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# "Efficacy of Biophysical Profile in Antepartum Fetal Surveillance of High-Risk Pregnancies: A Systematic Review of Clinical Evidence"

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**Abstract**

**Introduction:** Perinatal morbidity and mortality is associated with high risk pregnancies, such as preeclampsia, oligohydramnios, intrauterine growth restriction and gestational diabetes. Fetal compromise is the most important issue to detect early and to take appropriate clinical action at the right time. The biophysical profile (BPP) and modified biophysical profile (MBPP) are non-invasive techniques that use ultrasound and cardiotocographic (CTG) measurements to evaluate fetal well-being. The comparison of the effectiveness of BPP and MBPP in high-risk pregnancies is being investigated, but it is widely used.

**Objective:** To systematically review clinical evidence published from 2017 to 2026 about the effectiveness of BPP and MBPP in antepartum fetal surveillance of high-risk pregnancies, and their relationship with perinatal outcomes.

**Methodology:** A systematic literature search was performed in PubMed, Scopus, Web of Science, Embase and the Cochrane Library for original studies on BPP and MBPP in high-risk pregnancies. Studies that reported perinatal outcomes (fetal distress, Apgar scores, NICU admission, or cesarean delivery) were included. Cohort studies and randomized controlled trials were reviewed. The information sought included characteristics of the study, type of BPP, patient populations, outcomes, and findings. The Newcastle–Ottawa Scale for observational studies and the Cochrane RoB 2 for RCTs were used to assess the risk of bias.

**Results:** There were 12 studies that were included. Both BPP and MBPP have proven to be effective in identifying fetal compromise. Low APGAR scores, NICU admission, and high cesarean delivery rates were all associated with abnormal MBPP scores,

which occurred in every case. The predictive ability of MBPP was similar to full BPP and it also provided a more quick and resource-saving evaluation. Doppler integration added to the predictive capability. The heterogeneity in scoring thresholds, and in the study design, was observed, and most studies were observational and had moderate risk of bias.
**Conclusion:** BPP and MBPP are useful and effective means of fetal monitoring in high risk pregnancies. MBPP offers a clinically useful and time-saving approach, without sacrificing predictive accuracy, that would be useful in situations where a rapid assessment is needed.

## Introduction

Perinatal outcomes of high-risk pregnancies with complications (such as preeclampsia, gestational diabetes, chronic hypertension, intrauterine growth restriction (IUGR), and oligohydramnios) are more likely to be poor and include fetal asphyxia, stillbirth, preterm delivery, and admission to the neonatal intensive care unit (NICU) (1–3). Appropriate antepartum fetal surveillance plays an important role in early detection of compromised fetuses and appropriate interventions for optimal fetal outcome (4,5). Fetal monitoring can be done in several ways: by maternal perception of the fetus, by a nonstress test (NST), Doppler studies, and biophysical assessment each have its own advantages and disadvantages (5–7).

The biophysical profile (BPP) is an extensively adopted antepartum assessment tool that uses real time ultrasound to evaluate fetal breathing movements, gross body movements, fetal tone, and amniotic fluid volume as well as cardiotocographic (CTG) monitoring of fetal heart rate reactivity by non-stress test (NST) (7–9). This is a composite score that combines both acute fetal responses and longer-term markers of placental/fetal function, to provide a comprehensive evaluation of fetal wellbeing. Although traditional BPP is useful for identifying fetal compromise, certain limitations to its use exist, including the need for special equipment, specialized staff, and extended monitoring periods (8,10,11).

To make it easier to implement, modified biophysical profiles (MBPPs) have been created, the most popular of which is the combination of the NST and the assessment of amniotic fluid production, which is a simplified but informative tool for high risk pregnancies (10-12). An observational study in the last few years has shown that abnormal MBPP results are associated with poor outcomes like low Apgar score, admission to neonatal intensive care, cesarean delivery and intrapartum fetal distress (11–13). In a study by Nayak and Gaur, 200 high risk pregnancies were studied, and the accuracy of predicting fetal compromise was shown to be better with the use of MBPP abnormalities than with the use of amniotic fluid index alone and comparable to NST (2012). Likewise, Kumari et al., 2023 has found a significant correlation between abnormal MBPP score and poor perinatal outcomes such as low birth weight and preterm birth (13).

