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

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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 to 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 $1,190 to $30,000 USD and weight ranged from 0.9kg to 13.0kg.

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 to 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: Registered via Open Science Framework (DOI: 10.17605/OSF.IO/U8KXP)

ARTICLE SUMMARY

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, ensuring consistency and accuracy of the findings within the review.
- The findings from our formal scoping review were augmented by additional web searches of ultrasound manufacturers, providing additional insight into the commercial availability of devices, and allowing reflection on the differences between number of products available and those reflected in the peer-reviewed literature.
- We acknowledge that the nature of a scoping review design only provides insight into the breadth of information available on a given topic, and does not take in to account the integrity or accuracy of individual studies identified
- We also acknowledge that ultrasound manufacturers may conduct their own internal research that may include validation against conventional devices but does not end up published in peer-reviewed journals.

BACKGROUND

The World Health Organization (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- and 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 impacts 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 (JBI) Methodology for Scoping Reviews, and is reported as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) 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.

Research ethics approval

As a systematic review of publicly available data, ethical approval was not required.

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 included any study that assessed the use of a portable ultrasound device for any pregnancy-related indication, to ensure that no eligible devices or data were missed. Studies that related to the use of conventional ultrasound systems only (i.e., 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 (Supplemental Tables S1-S4). Identified citations were collated and de-duplicated 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 (Supplementary Table S5). We also searched individual websites of ultrasound manufacturers to identify what (if any) portable ultrasound systems were currently available (Supplementary 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 pre-tested 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 programs 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 (Supplementary 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.

All data were extracted by two reviewers independently, with disagreements resolved through discussion or consulting a third reviewer. 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 pre-sets, 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 (reproduced with permission from the World Health Organization'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 visualize anatomy with a transabdominal transducer.

RESULTS

Literature searches for the scoping review identified 2,770 citations, of which 793 duplicates were removed. Title and abstract screening of the remaining 1,977 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.

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 nine studies (16.1%), and low-income countries for eight 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 United States (10 studies, 17.9%).

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[1]	2	3.6%
Total	***56***	***100.0%***

[1] Both studies categorised under multiple were across countries classified as high income and upper middle income

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 programs for portable ultrasound 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).

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 (four studies each), and GE Voluson i (three studies). One device, the Enlace Hispano Americano de Salud (EHAS) Healthy Pregnancy Kit device, was described in two studies but does not appear to be commercially available.(18, 19)

Of the 56 studies, 47 (83.9%) primarily focused on pregnant women as participants, and nine studies (16.1%) collected data related to staff members who participated in portable ultrasound training programs. The 47 studies involved pregnant women without specific 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 (4 studies), physicians only (2 studies), nurses/midwives only (2 studies) and medical students (1 study).

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 (EHAS)	Healthy Pregnancy Kit specific (18, 19)	2	3.6%
General Electric	Logiq e (20)	1	1.8%
	Logiq I (21)	1	1.8%
	Voluson I (22-24)	3	5.4%
	VScan (25-32)	8	14.3%
Healcerion	SONON 300C (33)	1	1.8%
Konted	Gen 1 C10R (34)	1	1.8%
Lequio	US-304 (35)	1	1.8%
Mindray	DP-10 (36)	1	1.8%
	DP-20 (37, 38)	2	3.6%
Phillips	Lumify (39)	1	1.8%
	VISIQ (40)	1	1.8%
Primedic	Handyscan (41)	1	1.8%
Siemens	Accuson 10 (42)	1	1.8%
Signostics	Signos (43)	1	1.8%
SONON	300L (44)	1	1.8%
Sonoscanner	Orcheo Lite (45, 46)	2	3.6%
SonoScape	S2 (47)	1	1.8%
SonoSite	180 (48, 49)	2	3.6%
	180 Plus (50)	1	1.8%
	Edge (51)	1	1.8%
	M-Turbo (52-60)	9	16.1%
	Micromaxx (61-63)	3	5.4%
	Micromaxx OR M-Turbo (64)	1	1.8%
	S180 (65)	1	1.8%
	Titan (66-69)	4	7.1%
	Model not specified (70)	1	1.8%
Sony	Model not specified (71)	1	1.8%
Toshiba	SSA-510 A (72)	1	1.8%
Whale Imaging	Sigma P5 (73)	1	1.8%

Most studies (53 studies, 94.6%) were conducted in the antenatal period, though two were intrapartum and one was both antenatal and intrapartum. Of those 53 studies in the antenatal period, 10 were in the first trimester only, five in the second trimester only, five in the third trimester only and five 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 number, fetal lie, gestational age, placental location, small or large for gestational age, and fetal biometric measurements such as biparietal diameter and femur length. Of these 10 studies, nine 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 (Supplemental Table S8). The majority were produced in China, and prices ranged from USD$1,190 to $30,000. Devices ranged in weight from 0.9kg to 13.0kg and battery life was from 40 minutes 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.

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	Main objective of study	Portable ultrasound device used	Comparator	Key findings	Review team assessment
Dougherty, A et al (21)	2021	United States (USA)	Quality assurance and improvement protocol	113 pregnant women	Implementation of a remote quality assurance and improvement protocol in obstetric point-of-care ultrasound in low-resource areas. Results of the implemented protocol were compared to gold-standard measurements	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, S. et al (27)	2014	Belgium	Cohort study (prospective)	51 pregnant women	Implementation of a pocket-sized ultrasound machine for performing routine third trimester antenatal scans – assessing fetal growth, fetal wellbeing and placental location	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, A. et al (28)	2015	United States (USA)	Diagnostic accuracy study	251 pregnant women	Use of a handheld ultrasound device to measure fetal abdominal circumference (AC). Comparison to fundal height as well as formal ultrasound to compare diagnostic accuracies for detecting fetal growth restriction (FGR) or large for gestational age (LGA)	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<.001). Handheld ultrasound was also found to be viable for screening for FGR and LGA	Study demonstrates validity for these measures
Lausin, I. et al (42)	2009	Croatia	Diagnostic accuracy study	100 pregnant women	Comparison of a portable ultrasound device in basic fetal biometric fetal measurements to larger, conventional ultrasound machines	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, M. et al (34)	2020	United Kingdom (UK)	Proof-of-concept evaluation	1 pregnant woman	Development and application of a machine learning algorithm to automatically detect trans-cerebellar	Konted Gen 1 C10R	1) Sonographer performed manual estimation of TCD on scan; and 2) clinical	TCD automated measurement (26.2 mm) was an underestimation compared with manual measurement (34.9 mm) and the hospital	Study did not demonstrate validity of a machine learning

					diameter (TCD) in obstetric ultrasound images – firstly against a library of obstetric scan images, and then a real-world implementation using a scan from a portable ultrasound machine.		hospital scan TCD measurement on the same subject made using a high-end ultrasound machine (GE Voluson E8)	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.	algorithm for TCD measurement
Saul, T. et al (69)	2012	United States (USA)	Cross-sectional study	68 pregnant women	Determine the accuracy of emergency-physician performed gestational age estimation with a portable ultrasound, as compared to radiology department standard	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
Sayasneh, A. et al (31)	2012	United Kingdom (UK)	Cohort study (prospective)	204 women	Evaluate the performance of a pocket-sized ultrasound machine as a tool for obstetric triage in three distinct population categories: 1) women with pain and bleeding in early pregnancy; 2) women presenting for routine obstetric ultrasound assessment; and 3) women with possible gynaecological pathology	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, means ac diameter, FL and mean diameter of an ovarian mass	Study demonstrates validity for these measures
Shah, S. et al (59)	2010	United States (USA)	Cross-sectional study	96 ultrasound examinations on 38 pregnant women	Evaluation of emergency-physician performed ultrasound to determine gestational age, compared to conventional ultrasound	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, M. et al (36)	2021	Peru	Single-centre pilot study	126 pregnant women	Evaluation of a telediagnostic system in which ultrasound images were acquired by minimally trained healthcare professionals using a portable ultrasound device (using simple scan protocols) and then uploaded online and	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	Study demonstrates validity for these measures

					interpreted by an off-site specialist			biometric measurements – including kappa coefficient of 0.95 for estimated gestational age	
Troyano L. et al (32)	2013	Spain	Pilot study	80 women	Validation of a new clinical application for an existing portable ultrasound device by modifying the device for transvaginal use and testing its applicability on a population of pregnant women	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

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 training programs for health care 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, with six studies assessing fetal characteristics and four studies assessing gestational age estimation. These 10 studies incorporated seven devices, with which only six were described as valid compared to 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 pre-specified 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. 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-review literature, so that clinicians, administrators, and policymakers 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 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.(74) 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, program administrators and policymakers 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. Ideally, 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.

