RESEARCH PAPER

Impact of Color Doppler on the False Positive Rate of Oligohydramnios Diagnosis: A Systematic Review

Syed Sami Ahmad Samar Bukhari[1], Dr. Zohaib Shahid[2], Muhammad Naveed Babur[3], Amna Noor[4*], Misbah Karim[5], Iqra Abdul Razaq[6], Syed Asadullah Arslan[7]

[1]Faculty of Allied Health Sciences, Superior University, Lahore
Email: samibukhari79@gmail.com
[2]Associate Professor, Faculty of Allied Health Sciences, Superior University, Lahore
Email: zohaib.rana@superior.edu.pk
[3]Professor/Dean, Faculty of Allied Health Sciences, Superior University, Lahore
Email: Naveed.babur@superior.edu.pk
[4]Faculty of Allied Health Sciences, Superior University, Lahore
Email: amnanoor0988@gmail.com
[5]Faculty of Allied Health Sciences, Superior University, Lahore
Email: mishalmid@gmail.com
[6]Faculty of Allied Health Sciences, Superior University, Lahore
Email: iqrabhatti0988@gmail.com
[7]Department of Physical Therapy and Rehabilitation Sciences, Faculty of Allied Health Sciences, Superior University, Lahore
Email: asadshahgilani@gmail.com
***Corresponding Author:** Amna Noor, Faculty of Allied Health Sciences, Superior University, Lahore
Email: amnanoor0988@gmail.com

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ABSTRACT

Introduction:
Accurate assessment of amniotic fluid volume is essential for identifying pregnancies at risk of oligohydramnios and for guiding clinical management. The Amniotic Fluid Index is widely used in obstetric ultrasound, but reliance on AFI, particularly when combined with Color Doppler imaging, may reduce diagnostic accuracy. Emerging evidence suggests that these approaches increase false-positive diagnoses of low amniotic fluid without improving perinatal outcomes.

Objective:
To systematically review the impact of Color Doppler-assisted AFI measurement on the false positive rate of oligohydramnios diagnosis and to compare AFI with alternative ultrasound techniques, including the Single Deepest Pocket (SDP) and Maximum Vertical Pocket (MVP).

Methodology:
A systematic literature review was conducted following the PRISMA framework. The PICO framework guided study selection, focusing on third-trimester pregnancies, AFI measured with Color Doppler compared to Grey Scale ultrasound, and diagnostic outcomes. Methodological quality was assessed using the CASP checklist.

Results:
Sixteen studies, including randomized controlled trials, observational studies, systematic reviews, and meta-analyses, met the inclusion criteria. Three studies demonstrated that Color Doppler significantly lowers AFI measurements, leading to increased diagnosis of oligohydramnios without improvement in perinatal outcomes. Ten studies comparing AFI with SDP or MVP consistently showed higher rates of oligohydramnios diagnosis and obstetric interventions with AFI. Three studies examining borderline AFI reported mixed outcomes, with some indicating similar fetal assessment results to normal AFI, while pooled analyses revealed increased intervention and adverse outcome rates.

Conclusion:
The addition of Color Doppler to AFI measurement and the continued use of AFI as a primary assessment method contribute to overdiagnosis of oligohydramnios. Alternative pocket-based ultrasound techniques may reduce false positives and unnecessary interventions without compromising maternal or neonatal outcomes.

Keywords: Oligohydramnios, Amniotic Fluid Index, Color Doppler Ultrasound, Single Deepest Pocket, Overdiagnosis, Pregnancy Outcomes

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Introduction

Oligohydramnios is a condition in pregnancy characterized by a reduced volume of amniotic fluid surrounding the fetus (Rabie et al., 2017). Amniotic fluid plays a vital role in fetal growth and development by allowing movement, cushioning against external pressure, supporting lung maturation, and maintaining a stable temperature within the uterus (Zilberman Sharon et al., 2022). Clinically, oligohydramnios is most commonly diagnosed during the third trimester and is associated with complications such as fetal growth restriction, umbilical cord compression, increased risk of operative delivery, and adverse perinatal outcomes. Due to these potential risks, accurate assessment of amniotic fluid volume is essential for appropriate clinical decision-making and timely intervention (Bynarowicz et al., 2025).

The conventional approach to assessing the volume of amniotic fluid is ultrasound that has been in use over the decades. The Amniotic Fluid Index (AFI) was one of the most popular methods that was developed in the 1980s and became a standard measure in the sphere of obstetrics in 1988 (Mousavi et al., 2018). AFI is the division of the uterus into four quadrants and adding the deepest vertical fluid pocket in each of the quadrants (Sajjad, 2025). Oligohydramnios is commonly defined as below 5 cm AFI whereas 5 to 8 cm is regarded as a borderline (Madendag et al., 2019). AFI measurements traditionally have been done by use of grey scale ultrasound that gives a two-dimensional visual image without information of blood flow. It is very easy to use and is available, and thus has found extensive acceptance in clinical settings worldwide (Singh & Gautam, 2023).

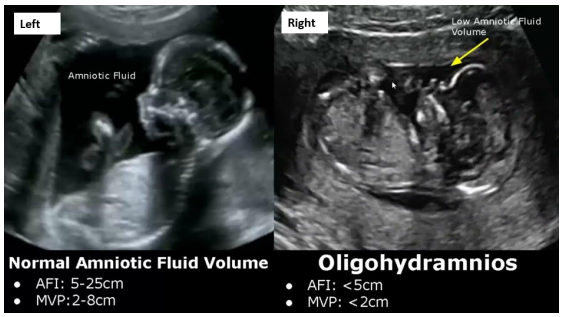


Figure 1: Ultrasound comparison of amniotic fluid volume: The left image shows normal amniotic fluid volume (AFI 5–25 cm, MVP 2–8 cm) versus oligohydramnios, characterized by markedly reduced fluid (AFI <5 cm, MVP <2 cm) on right.