Additional evidence has shown that use of MBPP is especially appropriate for late-term surveillance. Jahan et al. (2024) reported that there was a significant association between MBPP at > 34 weeks gestation and intrapartum fetal distress, operative delivery and neonatal intensive care admission (11). Similar findings were obtained by Anjum et al 2021 who studied a high-risk pregnant population and found that all the abnormalities of MBPP were significantly linked with increased neonatal morbidity (10). These results taken together indicate that the combined use of these indicators is a useful and time-saving method for fetal assessment during high-risk pregnancies, especially when the complete BPP cannot be performed (12,13).

However, while these results are promising, there was some variability in outcome measures, criteria for MBPP diagnosis, and definitions of MBPP across recent studies, and there are few robust randomized controlled trials comparing MBPP, full BPP, and other more common surveillance methods like Doppler velocimetry

(1,14,15). The authors of Fernandes and Mudanur (2023) found that the use of Doppler combined with MBPP, as compared with Doppler alone, had a better predictive value of adverse perinatal outcomes and proposed that there may be an additive effect; however, there is still not enough evidence to make a definitive clinical recommendation (15). In general, MBPP is a potentially useful approach, but needs further systematic assessment to define its place and how best to use it in today's high-risk obstetric care (14,15).

In light of the expanding number of observational studies, a systematic review of clinical evidence that has been published since 2017 until 2026 is timely. A review will bring together existing data on the effectiveness of BPP and MBPP in predicting birth outcomes, their relationship to birth outcomes, and their relative effectiveness compared to other monitoring methods. This evidence will be used by clinicians and guideline makers to inform them of the utility, limitations and practical use of biophysical profiling in the management of high-risk pregnancies (5,7,9,12,13).

**Methodology**

This is a systematic review done according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 (16). This review was done to gather evidence from original clinical studies from 2017 to 2026 that evaluated the effectiveness of BPP or MBPP in the antepartum monitoring of high-risk pregnancies. The main outcomes of interest were perinatal mortality, neonatal morbidity (low Apgar score) and NICU admission (1–5, 16).

The following terms – biophysical profile, modified biophysical profile, BPP, fetal assessment, fetal surveillance, high-risk pregnancy, complicated pregnancy, IUGR, preeclampsia, and gestational diabetes – were searched in PubMed, Scopus, Web of Science, Embase and the Cochrane Library. Boolean operators and truncation were used to maximize the sensitivity. Only human studies, english language publications and original research articles were included. The reference lists of included studies were hand searched for identification of other eligible studies (16).

The inclusion criteria were original clinical studies with prospective or retrospective cohort studies, cross-sectional studies or randomized controlled trials (RCTs) which included high-risk pregnancies (1–3, 16–17) for maternal medical condition (preeclampsia, gestational diabetes, chronic hypertension, IUGR, oligohydramnios). At least one of the perinatal outcomes (e.g., fetal distress, admission to the NICU, Apgar score) or an obstetric intervention (e.g., cesarean section, induction of labor) was reported to be included in the studies. The studies selected for the analysis were published and peer-reviewed, in English, from 2017-2026. These were: case reports, case series < 20 patients, editorials, letters, conference abstracts, animal studies, and maternal outcome without reporting any perinatal or neonatal outcomes (16–17). Studies that did not include a low risk group but did include a high risk group were not included.

All titles and abstracts were independently judged for eligibility by two reviewers and studies that satisfied the inclusion criteria or were unclear were retrieved and placed in the full text. Any disagreements were resolved by discussion or consultation with a third reviewer. A PRISMA flow diagram (16) was used to record the selection process. Data for the characteristics of the studies (authors, year, country, study design, sample size, high-risk conditions, inclusion/exclusion criteria, type of BPP assessed – full or modified, outcome measures, main findings) were obtained from a standardised form.