AUTHOR CONTRIBUTIONS

AE developed the review protocol and data extraction tools. AE and SMcD developed the search strategy. AE, EF and SA conducted title/abstract and full-text screening and data extraction. AE prepared the first draft of the analysis, which was reviewed by all authors and revised following their input. All named authors contributed to the writing of this manuscript.

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Lorena Romero helped with the initial design of the search strategy. Anna Shalit and Lauren Vallely helped with the initial title/abstract screening.

COMPETING INTERESTS

The authors declare no competing interests.

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DATA SHARING STATEMENT

Dataset available from the Dryad repository, DOI: (awaiting contact from Dryad).

RESEARCH ETHICS APPROVAL

As a systematic review of publicly available data, ethical approval was not required.

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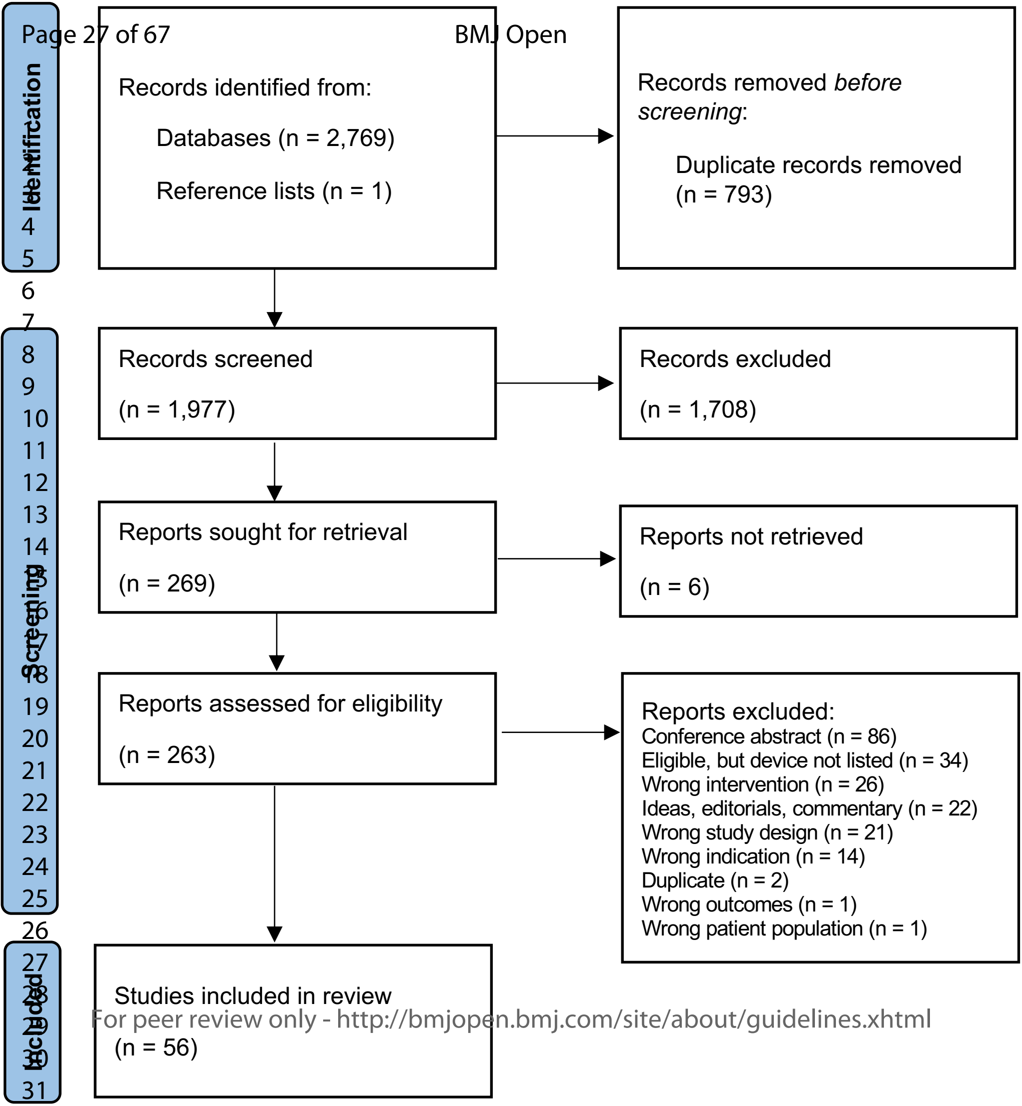
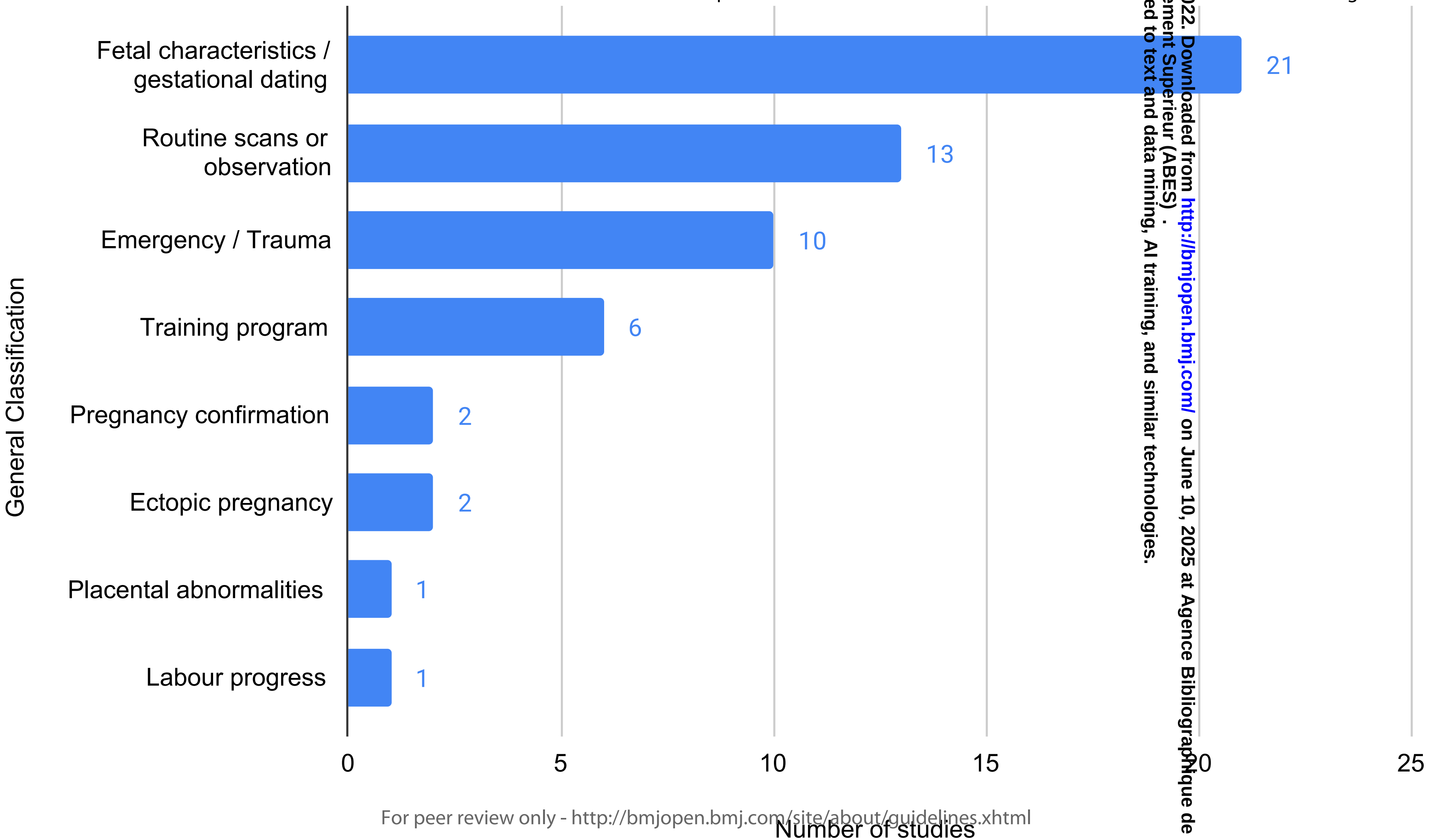
FIGURES

