

The Role of Prenatal Ultrasound in Ensuring Fetal Health

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Annotation: Background: The merits of carrying out an early ultrasound during pregnancy are the precise estimation of age, detection of multiple pregnancies before, and identifying failed pregnancies and some fetal anomalies.

Aim: A review study was conducted to analyse the extent to which prenatal ultrasound plays a role in ensuring fetal health.

Methods: A review study was conducted on participants who had undergone all previous reviews (6). The objective of our review was to examine the role of ultrasound techniques in the investigation of the prenatal period and their effect on the foetus. A total of 65 pregnant women were included in the review. As with all reviews, the objective was to ascertain the impact of ultrasound on fetal health.

Results: The earlier reviews that assessed the use of ultrasound screening have also had improved results in diagnosis, such as the early detection of cases of multiple pregnancy and correction of gestational age miscalculations, and also revealed different effects on ultrasound screening on the length of hospital stay and also induction of labor among other interventions. We found ultrasound diagnoses of fetal conditions, which are available during prenatal care, that contribute to the reduction in perinatal morbidity and mortality. In all reviews there was no difference in outcome, but we found that early detection by ultrasound technique contributed the most towards improved fetal findings.

Conclusion: Ultrasounds performed during pregnancy are important for the health of both the woman and the baby, helping caregivers make appropriate choices for managing the pregnancy.

Keywords: Prenatal period, Ultrasound technique, and Fetal Health.

1. INTRODUCTION

In recent years, there have been notable developments in the field of prenatal diagnosis, largely due to the increased utilisation of ultrasound [1]. This non-invasive imaging technique has significantly impacted the way pregnancies are viewed and managed, enabling the examination of the intricate

details of fetal development with a precision that was previously unattainable [2,3]. The application of ultrasonography for prenatal diagnosis has come as a wonderful advancement in detecting disabilities and providing medical care in an appropriate and timely manner, enhancing ante-natal services and the mother and child's health. Ultrasonographic prenatal diagnoses present a close-up view of a pregnant woman's abdomen, thus enabling the evaluation of aspects of the development of the fetus [4,5,6]. Starting from the first trimester, ultrasound scans assist in detecting and confirming multiple pregnancies, estimating the age of the fetus, checking for the presence of the fetus, and localizing the pregnancy. Further on in the gestation period, advanced imaging techniques can demonstrate the development of specific organs, bones, and even the vascular system of the fetus [7,8,9,10]. The field of prenatal diagnosis has witnessed significant advancements in the context of congenital structural and functional defects, particularly with the advent of ultrasound technology [11]. In particular, this approach has achieved considerable success in the early diagnosis of such defects. A comprehensive examination, particularly with three-dimensional ultrasound, enables the diagnosis of pathologies such as spina bifida, cardiac defects, omphalocele, and limb dysplasia. This facilitates the planning of treatment and daffodil therapy by the healthcare system [12]. Adopting this proactive approach enables the efficacy of treatment plans to be enhanced, the risks associated with the postnatal period to be minimised, and parents to gain a deeper understanding of and preparedness for their child's healthcare needs. In addition to identifying anomalies, ultrasonographic prenatal diagnosis is also crucial for evaluating the fetal state throughout the gestational period [13,14,15]. The procedure assesses a number of factors, including the volume of amniotic fluid, the state of the placenta, and growth trends in the fetus. This enables medical professionals to identify and address potential risks, such as intrauterine growth retardation, placental insufficiency, and oligohydramnios [16]. The use of ultrasound imaging provides reassurance to parents-to-be by promptly identifying and addressing any potential issues. In certain cases where further assessment or treatment is necessary, including in the context of risk, prenatal ultrasound diagnosis can serve as a mediator for the risk-inducing measures [17]. Techniques such as chorionic villus sampling (CVS), amniocentesis, fetoscopy, and plain ultrasound scans can be conducted in real-time using ultrasound technology, thereby reducing the likelihood of complications that are likely to arise and increasing the precision of the procedure [18,19]. As technology advances, we anticipate further developments that will enhance neonatal ultrasound diagnosis techniques and improve the quality of care for pregnant women and their unborn children. [20]

2. PATIENTS AND METHODS

We conducted a retrospective study on pregnant women during the period between August 2023 - October 2024. Six previous reviews were collected that evaluated the effectiveness of prenatal ultrasound in early detection of fetal health. All previous reviews covered defining the role of ultrasound by identifying the participants, purpose, methods used, year of review, contributions to the research, limitations, conclusions, problem statement and results. In comparison with previous studies, 65 samples of pregnant women and fetuses were recruited, aged 25-45 years, with gestational weights that included (< 45, 45-80, > 80) and live birth weights included (< 2.25, 2.25-4.2, > 4.2

The ultrasound findings, pregnancy results, as well as fetal results were established from the antenatal medical records and the inpatient hospital records, which included antepartum, delivery, and neonatal admissions for all women in the study who did not miscarry. Adverse perinatal outcome is defined as including fetal, severe, or moderate neonatal morbidity.