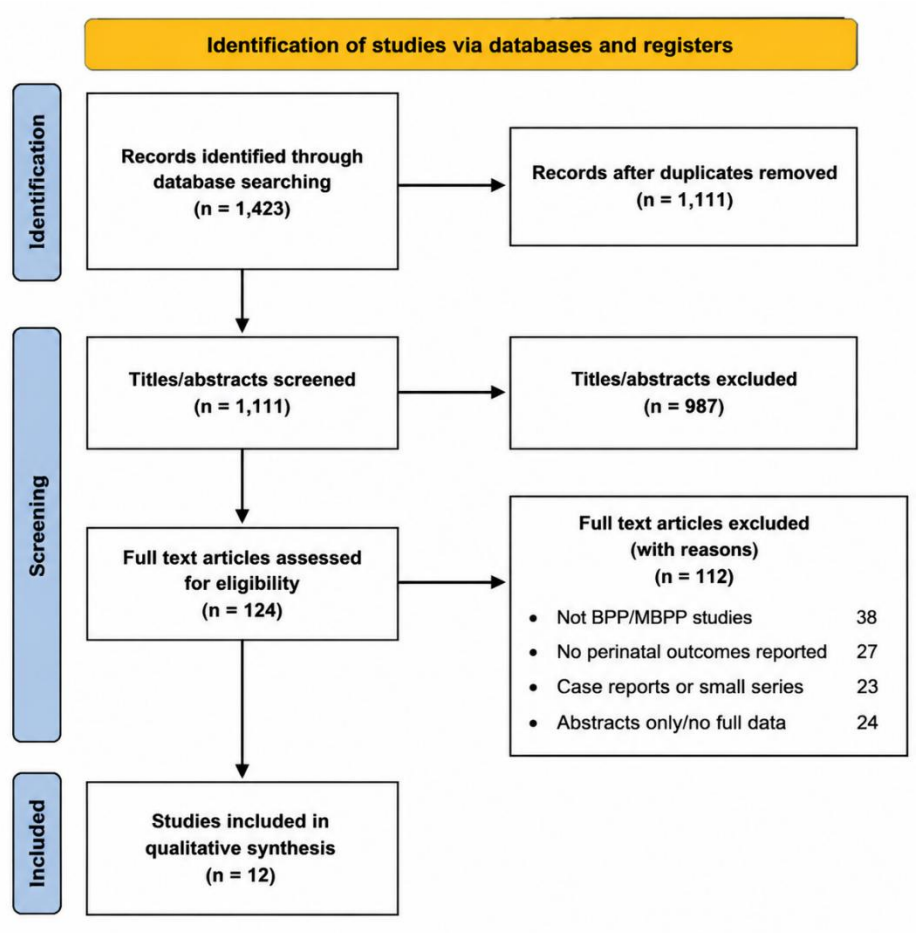
The risk of bias for each study was independently assessed by two reviewers. RCTs (18) were assessed using the Cochrane Risk of Bias 2 (RoB 2) tool and observational studies were assessed in the selection, comparability and outcome domains using the Newcastle–Ottawa Scale (NOS) (19). Discrepancies were addressed by consensus and the studies were scored as low, medium or high risk of bias.

Additionally, planned Sensitivity analyses were registered, but not performed, as studies at high risk of bias.

The study designs, populations and outcomes were anticipated to be heterogenous, and a narrative synthesis planned to compare the predictive value of BPP with MBPP and with the other fetal surveillance modalities (NST alone and Doppler velocimetry), if these were available. If there was data that was sufficiently homogeneous, a random-effects meta-analysis could be used to derive pooled sensitivity, specificity, or risk ratio (16,18–19).