As ultrasound technology became superior, it was then followed by the introduction of Color Doppler imaging to show the flow of blood in vessels, especially the umbilical cord and fetal circulation (Brzozowska et al., 2022). Gradually, it was observed that some clinicians started using Color Doppler when measuring AFI so that fluid pockets would not take into account areas that are occupied by umbilical cord (Odibo et al., 2017). The logic of this solution was that Doppler scan had the potential to enhance the accuracy by differentiating between actual amniotic fluid cavities and the ones containing cord (Jha et al., 2023). But, Color Doppler enhances the visualization of vascular structures; nevertheless, its effect on the diagnosis of oligohydramnios has been controversial (Hughes et al., 2020; Sekhon et al., 2021).

A number of researchers have indicated that AFI measurements using Color Doppler during the AFI measurement procedure can lead to low AFI scores than measurements of using the Grey Scale ultrasound (Urmee et al., 2022; Zlatnik et al., 2003). This is because color Doppler can easily indicate the existence of umbilical cord in pockets that are fluid-filled on grey scale and hence no measurement is made. This would consequently lead to a reduction in the overall AFI, which would put more pregnancies into the category of low amniotic fluid (Goldkrand et al., 2003). This brings up the issue of the possibility of false positive oligohydramnios diagnosis, in which the amount of

fluid in the body may not have actually been low enough to cause a clinically significant level of concern (Thobbi & Sabahath, 2017).

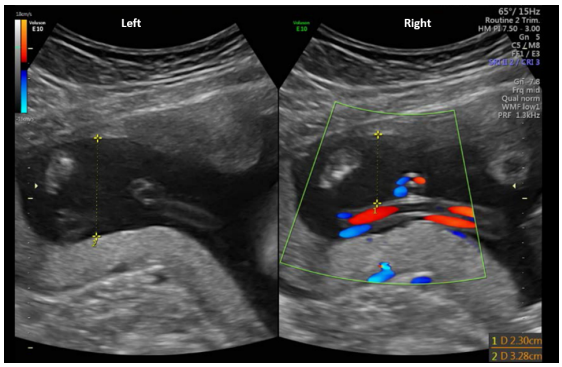


Figure 2: The left side of the screen uses a regular (gray-scale) ultrasound, and the right side uses color Doppler. The size of the amniotic fluid pocket is then measured (Magann et al., 2021).

The problem of false positive diagnosis is relevant to the obstetrics, as it may result in needless measures like increased monitoring, premature labor induction, or a caesarian operation (Jagatia et al., 2013). Although these interventions save lives in case of positive oligohydramnios, it becomes potentially dangerous to both the mother and the fetus in case of incorrect diagnosis (Zilberman Sharon et al., 2022). Overdiagnosis can also augment the expenditure on healthcare and maternal apprehension. Hence, a clearer insight into whether or not Color Doppler brings about a greater incidence of overdiagnosis would be instrumental in optimization of the ultrasound practices and delivering evidence-based care (Figueroa et al., 2020).

Over the past years, the growing body of research has suggested that AFI as a method of measurement is more likely to detect more cases of oligohydramnios than the other methods of measurement like single deepest vertical pocket (SDP) method (Yousaf et al., 2021). A number of meta-analyses and randomized controlled studies have proven that AFI-based assessment is linked to an increased rate of diagnosis and obstetric intervention without any substantial increase in perinatal outcomes (Bui et al., 2022). Though these studies are mainly on AFI in relation to SDP, these studies just support the overall issue that some of the techniques in measuring may inflate the circumstances that establish the presence of low amniotic fluid. In that regard, the incremental value of Color Doppler on AFI measurement deserves close consideration (Wax & Pinette, 2022). There is some limited evidence of early comparative studies that Doppler-assisted measurements can decrease AFI values, although more recent studies are concerned with the outcome of clinical performance and the measurement accuracy in general. Moreover, there is a growing interest in clinical guidelines in the use of standardized ultrasound methods but divergence in the use of Color Doppler as a routine part of fluid assessment (Bui et al., 2022; Goldkrand et al., 2003).

Since the clinical implications of overdiagnosis are serious and the practice of obstetric imaging changes and evolves, there is a need to conduct a systematic literature review to determine whether the application of the Color Doppler in the AFI measurement is associated with false positive rate increase (Odibo et al., 2017). The critical synthesis of existing evidence can aid clinicians to perceive the actual effect of Doppler-assisted measurements, and critical gaps in existing research, as well as the best practice guidelines regarding the ultrasound evaluation of the amniotic fluid volume (Siqueira et al., 2013). Hence, this proposed systematic literature review will evaluate and synthesize studies on the role of Color Doppler in the assessment of the AFI measurement during the application of the technique versus the use of the Grey Scale ultrasound on the diagnosis of oligohydramnios with emphasis on the prevalence of overdiagnosis or false positive results. This review aims to make explicit and evidence-based conclusions that can be applied in clinical decision-making and future studies in obstetric imaging, by using systematic methodological frameworks and quality assessment instruments.

