The role of fetal movement counting and ‘kick charts’ to reduce stillbirths in pregnancies ≥28 weeks’ gestation

Abstract

Background Stillbirths represent a significant global issue, with 2.6 million cases reported in 2015. Stillbirths are often unexplained and preceded by changes in fetal movement patterns. Fetal movement counting methods may be used to monitor maternally perceived fetal movement to identify pregnancies at increased risk.
Aims This article reports on an in-depth, evidence-based practice review conducted to investigate the relationship between fetal movement counting and stillbirth rates.
Methods A comprehensive search of online databases was undertaken to identify relevant literature using keywords. The results were then appraised.
Findings Although a lack of conclusive evidence exists to support or refute the routine implementation of fetal movement counting to reduce stillbirth, indirect evidence suggests that increased maternal and professional awareness of fetal movement may assist in reducing stillbirth rates.
Conclusions Further research is required to develop an appropriate definition of reduced fetal movement, and to determine the potential implications of fetal movement counting as a diagnostic screening tool to reduce stillbirths.

Keywords

Fetal movement | Kick charts | Reduced fetal movement | Fetal movement counting | Stillbirth | Perinatal mortality

Despite advances in maternity care internationally, stillbirths remain a significant global issue (Frøen et al, 2011) with approximately 2.6 million cases reported in 2015 (Lawn et al, 2016). In Ireland, stillbirth is defined as a baby born without signs of life beyond 23+6 weeks’ gestation or with a birthweight ≥500g (Health Service Executive (HSE), 2011; Manning et al, 2015). This accounted for approximately 1/250 births in 2015, representing a stillbirth rate of 4.0/1000 births (HSE, 2017). Reports demonstrate that stillbirths frequently occur in low-risk pregnancies (Warland et al, 2015), and an estimated 30% occur after 37 weeks’ gestation (Gilchrist, 2015), while approximately 50% of all stillbirths are unexplained (Draper et al, 2015). The significance of this issue must therefore be addressed. Stillbirth prevention has emerged as a leading research priority internationally (Goldenberg et al, 2011; Frøen et al, 2016).

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Research demonstrates that stillbirths are frequently preceded by changes in fetal movement patterns, generally presenting as periods of reduced or absent movement (Flenady et al, 2011; Warland et al, 2015). However, recent studies suggest that periods of excessive fetal movement are also a risk factor for late stillbirth (Stacey et al, 2011; Linde et al, 2015; Warland et al, 2015; Heazell et al, 2018). Fetal activity in utero is a commonly referenced indicator of fetal wellbeing (Heazell and Frøen, 2008; Saastad et al, 2011a), and is generally first perceived between 18-20 weeks’ gestation (Rådestad, 2010). Practice guidelines define fetal movement as any distinct roll, kick or flutter (Royal College of Obstetricians and Gynaecologists (RCOG), 2011), which develop into patterns of stronger gross movements as gestation advances (Tveit et al, 2009). These movements may occur between 4-100 times per hour (Mangesi et al, 2015), with natural periods of absent movements during fetal ‘sleep-cycles’ of up to 40 minutes (Gilchrist, 2015). These patterns provide an indirect indication of the integrity of fetal musculoskeletal and central nervous systems (Berbey et al, 2001). A perceived decrease in these movements can occur as a result of maternal factors, including smoking, obesity, sedatives, position, activity and anxiety; or fetal factors, including sleep-cycles, oligohydramnios, polyhydramnios, or an anterior placenta (Unterscheider et al, 2010; Mangesi et al, 2015). However, research also demonstrates that decreased movements may be indicative of fetal compromise associated with adverse outcomes including fetal growth restriction, hypoxia, preterm birth and stillbirth (Gilchrist, 2015). Maternally perceived reduced fetal movements (RFM) reportedly occurs in 5-15% of all pregnancies—frequently leading to unscheduled hospital consultations (Kamalifard et al, 2013)—and precedes approximately 50% of stillbirths (Efkarpidis et al, 2004; Linde et al, 2015).

There is no accepted definition for RFM (Gilchrist, 2015). Difficulties arise throughout the literature and clinical practice regarding consensus for an appropriate definition of RFM and a lack of evidence-based advice for pregnant women concerning recognition of abnormal movement (Heazell and Frøen, 2008).

