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Hayes DJL, Dumville JC, Walsh T, Higgins LE, Fisher M, Akselsson A, Whitworth M, Heazell AEP
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Effect of encouraging awareness of reduced fetal movement and subsequent clinical management on pregnancy outcome: a systematic review and meta-analysis

Condensation: this systematic review summarises the evidence for interventions aiming to reduce the incidence of adverse outcome in pregnancies with reduced fetal movement.

Short title: Effect of RFM awareness and clinical management on pregnancy outcome

AJOG at a Glance

A. Why was this study conducted?

- This study aimed to determine whether interventions aiming to encourage awareness of reduced fetal movement and/or improve its subsequent clinical management reduce the frequency of stillbirth or other adverse pregnancy outcomes

B. What are the key findings?

- The evidence is uncertain about the effect of encouraging awareness of fetal movement or fetal movement counting on stillbirth compared with standard care
- Encouraging awareness of fetal movement may reduce NICU admissions and Apgar scores <7 at five minutes of age, and may increase maternal fetal attachment and decrease maternal anxiety compared with standard care

C. What does this study add to what is already known?

- Encouraging awareness of fetal movement may be associated with reduced adverse neonatal outcomes without increased interventions in labour
- Meta-analysis is hampered by variation in outcome reporting and individual studies are frequently underpowered to detect reductions in rare outcomes; studies from high-burden settings are needed

Keywords – stillbirth, perinatal death, kick counting, ultrasound

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Abstract

Objective

Reduced fetal movement (RFM), defined as a decrease in maternal perception of frequency or strength of fetal movements, is a common reason for presentation to maternity care. Observational studies demonstrate an association between RFM, stillbirth, and fetal growth restriction related to placental insufficiency. However, individual intervention studies have described varying results. This systematic review and meta-analysis aimed to determine whether interventions aiming to encourage awareness of reduced fetal movement and/or improve its subsequent clinical management reduce the frequency of stillbirth or other important secondary outcomes.

Data sources

Searches were conducted in MEDLINE, EMBASE, CINAHL, The Cochrane Library, Web of Science and Google Scholar. Guidelines, trial registries, and grey literature were also searched. Databases were searched from inception to the 20th January 2022.

Study eligibility criteria

Randomised controlled trials (RCTs) and controlled non-randomised studies (NRS) were eligible if they assessed interventions aiming to encourage awareness of fetal movement or fetal movement counting and/or improve the subsequent clinical management of RFM. Eligible populations were singleton pregnancies after 24 completed weeks of gestation. The primary review outcome was stillbirth; a number of secondary maternal and neonatal outcomes were specified in the review.

Study appraisal and synthesis methods

Risk of bias was assessed using Cochrane Risk of Bias 2 and ROBINS-I for RCTs and NRS respectively. Variation due to heterogeneity was assessed using I^2. Data from studies employing similar interventions was combined using random effects meta-analysis.

Results

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1,609 citations were identified; 190 full text papers were evaluated against the inclusion criteria, 18 studies (16 RCTs and 2 NRS) were included.

The evidence is uncertain about the effect of encouraging awareness of fetal movement on stillbirth compared with standard care (two studies, n=330,084); pooled aOR 1.19 (95% CI 0.96, 1.47). Interventions for encouraging awareness of fetal movement may be associated with a reduction in NICU admissions and Apgar scores <7 at five minutes of age and may not be associated with increases in caesarean section or induction of labour.

The evidence is uncertain about the effect of encouraging fetal movement counting on stillbirth compared with standard care; pooled OR 0.69 (95% CI 0.18, 2.65), data from three RCTs (n=70,584). Counting fetal movements may increase maternal fetal attachment and decrease anxiety compared with standard care.

When comparing combined interventions of fetal movement awareness and subsequent clinical management with standard care (one study, n=393,857) the evidence is uncertain about the effect on stillbirth (aOR 0.86, 95% CI 0.70, 1.05).

Conclusions

The effect of interventions for encouraging awareness of RFM alone or in combination with subsequent clinical management on stillbirth is uncertain. Encouraging awareness of fetal movement may be associated with reduced adverse neonatal outcomes without an increase in interventions in labour. Meta-analysis is hampered by variation in interventions, outcome reporting and definitions. Individual studies are frequently underpowered to detect a reduction in severe, rare outcomes and no studies were included from high-burden settings. Studies from such settings are needed to determine whether interventions can reduce stillbirth.

