

Investigating the significance and current state of knowledge and practice of absent or reduced fetal movements in low and lower middle-income countries: a scoping review

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Background Absent or reduced fetal movements (ARFM) are linked to adverse perinatal outcome in high income countries but the significance of this symptom in low and lower middle income countries (LMICs) is less established. The objective of this study was to report the current state of knowledge and practice regarding the association between ARFM and adverse pregnancy outcomes in LMICs.

Methods Systematic literature searches were undertaken in MEDLINE, Web of Science, Google Scholar, LILACS, and AJOL. Studies were included if they reported adverse perinatal outcome(s) following ARFM, clinical management strategies employed following ARFM, or women's knowledge regarding perception of ARFM. Qualitative data were tabulated, where possible meta-analysis was performed on quantitative data.

Results Nineteen full-text papers were included; five studies reported the association between ARFM and stillbirth in LMICs (1466 pregnancies including 296 stillbirths). The likelihood of stillbirth was higher in ARFM (odds ratio 14.13, 95% CI 3.46-57.77). Women's awareness of ARFM as a danger sign varied greatly from 3.1-62.3%.

Conclusions There is a lack of published literature regarding the significance of ARFM in LMICs, but available data suggest a significant association between ARFM and adverse outcomes. Strategies to increase women's awareness require evaluation in LMICs.

Absent or reduced fetal movements (ARFM) are reported to occur in 4-18% of pregnancies (1) and studies in high income countries (HICs) have shown an association with adverse perinatal outcomes including stillbirth (2, 3), preterm birth and fetal growth restriction (FGR) (2). A recent Confidential Enquiry in the UK found that maternal presentation with ARFM occurred in 28% of in-trapartum perinatal deaths, and suboptimal care was evident in 33% of cases (4) highlighting the importance of appropriate management of ARFM.

Diagnosis of ARFM may occur following maternal perception or can be defined using tools such as "kick charts". Observational studies report that fetal move-

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ment counting is associated with better identification of FGR and a reduction in infants born with Apgar scores <4 at 1 minute (5), and interventions for ARFM may reduce the incidence of stillbirth without any associated increases in other adverse maternal or neonatal outcomes (6). However, data from randomised controlled trials are not sufficient to determine whether “kick charts” or management of ARFM can reduce mortality or morbidity (7, 8). Furthermore, it is not currently known whether the results of studies in HICs are applicable to low and lower-middle income countries (LMICs) that have higher stillbirth rates.

To meet the goals for stillbirth reduction in LMICs outlined in the Every Newborn Action Plan, strategies are needed to identify fetal compromise and to institute appropriate action. ARFM may represent a means to detect fetal compromise in low-resource settings. Thus, knowing the incidence of ARFM, its association to adverse pregnancy outcomes, and if any clinical interventions are effective could aid development of optimal methods of screening for fetal compromise in LMICs. Currently, the World Health Organization recommends that care providers enquire about ARFM at each visit and that women who perceive ARFM should be monitored (9).

The aim of this scoping review was to assess the current literature on ARFM in LMICs, the objectives of this review were to determine: i) the frequency of adverse pregnancy outcome after presentation with ARFM in LMICs and if there are investigations or clinical factors that predict this; ii) what women’s experiences are regarding the perception of fetal movements and their subsequent care and if there are any specialised management strategies in place; and iii) the extent of knowledge of women and care givers in LMICs with regard to ARFM as a potential cause of adverse outcomes in pregnancy.

A scoping review was chosen as this methodology allows broad inclusion criteria, thereby facilitating the reporting and analysis of as much relevant data as possible, even when meta-analysis cannot be performed (10). This approach was taken as it gives an idea of the number of studies addressing ARFM in LMICs and a view of the total body of research evidence.

METHODS

Following the methodological framework outlined by Arksey & O’Malley (11), preliminary searches were conducted in African Journals Online (AJOL) to evaluate the types of published studies and to help identify research questions. Using keywords and reference lists of papers identified by these searches, systematic searches were performed in MEDLINE, Web of Science, Google Scholar, LILACS, and AJOL from database inception to 2018. An example search strategy is included as Appendix S1 in **Online Supplementary Document**.

A systematic approach was taken to screening and data extraction; titles and abstracts resulting from our searches were screened according to our inclusion criteria and relevant studies were identified. Inclusion criteria were kept broad so as not to exclude any potentially relevant studies. The overall concept of interest is pregnancies in which there is maternal perception of ARFM; consequently studies that evaluated knowledge and/or practice in relation to ARFM were included, as were studies of the outcome of pregnancy after ARFM. Studies of interventions (whether this is specialised management, monitoring or admission, or induction of birth) for ARFM were also included. In this study, ARFM was defined by maternal perception or clinical diagnosis (e.g. use of a kick chart) after 28 weeks of gestation. Screening was performed by two authors (DH and AH) and any disagreements were resolved by consulting with a third author (RS). Reference lists of included studies were checked for other relevant studies. Countries were classified as LMICs based on the World Bank classification of income status (12).

