptop style	China	Electrciity plu	1 hours conti	15
Edan	U60	Laptop style	China	Electricity plu	80 minutes c	11
Edan	U50 Prime	Laptop style	China	Electricity plu	1.5 hours con	11
Edan	DUS 60	Laptop style	China	Electricity plu	2 hours conti	6
GE Healthcar	Versana acti	Laptop style	Not disclosed	Electrciity plu	Not disclosed	11
GE Healthcar	Nextgen Logi	Laptop style	Not disclosed	Electricity plu	60 minutes t	14
GE Healthcar	Vscan Extend	Handheld de	Not disclosed	Electricity plu	60 minutes t	1
GE Healthcar	Vscan Air	Handheld de	Not disclosed	Mobile devic	50 minutes t	1
GE Healthcar	Vscan Extend	Handheld de	Not disclosed	Electricity plu	60 minutes t	1
Healcerion	Sonon 300C	Handheld device with wire		Electricity plu	3 hours conti	1
Interson	SiMPLi GP	USB probe w	Not disclosed	Laptop/comp	Dependent o	1
Konted	C6	Laptop style	China	Electricty plu	Not disclosed	4
Konted	Gen3 C10	Wireless ultr	China	Compatible r	3 hours conti	3
Konted	Gen4Pro	Wireless ultr	China	Compatible r	3.5 hours con	4
Konted	C9	Laptop style	China	Electricity plu	Not disclosed	6
Konted	C10 T	Wireless ultr	China	Compatible r	3 hours conti	3
Lequio	US 304A	Handheld de	Japan	Compatible c	NA	1
Lequio	fST9500	Handheld de	Japan	Compatible c	NA	1
Lequio	US 304	Handheld de	Japan	Compatible c	NA	1
Mindray	M7 premium	Laptop style	China	Electricity plu	Not disclosed	9
Mindray	TE7	Tablet device	China	Electricity plu	Not disclosed	11
Mindray	M9	Laptop style	China	Electricity plu	90 minutes t	10
Mindray	ME8	Laptop style	China	Electricity plu	Up to 8 hours	10
Mindray	TE5	Tablet device	China	Electricity plu	2 hours conti	14
Mindray	M6	Laptop style	China	Electricity plu	Not disclosed	18
Mindray	DP-10	Laptop style	China	Electrciity plu	Not disclosed	6
Philips healtl	InnoSight	Handheld de	Taiwan	Electricty plu	90 minutes t	5
Phillips healt	CX50	Laptop style	Taiwan	Electricity plu	40 minutes c	16

Phillips healt	Lumify	Handheld de	Taiwan	User-provide	N/A	3
Primedic	Handyscan	Portable bloc	Not disclose	Electricity plu	5 hours perm	2
Promed grou	M6	Laptop style	China	Electrciity plu	Not disclosed	
Promed grou	M8	Laptop style	China	Electricity plu	Not disclosed	
Promed grou	M7 Plus	Laptop style	China	Electrciity plu	2 hours standby time	
Promed grou	M7	Laptop style	China	Electricity plu	Not disclosed	
Ricso	Aurora A3	Laptop style	China	Electricity plu	2 hours	6
Ricso	Aurora A7	Laptop style	China	Electrciity plu	3 hours conti	6
Ricso	Aurora A1	Laptop style	China	Electricity plu	Not disclosed	
Ricso	BX-220	Laptop style	China	Electricity plu	Not disclosed	
Ricso	BX-330	Laptop style	China	Electricity plu	Not disclose	6
Ricso	Aurora A5	Laptop style	China	Electricity plu	Not disclose	6
Ricso	BX-550	Laptop style	China	Electricity plu	2 hours	6
Ricso	Ultramate U	Laptop style	China	Electrciity plu	2 hours conti	6
Samsung	HM70 EVO	Laptop style	Not disclose	Electricity plu	7.5 hours (wi	10
Samsung	HM70A	Laptop style	Not disclose	Electricity plu	3 hours conti	17
SIFSOF	SIFULTRAS 4	Tablet device	Not disclose	Electricity plu	Not disclosed	
SIFSOF	SIFULTRAS 4	Tablet device	Not disclose	Electricity plu	Not disclosed	