Women who required ultrasounds for medical indications like diabetes mellitus, chronic hypertension, uncertain menstrual women, menstrual ages with discrepancy between the size of the uterus and gestation, and vaginal bleeding before 18 weeks were excluded. Ultrasound examinations performed for all intents and purposes, including screening and clinical indications, were conducted in participating ultrasound laboratories, and results were documented on a uniform data-collection form.

3. RESULTS

Table 1. Clinical and demographic findings of our study.

Variables	Participants, (n = 65)	Percentage, %
Age		
< 25	2	3.08%
25 – 35	59	90.77%
> 35	4	6.15%
Pregnancy weight, kg		
< 45	4	6.15%
45 - 80	59	90.77%
> 80	2	3.08%
Smoking status		
Yes	10	15.38%
No	55	84.62%
Medical history of pregnancy		
Primiparous	26	40.0%
Previous pregnancy	39	60.0%
Miscarriage		
0	57	87.69%
1	5	7.69%
> 1	3	4.62%
Induced abortion		
0	55	84.62%
1	6	9.23%
> 1	4	6.15%
Brith weight of the live-born infant, kg		
< 2.25	5	7.69%
2.25 - 4.2	52	80.0%
> 4.2	8	12.31%
Mortality and morbidity of fetal		
Death		
Yes	2	3.08%
No	63	96.92%
Morbidity		
None	59	90.77%
Mild	3	4.62%
Moderate	2	3.08%
Severe	1	1.54%

TABLE 2. Basic information of all last reviews (6) observed in this study.

<i>AUTHORS</i>	<i>NAME OF ARTICAL</i>	<i>Participants</i>	<i>AIM</i>	<i>Methods used</i>	<i>Year</i>
<i>Yuan X et al.</i>	<i>Prenatal ultrasound diagnosis and quality control of fetal nuchal</i>	<i>2214 cases</i>	<i>The study focuses on the accuracy of early pregnancy NT measures made by ultrasound</i>	<i>• The effectiveness of NT measurements was tracked in the 0.9–1.1 MoM range by each individual CRL NT-</i>	<i>2024</i>

	<i>translucency.</i>		<i>clinicians, the quality for fetal NT as well as CRL measurements, and the impact of enhanced fetal structural screening.</i>	<p>MoM.</p> <ul style="list-style-type: none"> • NT-MoM values sorted by number of years in service. • Data on chromosomal abnormalities, structural anomalies, and NT thickening were analyzed retrospectively. 	
Gang Guo et al.	Application of Complete Prenatal Diagnosis in Fetal Ultrasound Abnormalities.	685 cases	<i>to look at the importance of prenatal diagnosis of anomalies detected in fetal ultrasounds.</i>	<ul style="list-style-type: none"> • Samples gathered among June 2021 and January 2016. • An ultrasonography revealed structural anomalies. • Samples utilized for G manifest band karyotype testing and cell culture. 	2023
G Guo et al.	<i>Health Pregnancy, Healthy Baby: testing the added benefits of pregnancy ultrasound scan for child development in a randomised control trial</i>	100 cases	<ul style="list-style-type: none"> • Seek to enhance the growth and development for young children. • Examines the outcomes of nursing exclusively. Observe how parents and children interact. • Evaluate the attendance at prenatal and postnatal clinics. 	<ul style="list-style-type: none"> • In the course of standard antenatal service, all the parents are provided with a fetal ultrasound scan less than 25 weeks. • The participants undergo routine antenatal ultrasound scans and also additional scans within less than 25 weeks at the research site. • The participants undergo routine ultrasound scans at the research site and two additional scans. 	2020
Hosuk Ryou et al.	Automated 3-D Ultrasound Image Analysis for First Trimester Assessment of Fetal Health	44 cases	<ul style="list-style-type: none"> • Accommodates various fetal anatomies. • Comprises illustration and three-dimensional ultrasound imaging dimensions. 	<ul style="list-style-type: none"> • Carries out the segmentation of the image in regard to the item of interest (anatomical fetal parts). • Provides estimation for the plane angle with respect to biometry standard views. • Identifies the structures and performs estimation automatically. • Automatically finds fetal extremities in 3D data acquired in the first trimester. 	2019

				<ul style="list-style-type: none"> • Incorporates real study data set and separate clinical data set. • Comparison is made with the expert evaluation of the 3D volume in question. 	
T Omonuwa et al.	<i>Prenatal Maternal-Fetal Imaging for Global Health Radiology</i>	-----	<ul style="list-style-type: none"> • Practice is affected by geographical, legal, and sociopolitical traditions. • The use of obstetric imaging may help to decrease maternal and perinatal deaths. 	<ul style="list-style-type: none"> • The use of ultrasound in imaging before birth. • Assessment of the epidemiological statistics of under-developed countries. 	2014
Maeda K, et.al	<i>Contribution of an Ultrasound Tissue Characterization on Fetal and Neonatal Health</i>	----	<ul style="list-style-type: none"> • Utilizes objective B-mode imaging. • Employs echogenicity histogram analysis algorithm. • Utilizes off-the-shelf commercial B-mode equipment. 	<ul style="list-style-type: none"> • Uses Gray Level Histogram Width (GLHW) for tissue classification. • B-mode gain control is constant. • Avoids high imaging contrasts. 	2015

Table 3. Determining clinical findings of reviews in terms of limitations and contributions of the authors.

Authors	Contributions	Limitations
Yuan X et al.	<ul style="list-style-type: none"> • Develops and implements quality assurance for the assessment of fetal nuchal translucency (NT). • Assesses the quality of NT measurement performed by ultrasound physicians. 	<ul style="list-style-type: none"> • The process of maintaining the quality of NT and CRL images is not straightforward. • Complications in the imaging systems can be classified according to the very small quantitative differences.
Gang Guo et al.	<ul style="list-style-type: none"> • Soft markers were recognized as the primary fetal ultrasound anomalies. • Supplied the rationale for actions taken in the field of clinical genetic counseling. 	<ul style="list-style-type: none"> • Information on ultrasound images that support child development and family bonding.
G Guo et al.	<ul style="list-style-type: none"> • Examining the Effect of Ultrasound on Child Development and the Bond between Parent and Child. • Focusing on the Research 	<ul style="list-style-type: none"> • A deep learning and processing of images system

	<i>Problem of the Studies in Other Low- and Middle-Income Countries.</i>	
Hosuk Ryou et al.	<ul style="list-style-type: none"> • <i>Biometric measurements in the first-trimester 3D ultrasound are automated.</i> • <i>Mapping critical features concerning the fetus and automated performing of biometric measurements.</i> 	<ul style="list-style-type: none"> • There is a scarcity of studies that focus on the automation of first-trimester ultrasound images. • Target anatomy will be limited to certain structures. A full assessment will not be performed.
T Omonuwa et al.	<ul style="list-style-type: none"> • Investigates the factors behind maternal and fetal illness and death. • Supports the use of ultrasound during pregnancy for better health results. 	<ul style="list-style-type: none"> • Customs associated with the region, law, and politics have effects on professional ultrasonography. • Almost no progress has been made on maternal-fetal health upon the allocation of resources.
Maeda K, et al.	<ul style="list-style-type: none"> • Fibrin deposits have been identified within the intervillous space of the placenta. • Evaluated fetal brain echo pattern and degree of development of fetus' lungs. 	<ul style="list-style-type: none"> • All conditions are not strikingly clear before birth.

Table 4. Determining literature's conclusion's reviews of participants.

Authors	Conclusions
Yuan X et al.	<ul style="list-style-type: none"> • Quality control raises the NT measurements' precision. • Measurements performed by skilled doctors are more in keeping with expectations. • Accuracy is increased by fetal NT as well as CRL monitoring. • Chromosome abnormality detection is improved by structural screening.
Gang Guo et al.	<ul style="list-style-type: none"> • Soft indicators of abnormalities are fetal ultrasonography abnormalities. • Of all the soft ultrasonography signs, there is the highest risk of fetal chromosomal disorders. • There is no age-related rise in incidence. • There is no discernible variation in the prevalence of chromosomal abnormalities between the high and low age groups.
G Guo et al.	<ul style="list-style-type: none"> • Assessing the additional advantages of pregnancy ultrasound scans in enhancing child development is a research gap that the suggested trial in South Africa aims to fill.
Hosuk Ryou et al.	<ul style="list-style-type: none"> • Employs neural networks based on fully convolutional networks (FCN). • The initial exploration of concurrent automated biometry on a single volume of trimester 3-D scans.

	<ul style="list-style-type: none"> • Strives for doing biometry at a level that can compete with manual measurements in 3-D fetal ultrasound fully automatically.
T Omonuwa et al.	<ul style="list-style-type: none"> • Gaining access. • Responsible management. • Changes in society and education. • Millennium Development Goals attainment.
Maeda K, et al.	<ul style="list-style-type: none"> • Applied in the non-invasive in vivo assessment of pathology of the fibrin content of the placenta's intervillous space, tumors, periventricular echogenicity of the brain of a fetus with an immature lung, amniotic fluid contaminated with meconium, and healthy parenchyma of the liver in adults.

Table 5. Distribution of problem statement and findings for participants.

Authors	Problem statement	Findings
Yuan X et al.	<ul style="list-style-type: none"> • Ensuring accurate measurements of fetal nuchal translucency (NT) and crown-rump length (CRL) is often difficult. • Minor discrepancies in measurement may result in incorrect findings. 	<ul style="list-style-type: none"> • 36 incidents, representing 20.34% of total abnormalities per 100 examined cases • 36% of tested patients showed a positive result for chromosome aberrations.
Gang Guo et al.	<ul style="list-style-type: none"> • Evaluate the usefulness of prenatal examination in the presence of ultrasound fetal anomalies. • Concentrate on fetal anatomical defects and their soft markers. 	<ul style="list-style-type: none"> • In 9.64% of cases, there were aberrations in the chromosomal structure.
G Guo et al.	<ul style="list-style-type: none"> • Assessing the Effect of Ultrasound on Child Growth and Parent-Child Bond. • Responding To Deficiencies Is the Studies from Low and Middle Incomes Countries. 	<ul style="list-style-type: none"> • Assessment of the Efficacy of Ultrasound on Child Development and Attachment of Parents with the Infants. • Three-armed trial with 100 mothers and partners in Soweto.
Hosuk Ryou et al.	<ul style="list-style-type: none"> • The first-trimester fetal ultrasound examination shows limited pattern recognition capability. • Detailed analysis of different fetal anatomies is necessary. 	<ul style="list-style-type: none"> • The accuracy of automated methods approaches human expert assessment. • Algorithms developed illustrate important fetal structures and conduct biometrics.
T Omonuwa et al.	<ul style="list-style-type: none"> • The death rate driven by complications in pregnancy and childbirth in the developing world is still excessively high, posing a serious challenge. • There has been little improvement in the trends over the years, though resources and the world's focus have increased. 	<ul style="list-style-type: none"> • Despite the allocation of resources, high maternal mortality remains a characteristic feature of many developing countries. • Maternal and perinatal mortality can be decreased with the use of prenatal ultrasonography.
Maeda K, et al.	<ul style="list-style-type: none"> • Analysis of objective ultrasound B-mode images with the aim to discriminate tissue types using texture parameters. • Diagnosis of fetal growth restriction and neoplasms. 	<ul style="list-style-type: none"> • The presence of heparin in a neonate with vascular obstruction due to fibrin deposits caused no effect. • Elevated GLHW was observed in cancers as well as in cases with meconium-stained amniotic fluid.

4. DISCUSSION

Because prenatal ultrasonography enables doctors to closely observe the fetus's growth and development in utero, it is an essential tool for safeguarding the health of the developing foetus [21,22,23]. This non-invasive imaging method can reveal important details about the architecture of the fetus, including its heart, brain, spine, and various other essential organs. Early detection of any anomalies or consequences can provide prompt action and care. [24]

Pregnancy assessment through, for instance, obstetric ultrasound, allows early diagnosis of many abnormalities, contributing positively to maternal and fetal relationships as well as decision-making. New Technologies and quality assurance measures ensure it is very effective. [25]

Ultrasound is an invaluable imaging modality in the evaluation of fetal growth parameters and in the detection of structural anomalies; this has helped to considerably lower perinatal complications and deaths. According to the study, the incidence of chromosomal abnormalities was high for fetuses with increased nuchal translucency thickness, which demonstrates the need for screening at the earlier ages. [26,27,28]

Studies show that ultrasound imaging could also promote parent engagement and positive parent-infant interactions, thereby supporting the healthy growth of the infant. One particular reason why their bond is improved is the emotional feeling that parents derive from viewing their unborn baby during reaching the scanning phase of the pregnancy. [29,30,31]

5. CONCLUSION

The onset of ultrasound imaging in the prenatal diagnosis has proven to be beneficial in detecting possible existing conditions and performing preventative measures which in turn enhances the care woman receives before giving birth and the outcomes of pregnancy as a consequence.

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