Our primary outcome of interest was antepartum stillbirth, defined as death of a baby after 28 weeks of gestation or with a bodyweight of >1000g before birth (13). Secondary outcomes were alternative measures of fetal wellbeing: low Apgar score (<7 at 5 min); small-for-gestational-age (SGA) defined as birthweight below the tenth centile for gestational age or as

described by individual studies; preterm birth <37 weeks; neonatal unit (NNU) admission; umbilical artery pH <7.05 or BE >-12; low birthweight (<2.5kg); very low birthweight (<1.5kg); maternal outcomes were birth by caesarean section and postpartum haemorrhage (PPH).

Data were extracted using a piloted form by two authors independently (DH and AH); discrepancies were resolved through discussion with a third author (RS). Qualitative data in relation to women's knowledge or experiences of ARFM were tabulated and/or recorded narratively. Where possible, meta-analysis was performed, overall proportions and 95% confidence intervals were calculated for each outcome in women with and without ARFM. I^2 , a statistic derived from Cochran's chi-squared statistic Q , was used to describe the percentage of between-study variation that is attributable to variability in the true treatment effect (14). An I^2 value of 0-30% was classified as low, 31-60% as moderate, 61-90% substantial, and 91-100% considerable (15).

Meta-analysis was performed in STATA version 14 (StataCorp, TX, USA) using the metan (16) and metaprop (17) commands. Random effects meta-analysis was used in anticipation of heterogeneity between studies caused by differences in design. When necessary, analyses of proportions were conducted using a continuity correction to allow for the inclusion of studies with 0% or 100% values (17). The review was registered prospectively on PROSPERO (CRD42018088635).

RESULTS

Literature searches retrieved 729 abstracts, of which 34 full text papers were obtained after screening based on titles and abstracts (Figure 1). After evaluation of full text papers against the inclusion criteria, 19 studies were included. Twelve studies reported data on women's knowledge of fetal movements (18-29) and seven included quantitative data (30-36). One author was contacted for information (36); however additional relevant data were not available.

Included studies were from 11 countries: Ethiopia, the Gambia, Nepal, and Zimbabwe (LICs); Bangladesh, Ghana, India, Jordan, Kenya, Nigeria, and Pakistan (LMICs) (Figure 2). Characteristics of included studies for quantitative data are described in Table 1. Four studies used a case-control design and three were cohort studies. Four studies defined ARFM by maternal perception with the two oldest studies (both published in 1988) employing fetal movement counting charts. Six studies reported data for our primary outcome (stillbirth); four in women with and without ARFM and two in ARFM cohorts only. Three papers also reported data for at least one of our secondary outcomes and one paper reported data for one secondary outcome alone.

Data regarding the incidence of stillbirth in ARFM pregnancies and in those with normal movements were extracted from five studies (30-34), comprising 1466 pregnancies of which there were 296 stillbirths. Including all studies, the likelihood of stillbirth was significantly higher in pregnancies with ARFM (OR 14.13; 95% CI 3.46 to 57.77) than without. There was substan-

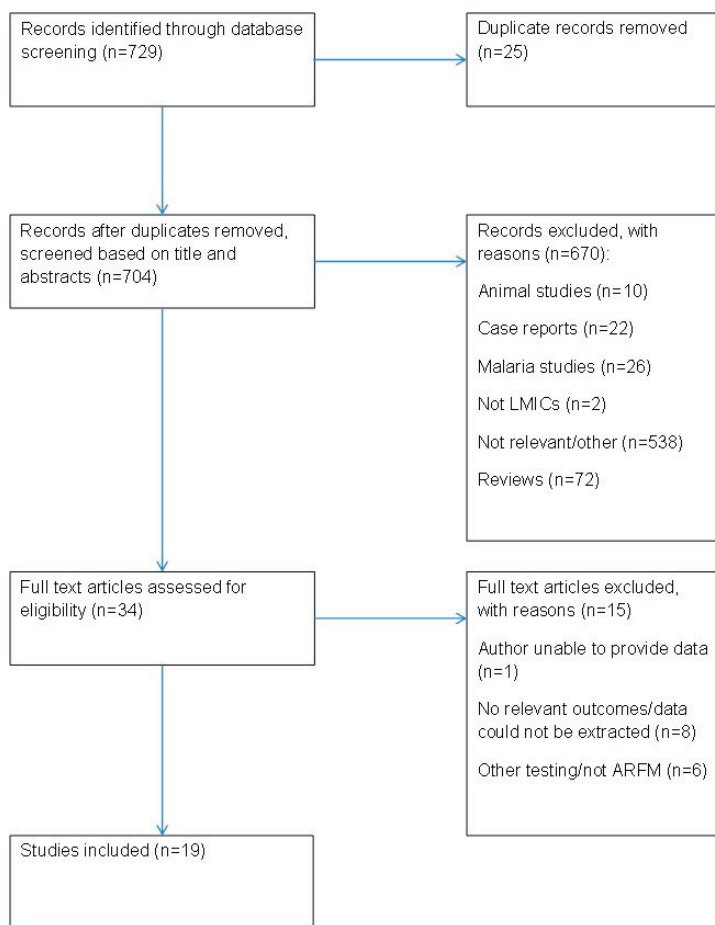


Figure 1. PRISMA diagram of included studies. PRISMA flow chart showing the literature screening process.