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Introduction

Reduced fetal movement

Reduced fetal movements (RFM) are defined as a decrease or change in maternal perception of a baby's normal pattern of movements *in utero*.[1] Concerns about RFM are a frequent reason for presentation at hospital, occurring in up 15% of pregnancies.[2] Around 70% of pregnancies where RFM has been reported have a normal outcome, but maternal perception of RFM is associated with adverse outcomes such as stillbirth and fetal growth restriction.[3,4–6] An individual participant data meta-analysis with data from five studies (n=3,108) reported an adjusted odds ratio (aOR) of 2.33 (95% CI 1.73 to 3.14) for stillbirth in pregnancies with a decreased frequency of fetal movement in the last 2 weeks.[7] Studies have demonstrated links between RFM and placental pathology, particularly those relating to maternal vascular malperfusion.[8–10] Thus, the association between RFM, fetal growth restriction, and stillbirth is thought to represent fetal compensation for placental insufficiency (where the placenta cannot meet the metabolic demands of the fetus) or other fetal stressors, in an attempt to conserve energy and oxygen consumption.[11,12]

Interventions for RFM

Interventions for RFM can be split into two categories: 1) those that aim to encourage awareness of fetal movement and/or fetal movement counting by clinicians, other healthcare professionals, or in people who are pregnant, and 2) those that employ subsequent clinical management when there is concern about RFM in order to identify fetal compromise.[13–15] Studies may employ one or the other approach, or a combination. A diagram demonstrating how interventions might work in clinical practice is shown in Supplementary file S1.

Several large randomised trials have shown insufficient evidence of an effect of interventions on stillbirth in high income settings.[13,16] Two systematic reviews from 2015 and 2016 reported no clear evidence of harms or benefits for formal fetal movement counting or encouraging maternal awareness of RFM respectively.[17,18] A 2020 systematic review and meta-analysis of five randomised trials of fetal movement counting reported a relative risk (RR) of 0.92 (95% CI 0.85 to 1.00) for perinatal death and 0.94 (95% CI 0.71 to 1.25) for stillbirth.[19]

Current guidance and management strategies for RFM

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Current guidance is to contact a health professional or maternity unit if a baby is moving less than usual or not at all.[20–22] Guidance with respect to formal fetal movement counting and clinical management is variable, as is the quality of clinical practice guidelines, leading to variation in care.[23,24] Uncertainties persist despite recent publication of RCTs measuring the effects of interventions for RFM.[14,25] Conducting a systematic review including both randomised and non-randomised studies will provide an updated view of available evidence and also maximise the pool of evidence that has so far been synthesised.

Objectives

The primary objective was to determine whether encouraging awareness of fetal movement and/or the subsequent clinical management of pregnancies with RFM affects adverse maternal or perinatal outcomes, when compared to other management strategies or no management.

Secondary objectives were:

- to determine whether there is an optimal management strategy for RFM pregnancies
- to determine if some management strategies are more effective than others
- to describe the state of current evidence and identify gaps in the literature

Methods

The protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) on 16/10/2020 (CRD 42018088635).[26] Reporting followed the PRISMA Statement.[27]

Eligibility criteria, information sources, search strategy

Studies of interventions that aimed to encourage clinician or maternal awareness of the pattern, strength, and/or frequency of RFM in pregnancy and/or interventions for the subsequent clinical management of RFM were included, delivered alone or in combination.

Studies were included if they reported data from singleton pregnancies after 24 completed weeks' gestation presenting at least once in a hospital setting. Included definitions of RFM were those based on maternal perception and/or confirmed by clinical assessment of fetal activity. The

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gestational age threshold was set at 24 completed weeks as this is consistent with the current definition of stillbirth in the UK.[28]

Study types considered for inclusion were RCTs, quasi-RCTs and some NRS. To be eligible, NRS needed to have a clearly reported mechanism of group formation, clearly defined inclusion criteria, and clearly described methods of ascertainment of eligible patients and their recruitment. Cross-sectional studies, case control studies, and cohort studies without clearly defined comparator groups were not included as their internal validity was considered too poor for any exploration of intervention effectiveness.