Methodology

Research Design

In this research, the design that was adopted was the systematic literature review in an attempt to determine how the application of the Color Doppler in measuring the amniotic fluid index (AFI) affects false positive diagnosis of oligohydramnios. A systematic methodology was chosen in order to guarantee transparency, reproducibility and extensive finding of applicable studies. The review was conducted based on the Preferred Reporting Items of systematic reviews and meta-analyses (PRISMA) guidelines, to inform the procedure of the study identification, screening, evaluation of eligibility, and inclusion.

Research Framework (PICO)

The research question was formulated based on the PICO framework and utilized in search strategy and study selection process. The third trimester of pregnant women was used as the population (P). The intervention (I) entailed the AFI measurement

which was conducted by use of the Color Doppler ultrasound. The comparison (C) consisted of using AFI measurement with the help of Grey Scale ultrasound only. O was related to the rate of false positive over-diagnosis of oligohydramnios. The inclusion of these components provided by definition meant that the review was focused on the studies directly related to the research objective and was used to generate similar inclusion criteria.

- Population (P): Third trimester pregnant women.
- Intervention (I): AFI evaluation by means of color Doppler ultrasound.
- Comparison (C): AFI measurement by measuring with Grey Scale ultrasound.
- Outcome (O): False positive or over-diagnosis of oligohydramnios.

Search Strategy

An extensive literature review has been performed in the largest scholarly databases: Google Scholar, Pubmed, Scopus, and Web of Science. It was searched by multiple combinations of keywords and Boolean operator based on the PICO framework. The keywords were: Color Doppler, Amniotic Fluid Index, Grey Scale ultrasound, oligohydramnios, false positive diagnosis, overdiagnosis and amniotic fluid measurement.

Each database had search strings that were slightly modified to maximize the search results. Moreover, the reference lists of the relevant articles were searched manually to find more research that might not have been found in the initial search in the database. The search was mainly restricted to the studies that were published within the past decade in order to maintain the current relevance but older landmark studies that directly compared the use of Color Doppler and Grey Scale AFI measurements were also considered since the studies were significant in the field.

Inclusion and Exclusion Criteria.

There was a clear set of eligibility requirements to make it consistent and relevant. The studies were selected on the basis of including pregnant women in the third trimester, making comparison of the AFI measurements with the use of the Color Doppler and the Grey Scale ultrasound or the assessment of the measurement methods associated with overdiagnosis, and the results of the studies were reported based on the outcomes of diagnosis rates, reliability or clinical implications of the low amniotic fluid detection. Randomized controlled trials, observational studies, case studies, systematic reviews and meta-analyses that were published in English were considered.

The studies were eliminated according to the following criteria: they concentrated only on Doppler measurement of fetal blood flow without any reference to amniotic fluid measurement, they had not concentrated on first or second trimester pregnancies, did not have comparative data, and were an editorial, conference abstract with no full-text, and animal researches. This made sure that it retained only the high relevance human clinical researches in the review findings.

Study Selection Process

The selection of studies was based on the PRISMA. First, all the identified articles were placed in a reference management system and the duplicates were eliminated. Abstracts and titles were subsequently filtered in order to remove obviously irrelevant studies. The rest of the articles were reviewed in their full text in order to determine their eligibility according to the inclusion and exclusion criterion.

The uncertainties arising during the study inclusion would be addressed by thoroughly considering the study objective, methods, and outcomes. The evidence base used in the data extraction and synthesis was made up of the final set of included studies. The number of records identified, screened, excluded and included at each stage of the process was graphically represented by the PRISMA flow diagram.

Quality Assessment

The Critical Appraisal Skills Programme (CASP) checklists were used to determine the methodological quality of included studies and they were based on the correct checklists depending on individual study design. The studies were independently checked according to the relevant CASP criteria and then divided into the high-quality, moderate-quality, and low-quality ones in accordance with the overall performance. Research papers that had major methodological constraints were not automatically excluded, but received lower weight when the results were interpreted.

Data Extraction

A data extraction form was designed which was on a standard format to select the information which was pertinent to each study included. Data that were extracted were author name, publication year, country of study, study design, author sample size,

gestational age range, method of AFI measurement, Color Doppler use, comparison technique, reported diagnosis rates, and important findings regarding false positive or overdiagnosis rates. This systematic strategy provided consistency in studies and helped in comparing study results. In cases where needed, more information was obtained by reading other supplementary materials that were given in the articles.

Data Synthesis

A narrative synthesis technique was adopted because of the differences in the study designs, the method of measurement, and the reported findings. Results were categorised according to similarities in methodology, and outcome focus, like direct Color Doppler verses Grey Scale AFI comparisons and papers that assessed overdiagnosis on the basis of measurement methods. Changes in AFI values with the use of Doppler, variations in the frequency of the diagnosis, and clinical intervention implications were identified as the patterns and trends in the studies. In the events where feasible, randomized controlled trials and meta-analyses outcomes were highlighted to increase the strength of conclusions.

Results

The initial database search conducted across Google Scholar, PubMed, Scopus, and Web of Science identified approximately 509 records published between 2000 and 2024. After removal of duplicate studies, 465 unique articles remained for title and abstract screening. Of these, 297 records were excluded due to irrelevance to amniotic fluid assessment methods, population outside the third trimester, or lack of comparative diagnostic outcomes. The full texts of 123 potentially relevant studies were then assessed for eligibility. Following application of the predefined inclusion and exclusion criteria, 82 studies were excluded for reasons such as absence of Color Doppler or AFI-related outcomes, insufficient methodological detail, or inappropriate study design. The remaining 38 studies underwent quality appraisal using the CASP checklist, which resulted in the exclusion of 22 studies due to high risk of bias or poor methodological quality. Consequently, a total of 16 studies were deemed suitable and were included in the final qualitative synthesis of this systematic review.