Fetal movement counting and 'kick charts'

Fetal movement counting (FMC) using 'kick-charts' to systematically quantify and monitor maternal perceptions of fetal activity over a defined period of time (Saastad et al, 2012) evolved between 1960-1970 (Frøen, 2004) and since then, its role in identifying pregnancies at increased risk of stillbirth has been explored repeatedly (Mangesi et al, 2015; Winje et al, 2016). FMC is one of the oldest and most commonly used methods to monitor fetal wellbeing (Bhutta et al, 2011) as it is simple, cost-effective, non-invasive and easily accessible (Kamalifard et al, 2013). A variety of formal FMC methods and 'alarm limits' for RFM have been published (Rayburn, 1995; Frøen et al, 2008), ranging from complete cessation of fetal movements for 1 day (Harper et al, 1981; Leader et al, 1981), to fewer than 10 movements in 12 hours, known as the 'Cardiff method' (Pearson and Weaver, 1976). Alternative measures also include fewer than 10 movements in 2 hours (Moore and Piacquadio, 1989), or fewer than two to three per hour during defined daily periods (Sadovsky and Polishuk, 1977; Neldham, 1980). The proposed rationale for 'kick-charts' is to identify fetal compromise through maternal detection of RFM (Winje et al, 2015). Timely reporting to health professionals should initiate further diagnostic screening, including cardiotocography (CTG) monitoring and ultrasonography (Velazquez and Rayburn, 2002; Haws et al, 2009) to prevent perinatal morbidity and mortality (Saastad et al, 2011b).

However, this method has been criticised for failing to acknowledge the importance of individual temporal patterns (Winje et al, 2012), as well as the issue of inconsistent and conflicting definitions of RFM (Pakenham et al, 2013). There is also concern that the implementation of FMC may cause maternal anxiety, leading to increased hospital consultations and obstetric interventions (Saastad et al, 2010; Delaram and Shams, 2016) As a result, in Ireland, and internationally, there is inconsistency in the use and perceived importance of FMC methods as an intervention to reduce fetal loss (Smith et al, 2014)—a problem that should therefore be addressed.

Due to the perceived association between fetal movements and stillbirth, this article proposes to conduct an in-depth literature review from the following question: 'What role has fetal movement counting interventions and "kick charts" to play in developing maternal awareness of fetal movement patterns to reduce stillbirths in pregnancies ≥28 weeks' gestation?'. This question was constructed using a population, intervention, outcome, comparison (PICO) framework to include pregnant women experiencing singleton pregnancies ≥28 weeks' gestation as the intended population (P) and FMC as the specific intervention (I). The primary outcome (O) was stillbirth rates and control/comparison (C) related to standard care or no FMC. This is an intervention/effectiveness question. Therefore, the most applicable evidence required includes systematic reviews, randomised controlled trials (RCTs) and cohort studies.

Method

A comprehensive search of online databases, including CINAHL, Medline, PubMed and Embase, was undertaken to identify relevant published literature. Supplementary searches using Google Scholar identified relevant grey literature. Keywords included 'fetal/foetal movement counting/monitoring', 'kick-charts', 'stillbirths' and 'perinatal mortality/deaths', used singularly and combined using 'and/or' as Boolean operators. Filters applied included English language, peer reviewed, scholarly/academic journals, RCTs and systematic reviews. Publication dates were not restricted due to insufficient evidence. One PubMed database search for systematic reviews using keywords 'fetal movement' yielded 17 results, from which a relevant systematic review was obtained. Further material that met the inclusion criteria of pregnancies ≥28 weeks using FMC and stillbirth outcomes was sourced by searching the reference list in this review.

Literature review

Introduction of evidence

From the systematic review conducted by Winje et al (2016) on FMC interventions to enhance maternal awareness of RFM, two RCTs (Neldam, 1980; Grant et al, 1989), one controlled non-randomised study (Lobb et al, 1985) and three cohort-analytic studies (Westgate and Jamieson, 1986; Moore and Piacquadio, 1989; Tveit et al, 2009) were also selected for appraisal in this review due to their correspondence with the proposed topic and the applicability of their research design in answering this intervention question based on published evidence hierarchies (Polit and Beck, 2014) (*Figure 1*).

All included studies aimed to examine the perceived association between fetal movement and perinatal deaths, either through specific focus on formal FMC (Neldam,