Figure 1. PRISMA flowchart of screening process for scoping review

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


Identification
Records identified from:
Databases (n = 2,769)
Reference lists (n = 1)
Records removed *before screening*:
Duplicate records removed (n = 793)
Screening
Records screened
(n = 1,977)
Records excluded
(n = 1,708)
Reports sought for retrieval
(n = 269)
Reports not retrieved
(n = 6)
Reports assessed for eligibility
(n = 263)
Reports excluded:
Conference abstract (n = 86)
Eligible, but device not listed (n = 34)
Wrong intervention (n = 26)
Ideas, editorials, commentary (n = 22)
Wrong study design (n = 21)
Wrong indication (n = 14)
Duplicate (n = 2)
Wrong outcomes (n = 1)
Wrong patient population (n = 1)
Included
Studies included in review
(n = 56)


Fetal characteristics / gestational dating
Routine scans or observation
Emergency / Trauma
Training program
Pregnancy confirmation
Ectopic pregnancy
Placental abnormalities
Labour progress
21
13
10
6
2
2
1
1
General Classification
0
5
10
15
20
25
Number of studies

Point-of-care ultrasound technologies for gestational age dating: protocol for a rapid scoping review

8 April 2021

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Background

Obstetric ultrasound (US) is performed to obtain fetal biometry, which facilitates estimation of gestational age (GA), particularly when a scan is performed early in pregnancy. Accurate and precise GA assessment supports appropriate time-sensitive interventions during pregnancy and management of pregnancy complications.

WHO currently recommends that all pregnant women should receive at least one US scan before 24 weeks gestation to estimate GA, improve detection of fetal anomalies and multiple pregnancies, reduce induction of labour for post-term pregnancy, and improve a woman's pregnancy experience.(1) Furthermore, in 2015 WHO recommended that ACS should be administered to women up to 34 weeks' gestation if they are at risk of imminent preterm birth.(2) The recommendation remarks caution that clinicians need to have a high confidence in the accuracy of the GA estimate, as there is currently insufficient evidence on the benefits and possible harms of ACS use beyond 34 weeks. A 2018-2019 WHO policy survey identified that obstetric ultrasound machines are in the national list of commodities

The importance of accuracy of GA estimation in preterm management was further emphasised by the findings of the recent WHO ACTION-I Trial.(3) ACTION-I was a multi-country, randomized trial involving pregnant women at risk of preterm birth between 26 weeks 0 days and 33 weeks 6 days of gestation.(4) The trial demonstrated that antenatal dexamethasone treatment of women at risk of early preterm birth in low-resource countries resulted in a significantly lower risk of neonatal mortality to 28 days of life (RR 0.84, 95% CI 0.72 - 0.97) and any baby death (RR 0.88; 95% CI 0.78 to 0.99), as well as reduced early neonatal death, severe respiratory distress at 24 hours, neonatal hypoglycemia at 6 hours, resuscitation at birth and use of continuous positive airway pressure. Importantly, the eligibility criteria for this trial stipulated that all women must have had an ultrasound-based estimate of GA prior to randomisation.

WHO is currently engaged in guideline updating and implementation research activities, to take the findings of ACTION-I to scale. Widespread availability of effective and reliable antenatal ultrasound services are a necessary pre-condition to maximising the safe and appropriate use of ACS. In recent years, new handheld or point-of-care technologies - such as portable, wireless, compact or mobile-based ultrasound systems - have become more widely available. These options can be more affordable, user-friendly and durable than other ultrasound systems. In 2014, PATH published a guide to selecting portable ultrasound devices, identifying eight models ranging in price from $3,600 to $20,000.(5) For limited-resource contexts, the "ideal" handheld ultrasound system would be accurate, easy to use (and easy to train new users), affordable, durable and acceptable. However, no systematic review has assessed available handheld ultrasound technologies from the perspective of these parameters.

A 2018 narrative review by Kim et al identified 65 articles that explored issues affecting implementation of ultrasound technology in LMICs, and identified critical considerations such as health personnel capacity, maintenance, cost, overuse and misuse of ultrasound, miscommunication between the providers and patients, patient diagnosis and care management, health outcomes, patient perceptions and concerns about fetal sex determination.(6) Available studies used a wide range of ultrasound technologies.

Aim

To conduct a scoping review to describe what handheld ultrasound devices are available for gestational age dating, and what (if any) such devices can meet requirements for resource-limited settings.

Objectives

1. Identify available handheld ultrasound options currently available in market
2. Describe available ultrasound options in terms of:
    - **Device characteristics:**
        - Device: Manufacturer, model, design, countries of availability/registration, country of servicing, environmental requirements (if any), maintenance requirements, warranty
        - Functionality: Intended use / versatility, durability/robustness (life span), ease of use, power requirements, battery type and life (including rechargeability)
        - Hardware: dimensions, weight, probe / transducer options, screen resolution
        - Software: user interface (particularly simplicity), image storage, wireless connectivity
    - **Device performance:** Effectiveness and accuracy, fetal parameters that can be measured
    - **Personnel and training requirements:** Who can use it, and what are the training requirements?
    - **Costs:** resource requirements, cost, cost-effectiveness, affordability
    - **Acceptability:** providers, women
    - **Feasibility:**
    - **Other implementation considerations:** if any

Methods

Study design

A scoping review as defined by the Canadian Institutes of Health Research, is an 'exploratory project' used to 'systematically map the literature available on a topic' (7). The value of a scoping review is its capacity to identify and examine the range and nature of the existing literature (7, 8). Suited to systematically addressing broad questions, scoping reviews create a map of the existing literature across a body of evidence in a reproducible and transparent manner (9). By summarising the research findings in this way, it will provide insight into how the subject area, intrapartum care measures and their provision and quality, has been studied and whether knowledge gaps exist.

The review will be conducted per the Joanna Briggs Institute (JBI) Methodology for Scoping Reviews and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping

Reviews (PRISMA-ScR) standards (8, 10). This protocol will be publicly registered on the Open Science Foundation (osf.io) database.

Eligibility criteria

POPULATION	Pregnant women
INTERVENTION	Use of handheld, portable, wireless, compact or mobile-based ultrasound for gestational age estimation
COMPARISON	-
OUTCOMES	Device characteristics Device performance Human resources and training Costs Acceptability Feasibility
TIME PERIOD	Literature from 1 January 2000 to present
SETTING	Any country or setting

Literrature search and screening of citations

The literature search will be conducted in three separate steps. Across all steps, we aim to identify and collate any citations pertaining to the use of handheld ultrasound for gestational age estimation, that provides usable information for any one or more the outcomes of interest.