Searches were performed in MEDLINE, EMBASE, CINAHL, The Cochrane Library, Web of Science and Google Scholar (described in Supplementary file S2). Guidelines, trial registries, and grey literature were also searched. Studies were included irrespective of publication status and language of publication; the last search was on the 20th January 2022.

Outcomes of interest

The primary outcome was stillbirth, defined as the death of a baby before birth and after 24 weeks' gestation, or as described by the authors (as definitions may vary between study populations and over time). Secondary outcomes were divided into maternal and neonatal outcomes. Maternal outcomes were: proportion of induced labours, mode of birth, postpartum haemorrhage, measures of maternal-fetal attachment and maternal anxiety using any standardised scale, time taken to present to hospital after perceiving RFM, and measures of delayed presentation with RFM. Neonatal outcomes were: neonatal death (death of a baby during the first 28 days of life), perinatal death (stillbirth or death within seven days of birth), small for gestational age infant (birthweight <10th percentile or the threshold used in the study if different), Apgar score (<7 at five minutes of age), preterm birth (<37 weeks of pregnancy), NICU admission, umbilical artery pH <7.05 or BE >-12 (indicating neonatal asphyxia).

Study selection and data extraction

Titles and abstracts of studies retrieved using our search strategy were screened by two authors independently (DH and AH), disagreements were resolved by consulting a third author (JD or TW). Full texts of included studies were obtained where possible and a standardised, pre-piloted

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form was used to extract data. Data were extracted by two authors independently (combinations of DH, MW, LH and AH) and discrepancies were amended through discussion.

Where possible, study protocols were obtained for more information on study design and to determine whether data for all pre-specified outcomes were reported. Attempts were made to contact study authors if no protocol was available, if any characteristics of the intervention were unclear, or to enquire about unpublished data. TIDieR checklists[29] were used to extract information from each study about the nature of the intervention.

Assessment of risk of bias

Risk of bias was assessed for randomised controlled trials using the Cochrane Risk of Bias 2 (RoB 2) tool;[30] for non-randomised studies the ROBINS-I tool was used.[31] Two authors independently assessed risk of bias and consultations took place in the case of any disagreements.

Assessment of heterogeneity and sensitivity analyses

Clinical and methodological heterogeneity was assessed using extracted information from studies. Heterogeneity was also quantitatively assessed using the Chi-squared statistic, χ^2, as well as the I-squared measure.[32] Variation due to heterogeneity was classified as low (I^2=0–40%), moderate (I^2=41–60%), substantial (I^2=61–80%), or considerable (I^2=81–100%).[33] Sensitivity analyses were planned to determine whether effect sizes were influenced by risk of bias or study inclusion criteria, described in the review protocol.

Data synthesis

Interventions were broadly classified using the categories in the review protocol[26] and these categories were used to group studies for analyses (Supplementary file S3).

Adjusted effect estimates were presented from included studies where possible. When adjusted values were unavailable, odds ratios (ORs) and their corresponding 95% confidence intervals (95% CI) were calculated for binary outcomes. Where adjusted and unadjusted estimates were provided for the same outcome and intervention groups, these were displayed as subgroups on the forest plot.[34]

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Data were only combined after careful assessment of clinical and methodological features of studies to ensure that pooled estimates would be meaningful. Binary data were combined using the random effects method (DerSimonian and Laird inverse variance[35]). For continuous outcomes, the standardised mean difference (SMD) was calculated along with corresponding 95% CIs. Effect estimates for RCTs and NRS were calculated separately.

When studies had zero events for an outcome in both the intervention and comparator group then they were not included in analyses. A correction of 0.5 was added if there was one group with zero events. Where synthesis was not possible, data from individual studies were reported. Data from secondary outcomes were only reported when available.