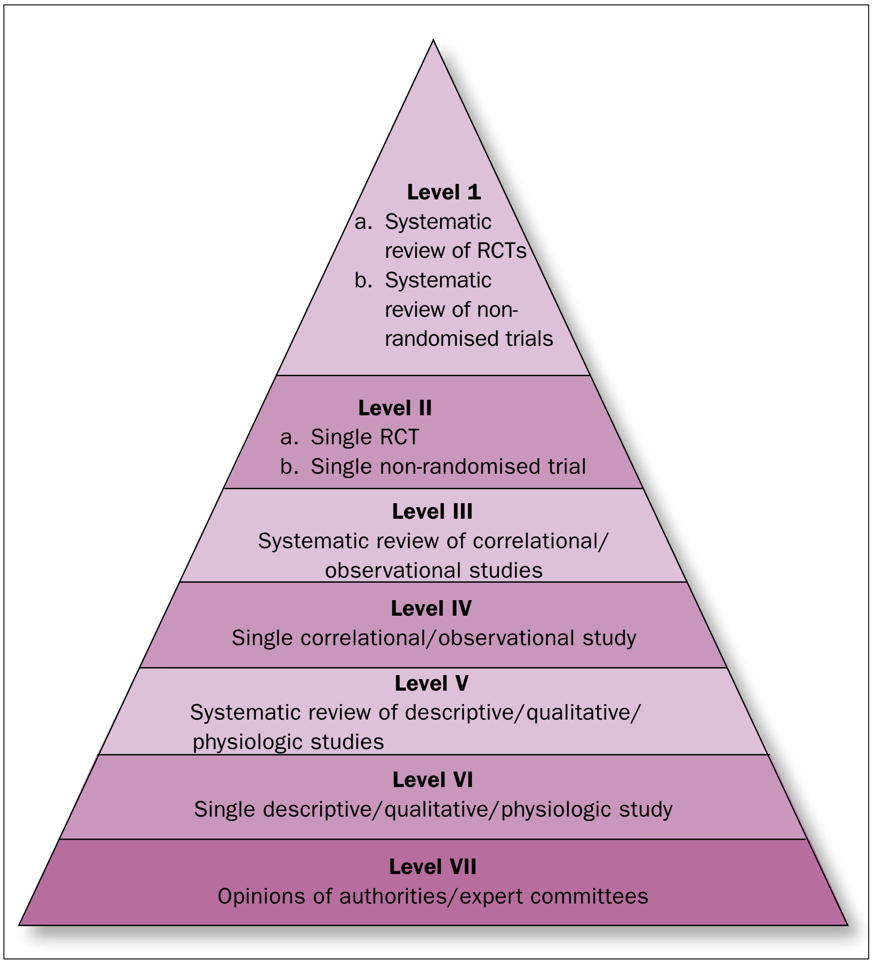

Figure 1. Hierarchy of evidence (Polit and Beck, 2014). RCT: randomised controlled trial

1980; Lobb et al, 1985; Westgate and Jamieson, 1986; Grant et al, 1989; Moore and Piacquadio, 1989) or the introduction of uniform information and guidelines related to fetal movement (Tveit et al, 2009). All studies included pregnant women in the third trimester as sample populations; however, methods of FMC and 'alarm limits' varied, as did comparisons between universal FMC and selective FMC, no FMC or standard care. A deductive paradigm and positivism approach was common across all studies which qualified them as suitable for inclusion is this review (*Table 1*).

Research designs

Winje et al (2016) involved 23 publications, including three RCTs (a total of 72 888 pregnant women) and five non-randomised studies (a total of 115 435 pregnant women), which focused on the effect of FMC interventions on perinatal death (*Table 2*). Both RCTs and non-RCTs were included as the potential for contamination in RCTs associated with public health interventions such as FMC may influence the validity of reported results.

Among these studies, Grant et al (1989) published a large multicentre 1:1 paired cluster allocation RCT across five countries, involving 68 654 women between 28-32 weeks' gestation. This study aimed to assess the effect of FMC on late antepartum fetal death in singleton pregnancies against a control group in which FMC was not routinely discussed. This strategy was also used in an older RCT (Neldam, 1980), involving 2250 women randomly allocated to commence FMC from 28 weeks' gestation or receive standard antenatal care. Lobb et al (1985) conducted a non-randomised study during which women attending Unit A (*n*=6597) were instructed regarding FMC while Unit B (*n*=13 705) were provided standard care that did not routinely use 'kick-charts', except for in selected high-risk cases and only with other measures of fetal wellbeing such as ultrasound and cardiotocography. Both Westgate and Jamieson (1986) and Moore and Piacquadio (1989) used a cohort-analytic design involving pre-intervention control and intervention study periods, during which the stillbirth rate for each period was assessed and compared. This design was also applied in Tveit et al (2009); however, the intervention consisted of routine information on fetal movement and guidelines for RFM management, and the subsequent impact on stillbirth rates. This study involved 14 hospitals across Norway, including 19 407 baseline and 46 143 intervention cohort participants.

FMC method and RFM 'alarm limits' varied between studies, which presented difficulties comparing methods and outcomes. In the study by Neldam (1980), participants were instructed to count fetal movement three times daily from 32 weeks' gestation, with RFM described as fewer than three movements per hour. Both Lobb et al (1985) and Westgate and Jamieson (1986) used the Cardiff 'count-to-10' method, as demonstrated in previous studies (Pearson and Weaver, 1976), whereby RFM was defined as the absence of fetal movement for 12 hours, or fewer than 10 fetal movements in 12 hours over 2 consecutive days. This method was also incorporated in Grant et al (1989), although modified to give sufficiently high specificity by defining RFM as no fetal movements in 1 day or fewer than 10 in 10 hours on 2 successive days. However, one cohort defined RFM as fewer than 10 movements perceived in 1 day. Significantly, Moore and Piacquadio (1989) undertook a pilot study (*n*=100) to identify and validate the parameters for maternally perceived fetal movements over 30 consecutive days, concluding the mean time to perceive ten fetal movements was 20.9 ± 18.1 (mean ± standard deviation (SD)) and 99.5% reported ten fetal movements within 90 minutes. This led to further modification of the 'count-to-10' method whereby RFM was defined as fewer than 10 movements in 2-hour periods, which was also incorporated in Tveit et al (2009).

Table 1. Evidence matrix

Study	Outcome	Design	Method	Sample
Winje et al (2015)	Determine effect of fetal movement interventions in reducing perinatal mortality and morbidity	Systematic review	Data from Cinahl, Cochrane, Embase, PsycInfo, Medline, Scopus Data screened to determine eligibility for inclusion	23 publications (16 studies) 3 RCTs (*n*=75 887) and 5 non-randomised studies (*n*=115 435) on FMC Population: 3rd trimester pregnancies
Neldam (1980)	Assess FMC as indicator of fetal wellbeing and effect on stillbirth	Prospective RCT	Randomisation on report numbers (odd/even) Data collected from patient records	2250 women. Demographic and baseline clinical variables not reported. 75% high risk Attrition rate not reported
Grant et al (1989)	Assess whether FMC results in decrease in late antepartum death	Multicentre cluster RCT	1:1 allocation within hospital Data: fetal movement charts, hospital records Postnatal questionnaire (26 clusters in-depth phase)	68 654 women, 66 paired clusters 5 countries (UK, USA, Ireland, Belgium, Sweden) with similar demographics Attrition rate not reported
Lobb et al (1985)	Evaluate fetal kick charts in preventing intrauterine death	Non-randomised controlled study	Controlled study Unit A trial participants FMC Unit B control participants FMC for high-risk patients Data collected from case notes	20 302 participants (6 597 trial vs 13 705 control) Attrition rate reported (excluded for no antenatal care) Population similar in mean age and parity
Westgate and Jamieson (1986)	Evaluate the effect of kick charts on stillbirth rates	Cohort analytic study	20-month (January 1981–August 1982) baseline control period Trial period (September 1982–April 1984) Outcomes assessed retrospectively	16 290 participants (8127 control vs 8163 trial)
Moore and Piacquadio (1989)	Evaluate effectiveness of FMC in reducing fetal mortality	Cohort analytic study	Control phase (7 months): no FMC assessment Pilot phase: parameters perceived fetal movement Data from FMC charts Study period: November 1985–May 1986	Control sample: 2519 Pilot sample: 100 Study sample: 1864 Population; dependents of active duty military members
Tveit et al (2009)	Examine effect of fetal movement information on stillbirth rates	Cohort analytic study	Registration period (7 months) Intervention period (17 months) Maternal consent not sought, to ensure unbiased registrations Patients registered prospectively when presented with RFM	Baseline: 1215/19 407 RFM Intervention: 3038/46 143 RFM 14 hospitals Included all singleton 3rd trimester pregnancies presenting with RFM (1st instance)

FMC: fetal movement counting; RCT: randomised controlled trial; RFM: reduced fetal movement

Results

Perinatal mortality and stillbirth rates associated with FMC introduction

The key outcome measured in each study, and the primary focus of this review, was perinatal mortality and stillbirth rates associated with FMC introduction. Significant variation in FMC method, RFM definition and obstetric risk status of participants led to significant heterogeneity between studies and, subsequently, pooling the results in Winje et al's (2016) systematic review was not feasible. Evidence both supporting and rejecting routine implementation of FMC was demonstrated. A reduction in stillbirths of between 24–75% was reported; however, the supportive evidence of improved outcomes is indirect from non-randomised studies, with no strong evidence of benefit or harm apparent (Winje et al, 2016).

In Neldam's (1980) RCT, eight stillbirths were recorded in the control group not instructed on fetal movements, while no stillbirths were recorded in the intervention group randomised to initiate FMC (95% CI; $P<0.01$). This resulted in an overall decrease in stillbirth rates in this population—of whom approximately

Table 2. Summary of study results				
Study	**Major variables**	**Measurement**	**Findings**	**Implications**
Winje et al (2015)	Independent variable: FMC Dependent variable: stillbirth/ perinatal death, preterm birth, small for gestational age, low birthweight, anxiety	Cochrane tool: assess RCT bias risk Ottawa Non-Randomised Studies Workshop checklist	Insufficient evidence. Lack high-quality trials. Indirect evidence from non-randomised studies 24–75% reduction in stillbirths	Insufficient evidence to recommend FMC RCTs needed
Neldam (1980)	Independent variable: FMC Dependent variable: stillbirth Discrete numerical variable: number of stillbirths	No blinding of participants and professionals FMC 3 times daily RFM=<3/hour	8 intrauterine deaths (control) vs 0 (treatment) 9 reports of RFM, 7 delivered (treatment). Stillbirth rate reduced from 6.3 (1978) to 4.3/1000 during trial	Recommended universal teaching of fetal movement monitoring Implication: Insufficient data to implement
Grant et al (1989)	Independent variable: FMC. Dependent variable: fetal death Discrete numerical variable: Number of fetal deaths	No blinding of participants and professionals RFM=<10 fetal movements in 10 hours over 2 days or no fetal movement 1 day	99 deaths (trial) vs 100 (control) Mortality rate decreased from 4.0 to 2.9/1000 17 deaths with RFM reported	Do not out rule benefit, evidence not supportive of routine implementation
Lobb et al (1985)	Independent variable: FMC Dependent variable: fetal death Discrete numerical variable: number of fetal deaths	Lack of blinding RFM=<10 fetal movements/12 hours over 2 days or no fetal movements in 12 hours	39 stillbirths (trial) vs 93 (control) not significant. Mortality rate decreased from 13 (previous 5 years) to 6.5/1000	Evidence insufficient to recommend changes in practice
Westgate and Jamieson (1986)	Independent variable: FMC Dependent variable: stillbirth Discrete numerical variable: number of stillbirths	Data on fetal movement collected from case notes RFM=<10 fetal movements over 2 consecutive days or no fetal movement 1 day	Control: 88 stillbirths (55% unexplained) Trial: 67 stillbirths (40% unexplained)	Evidence insufficient to recommend changes in practice
Moore and Piacquadio (1989)	Independent variable: FMC Dependent variable: fetal death Discrete numerical variable: number of fetal deaths	RFM=<10 fetal movements after 2 hours 10 fetal movements interval 21 ± 18mins (mean ± SD)	Mortality rate decreased from 8.7 to 2.1/1000 Antepartum tests increased by 13% RFM mortality decreased from 44 to 10/1000 Compliance >90%	Recommends introduction of 'count-to-10' FMC to reduce stillbirth. Evidence not sufficient to implement into practice
Tveit et al (2009)	Independent variable: written information on fetal movement/RFM and guidelines for RFM management Dependent variable: late stillbirth rates	Multivariate analysis; outcomes adjusted for potential confounding factors Pregnancy outcome collected independently from medical files	Stillbirth RFM decreased from 4.2% to 2.4% (OR 0.51; 95% CI 0.32-0.81, *P*=0.004) Cohort stillbirth rate decreased from 3 to 2/1000 (OR 0.67; 95% CI 0.48-0.93, *P*=0.02) Reports RFM stable	Improved management of RFM and provision of uniform information to women were associated with fewer stillbirths

FMC: fetal movement counting; RCT: randomised controlled trial; RFM: reduced fetal movement

75% were deemed to be of high obstetric risk—from 6.3/1000 births to 4.3/1000 births during the study period (*P*<0.01). Westgate and Jamieson (1986) also reported a reduction in population stillbirth rates from 10.83 to 8.21/1000 births (*P*<0.05) following the introduction of FMC. Before the intervention period, there were 88 stillbirths (*n*=8127), of which 55% were deemed unexplained. During the intervention (*n*=8163) 67 stillbirths were reported, 40% of which were unexplained, resulting in a reported relative risk of stillbirth of 0.76 (95% CI; 0.55–1.04). Moore and Piacquadio (1989) similarly reported a decrease in overall mortality rate from 8.7 during the control period (*n*=2519) to 2.1/1000 during the intervention (*n*=1864) (chi-squared (χ^2)=6.8; *P*<0.01), with 22 and 4 stillbirths, respectively.

Among women reporting RFM, Moore and Piacquadio (1989) found a decreased perinatal mortality rate from 44.5/1000 during the control period (*n*=247) to 10.3/1000 during the trial (*n*=290) (*P*<0.0001), as well as 97% compliance rate. A reduction in stillbirth in women specifically reporting RFM was also demonstrated in Tveit et al (2009) from 4.2% (*n*=50) to 2.4% (*n*=73) (OR=0.51; 95% CI 0.32-0.81; *P*<0.004) during the intervention period through the introduction of routine information and guidelines for RFM management. It also demonstrated an overall reduction in the cohort stillbirth rate of one-third, reporting a decrease from 3.0/1000 to 2.0/1000 (OR 0.67; 95% CI 0.48-0.93, *P*=0.02), suggesting increased awareness of fetal movements and the option of FMC had the potential to reduce stillbirth.

However, the large multicentre RCT conducted by Grant et al (1989) failed to demonstrate the same supportive findings regarding the effect of FMC on stillbirth rates. During the study, 99 stillbirths occurred in the intervention group assigned to FMC (*n*=31 648), while 100 stillbirths occurred in the control group (*n*=36 231); indicating that FMC was not recommended as an intervention to reduce perinatal mortality (95% CI; *P*<0.05). Approximately 10% of stillbirths (*n*=11) in the intervention group were predicted by FMC; however, fetal death occurred due to false reassurance from CTG monitoring and clinical error. Compliance with FMC was reported at 60%, with 50% of women responding appropriately to alarm triggers, which is significantly lower than that reported in Moore and Piacquadio (1989). However, a decrease in overall population perinatal mortality from 4.0 to 2.9 per 1000 during the study was reported, which may indicate that participation in the trial was beneficial. Similarly, the non-randomised study by Lobb et al (1985) demonstrated a statistically insignificant difference between stillbirths occurring in the intervention group using FMC (*n*=39/6597), and the control group whereby only high-risk patients were instructed on FMC (*n*=93/13 705) (95% CI 0.6-1.3; *P*=0.47). Absent fetal movement was reported in five cases in Unit A; however, failure to act on the alarm triggers and inappropriate management resulted in fetal demise. However, as in Grant et al (1989), an overall reduction in perinatal mortality rates to 6.5/1000 was seen during the trial, compared to 13.0/1000 in the 5 years preceding the introduction of FMC.

Appraisal of evidence

The evidence represented in this review was appraised for inclusion; however, as demonstrated in Winje et al (2016), a formal meta-analysis of the data was not feasible, due to significant variations in methodology, design and RFM definitions. Winje et al (2016), as a systematic review, was the highest level of evidence obtained and was deemed suitable, as a clear search strategy, specific inclusion and exclusion criteria, and quality assessment measures conducted independently by two authors were included. Data were clearly provided for risk of selection, performance, attrition, detection and reporting bias in RCTs, and for bias, confounding and directness in non-randomised studies using evidence-based checklists (Wells et al, 2013). Low effect magnitude/size was reported. Inconsistency of results may be related to variations in study type, FMC method and gestation. Precision was deemed insufficient in some studies, and significance levels for stillbirth outcomes ranged from *P*<0.01–0.63. This review was limited by the lack of high-quality studies and the proportion of studies conducted over 20 years previously that included insufficient data to accurately evaluate methodological standards.

Both Neldam (1980) and Grant et al (1989) demonstrated reliability and external validity through randomisation, large sample sizes and detailed methods undertaken during their respective RCTs, as well as low risk of detection bias as outcome assessments were blinded. However, reliability is uncertain, as both studies included modified measurement tools for FMC, and clinical errors reported in the management of RFM once identified by FMC may have affected the results. The effect sizes between intervention groups were low and internal validity may be affected by contamination through discussion of FMC in both groups and selected FMC in 8.9% of control groups of unknown risk status (Grant et al, 1989), as well as lack of blinding of controlled participants aware of FMC indicating performance bias. The use of in-hospital paired clusters in Grant et al (1989) may have increased awareness and vigilance towards fetal movement in the overall population, resulting in contamination of the study and consistency in findings is possibly affected by different alarm limits used for one cohort. Although RCTs are considered high-standard evidence in relation to intervention-based questions, the inability to blind participants and professionals to FMC, as well as the high risk of contamination through increased awareness throughout the population, suggests that RCTs may not be appropriate to accurately detect the effect of FMC on stillbirth rates. Consideration should also be given to potential ethical issues associated with conducting RCTs on fetal movements, as the nature of the intervention and link to fetal wellbeing raises questions about the suitability of RCTs in this area.

The strength of the remaining evidence included is impacted by the non-randomised designs. Three studies were historically controlled as participating sample groups were organised by time difference before and after the interventions (Westgate and Jamieson, 1986; Moore and Piacquadio, 1989; Tveit et al, 2009), while Lobb et al (1985) generated their sample population through separate locations. Risk of selection bias was present in this study, as exclusion criteria differed between groups. Directness of the evidence was demonstrated in Lobb et al (1985), Moore and Piacquadio, (1989), and Tveit et al (2009), based on the relevance of their population,

‘Although RCTs are considered high-standard evidence in relation to intervention-based questions, the inability to blind participants and professionals to FMC, as well as the high risk of contamination through increased awareness throughout the population, suggests that RCTs may not be appropriate’

interventions and outcome measures. However, Westgate and Jamieson (1986) exhibited methodological weaknesses with high risk of bias and uncertainty regarding the timing of retrospective outcome assessments which were not reported. χ^2 tests were used for statistical analysis in three of the studies (Lobb et al, 1985; Moore and Piacquadio, 1989; Tveit et al, 2009). There was also a substantial risk of confounding bias identified in Lobb et al (1985) and Westgate and Jamieson (1986) as limited evidence was provided for the suitable control of known or unknown confounding variables. Both Moore and Piacquadio (1989) and Tveit et al (2009) demonstrated consideration for confounding variables and assessed comparability between control and intervention groups based on these. Tveit et al (2009) undertook multivariate analysis, adjusting outcomes for potential confounders including maternal age, body mass index, parity, ethnicity and smoking. A correction was published in 2010 for this study; however, the results did not affect the focus of this review (Tveit et al, 2010). Although the evidence presented in these studies indicated support for FMC, caution in the acceptance of these results must be exercised, due to the potential for unknown confounding and the methodological weaknesses of non-randomised studies when compared to RCTs.

Implications for practice

The evidence for FMC and its role in antepartum care as a screening tool for fetal compromise through recognition of RFM is inconsistent and inconclusive, as demonstrated in this review, and has led to variation in practice internationally (Pakenham et al, 2013). As a result, maternal monitoring of fetal movement in Ireland and worldwide is predominantly an unstructured self-assessment interpreted by women individually with varying guidance from professionals (Saastad et al, 2011a). The concept of FMC is endorsed in Canada for high-risk patients from 28 weeks' gestation (The Society of Obstetricians and Gynaecologists of Canada (SOGC), 2007), while guidelines in the UK, USA, and Norway do not recommend FMC and argue that education on fetal moevment is significant to identify RFM (National Institute for Health and Care Excellence (NICE), 2008; RCOG, 2011; Saastad et al, 2011a; American Academy of Pediatrics (AAP) and American College of Obstetricians and Gynecologists (ACOG), 2012). However, commonly reported practice for RFM concerns involves implementation of the ‘count-to-10’ FMC method demonstrated in Moore and Piacquadio (1989) (RCOG, 2011; Winje et al, 2011; AAP and ACOG, 2012). That said, these numerical recommendations fail to highlight the importance of unique and individual movement patterns and maternal experiences (Akselsson et al, 2017). A study exploring 19 women's experience of fetal activity in the third trimester found that descriptions of movement patterns varied widely and were incomparable between participants (Bradford and Maude, 2018). Future guidelines must therefore take into account the wide variety in individual fetal movements to focus on the unique pattern of each fetus and avoid applying universal numerical recommendations for fetal activity.

Concerns regarding potentially laborious FMC methods, compliance, maternal anxiety and increased hospital attendance for RFM have been raised repeatedly throughout the literature (Christensen et al, 2003; Saastad et al, 2012). In order for FMC to be universally acceptable, minimal disruption to daily routines is needed to encourage maternal compliance and promote prolonged use (Pakenham et al, 2013). This is demonstrated in the high compliance rates of 67-90% reported in studies using the modified ‘count-to-10’ method requiring a maximum of 2 hours (Moore and Piacquadio, 1989; Freda et al, 1993; Christensen et al, 2003; Gómez et al, 2007). Recent literature also highlights the emergence of ‘mindfetalness’ as a daily self-assessment tool of fetal movements, where mothers are encouraged to focus on identifying their baby's movement pattern for 15 minutes daily from 28 weeks' (Akselsson et al, 2017), a concept that may warrant further exploration as a method to monitor and understand individual fetal movement patterns. Effective FMC or self-assessment of fetal movements requires ongoing support from health professionals and should be discussed routinely throughout antepartum care (Velazquez and Rayburn, 2002). However, arguments persist regarding the potential for increased maternal anxiety, cost and iatrogenic complications as RFM is a common reason for unscheduled hospital consultations (Delaram and Shams, 2016; Winje et al, 2016). Moore and Piacquadio (1989) reported an increase of 13% in antepartum investigations for RFM (χ^2=89, P<0.00001). This association was refuted in recent literature, however, which stated that routine fetal movement information and FMC did not increase RFM consultation rates compared with standard care (Tveit et al, 2009; Saastad et al, 2010; Delaram and Shams, 2016). The association between maternal anxiety and FMC has been studied repeatedly using validated tools to measure anxiety, including the Spielberger State-Trait Anxiety Inventory (Cronbach's alpha (α)=0.86) and the Cambridge Worry Scale (α=0.82), which reported reduced maternal anxiety levels associated with FMC use compared to control participants in several RCTs (Liston et al, 1994; Saastad et al, 2012; Delaram and Shams, 2016). Therefore, the association between FMC and increased maternal concern, as well as resource use, is not supported by the evidence (Saastad et al, 2012; Delaram and Shams, 2016).

As seen through the stillbirths reported due to clinical error in both Grant et al (1989) and Lobb et al (1985), appropriate and timely management of reported RFM is essential (Haws et al, 2009; RCOG, 2011). However, as many of the studies included in this review were conducted more than 20 years ago, consideration should be given to modern advances in maternity care, as well as changes in society and health complexities in the 21st century, which may influence the ability to apply these results to the current climate. That said, clinical practice regarding the management of RFM varies across Ireland and worldwide, and, therefore, there is a need for national and international guidelines to ensure safe and effective antenatal care for women perceiving RFM has been identified (Unterscheider et al, 2010; Draper et al, 2015).

As with FMC, evidence concerning the appropriate management and identification of RFM is inconsistent and inconclusive (Tveit et al, 2009; Unterscheider et al, 2010). Education regarding the significance of fetal movement is of vital importance and should be prioritised (McArdle et al, 2015); however, insufficient evidence on RFM definitions may impact maternal compliance with inconsistent advice (Draper et al, 2015). In addition, with the ever-increasing popularity of message boards and social media, pregnant women have easy access to information that may be of variable quality and lack an evidence-based foundation (Warland and Glover, 2017). Similarly, the increasing popularity of hand-held fetal Doppler devices indicates the need for a safe reliable tool to assist maternal monitoring of fetal wellbeing, as they are openly available to purchase online. These devices are not recommended for maternal use as an audible fetal heart is not reliably indicative of fetal wellbeing and may be present despite periods of RFM suggestive of fetal compromise (NICE, 2008; Gilchrist, 2015), which therefore give false reassurance to mothers. This represents a new challenge for maternity care providers in monitoring the use of these devices and providing information regarding the potential risks associated with their use. Further research is urgently needed to develop a suitable definition of RFM, and to devise consistent evidence-based clinical guidelines on the management of RFM to limit clinical error and false reassurances in order to allow the potential benefits of FMC discussed in this review to be explored further.

Key points

- There is a lack of conclusive evidence to support or refute the introduction of fetal movement counting (FMC) charts into clinical practice as a measure to reduce stillbirth rates in singleton pregnancies ≥28 weeks' gestation
- There is, however, strong evidence to support the importance of reduced fetal movement (RFM) as an indicator of fetal compromise
- Further research is warranted to identify an appropriate and applicable definition of RFM
- Further research is also needed to robustly evaluate the formal introduction of FMC as a diagnostic screening tool to identify fetal compromise as part of maternity care practice

Conclusion

This review demonstrates a lack of conclusive evidence to support or refute the introduction of FMC into clinical practice as a measure to reduce stillbirth rates in singleton pregnancies ≥28 weeks' gestation. However, indirect evidence appears to suggest that increased vigilance and awareness of fetal movements by midwives, doctors and women may help reduce the risk of stillbirth, as all studies included in this review reported a reduced overall mortality rate for the studied population following FMC interventions. There is strong evidence to support the importance of RFM as an indicator of fetal compromise; however, significant inconsistencies in the definition of RFM and appropriate management must be addressed in order to potentially influence stillbirth rates (Winje et al, 2011). Further research is warranted to identify an appropriate and applicable definition of RFM, developed using a sample representative of the complete obstetric population, in order to develop guidelines on the diagnosis and management of RFM to reduce perinatal mortality and improve antepartum care. In addition, further robust studies in obstetric settings are required to identify the acceptability, feasibility and potential implications of formal FMC as a diagnostic screening tool to identify fetal compromise and decrease stillbirth rates within Ireland and internationally. BJM

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CPD reflective questions

- How would you advise a woman concerned about reduced fetal movement?
- What are the policies in your hospital about the management of reduced fetal movement?
- What is the role of the midwife for women regarding fetal movements?

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