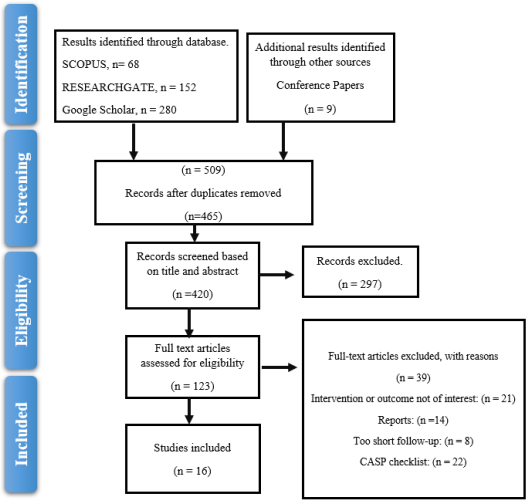


Figure 3: PRISMA flowchart of study selection: Out of 509 records identified, 16 studies met the eligibility and quality criteria and were included in the final review

Table 1: Characteristics and Key Findings of Included Studies (n = 16)

Author	Study Design	Sample Size / Population	Gestational Age	AFI Measurement Methods	Key Findings
Odibo et al.	Prospective comparative study	428 women	Term	AFI & SDP by Grey Scale and Color Doppler	Color Doppler significantly lowered AFI and SDP and increased low AFV diagnosis without improving outcomes.
Goldkrand et al.	Comparative observational study	77 pregnancies	22–41 weeks	AFI by Grey Scale and Color Doppler	Color Doppler produced lower AFI and classified up to 16% of borderline cases as oligohydramnios.
Magann et al.	Prospective diagnostic accuracy study	67 pregnancies	Mean 37.1 weeks	AFI & SDP with/without Color Doppler	Color Doppler increased oligohydramnios diagnosis from 3% to 21%, falsely labeling normal volumes.
Sekhon et al.	Systematic review & meta-analysis	6 RCTs (4,278 women)	Term	AFI vs MVP	MVP reduced oligohydramnios diagnosis and interventions without worse outcomes.
Kehl et al.	Multicenter RCT	1,052 women	Term	AFI vs SDP	AFI diagnosed more oligohydramn

					ios (9.8% vs 2.2%) and increased inductions without outcome benefit.
Kehl et al.	Multicenter RCT	SAFE trial cohort	Term	AFI vs SDP	AFI associated with higher low-fluid diagnosis and induction rates without perinatal improvement.
Rehman et al.	Randomized controlled trial	110 women	Term	AFI vs SDVP	AFI showed higher oligohydramnios diagnosis and higher caesarean
					section rates.
Haroon et al.	Prospective comparative study	110 women	Late pregnancy	AFI vs SDVP	Oligohydramnios significantly higher with AFI and more maternal complications.
Gunasingha et al.	Prospective observational study	448 pregnancies	≥37 weeks	AFI vs SDVP	AFI predicted more inductions, while SDVP better predicted adverse perinatal outcomes.
Naghizadeh et al.	Case-control study	300 women	Late pregnancy	Borderline AFI vs normal AFI	Borderline AFI showed similar NST and BPP

					results to normal AFI, suggesting limited clinical difference.
Sgayer et al.	Systematic review & meta-analysis	8 studies (2,311 women)	Low-risk singleton	Borderline AFI vs normal AFI	Borderline AFI associated with higher cesarean rates, low Apgar, LBW, and NICU admission.
Javad et al.	Prospective observational study	163 women	37–40 weeks	AFI measurement	Borderline AFI linked to high rates of low Apgar scores and NICU admissions.
Whittington et al.	Narrative review & guideline synthesis	Multiple studies	Antenatal period	AFI, SDP, ultrasound estimation	AFI often results in higher oligohydramnios diagnosis; definitions vary across guidelines.
Whittington et al.	Review article	Multiple trials & guidelines	Antenatal period	AFI vs SDP	Higher diagnosis rates with AFI; authors propose standardized management algorithms.
Wax & Pinette	Narrative review of RCTs & meta-analyses	6 RCTs + 2 meta-analyses	Late pregnancy	AFI vs SDP	AFI leads to more oligohydramnios diagnoses and interventions, though

					authors consider AFI acceptable.
Singh et al.	Retrospective observational study	Term pregnancies	Term	AFI vs SDVP	Low AFI or SDVP associated with higher induction and cesarean rates; SDVP showed better reliability for maternal outcomes.

Effect of Color Doppler on AFI Measurements

Three studies directly examined the impact of incorporating Color Doppler sonography into amniotic fluid volume assessment compared with conventional Grey Scale ultrasound. In these studies, the general result was that the values of amniotic fluid measured using the Color Doppler were lower by a significant margin. According to Odibo et al., the AFI and single deepest pocket measurements were significantly decreased in the presence of Color Doppler and both the Grey Scale and Doppler based measurements were in good agreement. On the same note, Goldkrand et al. noted that the AFI values calculated with the use of Color Doppler are lower in the vast majority of cases, especially in the borderline AFI range, where the application of Doppler produced a significant increase in the oligohydramnios classification. This trend was also achieved by Magann et al. who found out that the use of Color Doppler, in combination with measurement tools, significantly decreased the measurements of AFI and single deepest pocket as compared to the measurements made without Doppler aids.