Assessment of certainty of evidence

GRADE[36,37] was used to determine the certainty of the body of evidence by assessing study design, inconsistency of results, indirectness of evidence, imprecision, and publication bias. This assessment reflects the extent of confidence that the estimate is certain for any given finding, and was carried out for all comparisons for the outcomes of stillbirth, perinatal death, and neonatal death. Evidence from RCTs starts out as high certainty, evidence from NRS starts out as low certainty;[38] this was then upgraded or downgraded after assessing the characteristics of included studies.[39]

Results

Study selection and characteristics of included studies

The literature search identified 1,609 citations. These were screened based on their titles and abstracts, resulting in 18 included studies (Figure 1). These studies are described in Table 1. Additional data, study protocols, and/or further detail about the study were obtained from five authors.[14,40–43]

In total, 16 RCTs and two NRS were included. Of the RCTs, 12 focused on interventions aiming to encourage fetal movement counting and/or awareness of the frequency, strength, or pattern of fetal movement healthcare professionals and/or people who are pregnant, three focused on the subsequent clinical management of RFM after identification, and one employed a combination of these. Of the NRS, one compared an intervention to encourage maternal

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awareness of RFM with standard care and the other compared two interventions for the subsequent clinical management of RFM. One ongoing trial was identified.[44]

Risk of bias of included studies

Nine of the 16 included RCTs were rated as at low risk of bias; the other seven RCTs were rated as at high risk (Table 2). Concerns were mainly due to deviations from the intended intervention,[13,16,43,45,46] low intervention fidelity, or adequacy of the randomisation process.[13,47–50] Of the two NRS, one study was rated as at moderate risk of bias[51] and the other at critical risk[52] (Table 3). All NRS were judged to be of at least moderate risk of bias for confounding.

Synthesis of results

INTERVENTIONS FOR ENCOURAGING AWARENESS OF FETAL MOVEMENT [GROUP ONE]

Encouraging awareness of fetal movement compared with standard care (two RCTs; 330,084 participants)

Data were available from two RCTs. Akselsson et al. (n=39,865) compared the Mindfetalness intervention, aimed at encouraging maternal awareness of the pattern of fetal movements, with standard care.[14] Flenady et al (n=290,219) compared an intervention to encourage awareness of fetal movement (using a mobile phone app for pregnant women and an educational programme for clinicians) with standard care.[43]

Primary outcome

Stillbirth

The evidence is uncertain about the effect of encouraging awareness of fetal movement on stillbirth when compared with standard care; pooling aORs from both studies gave an aOR of 1.19 (95% CI 0.96 to 1.47; I^2 0.0, p=0.929). Evidence is of very low certainty, downgraded once for imprecision as the confidence interval fails to exclude important benefits and harms as well as no effect, once due to risk of bias (one study contributing most of the weight of the analysis was rated as being at high risk of bias[43]), and once for indirectness as evidence is from high income countries only (Figure 2).

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Secondary outcomes

Neonatal death

The evidence is uncertain about the effect of encouraging awareness of fetal movement on neonatal death when compared with standard care; pooling aORs from both studies gave an aOR of 0.80 (95% CI 0.54 to 1.20; I^2 0.0, p=0.780). Evidence is of very low certainty, downgraded once for imprecision as the confidence interval includes both benefit of the intervention and standard care, once for risk of bias as above, and once for indirectness as above (Figure 3).

Perinatal death

There is insufficient current evidence of a difference in the effectiveness of encouraging awareness of fetal movement when compared with standard care; pooling ORs calculated using the raw data from both studies gave an OR of 0.88 (95% CI 0.77 to 0.99). Flenady et al. also reported an aOR of 1.07 (95% CI 0.86 to 1.31) for perinatal death (Figure 4).

Evidence is of low certainty, downgraded once as one study contributing 94% of the weight to the analysis was rated as at high risk of bias, and once due to the indirectness of the evidence (included studies are from high income countries only).

Other secondary outcomes

Interventions for encouraging awareness of fetal movement may be associated with a reduction in NICU admissions; there may also be reductions in Apgar scores <7 at five minutes of age, caesarean section, and induction of labour (Figure 5).

Encouraging maternal awareness of RFM compared with standard care (one NRS; 140 participants

Data for this comparison were available from one study and stillbirth data were not reported,[53] the results of this study can be seen in Supplementary file S4.

Encouraging fetal movement counting compared with standard care (eight RCTs; 72,212 participants)

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Eight RCTs compared encouraging fetal movement counting with standard care (as defined by each study); four were rated as being at low risk of bias,[54–57] the other four as high risk.[13,47,58,59]

Further details of these studies can be seen in Table 1. None of these studies presented adjusted effect estimates.