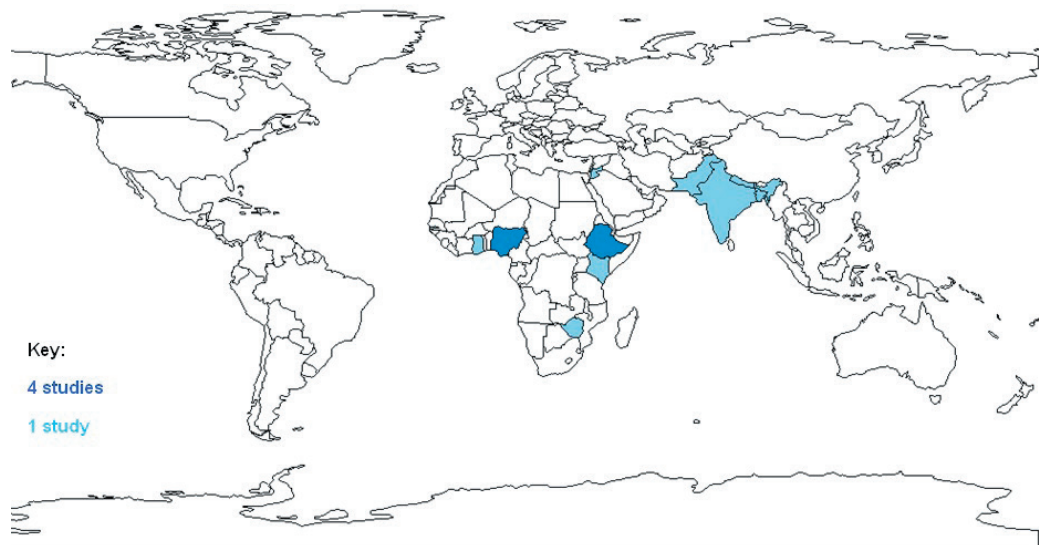


Figure 2. Map of included studies. STATA map showing the location of included studies.

Table 1. Characteristics of studies included in quantitative analysis

STUDY	STUDY TYPE	COUNTRY (INCOME STATUS)	ARFM DEFINITION	OUTCOME(S)*	STUDY POPULATION
De Muylder (1988) (34)	Cohort of high risk pregnancies	Zimbabwe (LIC)	DFMC chart, abnormal count defined as fewer than ten between 6am and 6pm	SB, Apgar, CS	200 pregnancies of which 36 had an abnormal DFMC count (19 were excluded as doubtful); 8 stillbirths (7 with ARFM) and 25 low Apgar scores (14 with ARFM)
Lema, Rogo & Mwalali (1988) (30)	Cohort of pregnant women who were given DFMC charts	Kenya (LMIC)	DFMC chart, abnormal count defined as fewer than ten between 9am and 9pm	SB, Apgar, PTD, BW <2500g	110 pregnancies, 27 with ARFM; 6 stillbirths (5 with ARFM) and 22 low Apgar scores (9 with ARFM)
Manandhar, Giri & Rana (2013) (35)	Cohort of women with ARFM	Nepal (LIC)	Maternal perception	SB, Apgar, CS, NNU	55 pregnancies with ARFM; 5 stillbirths and 1 low Apgar score
Nahar, Rahman & Nasreen (2013) (31)	Case control study of 464 live births and 231 stillbirths	Bangladesh (LMIC)	Maternal perception	SB, PTD	64 pregnancies with ARFM, 24 of these had stillbirths.
Oladapo, Adekanle & Durojaiye (2007) (32)	Case control study of 184 live births and 46 fetal deaths	Nigeria (LMIC)	Maternal perception	SB	18 pregnancies with ARFM, six of these pregnancies resulted in stillbirth.
Olagbuji et al (2011) (37)	Case control; 107 women who had induction of pregnancy for RFM and 107 who were induced for prolonged pregnancy (no RFM)	Nigeria (LMIC)	Maternal perception	Apgar, BW<2500g, CS, NNU	107 women were induced with ARFM as an indication, 10 of these had a low Apgar score.
Singh & Sidhu (2008) (33)	Case control; 250 women who were given DFMC charts and 250 who were not.	India (LMIC)	Maternal perception in the control group, DFMC chart in the study group	SB	8 of 250 pregnancies without DFMC charts had ARFM; 5 of these ended in stillbirth. There were no stillbirths in women without ARFM.

LMIC – lower middle-income country; LIC – low-income country; DFMC – decreased fetal movement count; ARFM – absent or reduced fetal movement

*Primary outcome: SB –stillbirth; Secondary outcomes: Apgar – Apgar score <7 at 5 minutes; PTD – preterm delivery; BW <2500g – birth weight less than 2500g; NNU – neonatal unit admission; CS – caesarean section.

tial heterogeneity between studies ($I^2 = 75.9\%$, $P < 0.005$) (Figure 3), which was likely due to data from the study by Singh & Sidhu (2008). Removing this study from the analysis gave an OR of 6.47 (95% CI 2.45 to 17.04) with an I^2 of 51.2% ($P = 0.10$). We were unable to compare the likelihood of other secondary outcomes in ARFM pregnancies to those with normal fetal movements due to a lack of information.

Data for the proportion of pregnancies ending in stillbirth in pregnancies with ARFM was extracted from six papers (30–35) comprising 49 stillbirths from 178 pregnancies. Two of these studies were cohort studies of ARFM pregnancies and from the others we used data

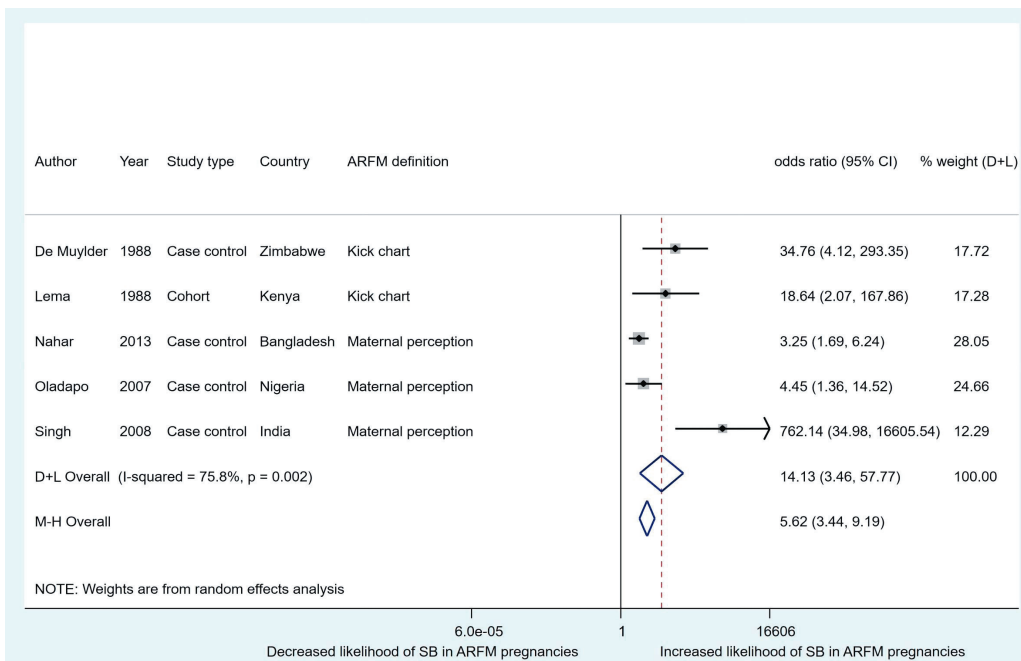


Figure 3. Likelihood of stillbirth in ARFM (absent or reduced fetal movements) pregnancies. Forest plot showing the likelihood of stillbirth in pregnancies with ARFM versus those without.

from the case arm of case control studies. The control group was used from the Singh & Sidhu (2008) study as there was no intervention for ARFM. The overall proportion of stillbirth in ARFM pregnancies was 0.33 (95% CI 0.13 to 0.54, $I^2=92.53\%$, $P<0.005$; Figure 4, panel a) i.e. 33% of ARFM pregnancies resulted in stillbirth.

Data for the incidence of low Apgar score (<7 at 5 min) were available on 225 pregnancies from 4 studies (30, 34, 35, 37). The proportion of low Apgar scores was 0.18 (95% CI 0.05 to 0.30) in pregnancies with ARFM. Again, overall heterogeneity was considerable ($I^2 = 90.70\%$, $P<0.005$; Figure 4, panel b).

Data on the frequency of caesarean section in ARFM pregnancies were available from three papers (34, 35, 37) reporting the outcomes of 191 pregnancies. Only caesarean sections for fetal distress were included, any procedures that were elective or performed for other reasons were excluded from this analysis. The overall proportion of caesarean section in women reporting ARFM was 0.15 (95 CI 0.06 to 0.24, $I^2= 65.20\%$, $P=0.06$; Figure 4, panel c).

NNU admission was recorded by two studies (35, 37). Olagbuji (37) reported an incidence of 7.5% from 107 pregnancies in their cohort of pregnant women who underwent induction for ARFM and Manandhar (35) reported an incidence of 20% from a cohort of 55 women with ARFM, in which there were two perinatal deaths.

Two papers (30, 37) recorded the incidence of birthweight <2.5kg; both of these studies found a significantly higher incidence of low birthweight in pregnancies with ARFM; Lema (30) found an incidence of 46.8% in 27 pregnancies with ARFM compared with 22.4% of the total population (n=110) and Olagbuji (37) found an incidence of 11.2% in 107 women who were induced for ARFM compared with 2.8% in 107 women who were induced for prolonged pregnancy (who had no evidence of ARFM).

No formal meta-analysis for studies that intervened based on ARFM status could be performed because the interventions and study methods were not comparable (Table 2). Interventions included screening for fetal compromise using cardiotocography, ultrasound fetal biometry, induction of labour and birth by caesarean section. In one study where women with ARFM were induced with misoprostol (37) the proportions of babies born with a 5 min Apgar score <7 was lower than in our pooled analysis (9.3% vs 18%) and the proportion of caesarean sections was higher (38% vs 30%); there were no stillbirths.

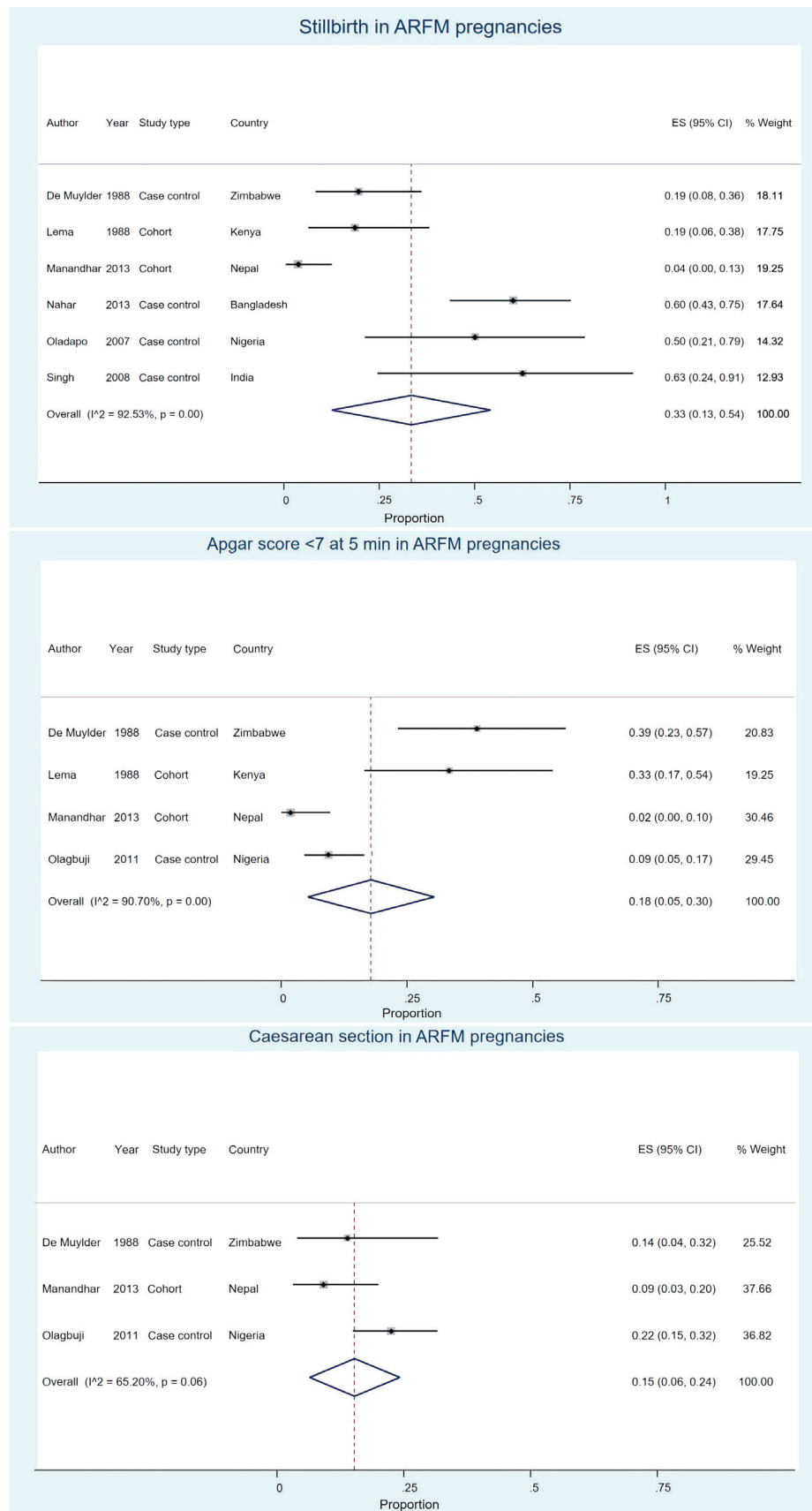


Figure 4. Panel a. Stillbirth in ARFM (absent or reduced fetal movements) pregnancies. Forest plot showing the proportion of stillbirth in ARFM pregnancies. Panel b. Apgar score <7 at 5 min in ARFM pregnancies. Forest plot showing the proportion of low Apgar score in ARFM pregnancies. Panel c. Caesarean section in ARFM pregnancies. Forest plot showing the proportion of caesarean section in ARFM pregnancies.

Table 2. Characteristics of studies that used interventions for ARFM

AUTHOR	INTERVENTION	POPULATION	OUTCOMES	STUDY INFORMATION
De Muylder (1988) (34)	Induction or caesarean delivery for all abnormal counts according to clinical context.	200 women with high risk pregnancies who were given a kick chart.	Action was only taken in 20 of 36 pregnancies with an abnormal chart; there were no antenatal deaths and five babies with a low Apgar score.	Cohort study of kick charts in high risk pregnancies in a public hospital in Gweru, Zimbabwe.
Lema (1988) (30)	Ultrasound, or amniocentesis with the aim of delivery. Immediate delivery if persistently poor counts after observation. Immediate delivery if abnormal FHR, if liquor was ammonium stained, or if at term.	110 mothers with GA >32 weeks who were instructed how to record fetal movements.	Outcomes not presented separately for women who received an intervention.	Cohort study of women with risk factors in a public tertiary referral hospital in Kenya.
Olagbuji et al (2011) (37)	Induction of labour at term (Misoprostol 50mg)	Women with maternal perception of decreased fetal movement.	Caesarean delivery 38%; 5 min Apgar score <7 9.3%; BW <2500g 11.2%; mean BW 3177+/- 409g; NNU admission 7.5%	Case control study of women induced for perception of fetal movement vs induced for prolonged pregnancy in a university teaching hospital in Nigeria
Singh & Sidhu (2008) (33)	Admission and screening by US and NST after a positive result.	250 women who were given DFMC charts.	15 of 36 women with abnormal kick charts were admitted, of these 12 were discharged when they had satisfactory fetal movements after screening. The three with persistent RFM had vaginal births. There were no stillbirths in this group.	Case control study of women who were and were not given DFMC charts at a military hospital in India.

Twelve studies used interviews and/or questionnaires, many of which were structured and pretested, to report women's knowledge of ARFM as an obstetric danger sign. We found no studies reporting care givers' knowledge of ARFM. The percentage of women who were aware of ARFM as a danger sign in each study ranged from 3.1% to 62.3%, reported in Table 3. In general, studies did not report women's source(s) of information about ARFM although the numbers of antenatal clinic visits as well as the care provider were commonly reported. One study (28) stated that 80.4% of women recalled their care providers enquiring about their perception of fetal movement. Women's main sources of information were doctors (53.3%) or nurses (46.2%) and 18.2% of women only received information from family and friends, or via the internet or media.

Table 3. Women's knowledge of absent or reduced fetal movements

AUTHOR	COUNTRY	STUDY DETAILS
Abiyot (2014) (18)	Ethiopia	Awareness: 87/359 (24.2%) were aware of decreased fetal movement as an obstetric danger sign Study area: 8 public health institutions in Mekelle City Participants: women visiting antenatal care; 76.9% resided in urban areas. 79.1% had 1-3 pregnancies, 8.1% had 4-6, and 0.6% had 7 or more Timeframe: December 2013 to June 2014
Anya (2008) (19)	The Gambia	Awareness: 13 out of 418 (3.1%) women were aware of "cessation of fetal movement/baby does not move" as a danger sign in pregnancy Study area: Western Health Division; clinics are led by trained midwives and less than 3% of women receive antenatal care at private facilities Participants: women attending 12 antenatal clinics; 346 women had one or more prior deliveries. 187 respondents were from rural areas and 231 from urban areas Timeframe: November to December 2004
Doctor (2013) (20)	Nigeria	Awareness: 16.4% of 5,083 women were aware of absent fetal movement as an obstetric danger sign during pregnancy Study area: the three northern Nigerian states of Katsina, Yobe, and Zamfara Participants: all women had been pregnant within the five years prior to the survey, 59.1% of these received no antenatal care. One third of participants lived in urban areas, the rest in rural areas. Timeframe: 2009, month not specified

Table 3. continued

AUTHOR	COUNTRY	STUDY DETAILS
Gebrehiwot (2014) (21)	Ethiopia	<p>Awareness: 4/422 (0.95%) had experienced loss of fetal movement; 32.4% of women knew information on RFM as a danger sign in pregnancy</p> <p>Study area: Mekelle hospital, a government hospital, and Ayder referral hospital in Mekelle town</p> <p>Participants: pregnant women; 40% of respondents had 3+ previous pregnancies and 25.9% were pregnant for the first time. 88.7% had antenatal clinic follow up</p> <p>Timeframe: November 2012 to January 2013</p>
Hailu (2010) (22)	Ethiopia	<p>Awareness: "Most of the focus group discussants and in-depth interview participants mentioned decreased fetal movement [and others] ... as the danger signs during pregnancy"</p> <p>Study area: 1 health centre, 2 upgrading health centres, 2 medium private clinics, and 2 non-governmental clinics in Aleta Wondo district</p> <p>Participants: 713 women with a gestational age of at least three months; 86.7% of respondents lived in rural areas</p> <p>Timeframe: 18th February to 20th March 2007</p>
Hailu (2014) (23)	Ethiopia	<p>Awareness: "...the most common spontaneously mentioned danger signs were... absence of fetal movement by 159 (32.8%)"</p> <p>Study area: 22 health posts, 7 health centres, one general hospital in Tsegedie district, Tigray regional state</p> <p>Participants: 485 women of childbearing age who gave birth in the two years prior to the survey; 430 from rural areas and 55 urban</p> <p>Timeframe: 20th October 2012 to 19th June 2013</p>
Hasan (2002) (24)	Pakistan	<p>Awareness: 5% of 329 women were aware of decreased/absent fetal movement as a clinically important danger sign</p> <p>Study area: Rehri Goth, a settlement with little access to secondary and tertiary healthcare</p> <p>Participants: systematic sampling of married women of reproductive age from all sixteen sectors, women had an average of four children and 75% had their last delivery at home</p> <p>Timeframe: 1999, months not specified</p>
Mengesha (2014) (25)	Ethiopia	<p>Awareness: when asked to mention danger signs during pregnancy, 113 (29.4%) mentioned reduced fetal movement</p> <p>Study area: Debarok Town, North Gondar Administrative Zone. There are five health posts, one health centre, one rural hospital</p> <p>Participants: systematic random sampling of women who had attended ANC follow up during the time of the survey; 34.5% of women had no children</p> <p>Timeframe: June to September 2012</p>
Morhason-Bello (2016) (26)	Nigeria	<p>Awareness: of 531 women, 62.3% were aware of reduced fetal movement as a danger sign during pregnancy and "almost all respondents knew that they should come to the hospital any time they noticed any of the key danger signs"</p> <p>Study area: University College Hospital, a tertiary health care facility in Oyo State</p> <p>Participants: random sampling of women who had attended at least one ANC session</p> <p>Timeframe: not specified</p>
Okour (2012) (27)	Jordan	<p>Awareness: 11.7% of 350 women were aware of absence of fetal movement as a pregnancy danger sign. 26.9% received information about danger signs from a doctor or healthcare provider</p> <p>Study area: public maternity centres in Zarqa</p> <p>Participants: pregnant women age 15 or older who attended 1 of 4 prenatal care clinics</p> <p>Timeframe: March 2010</p>
Olagbuji (2014) (28)	Nigeria	<p>Awareness: 47% of women demonstrated right knowledge of decreased fetal movement; 84 women (37.3%) reported knowledge of the alarm limit (fewer than 10 fetal movements in daytime period) and 52 of these women reported that they would seek care in this instance.</p> <p>53.5% of women mentioned doctors as their lead source of information about fetal movement in the third trimester. 39.6% reported that they received information from their antenatal care providers to "seek immediate care when faced with variation in their perceived average fetal movement".</p> <p>80 women had knowledge of at least one adverse pregnancy outcome that may arise from decreased or excessive fetal movement; stillbirth was mentioned by 16.4% of women.</p> <p>Study area: two tertiary teaching hospitals</p> <p>Participants: 225 women with singleton pregnancies at ≥ 28 weeks' gestation; 45.8% were nulliparous</p> <p>Timeframe: 1st December 2012 to 31st January 2013</p>
Udofia (2013) (29)	Ghana	<p>Awareness: 22 of 483 women (4.6%) were aware of reduced fetal movement as a maternal danger sign</p> <p>Study area: Korle Bu Teaching Hospital in Accra, the leading national referral centre and the only public tertiary hospital in southern Ghana</p> <p>Participants: women aged 15-49 attending the postnatal clinic</p> <p>Timeframe: March to December 2011</p>

DISCUSSION

This is the first review of studies of women's knowledge of ARFM in LMICs and related adverse perinatal outcomes; we have highlighted the relative paucity of literature on this topic relative to HICs and identified gaps that should be the focus of future research.

This review is strengthened in that it was conducted following pre-specified eligibility criteria in accordance with a registered protocol. Limitations of this study include that the lack of literature restricts our ability to draw robust conclusions from this review, particularly with respect to studies that looked at ARFM in relation to our desired outcomes. We also did not find any studies that recorded women's knowledge of ARFM in association with stillbirth, meaning that we were not able to meet all our objectives.

Data from studies of adverse outcomes showed that the likelihood of stillbirth was significantly higher in ARFM pregnancies compared to those without ARFM. This finding is consistent with studies in HICs (2, 3, 38). All of our included studies showed a higher likelihood of stillbirth in ARFM pregnancies, regardless of study methodology or how ARFM was defined. These data suggest that ARFM should be recognised as a risk factor for stillbirth in LMICs.

The overall proportion of stillbirth in ARFM pregnancies (0.33, 95% CI 0.13 to 0.54) is very high. The highest estimated stillbirth rate in one of our included countries, for example, is Bangladesh at 35.6 per 1000 births (39). The observed proportion of stillbirths is likely inflated by the inclusion of case control studies, meaning that the overall incidence of stillbirth in our included studies is higher than that of in the general population. The proportion of pregnancies ending in stillbirth was also higher than our reported proportions for low Apgar score or caesarean section rate. However, not all studies reported all outcomes, so these proportions may not be directly comparable. Critically, not all studies reported whether all stillbirths occurred following maternal perception of ARFM with a live fetus at first assessment or whether ARFM was the presenting symptom of stillbirth. One study reported that three of five stillbirths were diagnosed on presentation with ARFM (30) and in another (33) this number was five out of eight; in others this was not reported.

In HICs, ARFM is the single most common presenting symptom (in 44-55% of stillbirths). Thus, if it was the latter case, then ARFM may be useful to make a more prompt diagnosis of fetal death in utero which could avoid maternal complications. If it was the former, then ARFM could be a symptom of fetal compromise to prompt intervention.

The proportion of other outcomes such as SGA or preterm delivery in ARFM pregnancies, or their likelihoods in ARFM versus non ARFM pregnancies could not be examined. We were also unable to investigate the effect of income status, ease of access to care, education, and whether the community in each study is urban or rural on ARFM. From a clinical perspective, each study area should be considered individually, taking combinations of these factors into account.

Critically, we did not identify any studies which investigated whether increased levels of knowledge regarding ARFM resulted in increased presentation to maternity care providers or reduced adverse outcomes in LMICs, although one paper (28) reported that 62% of women with correct knowledge of ARFM would seek healthcare assistance if they perceived ARFM. In addition, no studies were found that directly addressed women's experiences of maternity care after perception of ARFM or of clinicians' knowledge and views about ARFM; these represent important gaps in the evidence base which need to be addressed as studies in HICs describe that women's concerns regarding ARFM may be dismissed by clinical staff (40). Robust studies are also needed to determine whether improved knowledge of ARFM is associated with improved pregnancy outcomes in LMICs.

The limited data available from studies of interventions based on ARFM status suggest that this may be a worthwhile strategy for prevention of adverse perinatal outcomes in LMICs. One study of 200 high risk pregnancies (34) monitored most women after they had abnormal kick charts (some were allowed to go home and told to return weekly or if kick counts were low). All women experiencing ARFM pregnancies were supposed to be induced or birth achieved by caesarean sec-

tion; of the 20 ARFM pregnancies with abnormal kick charts where action was taken there were no antepartum stillbirths (although there was one neonatal death due to meconium aspiration). When no action was taken for ARFM (apart from one caesarean section due to fetal distress) taken there were seven antepartum stillbirths (n=16). Another study (33) gave kick charts to 250 women; 15 were admitted for ARFM and screened using ultrasound and a non-stress test. Women with satisfactory test results were discharged; otherwise induction took place if indicated. There were no fetal deaths in this group. Another study (30) did not present outcomes separately for women who were delivered due to ARFM. One of our included studies (37) measured outcomes in 107 women who were induced for ARFM; incidence of stillbirth was not mentioned but there were no early neonatal deaths or low Apgar scores and 8 NNU admissions in this group. There were also two caesarean sections performed for non-reassuring fetal heart tracing; the lower incidence of adverse outcomes may be due to increased monitoring and surveillance.

Our included studies show that research in to women's knowledge of ARFM has been carried out in both low income and lower middle income countries; Ethiopia was a particular focus for this research with four included studies (18, 21, 22, 25), two of which (18, 21) were in the same city and over a similar timeframe. Included studies mostly looked at ARFM as a danger sign in pregnancy rather than as a direct link to stillbirth or other adverse outcomes, although one study (28) details that 16.4% of 225 women mentioned that stillbirth could arise as a variation from average fetal movement. We also found a number of manuscripts that reported the numbers of women who could identify a certain number of danger signs but did not specify which; it is possible that some mentioned ARFM but we were unable to use data from these papers in this analysis.

A lack of overlap between study populations meant that we were not able to directly compare women's knowledge of ARFM and the incidence of stillbirth, which could be addressed in future studies. Low levels of awareness (less than 50% of women were aware of the risks associated with ARFM or named ARFM as a danger sign in 10 out of our 12 included studies) could have led to an underestimation of the effect size.

The percentage of women in each study who were aware of ARFM as a danger sign also varied greatly, this variation could arise from a number of factors. Most studies did not identify sources of information about ARFM which could be useful in determining if the type of care, access to care, or care provider has an effect on maternal awareness of ARFM. Importantly, making multiple ANC clinic visits has been linked to increased awareness of danger signs (25); this may also underpin the differential effects in urban and rural communities due to access to care. However, only one of our included studies addressed this question (19) and found no significant difference in women's knowledge of ARFM between the different areas. Women with previous pregnancies may also be more aware than nulliparous women; again data were not sufficient for analysis. Importantly, outside factors affecting women's knowledge may have increased in frequency in the past ten years; one of our included studies (23) found that having a working television or radio was associated with knowledge of multiple danger signs of pregnancy. However, there was no clear pattern in terms of location or year of study and their relation to knowledge, but some of the lower percentages were from studies conducted over ten years ago. Further studies are needed to determine whether knowledge in these areas has improved over time, and the most effective ways of giving information about ARFM to women in LMICs.

CONCLUSIONS

The data that are available suggest that awareness of ARFM is an area that should be targeted for improvement, especially as we found an association between ARFM and stillbirth which was comparable to or stronger than that seen in HICs. Future intervention studies with larger sample sizes are needed to look at the effect of admission and further testing for women with ARFM to see if the overall stillbirth rate decreases or is smaller than the estimates found here. Although evidence regarding the usage of kick charts is inconclusive (7, 38, 41) in countries where awareness and resources are low fetal movement counting could be a worthwhile and simple way of defining ARFM in terms of whether further action should be taken.

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