Step 1: Google searches using structured search terms and synonyms to identify all current manufacturers of handheld ultrasound systems. For example, GE Healthcare, SonoSite, Siemens and Philips are all multinational ultrasound manufacturers that have current models of handheld ultrasound currently in the market. Individual manufacturers may be contacted for further information. This will be augmented by information from topic specialists (such as representatives form ISUOG, PATH and WHO Medical Technologies staff) and international procurement specialists (such as WHO Procurement Department)

Step 2: The following databases will be searched: MEDLINE (Ovid), EMBASE (Ovid), Global Index Medicus (WHO), CINAHL (EBSCO), and Maternity and Infant Care (Ovid). Searches will be limited by date of publication to 1 January 2000, to ensure mapping of contemporary literature. Search terms include synonyms for pregnancy AND handheld ultrasound.

Two reviewers will independently screen the titles and abstracts of sources using Covidence, and select sources based on the inclusion and exclusion criteria. If criteria are not met through title and abstract examination, then the full texts will be reviewed. Reviewers will meet to discuss results and resolve any disagreements regarding selection. If disagreements persist, a third reviewer (JV) will independently screen the source in question.

Step 3: Grey literature searches of websites of relevant international organizations, such as WHO, PATH, USAID and ISUOG.

Data Extraction
Data will initially be charted in an Excel spreadsheet according to the included data source and its characteristics, including publication year, journal, location research (i.e. one row per data source).

We will then chart data in a separate Excel spreadsheet, organized by individual ultrasound models. For each model, any information on the outcomes of interest will be extracted, with the relevant supporting data source cited.

Individual data sources will not be critically appraised, as per the JBI and PRISMA-ScR methodology.

It is anticipated that we may identify data sources or evidence that apply to handheld ultrasound devices, without specifying a particular manufacturer or model – for example, a systematic review pertaining to cost-effectiveness of handheld ultrasound technologies (regardless of model). These data will also be charted and analysed, as they can provide useful information to end users, regardless of what model of ultrasound is used.

Deliverables and timeline

Deliverables	Estimated date of completion
Contract commencement	1 March 2021
Review protocol submitted to OSF	15 April 2021
Searches run, citation screening completed	1 May 2021
Results completed and draft report of review findings completed	15 June 2021
Manuscript submitted for peer-review	15 July 2021

Authorship
It is anticipated that findings from the review will be disseminated through a peer-reviewed publication in an academic journal. Scientific paper/s emanating from this work will be co-authored by members of the evidence synthesis group, according to individuals' contributions and in accordance with ICMJE criteria.

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SUPPLEMENTAL FILE 1 – SEARCH STRATEGIES PER DATABASE

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"

SUPPLEMENTAL FILE 2 – SEARCH TERMS FOR ONLINE SEARCHES

Supplementary Table S5. Search terms used to identify portable ultrasound devices via Google searches

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

SUPPLEMENTARY FILE 3 – LIST OF MANUFACTURERS'

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 FILE 4 – PARAMETER CODES

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	Antenatal – unspecified Antenatal - first trimester Antenatal - second trimester	Fetal characteristics / gestational dating Routine scans or observation

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

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

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 cor	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 cor	7
Chison	Eco 2	Laptop style	China	Electricity plu	2.5 hours cor	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 cor	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 cor	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 cor	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 healt	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 disclosed	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 disclosed	6
Ricso	Aurora A5	Laptop style	China	Electricity plu	Not disclosed	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 disclosed	Electricity plu	7.5 hours (wi	10
Samsung	HM70A	Laptop style	Not disclosed	Electricity plu	3 hours conti	17
SIFSOF	SIFULTRAS 4	Tablet device	Not disclosed	Electricity plu	Not disclosed	
SIFSOF	SIFULTRAS 4	Tablet device	Not disclosed	Electricity plu	Not disclosed	
SIFSOF	SIFULTRAS 6	Laptop style	Not disclosed	Electricity plu	2 hours	16
SIFSOF	SIFULTRAS 6	Laptop style	Not disclosed	Electricity plu	Not disclosed	5
SIFSOF	SIFULTRAS 6	Laptop style	Not disclosed	Electricity plu	Not disclosed	8
SIFSOF	SIFULTRAS 8	Laptop style	Not disclosed	Electricity plu	8 hours	7
SIFSOF	SIFULTRAS 8	Laptop style	Not disclosed	Electricity plu	8 hours	5
SIFSOF	SIFULTRAS 6	Laptop style	Not disclosed	Electricity plu	Not disclosed	5
SIFSOF	SIFULTRAS7.	Tablet style (	Not disclosed	Electricity plug for chargin		4
SIFSOF	SIFULTRAS 3	Handheld de	Not disclosed	Mobile devic	Dependent o	3 (in 1)
Sonictec	Pocket Ultras	Wireless han	Not disclosed	Mobile devic	3 hours conti	5
Sonoque	C5PL	Handheld de	Not disclosed	Compatible r	3 hours conti	2
Sonoque	C6C	Handheld de	Not disclosed	Compatible r	3 hours	1
Sonoque	C4PL	Handheld de	Not disclosed	Compatible r	3 hours conti	2
Sonoque	C5C	Handheld de	Not disclosed	Compatible r	3 hours	1
Sonoque	C5	Handheld de	Not disclosed	Compatible r	3 hours	1
Sonoque	C3	Handheld de	Not disclosed	Compatible r	3 hours conti	1
SonoScanner	Orcheo Lite T	Laptop style	Not disclosed	Electricity plu	1hr 30 minut	9
SonoScanner	Ondina	Laptop style	Not disclosed	Electricity plu	1hr 30 minut	8
SonoScanner	T-Lite	Tablet style (	Not disclosed	Electricity plu	3 hours conti	11
SonoScanner	Orcheo Lite	Laptop style	Not disclosed	Electricity plu	1hr 30 minut	8
SonoScanner	U-Lite	Tablet style (	Not disclosed	Electricity plu	Not disclosed	Not disclosed
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 contin	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 measur	309	163 x 56 x 35	Lightening ca	$1,999
1x convex; 2x	B-mode; B/B	Dedicated ob	Not disclose	Not disclose	Rotatable LE	Not disclosed
1x convex; 1x	B-mode; 2B-	Ob/Gyn mea	Not disclose	304 x 406 x 1	15 inch high-	Not disclosed
1x convex; 3x	3D/4D, color	Not reported	7500	Not disclose	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 disclose	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 disclose	15"LED HD sc	$17,900
1.5 MHz-23 M	Not disclose	Obstetric ap	5400	Not disclose	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 disclose	15-inch LED s	$11,100
1x convex; 2x	2D; 3D/4D	Ob/Gyn appl	7500	Not disclose	15-inch LED s	$10,400
1x convex; 2x	B-mode; 2B-	fetal biometr	5900	330 x 330 x 1	12 inch LED c	$6,400
1x convex	B-mode; M-r	Not disclose	Not disclose	60 x 172 x 74	User's device	$5,265
1x convex; 2x	B-mode; B/B	Ob/gyn appli	6350	Not disclose	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 disclose	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 disclose	"Automate a	5000	Not disclose	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 disclose	**DU: 321P: 12**	**DU: 168 x 76**	Comes with	$4,995
Curved; Linea	B-mode; colo	Not dsiclose	205	131 x 64 x 31	Bluetooth co	$4,495
Phased	B-mode; M-r	Not disclose	**DU: 321P: 85**	**DU: 168 x 76**	Comes with	$2,995
3.5MHz	B-mode	Obstetric pre	390	78 x 38 x 229	Dependent o	$5,300
Curved array	B-W mode	Customised	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 disclose	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 disclose	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 mea	Not disclose	Not disclose	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 disclose	Ob/gyn meas	Not disclose	Not disclose	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; lin	2D; M-mode,	Fetal biomet	**DU: 2460**	**DU: 320 x 22**	Comes with	$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 dop	4-measurem	136	114 x 45	Compatible v	$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 LEI	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/N	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 2C	Dependent o	$3,200
1x convex	B, B/M, Colo	OB Measure	240	155 x 70 x 2C	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/N	OB Measure	240	155 x 70 x 2C	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 LCI	Not disclosed
1x Linear, 1x	B-Mode (2D	Ob/Gyn mea	Not disclose	Not disclose	15.6" HD LCI	Not disclosed
1x Linear, 1x	B-Mode (2D	Ob/Gyn mea	Not disclose	Not disclose	15.6" HD LCI	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 LCI	$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, including	3900	299 x 274 x 7	10.4 inch disp	$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 disclosed	B-mode; colo	Ob/Gyn mea	340	169 x 54 x 38	Dependent o	Not disclosed
Not disclosed	Not disclosed	Obstetrics m	Not disclosed	Not disclosed	15.6 inch LED	Not disclosed
1x convex; 1x	Not disclosed	Obstetric ap	Not disclosed	Not disclosed	Dependent o	Not disclosed
Not disclosed	Not disclosed	Ob/gyn appli	Not disclosed	Not disclosed	Not disclosed	Not disclosed
"up to 23MH	Not disclosed	Ob/gyn appli	3,500	Not disclosed	Not disclosed	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 disclosed	Obstetric ap	Not disclosed	Not disclosed	Not disclosed	$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 clo	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®10	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 inte	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Internal stor	TRUE	TRUE	TRUE	TRUE
Android 5.0 c	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 60GB	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 Image	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 storage	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 v	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 imag	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-I	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	URL/Source
TRUE	TRUE	TRUE	FALSE	https://store.butterflynetwork.com/au/
TRUE	TRUE	TRUE	FALSE	https://www.chison.com/b-w-ultrasour
TRUE	TRUE	TRUE	FALSE	https://www.providianmedical.com/ult
TRUE	TRUE	FALSE	FALSE	https://www.chison.com/ebit/ebit-30.h
TRUE	TRUE	TRUE	FALSE	https://www.chison.com/eco/eco-5.htr
TRUE	TRUE	TRUE	FALSE	https://www.chison.com/b-w-ultrasour
TRUE	TRUE	TRUE	FALSE	https://www.chison.com/sonobook/sor
TRUE	FALSE	TRUE	FALSE	https://www.chison.com/sonobook/sor
TRUE	TRUE	TRUE	FALSE	https://www.chison.com/sonobook/sor
TRUE	TRUE	TRUE	FALSE	https://www.chison.com/sonotouch/so
TRUE	TRUE	FALSE	FALSE	https://www.chison.com/ebit/ebit-50.h
TRUE	TRUE	TRUE	FALSE	https://www.chison.com/ebit/ebit-60.h
TRUE	TRUE	TRUE	FALSE	https://www.chison.com/eco/eco-6.htr
TRUE	TRUE	TRUE	FALSE	http://www.chisonsonoeye.com/index.
TRUE	TRUE	TRUE	FALSE	https://www.chison.com/b-w-ultrasour
TRUE	TRUE	TRUE	FALSE	https://clarius.com/au/scanners/c3/
TRUE	FALSE	TRUE	FALSE	https://www.draminski.com/med/doct
TRUE	TRUE	TRUE	FALSE	https://www.edan.com/Uploads/2021(
TRUE	TRUE	TRUE	FALSE	https://www.edan.com/product/a/AX8
TRUE	TRUE	TRUE	FALSE	https://edanusa.com/product/u60-diag
TRUE	TRUE	TRUE	FALSE	https://www.edan.com/Uploads/2020(
TRUE	TRUE	TRUE	FALSE	https://www.edan.com/Uploads/2020(
TRUE	TRUE	TRUE	FALSE	https://www.ultrasoundportables.com/
TRUE	TRUE	TRUE	FALSE	https://www.gehealthcare.com/produc
TRUE	TRUE	TRUE	FALSE	https://handheldultrasound.gehealthcar
TRUE	TRUE	TRUE	FALSE	https://handheldultrasound.gehealthcar
TRUE	TRUE	TRUE	FALSE	https://handheldultrasound.gehealthcar
TRUE	TRUE	TRUE	FALSE	https://www.healcerion.com/explore-s
TRUE	TRUE	TRUE	FALSE	https://interson.com/simpli-series/http
TRUE	TRUE	TRUE	FALSE	http://www.konted.cn/products/color-c
TRUE	TRUE	TRUE	FALSE	http://www.konted.cn/products/image
TRUE	TRUE	TRUE	FALSE	http://www.konted.cn/products/image
TRUE	TRUE	TRUE	FALSE	http://www.konted.cn/products/color-c
TRUE	TRUE	TRUE	FALSE	http://www.konted.cn/products/image
TRUE	TRUE	TRUE	FALSE	https://www.lequiopower.com/wp-con
TRUE	TRUE	TRUE	FALSE	https://www.lequiopower.com/wp-con
TRUE	TRUE	TRUE	FALSE	https://www.lequiopower.com/wp-con
TRUE	TRUE	TRUE	FALSE	https://www.mindray.com/au/product/
TRUE	TRUE	TRUE	FALSE	https://www.mindraynorthamerica.con
TRUE	TRUE	TRUE	FALSE	https://www.mindraynorthamerica.con
TRUE	TRUE	TRUE	FALSE	https://www.mindraynorthamerica.con
TRUE	TRUE	TRUE	FALSE	https://www.mindray.com/au/product/
TRUE	TRUE	TRUE	FALSE	https://www.mindray.com/au/product/
FALSE	TRUE	TRUE	FALSE	https://www.mindray.com/au/product/
TRUE	TRUE	TRUE	FALSE	https://www.philips.com.au/healthcare
TRUE	TRUE	TRUE	FALSE	https://www.philips.com.au/healthcare
TRUE	TRUE	TRUE	FALSE	https://www.philips.com.au/healthcare

TRUE	FALSE	TRUE	FALSE	https://www.yumpu.com/en/documen
TRUE	TRUE	TRUE	FALSE	http://promed-medical.com/productsh
TRUE	TRUE	TRUE	FALSE	http://promed-medical.com/productsh
TRUE	TRUE	TRUE	FALSE	http://promed-medical.com/productsh
TRUE	TRUE	TRUE	FALSE	http://promed-medical.com/productsh
TRUE	TRUE	TRUE	FALSE	https://ricso.com/product-item/aurora-
TRUE	FALSE	TRUE	FALSE	https://ricso.com/product-item/color-d
TRUE	FALSE	TRUE	FALSE	https://ricso.com/product-item/portabl
TRUE	FALSE	FALSE	FALSE	https://ricso.com/product-item/portabl
TRUE	FALSE	FALSE	FALSE	https://ricso.com/product-item/ultraso
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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5-6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	SF1
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	6-7
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	6-7
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	NA

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SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	7
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	7
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	9
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	9-12
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	9-12
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	16
Limitations	20	Discuss the limitations of the scoping review process.	16
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	18
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	19

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

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

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

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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 to 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 $1,190 to $30,000 USD and weight ranged from 0.9kg to 13.0kg.

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 to 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: Registered via Open Science Framework (DOI: 10.17605/OSF.IO/U8KXP)

ARTICLE SUMMARY

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 in to 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 World Health Organization (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- and 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 impacts 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 (JBI) Methodology for Scoping Reviews, and is reported as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) 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 (i.e., 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 (Supplemental Tables S1-S4). Identified citations were collated and de-duplicated 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 (Supplementary Table S5). We also searched individual websites of ultrasound manufacturers to identify what (if any) portable ultrasound systems were currently available (Supplementary 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 pre-tested 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 programs 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 (Supplementary 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 pre-sets, 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 (reproduced with permission from the World Health Organization'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 visualize anatomy with a transabdominal transducer.

RESULTS

Literature searches for the scoping review identified 2,770 citations, of which 793 duplicates were removed. Title and abstract screening of the remaining 1,977 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 nine studies (16.1%), and low-income countries for eight 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 United States (10 studies, 17.9%).

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[1]	2	3.6%
Total	***56***	***100.0%***

[1] Both studies categorised under multiple were across countries classified as high income and upper middle income

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 programs for portable ultrasound 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).

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 (four studies each), and GE Voluson i (three studies). One device, the Enlace Hispano Americano de Salud (EHAS) 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 nine studies (16.1%) collected data related to staff members who participated in portable ultrasound training programs. The 47 studies involved pregnant women without specific 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 (4 studies), physicians only (2 studies), nurses/midwives only (2 studies) and medical students (1 study).

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 (EHAS)	Healthy Pregnancy Kit specific (19, 20)	2	3.6%
General Electric	Logiq e (21)	1	1.8%
	Logiq I (22)	1	1.8%
	Voluson I (23-25)	3	5.4%
	VScan (26-33)	8	14.3%
Healcerion	SONON 300C (34)	1	1.8%
Konted	Gen 1 C10R (35)	1	1.8%
Lequio	US-304 (36)	1	1.8%
Mindray	DP-10 (37)	1	1.8%
	DP-20 (38, 39)	2	3.6%
Phillips	Lumify (40)	1	1.8%
	VISIQ (41)	1	1.8%
Primedic	Handyscan (42)	1	1.8%
Siemens	Accuson 10 (43)	1	1.8%
Signostics	Signos (44)	1	1.8%
SONON	300L (45)	1	1.8%
Sonoscanner	Orcheo Lite (46, 47)	2	3.6%
SonoScape	S2 (48)	1	1.8%
SonoSite	180 (49, 50)	2	3.6%
	180 Plus (51)	1	1.8%
	Edge (52)	1	1.8%
	M-Turbo (53-61)	9	16.1%
	Micromaxx (62-64)	3	5.4%
	Micromaxx OR M-Turbo (65)	1	1.8%
	S180 (66)	1	1.8%
	Titan (67-70)	4	7.1%
	Model not specified (71)	1	1.8%
Sony	Model not specified (72)	1	1.8%
Toshiba	SSA-510 A (73)	1	1.8%
Whale Imaging	Sigma P5 (74)	1	1.8%

Most studies (53 studies, 94.6%) were conducted in the antenatal period, though two were intrapartum and one was both antenatal and intrapartum. Of those 53 studies in the antenatal period, 10 were in the first trimester only, five in the second trimester only, five in the third trimester only and five 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, nine 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 (Supplemental Table S8). The majority were produced in China, and prices ranged from USD$1,190 to $30,000. Devices ranged in weight from 0.9kg to 13.0kg and battery life was from 40 minutes 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.

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, A et al (22)	2021	United States (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, S. et al (28)	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, A. et al (29)	2015	United States (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<.001). Handheld ultrasound was also found to be viable for screening for FGR and LGA	Study demonstrates validity for these measures
Lausin, I. et al (43)	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, M. et al (35)	2020	United Kingdom (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, T. et al (70)	2012	United States (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 co-efficient was 0.978	Study demonstrates validity for these measures
Sayasneh, A. et al (32)	2012	United Kingdom (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 for 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, S. et al (60)	2010	United States (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, M. et al (37)	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 0.85 for estimated gestational age	Study demonstrates validity for these measures
Troyano L. et al (33)	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

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 training programs for health care 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 seven devices, with which only six were described as valid compared to 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 pre-specified 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. (35) 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-review literature, so that clinicians, administrators, and policymakers 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 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.(75) 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, program administrators and policymakers 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); utilise 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.

AUTHOR CONTRIBUTIONS

AE developed the review protocol and data extraction tools. AE and SMcD (an information specialist) developed the search strategy. AE, 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. AE prepared the first draft of the analysis, which was reviewed by all authors and revised following their input. 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.

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COMPETING INTERESTS

The authors declare no competing interests.

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DATA SHARING STATEMENT

Extra data can be accessed via the Dryad data repository at http://datadryad.org/ with the doi: 10.5061/dryad.05qfttf5c

RESEARCH ETHICS APPROVAL

As a systematic review of publicly available data, ethical approval was not required.

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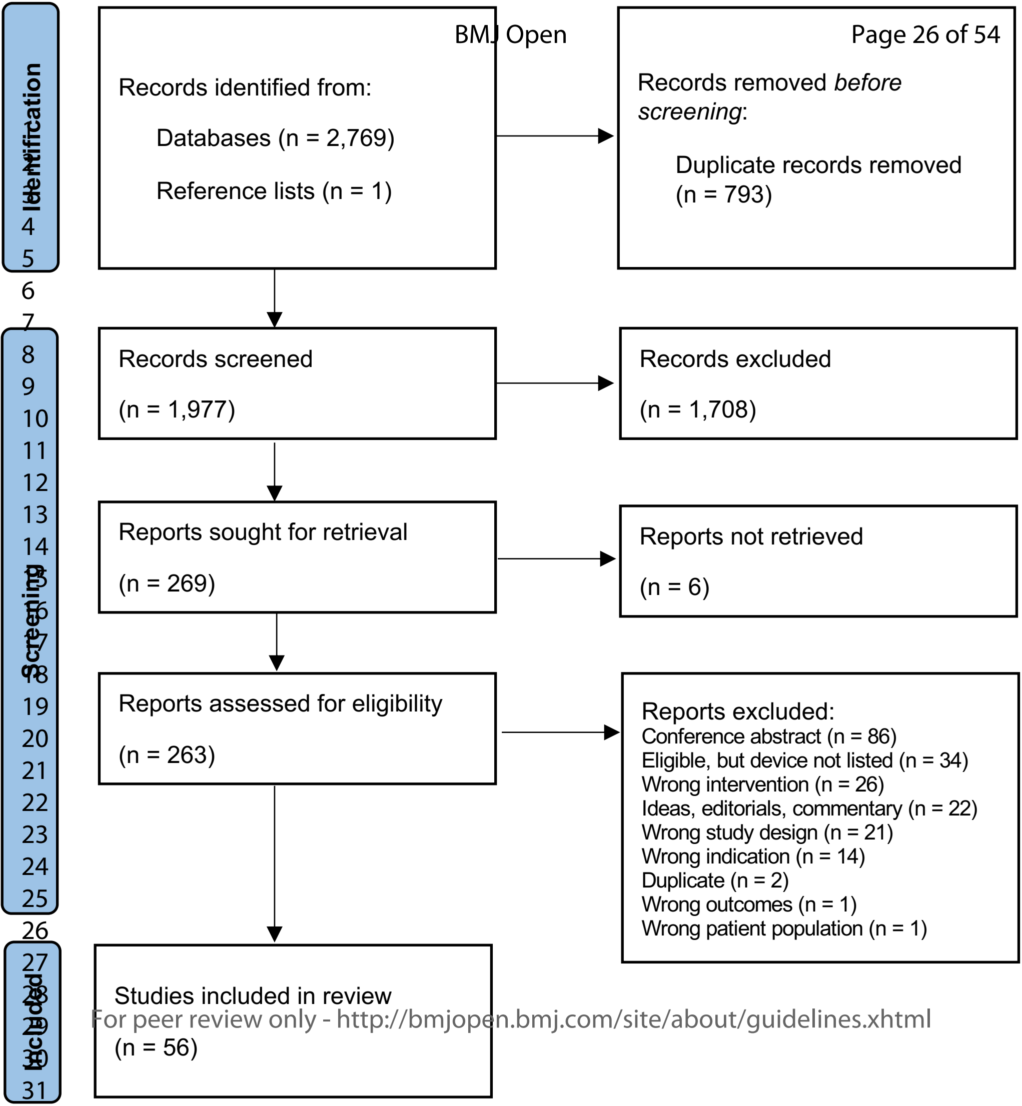
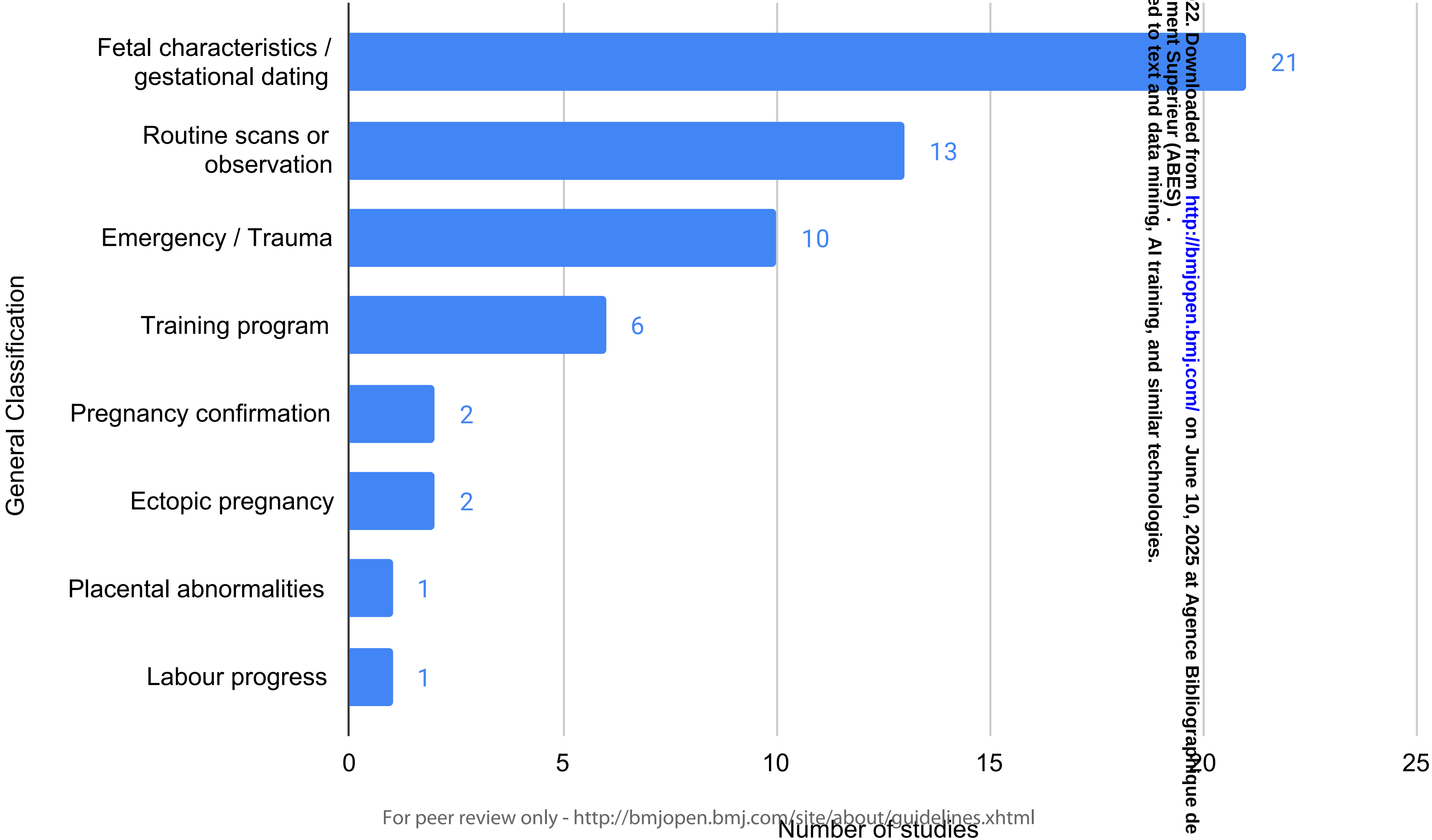
FIGURES

Figure 1. PRISMA flowchart of screening process for scoping review

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


Identification
Records identified from:
Databases (n = 2,769)
Reference lists (n = 1)
Records removed *before screening*:
Duplicate records removed (n = 793)
Screening
Records screened
(n = 1,977)
Records excluded
(n = 1,708)
Reports sought for retrieval
(n = 269)
Reports not retrieved
(n = 6)
Reports assessed for eligibility
(n = 263)
Reports excluded:
Conference abstract (n = 86)
Eligible, but device not listed (n = 34)
Wrong intervention (n = 26)
Ideas, editorials, commentary (n = 22)
Wrong study design (n = 21)
Wrong indication (n = 14)
Duplicate (n = 2)
Wrong outcomes (n = 1)
Wrong patient population (n = 1)
Included
Studies included in review
(n = 56)


General Classification
Fetal characteristics / gestational dating
21
Routine scans or observation
13
Emergency / Trauma
10
Training program
6
Pregnancy confirmation
2
Ectopic pregnancy
2
Placental abnormalities
1
Labour progress
1
0
5
10
15
20
25
Number of studies