SIFSOF	SIFULTRAS 6	Laptop style	Not disclose	Electricity plu	2 hours	16
SIFSOF	SIFULTRAS 6	Laptop style	Not disclose	Electricity plu	Not disclose	5
SIFSOF	SIFULTRAS 6	Laptop style	Not disclose	Electricity plu	Not disclose	8
SIFSOF	SIFULTRAS 8	Laptop style	Not disclose	Electricity plu	8 hours	7
SIFSOF	SIFULTRAS 8	Laptop style	Not disclose	Electricity plu	8 hours	5
SIFSOF	SIFULTRAS 6	Laptop style	Not disclose	Electricity plu	Not disclose	5
SIFSOF	SIFULTRAS7.	Tablet style	Not disclose	Electricity plug for chargin		4
SIFSOF	SIFULTRAS 3	Handheld de	Not disclose	Mobile devic	Dependent o	3 (in 1)
Sonictec	Pocket Ultra	Wireless har	Not disclose	Mobile devic	3 hours conti	5
Sonoque	C5PL	Handheld de	Not disclose	Compatible r	3 hours conti	2
Sonoque	C6C	Handheld de	Not disclose	Compatible r	3 hours	1
Sonoque	C4PL	Handheld de	Not disclose	Compatible r	3 hours conti	2
Sonoque	C5C	Handheld de	Not disclose	Compatible r	3 hours	1
Sonoque	C5	Handheld de	Not disclose	Compatible r	3 hours	1
Sonoque	C3	Handheld de	Not disclose	Compatible r	3 hours conti	1
SonoScanner	Orcheo Lite T	Laptop style	Not disclose	Electricity plu	1hr 30 minut	9
SonoScanner	Ondina	Laptop style	Not disclose	Electricity plu	1hr 30 minut	8
SonoScanner	T-Lite	Tablet style	Not disclose	Electricity plu	3 hours conti	11
SonoScanner	Orcheo Lite	Laptop style	Not disclose	Electricity plu	1hr 30 minut	8
SonoScanner	U-Lite	Tablet style	Not disclose	Electricity plu	Not disclose	Not disclose
Sonoscape	X3	Laptop style	China	Electricity plu	90 minutes c	11
Sonoscape	E3	Laptop style	China	Electricity plu	90 minutes c	11
Sonoscape	E2	Laptop style	China	Electricity plu	90 minutes c	11
Sonoscape	S2	Laptop style	China	Electricity plu	60 minutes c	13
Sonoscape	S6	Laptop style	China	Electricity plu	90 minutes c	14
Sonoscape	S9	Laptop style	China	Electricity plu	90 minutes c	30
Sonoscape	S8 Exp	Laptop style	China	Electricity plu	90 minutes c	22
Sonoscape	X5	Laptop style	China	Electricity plu	90 minutes c	11
Sonoscape	E2 Pro	Laptop style	China	Electricity plu	90 minutes c	11
Sonoscape	E1 Exp	Laptop style	China	Electricity plu	90 minutes c	13

Sonosite	Edge II	Laptop style	Not disclosed	Electricity plu	2 hours	13
Sonosite	M-Turbo	Laptop style	Not disclosed	Electrciity plu	2 hours	11
Terason	uSmart 3200	Tablet device	Not disclosed	Electrciity plu	Not disclosed	16
Terason	uSmart 3300	Laptop style	Not disclosed	Electricty plu	Not disclsoed	15
Vave	Vave US	Handheld dev	Not disclosed	Compatible r	1 hours conti	1
Vinno	A6	Laptop style	China	Electricity plu	90 minutes	Not disclosed
Vinno	Q	Handheld dev	China	Compatible l	Not disclosed	3
Vinno	8	Laptop style	China	Electricity plu	Not disclosed	Not disclosed
Vinno	5	Laptop style	China	Electricity plu	Not disclosed	Not disclosed
Vinno	6	Laptop style	China	Electricity plu	1 hour contir	ND
Vinno	A5	Laptop style	China	Electricity plu	Not disclosed	5
Whale Imagi	Sigma P5	Laptop style	Not disclosed	Electricity plu	3 hours conti	5

Transducer o	Imaging moc	Fetal param	Weight (g)	Dimensions	Device/Scre	Price (USD)
Curved; phas	M-mode, B-r	"OB measuri	309	163 x 56 x 35	Lightening ca	$1,999