Stillbirth

The evidence is uncertain about the effect of encouraging fetal movement counting on the proportion of stillbirths when compared with standard care, pooling unadjusted data from three RCTs (n =70,584)[13,54,59] gave an OR of 0.69, 95% CI (0.18 to 2.65) (I^2 53.1%) (Figure 6). Evidence is of very low certainty, downgraded three times: once due to imprecision (the 95% CI fails to exclude important benefit or harm), once due to the inconsistency of the evidence due to clinical heterogeneity (study populations and definitions of standard care across these populations are likely to differ), and once as two studies (contributing to over 70% of the weight of the analysis) were at high risk of bias.

Secondary outcomes

Three randomised studies (n=406) presented data for maternal-fetal attachment; two studies[47,57] used the Cranley maternal-fetal attachment (MFA) scale, the third[55] used the Condon maternal antenatal attachment scale (MAAS). Maternal-fetal attachment scores may be higher, indicating greater attachment, in fetal movement counting groups compared with standard care; meta-analysis gave a pooled SMD of 1.22 (95% CI 1.01 to 1.43; I^2 48.0%, p=0.146) (Figure 7).

Three randomised studies (n=281) presented data on maternal anxiety measured using the Spielberger state trait anxiety index (STAI), trait scores[58,60] or the Cambridge worry scale.[61] Another RCT could not be included in this analysis as it presented only p values and no data.[48] Pooling data from three studies suggested that maternal anxiety scores, and therefore anxiety itself, during pregnancy may be lower in those offered fetal movement counting; pooled SMD of -0.16 (95% CI -0.24 to -0.08; I^2 66.2%, p=0.052) (Figure 7)

Data for other secondary outcomes are shown in Supplementary file S4. It was only possible to calculate effect sizes from one study;[61] there is insufficient evidence of any effects on other secondary outcomes as confidence intervals are wide and overlap zero.

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Fetal movement counting compared with hormone analysis (one study; 1,112 participants)

One RCT in a low risk obstetric population compared fetal movement counting from 29 weeks' gestation to blood tests for oestriol and human placental lactogen (hPL) starting at 33 weeks.[50]

Stillbirth

The evidence is uncertain about the effect of fetal movement counting on stillbirth when compared with hormone analysis. OR of 3.67 (95% CI 0.15 to 90.17). Evidence is of very low certainty; findings were downgraded once for imprecision (data from one study with one stillbirth; confidence intervals fail to exclude important benefit or harm), once as the study is at high risk of bias due to concerns about the randomisation process, and once due to indirectness as the study was carried out in a low risk population.

Secondary outcomes

Data for secondary outcomes can be seen in the supplementary file; there is no current evidence of any effects as confidence intervals are wide and include both benefits and harms.

Other fetal movement counting comparisons (one study; 1,400 participants)

One RCT compared two fetal movement counting methods;[46] this study reported no relevant outcome data (Supplementary file S4).

INTERVENTIONS FOR THE SUBSEQUENT CLINICAL MANAGEMENT OF RFM [GROUP TWO]

Universal ultrasound screening for RFM compared with ultrasound when indicated (one NRS; 579 participants)

One NRS compared universal CTG and ultrasound screening with universal CTG and targeted ultrasound (for biophysical profile) only if indicated.[52] This was a retrospective observational study with 579 participants, who all self-reported RFM after 26 weeks of gestation.

Stillbirth

The evidence is uncertain about the effect of universal ultrasound screening on the proportion of stillbirths in RFM pregnancies compared with targeted ultrasound; OR 0.53 (95% CI 0.05 to

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5.86). Evidence is of very low certainty, downgraded once due to serious and critical risk of bias in this study and once due to imprecision (95% CIs fail to exclude important benefits or harms). No further outcomes relevant to the review were reported.