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

[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 probe
Butterfly	Butterfly iQ+	Handheld de	Not disclose	Mobile devic	>= 2 hours cc	1
Chison	Eco 3 expert	Laptop style	China	Electricity plu	2.5 hours cor	7
Chison	Q5	Laptop style	Not disclose	Electricty plu	Not disclose	7
Chison	EBit30	Laptop style	China	Electricity plu	Not disclose	10
Chison	Eco 5	Laptop style	China	Electricity plu	2.5 hours cor	7
Chison	Eco 2	Laptop style	China	Electricity plu	2.5 hours cor	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 disclose	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 disclose	6
Clarius	C3 HD	Handheld de	Not disclose	Compatible r	60 minutes t	1
DRAMINSKI	BLUE	Tablet device	Poland	Electrciity plu	2.5 hours cor	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 cor	11
Edan	DUS 60	Laptop style	China	Electricity plu	2 hours conti	6
GE Healthcar	Versana acti	Laptop style	Not disclose	Electrciity plu	Not disclose	11
GE Healthcar	Nextgen Logi	Laptop style	Not disclose	Electricity plu	60 minutes t	14
GE Healthcar	Vscan Extenc	Handheld de	Not disclose	Electricity plu	60 minutes t	1
GE Healthcar	Vscan Air	Handheld de	Not disclose	Mobile devic	50 minutes t	1
GE Healthcar	Vscan Extenc	Handheld de	Not disclose	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 disclose	Laptop/comp	Dependent o	1
Konted	C6	Laptop style	China	Electricty plu	Not disclose	4
Konted	Gen3 C10	Wireless ultr	China	Compatible r	3 hours conti	3
Konted	Gen4Pro	Wireless ultr	China	Compatible r	3.5 hours cor	4
Konted	C9	Laptop style	China	Electricity plu	Not disclose	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 disclose	9
Mindray	TE7	Tablet device	China	Electricity plu	Not disclose	11
Mindray	M9	Laptop style	China	Electricity plu	90 minutes t	10
Mindray	ME8	Laptop style	China	Electricity plu	Up to 8 hour	10
Mindray	TE5	Tablet device	China	Electricity plu	2 hours conti	14
Mindray	M6	Laptop style	China	Electricity plu	Not disclose	18
Mindray	DP-10	Laptop style	China	Electrciity plu	Not disclose	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 disclosec	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 disclosec	6
Ricso	Aurora A5	Laptop style	China	Electricity plu	Not disclosec	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 disclosec	Electricity plu	7.5 hours (wi	10
Samsung	HM70A	Laptop style	Not disclosec	Electricity plu	3 hours conti	17
SIFSOF	SIFULTRAS 4	Tablet device	Not disclosec	Electricity plu	Not disclosed	
SIFSOF	SIFULTRAS 4	Tablet device	Not disclosec	Electricity plu	Not disclosed	
SIFSOF	SIFULTRAS 6	Laptop style	Not disclosec	Electricity plu	2 hours	16
SIFSOF	SIFULTRAS 6	Laptop style	Not disclosec	Electricity plu	Not disclosec	5
SIFSOF	SIFULTRAS 6	Laptop style	Not disclosec	Electricity plu	Not disclosec	8
SIFSOF	SIFULTRAS 8	Laptop style	Not disclosec	Electricity plu	8 hours	7
SIFSOF	SIFULTRAS 8	Laptop style	Not disclosec	Electricity plu	8 hours	5
SIFSOF	SIFULTRAS 6	Laptop style	Not disclosec	Electricity plu	Not disclosec	5
SIFSOF	SIFULTRAS7.	Tablet style (	Not disclosec	Electricity plug for chargin		4
SIFSOF	SIFULTRAS 3	Handheld de	Not disclosec	Mobile devic	Dependent o	3 (in 1)
Sonictec	Pocket Ultras	Wireless har	Not disclosec	Mobile devic	3 hours conti	5
Sonoque	C5PL	Handheld de	Not disclosec	Compatible r	3 hours conti	2
Sonoque	C6C	Handheld de	Not disclosec	Compatible r	3 hours	1
Sonoque	C4PL	Handheld de	Not disclosec	Compatible r	3 hours conti	2
Sonoque	C5C	Handheld de	Not disclosec	Compatible r	3 hours	1
Sonoque	C5	Handheld de	Not disclosec	Compatible r	3 hours	1
Sonoque	C3	Handheld de	Not disclosec	Compatible r	3 hours conti	1
SonoScanner	Orcheo Lite T	Laptop style	Not disclosec	Electricity plu	1hr 30 minut	9
SonoScanner	Ondina	Laptop style	Not disclosec	Electricity plu	1hr 30 minut	8
SonoScanner	T-Lite	Tablet style (	Not disclosec	Electricity plu	3 hours conti	11
SonoScanner	Orcheo Lite	Laptop style	Not disclosec	Electricity plu	1hr 30 minut	8
SonoScanner	U-Lite	Tablet style (	Not disclosec	Electricity plu	Not disclosec	Not disclosec
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; colc	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; colc	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; colc	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; lin	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 dop	4-measurem	136	114 x 45	Compatible w	$5,380
3.5/5.0 MHz	dual frequen	Not disclsoed	2000	115 x 190 x 1	5 inch TFT LC	Not disclosed
unsure of ho	B, B|B, 4B, E	Obstetric pa	Not disclosed	Not disclosed	15-inch LED s	Not disclosed
Unsure of all	B/W, color d	Obstetrics ar	Not disclosed	Not disclosed	15 inch LCD s	Not disclosed
Not disclosed	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 disclosed	15-inch LED s	Not disclosed
1x convex; 2x	B/W	Ob/gyn appli	Not disclosed	Not disclosed	12-inch LED (	Not disclosed
1x convex; 1x	B-mode; C-m	Not disclosed	Not disclosed	Not disclosed	15-inch LED s	Not disclosed
Not disclosed	B/W	Not disclosed	Not disclosed	Not disclosed	12-inch LED (	Not disclosed
Not disclosed	B/W	Not disclosed	Not disclosed	Not disclosed	10-inch CRT s	Not disclosed
1x convex; 2x	B/W	Not disclosed	6000	Not disclosed	12-inch LCD s	Not disclosed
1x convex; 2x	color doppler	Ob/gyn appli	5500	138 thick	12-inch LED l	Not disclosed
1x convex; 2x	B/W	Ob/gyn appli	3500	Not disclosed	10.4-inch TFT	Not disclosed
1x convex; 2x	Not disclosed	Obstetric pa	2500	Not disclosed	12-inch LED (	Not disclosed
3x curved; 2x	Not disclosed	Ob/gyn appli	Not disclosed	Not disclosed	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 disclosed	Ob/gyn appli	Not disclosed	Not disclosed	13.3 Inch Tou	Not disclosed
"Broard rang	Not disclosed	Ob/gyn appli	2000	Not disclosed	13.3 Inch Tou	Not disclosed
Multiple opti	Not disclosed	Ob/gyn appli	5400	Not disclosed	Not disclosed	$19,500
1x convex; 1x	B, B|B, 4B, E	Ob/gyn appli	Not disclosed	Not disclosed	Not disclosed	$9,877
1x convex; 2x	B, B|B, 4B, E	Ob/gyn appli	Not disclosed	Not disclosed	15 Inch LCD S	$9,877
1x convex; 1x	B,B/B,M,B/M	Obstetrics pa	7000	380 x 212 x 3	15-inch LCD (	$8,999
1x convex; 1x	2D,B/M,PDI,I	Ob/gyn appli	6000	370 × 382 × 9	15 inch LCD c	$8,889
1x convex; 1x	B, B|B, 4B, E	Ob/gyn appli	Not disclosed	Not disclosed	15 Inch LED S	$7,455
1x convex; 1x	B, BB, M, CD	Ob/gyn appli	Not disclosed	Not disclosed	12 inch color	$6,589
1x convex; 1x	Not disclosed	Not disclosed	90	125	Dependent o	$2,895
1x convex; 1x	Not disclosed	Not disclosed	280	Not disclosed	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, COLO	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; 2x	B-mode; M-r	Ob/Gyn appl	Not disclosed	Not disclosed	Not disclosed	Not disclosed
2x convex; 2x	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 to	Not disclosed
2x convex; 2x	B-mode; M-r	Ob/Gyn appl	5500	420 x 370 x 8	15-inch HD L	$30,000
Not disclosed	Color doppler	Ob/Gyn appl	Not disclosed	Not disclosed	7-inch HD tou	$7,845
1x Linear, 1x	B-Mode (2D	Ob/Gyn mea	Not disclosed	Not disclosed	15.6" HD LCD	Not disclosed
1x Linear, 1x	B-Mode (2D	Ob/Gyn mea	Not disclosed	Not disclosed	15.6" HD LCD	Not disclosed
1x Linear, 1x	B-Mode (2D	Ob/Gyn mea	Not disclosed	Not disclosed	15.6" HD LCD	Not disclosed
Wide range -	B-Mode (2D	Ob/Gyn mea	13,000	230 x 350 x 1	15" HD LED V	Not disclosed
Wide range -	B-Mode (2D	Ob/Gyn mea	7,900	230 x 350 x 1	15" HD LED V	Not disclosed
Wide range -	B-Mode (2D	Ob/Gyn mea	7,800	357 x 392 x 1	15" HD LED V	Not disclosed
Wide range -	B-Mode (2D	Ob/Gyn mea	7,800	357 x 392 x 1	15" HD LED V	Not disclosed
1x linear; 2x	B/ 2B/ 4B/ M	Ob/Gyn mea	4500	378 x 61 x 34	15.6 inch Wi	$9,000 - $15,000
1x Linear, 1x	B/ 2B/ 4B/ M	Ob/Gyn mea	Not disclosed	Not disclosed	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, including	4600	330 x 315 x 6	12.1 inch dis	$29,000
Types not dir	2D; M-mode,	Yes, including	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 avail	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 inte	TRUE	TRUE	TRUE	TRUE
System com	Not disclose	Internal stor	TRUE	TRUE	TRUE	TRUE

Android 5.0 c	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 60GE	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 Image	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 storage	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 v	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-I	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

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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5-6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	SF1
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	6-7
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	6-7
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	NA

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SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	7
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	7
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	9
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	9-12
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	9-12
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	16
Limitations	20	Discuss the limitations of the scoping review process.	16
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	18
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	19

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.