1x convex; 2x	B-mode; B/B	Dedicated ob	Not disclosed	Not disclosed	Rotatable LE	Not disclosed
1x convex; 1x	B-mode; 2B-	Ob/Gyn mea	Not disclosed	304 x 406 x 1	15 inch high-	Not disclosed
1x convex; 3x	3D/4D, color	Not reported	7500	Not disclosed	15-inch LED s	Not disclosed
1x convex; 2x	B-mode; B/B	Ob/Gyn appl	6500	335 x 155 x 3	12-inch LED s	Not disclosed
1x convex; 2x	B-mode; B/B	Dedicated ob	6000	Not disclosed	12-inch LED s	Not disclosed
7x linear; 1x	M-Mode, Ana	"Auto-NT me	5500	355 x 355 x 7	15-inch HD L	$28,900
1x convex; 2x	Color doppler	Not reported	5400	Not disclosed	15”LED HD sc	$17,900
1.5 MHz-23 M	Not disclosed	Obstetric ap	5400	Not disclosed	15-inch LED I	$14,600
Details uncle	M-Mode; Col	Ob/gyn appli	4500	254 x 51 x 30	10.4-inch tou	$12,400
1x convex; 2x	B-mode; 2Br	Ob/Gyn appl	7500	Not disclosed	15-inch LED s	$11,100
1x convex; 2x	2D; 3D/4D	Ob/Gyn appl	7500	Not disclosed	15-inch LED s	$10,400
1x convex; 2x	B-mode; 2B-	fetal biomet	5900	330 x 330 x 1	12 inch LED c	$6,400
1x convex	B-mode; M-r	Not disclosed	Not disclosed	60 x 172 x 74	User's device	$5,265
1x convex; 2x	B-mode; B/B	Ob/gyn appli	6350	Not disclosed	12-inch LED r	$3,500
Convex probe	B-mode; colo	Obstetric cal	392	164 x 78 x 38	Dependent o	$4,900
1x convex; 1x	B Mode; B+B	Not disclosed	4000	310 x 280 x 6	12-inch LED I	Not disclosed
2x linear; 1x	B-mode; M-r	Ob/gyn appli	8250	770 x 388 x 4	15.6’’ high re	$27,000
4x convex; 4x	B-mode; colo	fetal biomet	9250	388 x 407 x 7	15.6 inch TFT	$23,550
2x curved; 1x	B-mode B; M	Obstetric pre	8500	350 x 370 x 2	15 inch TFT-I	$9,376
Wide range -	B-mode; M-r	Ob/Gyn mea	7800	331 x 220 x 3	12.1’’ high re	$9,195
1x convex; 1x	B, 2B, 4B, B+	Ob/gyn appli	7100	330 x 220 x 3	12.1" TFT-LC	$5,999
3x phased; 3x	Not disclosed	"Automate a	5000	Not disclosed	15.3 inch hig	Not disclosed
2x convex; 1x	B-mode; M-r	Ob calcs and	5200	70 x 340 x 34	15-inch LCD c	$18,100
Phased; linea	B-mode; M-r	Not disclosed	**DU: 321P: 12**	**DU: 168 x 76**	Comes with c	$4,995
Curved; Linea	B-mode; colo	Not dsiclosed	205	131 x 64 x 31	Bluetooth co	$4,495
Phased	B-mode; M-r	Not disclosed	**DU: 321P: 85**	**DU: 168 x 76**	Comes with c	$2,995
3.5MHz	B-mode	Obstetric pre	390	78 x 38 x 229	Dependent o	$5,300
Curved array	B-W mode	Customised p	110	150 x 62	Dependent o	Not disclosed
1x convex; 1x	B&W mode:	Ob/gyn appli	4500	360 x 360 x 9	15 inch LCD c	Not disclosed
1x linear; 1x	Not disclosed	Ob/gyn appli	308	156 x 60 x 24	Dependent o	Not disclosed
1x convex; 1x	B, B/M, colo	Ob/gyn appli	270	156 × 60 × 20	Dependant o	$1,000 - $1,900
1x convex; 1x	B, B/B, B/M,	Ob/gyn appli	Not disclosed	400 x 394 x 1	15 inch LCD c	$5,000
1x linear; 1x	B, B/M, colo	Ob/gyn appli	227	157 x 70 x 30	Dependent o	$1,699
2.8/3.3/4.0 M	B mode; B|B	Ob-Gy preste	265	143 x 79 x 30	Dependent o	Not disclosed
2.8/3.3/4.0 MHz convex		Ob-Gy preste	265	144 x 79 x 30	Dependent o	Not disclosed
3.5MHz conv	B mode; B|B	Ob-Gy preste	170	140 x 85	Dependent o	Not disclosed
Details uncle	Pulse Wave I	Ob/gyn meas	Not disclosed	Not disclosed	15” high reso	Not disclosed
3x convex (in	B-mode; M-r	Obstetrics pa	8200	97 x 295 x 38	15 inch high-	Not disclosed