Universal ultrasound screening plus blood tests compared with standard care (two RCTs; 336 participants)

One RCT compared intensive management (ultrasound scan, serum hPL, expedited birth if indicated by these tests) with standard care for presentations with RFM after 36 weeks' gestation (n=120).[62] A second RCT (n=216) compared standard care and a biomarker blood test (sFlt-1/PlGF), where the result of the blood test indicated whether expedited birth was offered, with standard care alone in presentations with RFM after 36 weeks' gestation.[63] No data for our primary outcome of stillbirth were reported; we did not pool data for secondary analyses due to differences in the interventions. Effect sizes for secondary outcomes can be seen in Supplementary file S4.

COMBINED INTERVENTIONS FOR ENCOURAGING AWARENESS OF FETAL MOVEMENT AND ITS SUBSEQUENT CLINICAL MANAGEMENT [GROUP THREE]

Encouraging maternal awareness of RFM and subsequent clinical management compared with standard care (one RCT, n=393,857).

Norman et al. conducted a stepped wedge RCT in 33 hospitals comparing education of pregnant women and clinicians, along with a clinical management plan including CTG and ultrasound for all presentations with RFM, with standard care.[16]

Stillbirth

The evidence is uncertain about the effect on stillbirth after 24 weeks' gestation when comparing this combination intervention with standard care (aOR 0.86, 95% CI 0.70 to 1.05). Evidence is of very low certainty, downgraded once as this study was rated as at high risk of bias, once as the confidence interval fails to exclude important benefits or harms as well as no effect, and once due to indirectness as this is a single study in a high income setting.

Perinatal death

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The evidence is uncertain about the effect on perinatal death between the intervention and standard care, this study presented an aOR of 0.95 (95% CI 0.81 to 1.12). Evidence is of very low certainty, downgraded once due to study limitations (rated as at high risk of bias), once due to imprecision, and once due to indirectness as described above.

Secondary outcomes

In the intervention group, this study reported statistically significant increases in the number of Apgar scores <7 at five minutes, caesarean section, emergency caesarean section, and NICU admission and statistically significant reductions in induction of labour and the proportion of SGA babies (Supplementary file S4). However, conclusions that can be drawn from these results are limited by the high risk of bias. Data were used from a corrected version of the online supplementary appendix.[64]

Other planned analyses and changes from protocol

We planned on presenting data as RRs, however, due to the data that were available (adjusted estimates were available as ORs only) we presented all data as ORs to minimise confusion. The majority of studies did not present adjusted effect estimates, although these were used where available. Planned sensitivity analyses were not possible due to the number of studies at overall low risk of bias and low number of included studies in each comparison. Comparisons between RCTs and NRS were not possible. Other intervention comparison groups, such as hormone analyses, were added after extracting data from all studies.

Comment

Main findings

Current evidence is insufficient for understanding the effects of interventions for encouraging awareness of fetal movement or fetal movement counting on stillbirth, neonatal death or perinatal death, when compared with standard care. This may be in part due to the relative rarity of these severe outcomes in high-resource settings and the size of the trials that have evaluated them rather than the interventions themselves.

Meta-analysis indicates that interventions for encouraging awareness of fetal movement may lower NICU admissions. NICU admission is a more common outcome than perinatal death, so

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it may be that the sample size is more likely to detect an effect on this outcome. From a clinical standpoint, lower NICU admissions, lower frequency of Apgar scores <7 at 5 minutes, and no increases in other outcomes such as caesarean section or induction of labour indicates that the effects of these interventions are all acting in the same direction along the proposed clinical pathway. Thus, acting on presentations with RFM is able to reduce the number of babies that end up in NICU (i.e. those that are unwell but not at immediate risk of death) but is not always able to save those babies that are at immediate risk of death as in some cases RFM may be too late an indicator

Our analyses also show that interventions for encouraging fetal movement counting may result in higher maternal-fetal attachment and lower maternal anxiety when compared with standard care, although the risk of bias of the included studies must be considered, as well as whether the degrees of difference seen in the standardised measures are clinically significant.

Importantly, there have been few studies of the subsequent clinical management of RFM, and no conclusions can be drawn as to whether ultrasound screening or blood tests of placental markers are likely to be of benefit. The link between reduced fetal movements, placental insufficiency, and stillbirth is well established; the challenge is whether this link can be modified and demonstrated by trials.