Notably, these amniotic fluid volume decreases in measured volume were converted into increased low fluid diagnosis cases without proportional clinical outcomes. Odibo et al. did not observe any significant difference in perinatal complications or neonatal outcome in cases of low fluid measured by Color Doppler of the pregnancy compared with the case measured using the grey Scale ultrasound. Similarly, Magann et al. showed that the greater failure to identify oligohydramnios with Doppler compared to dye-dilution reference values led to the misclassification of normal pregnancies as oligohydramnios. Taken together, these results indicate that the inclusion of Color Doppler with AFI testing can lead to an overdiagnosis of low amniotic fluid (by eliminating fluid masses that hold umbilical cord ulcers) which in turn causes the reduction in the aggregate AFI values without enhancing anticipation of adverse birth outcomes.

Table 2: Comparison of oligohydramnios diagnosis using AFI and SDVP/MVP across key studies: Across the included studies, the amniotic fluid index consistently identified a higher proportion of pregnancies as having oligohydramnios compared with the single deepest vertical pocket or maximum vertical pocket methods.

Study	AFI Diagnosis (%)	SDVP/MVP Diagnosis (%)	Key Finding
Sekhon et al., 2019 (Meta-analysis)	Higher (RR reference)	Reduced by 62% (RR 0.38)	MVP significantly lowers diagnosis
Kehl et al., 2015 (SAFE Trial)	9.8%	2.2%	AFI overdiagnosed
Rehman et al., 2022	34.5%	20.0%	AFI higher detection
Haroon et al., 2020	13.6%	2.7%	AFI significantly higher
Gunasingha et al., 2022	Higher	Lower	AFI detects more cases

Comparison of AFI with SDP/MVP in the Diagnosis of Oligohydramnios

- **Clinical Impact of AFI Versus SDP in Oligohydramnios Diagnosis**

A number of large-scale clinical trials compared Amniotic Fluid Index (AFI) with Single Deepest Pocket (SDP) method and repeatedly proved that AFI recognizes more pregnancies as oligohydramnios. The Kehl et al. (2016) multicenter randomized controlled trial that involved 1,052 term pregnancies in four hospitals in Germany revealed that oligohydramnios was much more frequently diagnosed in the AFI group (9.8%), than in SDP group (2.2%). This augmented diagnosis when coupled with elevated rates of labor induction to treat oligohydramnios in the AFI sample whereas admissions to a neonatal intensive care unit were equal across groups. These findings were also validated by a follow-up report by Kehl et al. (2018) on the same cohort of the SAFE trial, which found the rates of higher diagnosis and intervention did not increase with the use of AFI by itself with no perinatal outcome improvement.

These trends were also found in smaller clinical studies. Rehman et al. (2022) randomly selected 110 women in Rawalpindi, 55 women were examined by AFI and 55 by SDP. The researchers cited a greater prevalence in the diagnosis of oligohydramnios in the AFI group (34.5) than in

the SDP group (20.0) as well as higher rates of caesarean. Even in a prospective comparative study of 110 pregnant women, Haroon et al. (2020) reported a significantly high detection of oligohydramnios in the AFI group (13.6) over the SDP group (2.7) with more maternal complications. In combination, these studies suggest that AFI regularly reports more pregnancies as being low amniotic fluid than SDP, which results in more clinical intervention.

- **Limitations of AFI in Predicting Adverse Outcomes**

The review and meta-analysis by Sekhon et al. (2021) comprised six randomized controlled trials of 4,278 women, who compared AFI and the Maximum Vertical Pocket (MVP) technique. The meta-analysis indicated that the MVP use had a significant lowering effect on the diagnosis of oligohydramnios (relative risk 0.38), and also it had lower rates of labor induction, caesarian section due to fetal distress and non-reassuring fetal heart tracing with no deterioration of the perinatal outcomes. These results indicate that AFI is prone to exaggerating the low fluid conditions in comparison with other assessments methods.

This pattern also can be seen by observational evidence. The article by Gunasingha et al. (2022), who examined 448 singleton term pregnancies in Sri Lanka, concluded that low AFI indicated more labor induction, whereas SDP predicted more adverse perinatal outcomes evaluated as operative childbirth and low Apgar scores. Moreover, these results were supported by a number of narrative reviews and guideline-based analyses. The authors of the review of clinical studies and international guidelines emphasize that AFI often leads to more cases of oligohydramnios diagnosis than SDP, and the management recommendations differ significantly across organizations (Whittington et al., 2024). Likewise, Wax and Pinette (2022) who examined six randomized trials and two meta-analyses also admitted that AFI results in more diagnoses and interventions but claimed that AFI is still an acceptable approach. On the whole, the combination of evidence suggests that AFI, especially in case of Doppler techniques of measuring it, leads to a higher number of low amniotic fluid being detected, with no reliable results regarding the outcomes of pregnancy.

Outcomes Associated with Borderline or Low Amniotic Fluid Index

Three of the studies in particular focused their attention on the clinical outcomes of borderline or low amniotic fluid index (AFI) in order to assess whether the classifications are indicative of actual fetal risk. A case-control study was carried out by Naghizadeh et al. (2025) in the population of 300 pregnant women (150 borderline AFI and 150 normal AFI). The authors did not significant differences between the two groups in the main fetal surveillance tests like non-stress test and biophysical profile, which indicated that borderline AFI might be not linked with any meaningful worsening of the fetal well-being. Despite the higher perception of decreased fetal movements in women with borderline AFI, the overall clinical assessment outcome was not different with borderline AFI classification and normal AFI, suggesting that there is low diagnostic power of borderline AFI classification.