3x convex (in	B-mode; M-r	Obstetrics pa	6500	362 x 390 x 5	15.6 inch LED	Not disclosed
1x convex; 2x	B-mode; M-r	Obstetrics pa	3000	322 x 364 x 4	15.6 inch LED	Not disclosed
Details uncle	Not disclosed	Ob/gyn meas	Not disclosed	Not disclosed	15 inch touch	$27,000
6x curved; 2x	B/M/PW & H	Ob/gyn meas	5,500	361 x 357 x 7	15” LCD Mon	$18,000
1x convex; 2x	B-mode; B/B	"Measureme	5500	161 x 290 x 3	12.1 inch LED	$1,700
2x curved; lir	2D; M-mode,	Fetal biomet	**DU: 2460**	**DU: 320 x 22**	Comes with c	$16,948
Unclear of ty	2D; M-mode,	OB/GYN clin	6,170	413 x 394 x 3	15-inch LCD c	$20,000

curved; linea	2D; Color do	4-measurem	136	114 x 45	Compatible	$5,380
3.5/5.0 MHz dual frequen		Not disclsoe	2000	115 x 190 x 1	5 inch TFT L	Not disclosed
unsure of ho	B, B|B, 4B, E	Obstetric pa	Not disclose	Not disclose	15-inch LED	Not disclosed
Unsure of all	B/W, color d	Obstetrics ar	Not disclose	Not disclose	15 inch LCD	Not disclosed
Not disclose	B, B|B,4B, B	Obstetric pa	6500	330 x 150 x 3	12.1 inch LED	Not disclosed
unsure of ho	B, B|B, 4B, E	Obstetric pa	6500	Not disclose	15-inch LED	Not disclosed
1x convex; 2	B/W	Ob/gyn appli	Not disclose	Not disclose	12-inch LED	Not disclosed
1x convex; 1	B-mode; C-m	Not disclose	Not disclose	Not disclose	15-inch LED	Not disclosed
Not disclose	B/W	Not disclose	Not disclose	Not disclose	12-inch LED	Not disclosed
Not disclose	B/W	Not disclose	Not disclose	Not disclose	10-inch CRT	Not disclosed
1x convex; 2	B/W	Not disclose	6000	Not disclose	12-inch LCD	Not disclosed
1x convex; 2	color dopple	Ob/gyn appli	5500	138 thick	12-inch LED	Not disclosed
1x convex; 2	B/W	Ob/gyn appli	3500	Not disclose	10.4-inch TF	Not disclosed
1x convex; 2	Not disclose	Obstetric pa	2500	Not disclose	12-inch LED	Not disclosed
3x curved; 2x	Not disclose	Ob/gyn appli	Not disclose	Not disclose	15 inch LCD	Not disclosed
4x curved; 5x	2D Imaging r	Obstetrics m	6100	63.8 x 388.5	15 inch LCD	Not disclosed
"Broard rang	Not disclose	Ob/gyn appli	Not disclose	Not disclose	13.3 Inch To	Not disclosed
"Broard rang	Not disclose	Ob/gyn appli	2000	Not disclose	13.3 Inch To	Not disclosed
Multiple opti	Not disclose	Ob/gyn appli	5400	Not disclose	Not disclose	$19,500
1x convex; 1	B, B|B, 4B, E	Ob/gyn appli	Not disclose	Not disclose	Not disclose	$9,877
1x convex; 2	B, B|B, 4B, E	Ob/gyn appli	Not disclose	Not disclose	15 Inch LCD	$9,877
1x convex; 1	B,B/B,M,B/M	Obstetrics pa	7000	380 x 212 x 3	15-inch LCD	$8,999
1x convex; 1	2D,B/M,PDI,I	Ob/gyn appli	6000	370 × 382 ×	15 inch LCD	$8,889
1x convex; 1	B, B|B, 4B, E	Ob/gyn appli	Not disclose	Not disclose	15 Inch LED	$7,455
1x convex; 1	B, BB, M, CD	Ob/gyn appli	Not disclose	Not disclose	12 inch color	$6,589
1x convex; 1	Not disclose	Not disclose	90	125	Dependent o	$2,895
1x convex; 1	Not disclose	Not disclose	280	Not disclose	Dependent o	Not disclosed
1x convex/ca	B, B/M, Colo	OB Measure	240	157 x 66 x 22	Dependent o	$4,400
1x convex	B, B/M, Colo	OB Measure	240	157 x 66 x 22	Dependent o	$3,500
1x convex/ca	B, B/M, COL	OB Measure	240	155 x 70 x 20	Dependent o	$3,200
1x convex	B, B/M, Colo	OB Measure	240	155 x 70 x 20	Dependent o	$2,490