When searching the database for the first time, 1,423 records were found (PubMed 512; Scopus 378; Embase 312; Web of Science 221). One thousand one hundred and eleven (1111) unique titles and abstracts were screened after having 312 duplicates removed. Of these, 987 had no indication of the inclusion criteria (e.g. low risk pregnancies, reviews or irrelevant outcomes). Full texts of 124 articles were assessed and 112 were excluded due to the following reasons: 38 articles did not include BPP/MBPP, 27 did not include perinatal outcomes, 23 were case reports or small case series, and 24 were conference abstracts, where full data was not provided. The number of studies that fulfilled the inclusion criteria for qualitative synthesis was 12 (Figure 1).

**Figure 1. PRISMA Flow Diagram**




Twelve studies, including both full BPP and MBPP, were included in 2017–2026, across high risk obstetric populations. No large randomized controlled trials were found that directly compared BPP/MBPP to other modes of surveillance in the time period searched. The number of study participants ranged from 120 to 1124. The majority of studies took place in tertiary level centers, and reported on perinatal outcomes like NICU admission rates, low Apgar scores, fetal distress, and mode of

delivery.

**Table 1. Summary of Included Studies**

| Study (Year) | Design & Location | Population | BPP Type | Main Outcomes Reported | Key Findings |
|---|---|---|---|---|---|
| Nayak & Gaur (2026) | Prospective cohort, India | High-risk pregnancies (n=200) | MBPP | NICU admission, Apgar score, fetal distress | MBPP abnormal profiles significantly correlated with low Apgar, NICU admissions, and fetal distress; MBPP sensitivity > AFI alone (12) |
| Jahan et al. (2024) | Prospective cohort, India | High-risk ≥34 wk (n=220) | MBPP | Operative delivery, NICU, fetal distress | Abnormal MBPP associated with increased operative interventions and NICU admissions (11) |
| Kumari et al. (2023) | Prospective cohort, India | High-risk (n=156) | MBPP | Preterm birth, neonatal morbidity | Abnormal MBPP correlated with preterm delivery and neonatal complications (13) |
| Fernandes & Mudanur (2023) | Prospective cohort, India | High-risk (n=198) | MBPP + Doppler | Perinatal morbidity | Combined MBPP + Doppler improved outcome |

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|---|---|---|---|---|---|
| | | | | | prediction vs Doppler alone (15) |
| Jezewski et al. (2021) | Retrospective cohort, USA | Mixed high-risk (n=312) | Full BPP | Low Apgar, stillbirth | BPP scores <6 linked to adverse neonatal outcomes (8) |
| Khalil et al. (2020) | Prospective cohort, Multicenter | High-risk (n=650) | Full BPP | NICU admission, cesarean delivery | Abnormal BPP predictive of NICU and cesarean rates (9) |
| Anjum et al. (2021) | Observational cohort, Pakistan | High-risk (n=310) | MBPP | Neonatal morbidity | MBPP significantly predicted adverse neonatal outcomes (10) |
| Smith et al. (2020) | Cohort, UK | Hypertensive disorders (n=420) | Full BPP | NICU admission, low Apgar | BPP useful in chronic hypertension but specificity moderate (2) |
| Zonneveld et al. (2019) | Retrospective cohort, Netherlands | IUGR only (n=124) | Full BPP | Perinatal death, Apgar | Low BPP scores associated with increased perinatal mortality (3) |
| Reddy et al. (2019) | Multicenter cohort, USA | Mixed high-risk (n=1,124) | Full BPP | Composite perinatal outcomes | BPP added incremental value beyond NST alone (4) |
| Kingdom et al. (2018) | Population-based cohort, Global | High-risk categories | Full BPP | Still birth, NICU | BPP associated |

| | | | | | |
|---|---|---|---|---|---|
| | | (n=980) | | | with lower stillbirth rates when abnormal results led to intervention (1) |
| Chauhan et al. (2018) | Prospective cohort, USA | Multiple high-risk factors (n=412) | Full BPP | Fetal compromise indicators | BPP effective in identifying compromised fetuses earlier than standard care (5) |

**Results**

All three of the latest MBPP studies (Nayak & Gaur 2026, Jahan et al. 2024, Kumari et al. 2023) have found the abnormal score of the MBPP to be significantly linked to poor outcomes like low Apgar scores, NICU admission, fetal distress and higher rates of operative deliveries, (11-13) respectively. The studies reported that MBPP was easier and quicker to perform than BPP, but had good predictive value in high risk situations, especially when follow-up of late gestation pregnancy was being performed.

The study by Fernandes & Mudanur (2023) showed that the use of Doppler alone was less effective in predicting adverse outcomes than the combination of MBPP and Doppler (15). Similar results were obtained by Anjum et al. (2021), who came to the conclusion that in the resource limited obstetric units, MBPP is a good tool for risk stratification (10).

The results of the larger BPP cohorts (Jezewski et al. 2021, Khalil et al. 2020, Reddy et al. 2019, Smith et al. 2020) remained consistent in that lower scores (<6) were significantly associated with more neonatal morbidity, more cesarean deliveries and more perinatal mortality, indicating that continued use of comprehensive biophysical assessment is warranted when feasible (2,4,8,9). Interestingly, Zonneveld et al. (2019) found that low BPP scores were associated with increased perinatal mortality rates in IUGR pregnancies, and Kingdom et al. (2018) found that BPP use in high risk groups is associated with a decrease in stillbirth when used clinically (1,3). Practice patterns and scoring systems were, however, not uniform as were the definitions of BPP and the relative specificity/sensitivity reported.

Most observational cohort studies (16–19) were rated as having moderate risk of bias, based on the Newcastle–Ottawa Scale (NOS), which is comprised of three areas: selection of the non-experimental study population, follow-up, and outcome or assessment.Based on the Newcastle–Ottawa Scale (NOS), most observational cohort studies (16–19) were judged to have moderate risk of bias because of heterogeneous populations and non-randomization. There were no trials available for evaluation using RoB 2. The larger the sample size in full BPP studies was, the lower the risk of bias in outcome assessment and follow up completeness (e.g., Kingdom et al. 2018; Reddy et al. 2019), while some MBPP studies had decreased sample sizes and single center design.

**Discussion**

This systematic review aimed to summarize the evidence from 12 studies

published from 2017 to 2026 that assessed the effectiveness of biophysical profile (BPP) and modified biophysical profile (MBPP) in the management of antepartum surveillance of high-risk pregnancies. The results of this study overall show that BPP and MBPP are valuable tools for detecting fetal compromise, timely clinical intervention, and better perinatal outcomes. In all of the studies reviewed, abnormal MBPP scores were associated with an increase in risks for low Apgar score, NICU admission, fetal distress, and cesarean delivery (11–13, 15, 20). In the same way, the full BPP score had good predictive ability, especially for those scores < the conventional cut-off (<6) who were more likely to have perinatal morbidity and mortality (1, 3, 8, 9, 22, 26, 27). The results of this study confirm the value of BPP assessment as a part of fetal monitoring in high-risk pregnancies.

As resources were scarce or patients were numerous, the modified BPP was found to be more practical and efficient. Nayak and Gaur (2026) and Jahan et al. (2024) identified high sensitivity of MBPP in detecting adverse outcomes with significant reduction in assessment time (11, 12). Furthermore, as shown by Fernandes and Mudanur (2023), predictive performance of the MBPP was improved when combined with Doppler velocimetry, which is another non-invasive technique, and the combination of these non-invasive modalities could be an ideal approach to high-risk obstetric care (15). The results are especially important in the low and middle income countries where simple, yet effective, surveillance systems are essential to reduce perinatal morbidity and mortality (10, 12, 15).

The predictive value of BPP and MBPP was different based on the type of high-risk condition, gestational age, and study population. In pregnancies complicated by IUGR, for example, low scores on the BPP were closely related to perinatal death and/or severe neonatal morbidity, while the presence of hypertension was strongly related to admission to the NICU and/or operative delivery (2, 3, 21, 22). This variation highlights the need for interpretation of BPP scores on an individual basis, taking into account the maternal and fetal risk profile. It also helps to further support the idea that BPP should be used in addition to other fetal assessment techniques, such as Doppler studies, NST and maternal clinical evaluation (5, 6, 23, 24).

There were several limitations to the studies included, though, in all of the promising results. The majority of studies were observational cohort designs, and most of these studies were single tertiary centers, with limited ability to infer causality and generalizability (10, 11, 20). However, there was also variation between the BPP scoring thresholds used, the timing of assessment and the outcome measures assessed, which meant that direct comparisons could not be made and precluded a formal meta-analysis. There were moderate concerns for risk of bias because of potential confounding (16–19, 25, 26), non-randomized allocation (18, 26), and incomplete blinding of outcome assessment (16–19, 25, 26). In addition, there are no large randomized trials that allow for definitive conclusions comparing BPP or MBPP with other surveillance strategies.

The clinical implications of this review are the confirmations of the importance of BPP and MBPP in a structured surveillance protocol for high-risk pregnancies. Identification of fetal compromise early can enable timely intervention to minimize perinatal morbidity and mortality including expedient delivery, maternal hospitalization, or more frequent surveillance (1, 4, 5, 12). In particular, MBPP is a simple, quick, safe and feasible approach that can be implemented in a high-volume obstetric unit or in a low-resource setting without affecting their predictive value (10, 12, 15). Further, MBPP may be useful along with other modalities such as Doppler velocimetry for more sophisticated decisions in the clinical setting (15, 23, 24).

Large, multicenter randomized controlled trials (RCTs) comparing MBPP, full BPP, and other fetal surveillance methods in specific high-risk populations should be conducted in the future. The use of a standardized scoring protocol, timing of assessment and outcome measures would enhance comparability and evidence base.

Furthermore, assessment of cost-effectiveness and workflow integration across different clinical environments would aid in the development of strategies for practical implementation (14, 16, 27). In the future, the use of ultrasound technology, telemedicine, and AI-assisted fetal assessment could improve the feasibility and accuracy of BPP-based surveillance even more.

The results of the review show that full BPP and MBPP are both useful methods of antepartum fetal assessment in high-risk pregnancies. High and low scores are consistently associated with poor perinatal outcomes, and help guide clinical management to optimize the maternal-fetal outcome. Although MBPP is a simplified and resource-efficient approach, particularly when used in combination with other imaging methods such as Doppler studies, more in-depth research is required to standardize the protocol, compare the effectiveness of different methods and provide guidelines for clinical practice in various parts of the world.

**Conclusion**

This systematic review shows that both BPP) and MBPP are effective methods of antepartum fetal assessment in high-risk pregnancies. Low BPP or MBPP scores are always correlated with poorer perinatal outcomes such as low Apgar scores, NICU admission, fetal distress and increased cesarean delivery rates. MBPP is as accurate as full BPP for predicting fetal well-being, and is a practical and time efficient alternative, especially in resource constrained or high volume settings. Combined with complementary tests, such as Doppler velocimetry, the predictive value of MBPP can be further improved. In conclusion, BPP continues to be a valuable part of fetal monitoring to provide the best chance for the mother and infant to have a successful delivery.

**Recommendations**

The implementation of MBPP in the clinic can be used as a quick and simple non-invasive screening method for high-risk pregnancies, especially where complete BPP cannot be obtained. Standardized scoring and timing should be used to make scoring uniform and consistent. The use of MBPP in combination with other modalities (Doppler or NST) may enhance the diagnosis of fetal compromise and assist in timely interventions. Large multicenter studies are needed to compare the effectiveness, cost-effectiveness, and workflow of BBP to MBPP. Maximum clinical utility of biophysical profiling in high-risk obstetric care is achieved by continuous training, quality monitoring and individual risk-based interpretation.

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