Conversely, a systematic review and meta-analysis by Sgayer et al. (2025) of eight observational studies involving 2,311 singleton pregnancies showed that borderline oligohydramnios was being strongly linked with much higher risks of adverse perinatal results. These were marked with increased caesarean birth rates, low Apgar reading, low birth weight, and the neonatal intensive care unitization when compared to the pregnancies with normal AFI. In line with these results, Javad et al. (2025) performed a prospective observational study of 163 term pregnancies diagnosed with isolated borderline AFI and found that the rates of neonatal morbidity were high, especially low Apgar scores and high rates of NICU admission. Collectively, these studies indicate that there is variability in the clinical significance of borderline AFI, with some evidence finding little effect on the results of fetal testing, and larger pooled studies finding more intervention and negative consequences.

Table 3: Key themes in amniotic fluid assessment.Color Doppler tends to lower AFI values and increase diagnoses of oligohydramnios, while AFI identifies more low-fluid cases than SDP/MVP without clear improvement in outcomes; evidence on borderline AFI remains mixed, leading to clinical uncertainty

Theme	Number of Studies	Main Evidence	Clinical Implication
Effect of Color Doppler on AFI	3	Doppler consistently reduced AFI values and increased	Increased false positive oligohydramnios

		diagnosis of low fluid	
AFI vs SDP/MVP comparison	10	AFI diagnosed more oligohydramnios and led to more interventions	Overdiagnosis without improved outcomes
Outcomes of borderline AFI	3	Mixed results; some similar to normal AFI, others linked to adverse outcomes	Clinical uncertainty and increased monitoring

Discussion

This is a systematic literature review study that discussed the effect of the use of Color Doppler during amniotic fluid index (AFI) measurement and the overall role of AFI over other methods of ultrasound in diagnosing oligohydramnios. The results are consistent in that the implementation of Color Doppler in the AFI evaluation results in a reduction in the measured amniotic fluid and higher rate of low fluid diagnosis without enhanced prediction of adverse birth outcomes (Yousaf et al., 2021). Direct comparative studies of the ultrasound ratings of Gray Scale and Color Doppler showed that the Doppler imaging will regularly overlook fluid pockets enclosing umbilical cord structures, thus lowering the AFI values and also adding to false positive classification of oligohydramnios. Notably, these reduced values were not associated with an increase in the perinatal complication rates, indicating that Color Doppler-assisted AFI can overestimate clinical risk (Javad et al., 2025, Odibo et al., 2017).

Along with Doppler-specific results, there was solid evidence based on randomized controlled trials, meta-analyses and observational studies demonstrating that the AFI method is more likely than the Single Deepest Pocket (SDP) or Maximum Vertical Pocket (MVP) method to detect cases of oligohydramnios. The use of AFI in large trials like the SAFE trial and pool analyses such as the ones by Sekhon et al. showed that the diagnosis of oligohydramnios and obstetric interventions, especially labor induction and cesarean section were significantly increased but without any change in neonatal outcome. The evidence in these findings confirms the perspective that AFI is perhaps a highly sensitive test and can be over-diagnosed thus subjecting patients to redundant clinical procedures (Wax & Pinette, 2022).

The analysis of borderline AFI also indicated the uncertainty in the clinical significance of low or borderline fluid measures. Although a few of the researches have indicated that there is no fetal surveillance difference between borderline and normal AFI groups, a greater pooled analysis indicated that there are risks of adverse outcomes and higher rates of intervention in borderline oligohydramnios. This discrepancy hints at the fact that although borderline AFI does not necessarily imply a compromised fetus, it often leads to more frequent monitoring and obstetric interventions, which could be a source of medical overuse (Bui et al., 2022, Huri et al., 2023).

Taken together, the evidence indicates that addition of Color Doppler to AFI measurement, as well as AFI method, both, predisposes the chances of diagnosing oligohydramnios as compared to other ultrasound methods. This overdiagnosis has the potential of exposing pregnant women to interventions that have no apparent benefit to motherly or neonatal outcomes. Such results align with the existing trends in clinical guidelines that give preference to SDP or MVP techniques of amniotic fluid evaluation. Nevertheless, changes in the recommendations of different guidelines and the current discussions on the best methods of measurement mean that additional high-quality studies are required (Sgayer et al., 2025, Sajjad, 2025). The next round of research ought to be on standardized measurement guidelines and the long-term clinical outcomes to come up with the best approach of assessing amniotic fluid, that is accurate and of clinical value. False positive diagnoses should be minimized so that unnecessary interventions may be avoided and proper attention given to pregnancies at risk as such (Bynarowicz et al., 2025).