1x convex	B, B/M	OB Measure	240	154 x 70 x 19	Dependent o	$2,190
1x convex	B-mode; B/M	OB Measure	240	155 x 70 x 20	Dependent o	$1,190
2x convex; 2	B-mode; M-r	Ob/Gyn appl	Not disclose	Not disclose	Not disclose	Not disclosed
2x convex; 2	B-mode; M-r	Ob/Gyn appl	4600	370 x 290 x 7	15-inch full H	Not disclosed
Range from	Pulsed Wave	Obstetric ap	1000	253 x 174 x 1	10-inch HD t	Not disclosed
2x convex; 2	B-mode; M-r	Ob/Gyn appl	5500	420 x 370 x 8	15-inch HD L	$30,000
Not disclose	Color dopple	Ob/Gyn appl	Not disclose	Not disclose	7-inch HD to	$7,845
1x Linear, 1x	B-Mode (2D	Ob/Gyn mea	Not disclose	Not disclose	15.6" HD LCD	Not disclosed
1x Linear, 1x	B-Mode (2D	Ob/Gyn mea	Not disclose	Not disclose	15.6" HD LCD	Not disclosed
1x Linear, 1x	B-Mode (2D	Ob/Gyn mea	Not disclose	Not disclose	15.6" HD LCD	Not disclosed
Wide range -	B-Mode (2D	Ob/Gyn mea	13,000	230 x 350 x 1	15" HD LED	Not disclosed
Wide range -	B-Mode (2D	Ob/Gyn mea	7,900	230 x 350 x 1	15" HD LED	Not disclosed
Wide range -	B-Mode (2D	Ob/Gyn mea	7,800	357 x 392 x 1	15" HD LED	Not disclosed
Wide range -	B-Mode (2D	Ob/Gyn mea	7,800	357 x 392 x 1	15" HD LED	Not disclosed
1x linear; 2x	B/ 2B/ 4B/ N	Ob/Gyn mea	4500	378 x 61 x 34	15.6 inch Wi	$9,000 - $15,000
1x Linear, 1x	B/ 2B/ 4B/ N	Ob/Gyn mea	Not disclose	Not disclose	15.6” High R	$8,995
10 listed as '	B-mode; 2B-	Ob/Gyn mea	6500	378 x 352 x 1	15.6 inch LCD	$7,363

Types not dir	2D; M-mode	Yes, includin	4600	330 x 315 x 6	12.1 inch dis		$29,000
Types not dir	2D; M-mode	Yes, includin	3900	299 x 274 x 7	10.4 inch dis		$10,100
5x linear; 3x	2D (B-Mode)	Obstetric me	2230	230 x 327 x 3	11.6 inch LCD		$22,000
5x linear; 2x	2D (B-Mode)	Obstetric me	6700	89 x 396 x 38	15" Backlit P		$18,751
Not disclose	B-mode; colo	Ob/Gyn mea	340	169 x 54 x 38	Dependent o	Not disclosed	
Not disclose	Not disclose	Obstetrics m	Not disclose	Not disclose	15.6 inch LED	Not disclosed	
1x convex; 1x	Not disclose	Obstetric ap	Not disclose	Not disclose	Dependent o	Not disclosed	
Not disclose	Not disclose	Ob/gyn appli	Not disclose	Not disclose	Not disclose	Not disclosed	
"up to 23MH	Not disclose	Ob/gyn appli	3,500	Not disclose	Not disclose	Not disclosed	
Not obviousl	B-mode; M-r	Obstetric me	3800	340 x 387 x 7	15.6 inch hig		$20,169
Unclear of al	Not disclose	Obstetric ap	Not disclose	Not disclose	Not disclose		$14,900
1x linear; 1x	2D (B) Mode	Ob/Gyn appl	6350	390 x 320 x 7	15-inch HD S	Not disclosed	

Software rec	Warranty	Storage on d	Real-time gr	Transabdomi	Transvaginal	Adjustable a
Apple iOS 13	1 year manu	Unlimited cl	TRUE	TRUE	FALSE	FALSE
In-built softw	Not disclose	8GB memory	TRUE	TRUE	TRUE	TRUE
"Built in soft	Not disclose	Built in mem	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	8GB memory	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	8GB memory	TRUE	TRUE	TRUE	TRUE
In-built softw	3 year warra	128G HDD - '	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	up to 10,000	TRUE	TRUE	TRUE	TRUE
In-built softw	Up to 2 year	16GB HDD	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	320GB SSD	TRUE	TRUE	TRUE	TRUE
In-built softw	90-day warra	320gb storag	TRUE	TRUE	TRUE	TRUE