Strengths and limitations

This is the most comprehensive systematic review and meta-analysis of interventions for RFM, including both RCTs and the most appropriate NRS while still employing strict inclusion criteria, and conducted in accordance with a published protocol. This review builds on earlier work by widening the inclusion criteria for both study design and the types of intervention that were included, as well as by extracting data for a larger range of outcomes.[17,65] Validity has been maintained by only including robust study designs, only comparing interventions that we judged to be similar using the TIDieR checklist, and applying GRADE to our findings. We were also able to obtain unpublished data from study authors to conduct analyses that would otherwise not have been possible.

Importantly, many included studies were not adequately powered to measure the effects of interventions on stillbirth. We were only able to pool data from five studies (n=400,668) containing 962 stillbirths, leading to potential fragility of the meta-analyses. Several uncontrolled

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before and after studies have been conducted to measure the effect of guideline implementation for RFM on adverse outcomes.[15,41,66] However, this study design means that it is not possible to attribute any differences in outcome to the intervention. Our analyses were also limited by drawing evidence from high income countries only; consequently, all analyses were downgraded.

Implications for future research

Interventions

Interventions for RFM should be multifaceted; encouraging awareness of RFM can only prevent adverse outcomes if combined with effective clinical management. Likewise, clinical management can only prevent fetal death in the event of timely presentation with RFM. Studies should consider the prognostic accuracy of clinical tests such as ultrasound - the accuracy of which has been shown to be lacking for predicting stillbirth.[67]

In addition to this, the expected adherence to and acceptability of interventions needs to be considered, as well as whether they will reach the people who need them the most; for example those at higher risk of adverse outcome due to socioeconomic factors, who are often less able and/or more reluctant to go to hospital if they suspect something is wrong.[68]

Sample size

A 2015 confidential enquiry showed that there was suboptimal management of RFM in 25% of antepartum stillbirths.[69] An intervention that is 50% effective would reduce antepartum stillbirth in these pregnancies by 12.5%. Using these numbers and a stillbirth rate of 4 in 1,000, a trial would require over 230,000 participants in each arm.

NRS may be an easier way to achieve necessary sample sizes and retrospective designs may also give more accurate reflections of standard care. Trials across multiple centres would allow for larger sample sizes and detection of potential variation in effectiveness by country and income setting. Crucially, this would also allow the effects of interventions in low–resource settings, where incidences of severe outcomes are normally higher (and the link between RFM and stillbirth may be stronger[70]), to be examined. Current evidence suggests that interventions are unlikely to cause harm, although this is yet to be tested in lower resource settings. Interventions for awareness and kick counting are easiest to implement and come with fewer associated costs.

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Stillbirth rates

Study stillbirth rates varied, due to the study settings and years in which they took place (Supplementary file S5). Notably, in several large trials, stillbirth rates in both the control and intervention groups were lower than the population stillbirth rates during the study period;[13,14] this may be due to trial effects,[71] variation in the quality of guidelines in individual maternity units,[24] or under-representation of minority ethnic groups.[72] Changes in population stillbirth rates over the course of the trial, as seen in some of our included studies,[16,43] also need to be accounted for as this could mean that any decreases in stillbirth rate associated with the interventions themselves are difficult to detect.

Outcome measurement

There was wide variation in measured outcomes of included studies, which impedes meta-analysis. A core outcome set to be used in studies of encouraging awareness and/or evaluating the clinical management of RFM is currently being developed to ensure that future studies measure the most important outcomes, and to reduce the need for review authors to obtain unpublished data.[73]

Conclusions

Using evidence from both RCT and NRS it is uncertain whether interventions to encourage maternal awareness of fetal movement over and above standard care affect the rate of stillbirth or perinatal death. Included studies varied in population stillbirth rates and adherence to the interventions, which may affect whether the true effect of the intervention is measurable. Further research is necessary as people who are pregnant are likely to present with concerns about their babies' movements which need to be investigated and responded to appropriately. Thus, high quality controlled studies including those from low-resource settings are needed to provide evidence of, or refute, the effectiveness of common and novel clinical management strategies for presentations for RFM.

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Supporting information

S1 – Logic model for the effects of RFM interventions

S2 – Search strategies

S3 – Classification of interventions

S4 – Additional data from studies where pooled analyses were not possible

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646 S5 – Stillbirth rates in included studies