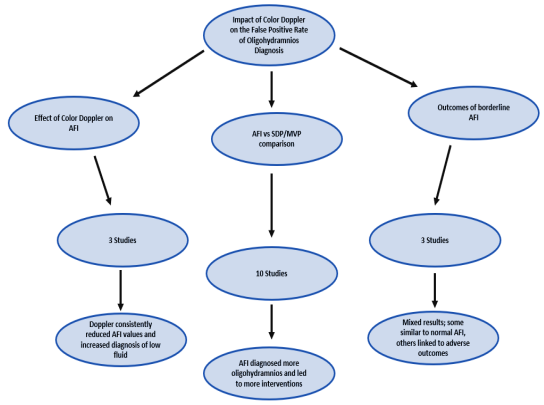


Figure 4: NVivo concept map summarizing thematic findings from the included studies.: Three studies showed that use of color Doppler consistently reduced AFI values and increased the diagnosis of low amniotic fluid, while ten studies comparing AFI with SDP/MVP reported higher rates of oligohydramnios diagnosis and intervention with AFI. Three additional studies on borderline AFI showed mixed outcomes, with some findings similar to normal AFI and others associated with adverse perinatal outcomes.

Conclusion

This systematic literature review proves that the addition of the use of Color Doppler in measuring amniotic fluid index, and the persistence of use of AFI as the primary method of assessment is added to the increased diagnosis of oligohydramnios with no consistent evidence of better perinatal outcomes. Research studies have repeatedly demonstrated that Color Doppler reduces values of measured fluid and raises false positive results of low amniotic fluid, with comparisons of AFI with other methods of measuring such as the Single Deepest Pocket and the Maximum Vertical Pocket showing higher rates of diagnosis and intervention with AFI. Despite the variability of outcomes associated with borderline AFI, the evidence in general is that the common consequences of overdiagnosis is the unnecessary obstetric interventions. These results confirm the use of simpler pocket-based ultrasound methods to conduct amniotic fluid evaluation preferentially and emphasize the necessity of standardized measurement methods to decrease the number of false positive diagnoses without endangering patients.

References

Brzozowska, A., Stankiewicz, T., Błaszczyk, B., Chundekkad, P., Udała, J., & Wojtasiak, N. (2022). Ultrasound parameters of early pregnancy and Doppler indices of blood vessels in the placenta and umbilical cord throughout the pregnancy period in sheep. *BMC Veterinary Research, 18*(1), 326.

Bui, L., Gul, S., & Mahmoud, I. (2022). Amniotic Fluid Index Versus Single Deepest Pocket Techniques in Evaluation of Oligohydramnios: A Review of Current Literature. *Canadian Journal of Medical Sonography, 12*(4), 18–22.

Bynarowicz, T., Jenkins, S., & Shanks, A. (2025). Oligohydramnios. *StatPearls.*

Figueroa, L., McClure, E. M., Swanson, J., Nathan, R., Garces, A. L., Moore, J. L., Krebs, N. F., Hambidge, K. M., Bauserman, M., & Lokangaka, A. (2020). Oligohydramnios: a prospective study of fetal, neonatal and maternal outcomes in low-middle income countries. *Reproductive health, 17*(1), 19.

Goldkrand, J. W., Hough, T. M., Lentz, S. U., Clements, S. P., Bryant, J. L., & Hodges, J. A. (2003). Comparison of the amniotic fluid index with gray-scale and color Doppler ultrasound. *The Journal of Maternal-Fetal & Neonatal Medicine, 13*(5), 318-322.

Gunasingha, H., Hemapriya, S., & Mendis, S. (2022). A comparison of amniotic fluid index versus single deepest vertical pocket measurement at term as a predictor of adverse perinatal outcome. *Open Journal of Obstetrics and Gynecology, 12*(10), 1062-1078.

Haroon, M., Choudry, A., Ahmed, M., Gul, M., & Altaf, A. (2020). Evaluation of fetomaternal outcomes using amniotic fluid index and single deepest vertical pocket for amniotic fluid volume assessment. *Pakistan Armed Forces Medical Journal,* (5), 1266.

Hughes, D. S., Magann, E. F., Whittington, J. R., Wendel, M. P., Sandlin, A. T., & Ounpraseuth, S. T. (2020). Accuracy of the ultrasound estimate of the amniotic fluid volume (amniotic fluid index and single deepest pocket) to identify actual low, normal, and high amniotic fluid volumes as determined by quantile regression. *Journal of Ultrasound in Medicine, 39*(2), 373–378.

Huri, M., Di Tommaso, M., & Seravalli, V. (2023). Amniotic fluid disorders: from prenatal management to neonatal outcomes. *Children, 10*(3), 561.

Jagatia, K., Singh, N., & Patel, S. (2013). Maternal and fetal outcome in oligohydramnios: A study of 100 cases. *Int J Med Sci Public Health, 2*(3), 724–727.

Javad, S., Hassan, S., Nazir, R., Gul, S., & Kousar, S. (2025). Adverse Perinatal Outcomes in Isolated Borderline Amniotic Fluid Index at Term Pregnancies. *Journal of The Society of Obstetricians and Gynaecologists of Pakistan, 15*(3), 203-207.

Jha, P., Raghu, P., Kennedy, A. M., Sugi, M., Morgan, T. A., Feldstein, V., Põder, L., & Penna, R. (2023). Assessment of amniotic fluid volume in pregnancy. *Radiographics, 43*(6), e220146.

Kehl, S. (2018). Single deepest vertical pocket or amniotic fluid index as evaluation test for predicting adverse pregnancy outcome (SAFE trial): a multicenter, open-label, randomized controlled trial. *Zeitschrift fur Geburtshilfe und Neonatologie, 222*(1), 28-30.

Kehl, S., Schelkle, A., Thomas, A., Puhl, A., Meqdad, K., Tuschy, B., ... & Sütterlin, M. (2016). Single deepest vertical pocket or amniotic fluid index as evaluation test for predicting adverse pregnancy outcome (SAFE trial): a multicenter, open-label, randomized controlled trial.

Madendag, Y., Madendag, I. C., Sahin, E., Aydin, E., Sahin, M. E., & Acmaz, G. (2019). How well do the popular ultrasonic techniques estimate amniotic fluid volume and diagnose oligohydramnios, in fact? *Ultrasound quarterly, 35*(1), 35–38.

Magann, E. F., Chauhan, S. P., Barrilleaux, P. S., Whitworth, N. S., McCurley, S., & Martin Jr, J. N. (2001). Ultrasound estimate of amniotic fluid volume: color Doppler overdiagnosis of oligohydramnios. *Obstetrics & Gynecology, 98*(1), 71-74.

Mousavi, A. S., Hashemi, N., Kashanian, M., Sheikhansari, N., Bordbar, A., & Parashi, S. (2018). Comparison between maternal and neonatal outcome of PPROM in the cases of amniotic fluid index (AFI) of more and less than 5 cm. *Journal of Obstetrics and Gynaecology, 38*(5), 611–615.

Naghizadeh, S., Faroughi, F., & Mirghafourvand, M. (2025). Results of fetal health assessment tests in pregnancies with borderline and normal amniotic fluid index: A case-control study. *International Journal of Africa Nursing Sciences,* 100874.

Odibo, I. N., Whittemore, B. S., Hughes, D. S., Simmons, P. M., Ounpraseuth, S. T., & Magann, E. F. (2017). Addition of color Doppler sonography for detection of amniotic fluid disturbances and its implications on perinatal outcomes. *Journal of Ultrasound in Medicine, 36*(9), 1875–1881.

Rabie, N., Magann, E., Steelman, S., & Ounpraseuth, S. (2017). Oligohydramnios in complicated and uncomplicated pregnancy: a systematic review and meta-analysis. *Ultrasound in Obstetrics & Gynecology, 49*(4), 442–449.

Rehman, S., Bilqis, H., Rizwan, H., Akram, A., Kousar, S., & Irshad, S. (2022). Comparison of frequency of diagnosis, induction of labour and caesarean section in patients with isolated oligohydramnios diagnosed by amniotic fluid index versus single deepest vertical pocket. *Journal of Rawalpindi Medical College, 26*(2).

Sajjad, S. (2025). A Comparative Evaluation of AFI Measurement Techniques and Their Association with Fetomaternal Outcomes in Late Pregnancy. *Pakistan Journal of Clinical Research, 2*(1), 20–26.

Sekhon, S., Rosenbloom, J. I., Doering, M., Conner, S. N., Macones, G. A., Colditz, G. A., ... & Carter, E. B. (2021). Diagnostic utility of maximum vertical pocket versus amniotic fluid index in assessing amniotic fluid volume for the prediction of adverse maternal and fetal outcomes: a systematic review and meta-analysis. *The Journal of Maternal-Fetal & Neonatal Medicine, 34*(22), 3730-3739.

Sgayer, I., Kayal, R. S., Ganem, N., Wolf, M. F., Lowenstein, L., & Odeh, M. (2025). Association between borderline amniotic fluid levels and adverse perinatal

outcome: systematic review and meta-analysis. *Ultrasound in Obstetrics & Gynecology, 66*(5), 562-570.

Singh, S., & Gautam, P. (2023). PERINATAL OUTCOME IN OLIGOHYDRAMNIOS (AFI< 5) AT TERM. *Int J Acad Med Pharm, 5*(3), 1280–1285.

Siqueira, L., Ghetti, A., Fonseca, J., Palhao, M., Fernandes, C., & Viana, J. (2013). Color Doppler flow imaging for the early detection of nonpregnant cattle at 20 days after timed artificial insemination. *Journal of Dairy Science, 96*(10), 6461–6472.

Thobbi, V. A., & Sabahath, S. (2017). A study of perinatal outcome in patients with low Amniotic Fluid Index (AFI). *Age, 20*(40), 60.

Urmee, S. H., Jahan, A. B., Choudhury, N. A., Nahid, S., Islam, M. U., Afrin, R., & Gope, S. (2022). Comparison the Amniotic Fluid Index (AFI) Obtained with Gray-Scale Ultrasound and Color Doppler. *Sch J App Med Sci, 4,* 556–561.

Wax, J. R., & Pinette, M. G. (2022). The amniotic fluid index and oligohydramnios: a deeper dive into the shallow end. *American journal of obstetrics and gynecology, 227*(3), 462–470.

Whittington, J. R., Chauhan, S. P., Wendel, M. P., Ghahremani, T. L., Pagan, M. E., Carter, M. M., & Magann, E. F. (2024). Historical assessment, practical management, and future recommendations for abnormal amniotic fluid volumes. *Journal of Clinical Medicine, 13*(16), 4702.

Yousaf, S., Naeem, M. A., John, A., & Ali, A. (2021). Sonographic Correlation between Maximum Vertical Pocket and Amniotic Fluid Index in Second and Third Trimester.

Zilberman Sharon, N., Pekar-Zlotin, M., Kugler, N., Accart, Z., Nimrodi, M., Melcer, Y., Cuckle, H., & Maymon, R. (2022). Oligohydramnios: how severe is severe? *The Journal of Maternal-fetal & Neonatal Medicine, 35*(25), 5754–5760.

Zlatnik, M., Olson, G., Bukowski, R., & Saade, G. (2003). Amniotic fluid index measured with the aid of color flow Doppler. *The Journal of Maternal-fetal & Neonatal Medicine, 13*(4), 242–245.