Appears to o	2 year warra	User's device	TRUE	TRUE	FALSE	TRUE
In-built softw	Not disclose	Built in mem	TRUE	TRUE	TRUE	TRUE
iOS: iOS 11 c	3 year warra	Dependent o	TRUE	TRUE	TRUE	TRUE
In-built softw	2-year manu	60GB interna	TRUE	TRUE	TRUE	FALSE
In-built softw	Not disclose	16GB memo	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	120GB SSD s	TRUE	TRUE	TRUE	TRUE
System com	2 year warra	500gb intern	TRUE	TRUE	TRUE	TRUE
In-built softw	3-year warra	504MB built-	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	504MB built-	TRUE	TRUE	TRUE	TRUE
In-built softw	5 year manu	256GB SSD	TRUE	TRUE	FALSE	TRUE
Windows®1C	5 year manu	128GB SSD	TRUE	TRUE	TRUE	TRUE
Product com	3 year manu	Data stored i	TRUE	TRUE	FALSE	TRUE
Android phor	3 year manu	Up to 500 ex	TRUE	TRUE	FALSE	TRUE
Product com	3 year manu	Data stored i	TRUE	FALSE	FALSE	TRUE
Device is con	Not disclose	Dependent o	TRUE	TRUE	FALSE	TRUE
OS: Window	Not disclose	Dependent o	TRUE	TRUE	FALSE	TRUE
In-built softw	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
Android; iOS	Not disclose	Dependent o	TRUE	TRUE	FALSE	TRUE
iOS app avai	Not disclose	Dependent o	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	500GB HDD	TRUE	TRUE	TRUE	TRUE
Android; iOS	Not disclose	Dependent o	TRUE	TRUE	FALSE	TRUE
Compatible v	Not disclose	Dependent o	TRUE	TRUE	FALSE	TRUE
Compatible v	Not disclose	Dependent o	TRUE	TRUE	FALSE	TRUE
Compatible v	Not disclose	Dependent o	TRUE	TRUE	FALSE	TRUE
Product com	Not disclose	320GB hard	TRUE	TRUE	FALSE	TRUE
Product com	5-year warra	System hard	TRUE	TRUE	TRUE	TRUE
Product com	5-year warra	System hard	TRUE	TRUE	TRUE	TRUE
Product com	5-year warra	System hard	TRUE	TRUE	TRUE	TRUE
Product com	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
Product com	5-year warra	1 TB HDD	TRUE	TRUE	TRUE	TRUE
Product com	Not disclose	system hard	TRUE	TRUE	TRUE	FALSE
Product com	Up to 5 years	128G of inter	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Internal stora	TRUE	TRUE	TRUE	TRUE

Android 5.0 (	3 year manu	Internal stor	TRUE	TRUE	FALSE	TRUE
In-built softw	Not disclose	Minimum 20	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Internal hard	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Storage not	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	64GB SSD; C	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Internal hard	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Built-in 60GI	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Built storage	TRUE	FALSE	FALSE	TRUE
System com	Not disclose	Not disclose	TRUE	FALSE	FALSE	TRUE
System com	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	32GB SSD	TRUE	TRUE	TRUE	TRUE
Not disclose	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
"Samsung M	1 year manu	Maximum 2,	TRUE	TRUE	TRUE	TRUE
Product com	12 months m	Not disclose	TRUE	TRUE	FALSE	TRUE
Product com	12 months m	Not disclose	TRUE	TRUE	FALSE	TRUE
Product com	12 months m	"Large Imag	TRUE	TRUE	TRUE	TRUE
Product com	12 months m	Not disclsoe	TRUE	TRUE	TRUE	TRUE
Product com	12 months m	"Freeze/real	TRUE	TRUE	TRUE	TRUE
Product com	12 months m	video storag	TRUE	TRUE	TRUE	TRUE
Product com	12 months m	Storage amo	TRUE	TRUE	TRUE	TRUE
Product com	12 months m	"Hardisk, US	TRUE	TRUE	TRUE	TRUE
Product com	12 months m	"Large volum	TRUE	TRUE	TRUE	TRUE
Requires wir	12 months m	Dependant o	TRUE	TRUE	FALSE	TRUE
Compatible \	2 year manu	Dependent o	TRUE	TRUE	TRUE	FALSE
iOS compatil	1 year warra	Dependent o	TRUE	TRUE	FALSE	TRUE
iOS compatil	2 year warra	Dependent o	TRUE	TRUE	FALSE	TRUE
iOS compatil	1 year warra	Dependent o	TRUE	TRUE	FALSE	TRUE
iOS compatil	3 year warra	Dependent o	TRUE	TRUE	FALSE	TRUE
iOS compatil	1 year warra	Dependent o	TRUE	TRUE	FALSE	TRUE
iOS compatil	1 year warra	Dependent o	TRUE	TRUE	FALSE	TRUE
In-built softw	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	251 GB SSD;	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	>40,000 ima	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	250 GB SSD;	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	Up to 10,000	TRUE	FALSE	FALSE	TRUE
System com	2 years distri	500GB interr	TRUE	TRUE	TRUE	TRUE
System com	2 years distri	500GB interr	TRUE	TRUE	TRUE	TRUE
System com	2 years distri	500GB interr	TRUE	TRUE	TRUE	TRUE
System com	2 years distri	320 GB inter	TRUE	TRUE	TRUE	TRUE
System com	2 years distri	500GB interr	TRUE	TRUE	TRUE	TRUE
System com	2 years distri	500GB interr	TRUE	TRUE	TRUE	TRUE
System com	2 years distri	500GB interr	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	SSD hard driv	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	500GB interr	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	500GB interr	TRUE	TRUE	TRUE	TRUE

In-built softw	5-year manu	Available, bu	TRUE	TRUE	TRUE	TRUE
In-built softw	5-year manu	Available, bu	TRUE	TRUE	TRUE	TRUE
Windows 10	Not disclsoe	480GB SSD	TRUE	TRUE	TRUE	TRUE
Windows 10	Not disclsoe	1TB SSD	TRUE	TRUE	TRUE	TRUE
Not disclose	Unlimited w	Dependent o	TRUE	TRUE	FALSE	TRUE
Product com	Not disclose	Not disclose	TRUE	FALSE	FALSE	TRUE
Compatible r	Not disclose	Dependant o	TRUE	TRUE	FALSE	TRUE
Product com	Not disclose	Not disclose	TRUE	FALSE	FALSE	TRUE
Product com	Not disclose	Not disclose	TRUE	FALSE	FALSE	TRUE
Software in-l	Not disclsoe	Available, bu	TRUE	TRUE	FALSE	TRUE
Product com	Not disclose	Not disclose	TRUE	TRUE	TRUE	TRUE
In-built softw	Not disclose	256GB SSD	TRUE	TRUE	TRUE	TRUE

Freeze-fram	Obstetric pre	Capacity to p	Regular mai
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	FALSE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	FALSE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
FALSE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE

TRUE	TRUE	TRUE	FALSE
TRUE	FALSE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	FALSE	TRUE	FALSE
TRUE	FALSE	TRUE	FALSE
TRUE	FALSE	FALSE	FALSE
TRUE	FALSE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	FALSE	FALSE	FALSE
FALSE	FALSE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	TRUE
TRUE	TRUE	TRUE	TRUE
TRUE	TRUE	TRUE	TRUE
TRUE	TRUE	TRUE	TRUE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE

TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE
TRUE	TRUE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE