

Causes and temporal changes in nationally collected stillbirth audit data in high resource settings

Tom Norris (PhD)

tom.norris@le.ac.uk

Department of Health Sciences, College of Medicine, Biological Sciences and Psychology, University of Leicester, Centre for Medicine, University Road, Leicester, LE1 7RH, UK

Tel: +44 (0)116 252 5439

Bradley N Manktelow (PhD)

brad.manktelow@leicester.ac.uk

MBRRACE-UK, Department of Health Sciences, College of Medicine, Biological Sciences and Psychology, University of Leicester, Centre for Medicine, University Road, Leicester, LE1 7RH, UK

Tel: +44 (0)116 2525496

Lucy K Smith (PhD)

lucy.smith@leicester.ac.uk

MBRRACE-UK, Department of Health Sciences, College of Medicine, Biological Sciences and Psychology, University of Leicester, Centre for Medicine, University Road, Leicester, LE1 7RH, UK

Tel: +44 (0)116 252 5418

Elizabeth S Draper (PhD) - corresponding author

msn@leicester.ac.uk

Tel: +44 (0)116 2523200

MBRRACE-UK, Department of Health Sciences, College of Medicine, Biological Sciences and Psychology, University of Leicester, Centre for Medicine, University Road, Leicester, LE1 7RH, UK

Abstract

Few high income countries have an active national programme of stillbirth audit. From the three national programmes identified (UK, New Zealand and Netherlands) steady declines in annual stillbirth rates have been observed over the audit period between 1993 and 2014. Unexplained stillbirth remains the largest group in the classification of stillbirths, with a decline in intrapartum related stillbirths, which could represent improvements in intrapartum care. All three national audits of stillbirths suggest that up to half of all reviewed stillbirths have elements of care that failed to follow standards and guidance. Variation in the classification of stillbirth, cause of death and frequency of risk factor groups limit our ability to draw meaningful conclusions as to the true scale of the burden and the changing epidemiology of stillbirths in high income countries (HICs). International standardization of these would facilitate direct comparisons between countries. The observed declines in stillbirth rates over the period of perinatal audit, a possible consequence of recommendations for improved antenatal care, should serve to incentivize other countries to implement similar audit programs.

Keywords: Stillbirth, National Perinatal Audit, High Income Country.

Introduction

Stillbirth is a global problem and whilst the vast majority (98%) of stillbirths occur in low and middle income countries ^[1], stillbirth remains an issue for high income countries (HICs) with rates declining in some countries and remaining fairly static or even increasing in others ^[2]. In order to achieve the ambition set out in the recent Lancet series to end preventable stillbirths, national initiatives need to be both established and implemented.

Whilst the stillbirth and neonatal mortality rates in some HICs appear relatively high in relation to their peers, the lack of detail available about these deaths, in most countries, limits our understanding of both the scale of the true difference and also what we might learn from other countries. Findings from focus groups with professional and parent organisations in the UK Stillbirth priority Setting Partnership identified 11 research priorities necessary for addressing the prevention of still birth, including the contribution of lifestyle factors to the stillbirth risk and investigating why the stillbirth incidence in the UK is higher than that of other HICs ^[3]. Furthermore, monitoring the impact of initiatives internationally is compromised by the use of different definitions of mortality rates between countries, with the cut-off for inclusion in routine national statistics varying from 20⁺⁰ to 28⁺⁰ weeks gestational age.

In this paper stillbirth rates over recent years will be reviewed together with changes in the classification of the cause of death of stillbirths. Data from national perinatal audits in HICs will be used to describe the changing epidemiology of stillbirth in order to try and identify potential strategies for the reduction in stillbirths.

Trends in stillbirth rates in high income countries

International comparisons of stillbirth rates are complex due to the lack of a common definition of stillbirth in terms of the lowest gestational age (ranging from 20 to 28 weeks) and/or birthweight cut-off (400 to 1000g) included and reporting issues even within HICs. Standardizing to the WHO stillbirth definition of ≥ 28 weeks gestation in 2015, HICs showed wide variation ^[4], with rates for stillbirths ranging from 1.3 to 8.8 per 1000 total births, with similar levels of variation in the annual rate of reduction (ARR) for stillbirths from a small increase of 0.5% to a reduction of 6.8% over the period 2000 to 2015.

However, despite the problems with direct international comparisons, aggregating data from HICs using the same definitions (gestational age and/or birth weight criteria) provides information about trends over time for each defined group, although not direct comparison of the absolute rates (Figures 1 & 2). The trend for stillbirth in HICs over the past 20 years shows a small decrease, although there are variations between countries. In Australia and New Zealand, where the stillbirth rate includes outcomes from 20 weeks gestational age, there has been little change over this period, whereas an overall decline can be seen in most countries using a 22/24 week or 28 week definition of stillbirth. In both birthweight inclusion groups there has been a decline in the stillbirth rate over time apart from in the Czech Republic, where the rate has increased from 3.11 per 1000 births in 1995 to 3.58 per 1000 births in 2015.

National audit of stillbirths

The widely accepted definition of perinatal audit is “the systematic, critical analysis of the quality of perinatal care, including the procedures used for diagnosis and treatment, the use of resources and the resultant outcome and quality of life for women and their babies” [5]. To date few HICs have instigated a national system of stillbirth audit as identified in the recent Lancet stillbirth series [4]. Updating their search strategy we checked if additional programs had been established or whether there had been further developments since publication in 2016. This search confirmed that there are currently national perinatal audit programmes in only three HICs: New Zealand, the UK and the Netherlands. Ireland have established national perinatal data collection but do not, as yet, carry out confidential enquiries or other in-depth case reviews although they have recommended that a formal system of national confidential enquiries for stillbirth be established [6]. National perinatal audit was carried out from 1984 in Norway but has now been terminated at a national level despite being associated with a substantial decrease in the perinatal mortality rate (13.8 to 7.7 per 1000 live births) over its period of use [7].

Stillbirth proportions and rates are presented. The statistical significance of any trends were investigated using the Cochran Armitage test and Spearman’s test for correlation, respectively, in Stata/IC (v14).

Cause and temporal trends in stillbirths from current national audits

a) New Zealand

A Perinatal and Mortality Review Committee (PMMRC) was established in New Zealand in 2006 with a primary aim of reducing the number of preventable perinatal and maternal deaths. This programme reviews all stillbirths following a standardised protocol ^[8], providing classifications of death according to the Perinatal Society of Australia and New Zealand (PSANZ) - Perinatal Death Classification (PDC) and evaluating the circumstances surrounding the stillbirth, including potential contributing factors. Stillbirths are registered from 20 weeks gestation and/or 400g birthweight. Health professionals enter data directly onto a secure database and cases are then discussed in local perinatal review meetings. Reviews consider the presence of contributing factors in three main areas: factors relating to (i) the woman including her social situation; (ii) the setting in which the care was provided; and (iii) the clinical care provided. Following review stillbirths are classified in terms of their cause of death using PSANZ-PDC. Annual reports provide recommendations for improving care and the development of implementation plans. Vigorous data quality checks are carried out against clinical records including validating the classification of death with clinical records to highlight areas for improvement for local coordinators. Annual review of the recommendations is used to monitor progress to date at district and national levels to facilitate implementation of the findings.

Perinatal audit data collection started in New Zealand in 2007 since when the stillbirth rate (excluding termination of pregnancies (TOPs)) reduced from 5.6 per 1000 total births ^[9] to 5.1 per 1000 total births in 2013 ^[10], rising to 5.5 per 1000 total births in 2014 ^[11]. However, stillbirths of ≥ 28 weeks gestation have shown a much greater reduction over the last 15 years with an ARR of 2.8% ^[4]. The fetal death rate from TOP increased significantly from 2.2 to 2.5 per 1,000 total births (chi² for trend $p=0.04$) over this period, the majority of which occur following the antenatal detection

of a congenital anomaly (75% in 2014). Table 1 shows the proportion of stillbirths by PSANZ-PDC cause of death from 2007 to 2014. The largest group of stillbirths were classified as unexplained antepartum deaths (27.7% in 2014); specific perinatal conditions and spontaneous preterm accounted for 13.2% and 13.5% respectively and congenital anomalies, antepartum haemorrhage and fetal growth restriction accounted for approximately 10% each. There was a significant trend over time in stillbirths classified as hypoxic peripartum death, reducing from 4.6% in 2007 to 2.2% in 2014 ($p<0.001$), which may be indicative of improving intrapartum care.

Table 1 here

Changes in the characteristics of both mothers and babies can have a major impact on stillbirth rates. Tables 2 and 3 provide the proportions of stillbirths and the stillbirth rate (for characteristics with denominator data for all births) associated with known risk factors, from 2007 to 2014. In New Zealand, mothers of Maori, Pacific and Indian ethnicity have a higher risk of stillbirth than NZ European, other Asian and Other mothers, with a significant increase in the proportion of total stillbirths from Indian mothers (3.6% to 5.5%, $p=0.02$). This observed risk in indigenous populations is in accordance with studies in other indigenous groups, including those in Australia [12, 13], Canada [14, 15] and the United States [16]. There is a small decreasing trend in the stillbirth rate for the most deprived mothers which fails to reach statistical significance. There are no significant trends in either the stillbirth rate or proportion by maternal age despite a consistent reduction in births to mothers of ≤ 20 years.

There has been a significant increasing trend in the proportion of stillbirths in the lowest gestational age (22-23 weeks) and birthweight groups (<500 g). The proportion of stillbirths delivering after 40 weeks gestation has fallen significantly

over the period from 5.5% to 0.9% and the stillbirth rate associated with this group also shows a significant reducing trend from 1.6 to 0.33 per 1000 total births ($p<0.001$). This may reflect changes in the management of post term pregnancies which can be seen in the national birth data, where the proportion of births after 40 week gestation shows a significant decreasing trend falling from 19.2% to 15.6% ($p<0.001$)^[11]. There is also a significant decreasing trend in the stillbirth rate for term infants (37 to 40 weeks) from 2.0 to 1.61 per 1000 total births ($p=0.05$).

Multiple births are associated with an increased risk of stillbirth and over the period of this audit the proportion of stillbirths (10.1% to 10.5%, $p=0.07$) and stillbirth rate (18.8 to 20.3 per 1000 total births ($p=0.03$)) for multiple births shows a significant (or borderline significant) increasing trend, at a time when there is a small decreasing trend in multiple births in New Zealand.

Denominator data was not available for maternal body mass index and smoking status, so only stillbirth proportions are presented. Analysis of BMI is limited by missing data. However both stillbirth and national births data have shown a significant increase in the most obese women ($BMI>40$) over the audit period^[17]. There was an increasing trend in the proportion of mothers of stillborn infants who were non-smokers, increasing from 64.8% to 74.2% ($p<0.001$) reflecting national survey data which showed a reduction in smokers from 18.9% in 2006/2007 to 15.0% in 2014/2015^[18].

Tables 2 and 3

Reviews of stillbirths in New Zealand have identified that up to 15% are potentially avoidable with contributory factors identified in up to a quarter of all cases^[19]. The most common factors identified were barriers to accessing services (15%),

personnel issues (7%) and organisation and management issues (5%). Early recommendations suggest the development of strategies to increase antenatal detection of SGA babies using appropriate monitoring and plotting of measurements, e.g. the plotting of symphysis fundal height on individualised charts and serial ultrasound scans to monitor fetal growth for women suspected of carrying an SGA baby; the use of multidisciplinary teams for women with complex medical conditions; and the full investigation of normally formed intrapartum stillbirths including a post-mortem ^[9]. A recurrent message focusses on the continuing education of staff concerning the identification of women at high risk of poor perinatal outcome ^[20], including the use of clinical flags (e.g. previous stillbirth, maternal age <20 years or ≥40 years, obesity, risk behaviours) to identify vulnerable women ^[19] as well as increasing staff knowledge and skills. Building on these messages the responsibility of local clinical services and clinicians to implement and audit best practice, carry out local reviews and to update, implement and audit policies and guidelines, are highlighted ^[19]. The seventh report ^[21] concentrates on the management of multiple pregnancies and those pregnancies affected by congenital anomalies highlighting areas for improvement such as the poor documentation of folate prophylaxis, the offer of first trimester screening, monitoring of infertility treatment and the timing and referral of women to the appropriate clinical service. More recently recommendations have centred on a number of initiatives to reduce the impact of known risk factors for stillbirth, encouraging women to engage in effective smoking cessation programmes, supporting public health initiatives to prevent obesity and the recognition of the impact of deprivation ^[22]. Maternity workforce education programmes have been highlighted to implement national fetal surveillance guidelines ^[23]. The need for reiteration of key recommendations has been identified concerning the reduction of

modifiable factors from risk behaviours, prevention of multiple pregnancy and preterm birth, improving the antenatal recognition of fetal growth restriction, providing advice to women about reduced fetal movements, as well as following evidence-based recommendations for indications for induction of labour ^[10].

b) United Kingdom

The UK has been running a programme of perinatal surveillance and confidential enquiries since 1993. Since 2012 this programme has been run by MBRRACE-UK 'Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK' commissioned by the Healthcare Quality Improvement Partnership (HQIP) with data collection from 2013. This programme carries out surveillance of all late fetal losses (22⁺⁰ to 23⁺⁶ weeks gestational age), stillbirths (≥24 weeks) and neonatal deaths, and includes a series of confidential enquiries on perinatal topics. Active perinatal surveillance is carried out using a bespoke web based data collection system which provides regular feedback to local reporters about data quality, completeness and case ascertainment. Validation of case ascertainment is carried out for each UK country against statutorily registered stillbirth data ^[24]. Confidential Enquiries use multidisciplinary panels who review anonymised case notes to reach a consensus opinion about the quality of care provided, measured against current standards and guidance and any impact on the outcome ^{[25] [26]}. Checklists are used to ensure all relevant issues have been reviewed ^[25].

Initially this programme used the extended Wigglesworth classification of death ^[27] over the period 1993 to 2007, supplemented by the Aberdeen obstetric classification ^[28] from 2000 to 2007. In 2008/2009 a CMACE defined maternal and fetal

classification of death was used. In 2013 the Cause of Death and Associated Conditions (CODAC) classification system was introduced following consultation with experts ^[29] who felt that this system would provide a greater understanding of the factors associated with antepartum stillbirth.

The UK stillbirth rate remained fairly static over the period 1993 to 2003, from 5.75 to 5.70 per 1,000 total births, then showed a steady decline to 4.64 per 1,000 total births in 2013. Due to changes in the classification of stillbirths in the UK a test for trend has been limited to the period 1993 to 2007 when the extended Wigglesworth classification was used (Table 4). Between half and just over two thirds of stillbirths were unexplained with a reduction in the latter years mainly due to the additional use of the Aberdeen obstetric classification which provides additional information about maternal conditions. The increasing trend in stillbirths whose cause of death was a congenital anomaly reflects the changes in antenatal screening programmes and an increase in late TOPs which were included in the stillbirth figures ^[30]. In 1993 7.1% stillbirths were due to congenital anomalies which increased to a peak of 15.9% in 2000 and then plateaued until 2006 (15.1%). In 2007 TOPs for fetal anomalies were excluded leading to a large reduction in the proportion of stillbirths due to congenital anomalies (8.3%). There was a significant reducing trend in intrapartum related stillbirths between 1993 and 2007 (from 10.9% to 6.4%) and in 2014 the rate was 5.8%. Using the Aberdeen obstetric classification of death, the proportion of stillbirths caused by antepartum haemorrhage show a significant reducing trend over the period 2000 to 2007 (10.2% to 8.15%), whilst those caused by maternal disorders show a significantly increasing trend (4.5% to 6.17%). Changes to the cause of death classification in 2008 and 2013 prevent the direct investigation of trends in this

period. However the proportion of stillbirths from unexplained causes has reduced, with a proportion of previously unexplained stillbirths being ascribed to intrauterine / fetal growth restriction using the CMACE defined maternal and fetal classification of death (2008/2009), with up to one fifth of stillbirths ascribed to placental causes using CODAC (2013/2014).

Table 4 here

Tables 5 & 6 show the proportions of stillbirths and the stillbirth rate associated with known risk factors over the period 2004 to 2014. There is a significantly decreasing trend for both the proportion of stillbirths associated with multiple birth ($p=0.05$) and the stillbirth rate for multiple births ($p=0.003$). Increased risk of stillbirth is associated with mothers of Asian or Black ethnicity in the UK. There are significant increasing trends in the proportion of stillbirths from Asian (borderline) and mixed ethnic groups, with decreasing trends in White, Black and 'Other' ethnic groups, reflecting migration patterns. However there has been a significant decreasing trend in the stillbirth rate across all ethnic groups. Births to the most deprived quintile of mothers shows a significant decreasing trend in the proportion of stillbirths. The stillbirth rates in mothers in deprivation quintiles three and four show a significantly decreasing trend. In the most deprived mothers the stillbirth rate remained static over the period 2005 to 2009 and then reduced in 2013 and 2014, but this trend is not significant.

There has been a significantly decreasing trend in the proportion of stillbirths in both the lowest birthweight (<1500g) and gestational age (24-27 weeks) groups, with significantly increasing trends in the proportion of stillbirths of birthweight ≥ 2.5 kilograms and at term or post term. Stillbirth rates show a decreasing trend for gestational age groups between 28 and 41 weeks.

Reflecting changes for all births, there is a significantly decreasing trend in the proportion of stillbirths to teenage mothers alongside an increasing trend for mothers of ≥ 40 years ^[31]. There is a significant decreasing proportion of stillbirths from mothers who are in the highest BMI category (≥ 35), at a time when there is an increasing problem with levels of obesity in the population ^[32].

Tables 5 and 6 here

In the UK the methodology of the perinatal confidential enquiries maintain the anonymity of the cases reviewed and does not allow direct feedback to the care providers. Enquiry recommendations are targeted at service commissioners, health organisations and individual health professionals to enable them to implement changes to their local care provision as required. Findings from the first Confidential Enquiry into Stillbirth and Deaths in Infancy (CESDI) which focussed on intrapartum stillbirths and deaths with a birthweight $>1.5\text{kg}$ identified that over three quarters of these cases had at least one element of sub-optimal care where different management might have, or may reasonably have, been expected to have made a difference to the outcome ^[26]. Over the next few years of enquiries lower levels of sub-optimal care were identified with around two thirds in the term antepartum stillbirth enquiry ^[33] and just under half of the stillbirths in the $>1\text{kg}$ enquiry ^[34].

Recurrent themes across these enquiries include failure to modify the management of labour following concerns about poor fetal growth, problems with the use and interpretation of pre-labour and intrapartum fetal heart monitoring, failure to act appropriately when an abnormal fetal heart rate had been identified and subsequent delays in expediting the delivery of a compromised fetus, failure to recognize and/or act on risk factors for stillbirth (e.g. maternal obesity, smoking, a previous pregnancy complicated by fetal growth restriction) and failure to diagnose gestational diabetes.

Poor quality maternity records and poor communication were implicated in many of these issues and recommendations were made for the improvement of maternity records, providing clear identification of risk factors and a management plan, with updates as necessary. The development of national guidance and training for assessment of fetal heart rate was also recommended to ensure adequate levels of competence.

The most recent UK confidential enquiry focussed on term, singleton, normally-formed antepartum stillbirth in 2013. Findings repeated many of the issues highlighted in the previous enquiry into this group when measured against current standards and guidance. Overall half of the cases reviewed were assessed as having at least one aspect of antenatal care where improvements in care may have made a difference to the outcome. Required improvements fell into three areas: failure to follow national guidance for identifying women at risk of gestational diabetes and to refer women for testing ^[35], failure to monitor fetal growth in terms of the measurement, plotting or response to abnormal growth ^[36], and failure to respond appropriately to reduced fetal movements ^[37]. Although quality of care issues were highlighted at all points on the care pathway, the other major area of concern was that only one quarter of antepartum stillbirths had a local review carried out and only 10% were compliant with the RCOG guidance with respect to the use of a multidisciplinary panel ^[38].

c) **The Netherlands**

Although regional perinatal mortality audits were established in the Netherlands in the 1980s ^[39] perinatal mortality rates were still high compared with other countries across Europe in 1999 ^[40]. Following the establishment of the national Perinatal Registration Netherlands (PRN) Foundation in October 2001 the national stillbirth rate (≥ 22 weeks) reduced significantly from 7.5 to 6.4 per 1000 total births between 2000 and 2006 although it remained high compared with other European countries. This improvement has continued over time and in the recent Lancet series ^[4] the Netherlands was shown to have the highest ARR in stillbirth (6.8%) over the period 2000 to 2015, resulting in one of the lowest rates for HICs of 1.8 per 1000 total births (for stillbirths ≥ 28 weeks gestation).

The national audit (Foundation Perinatal Audit in the Netherlands (PAN)) has focussed on term outcomes: term perinatal deaths over the period 2010 to 2012 and asphyxia at term in 2013 to 2014. PAN audits use perinatal cooperation groups which comprise local hospitals with obstetric and paediatric care facilities with surrounding community practices which are responsible for the audit and systematic multidisciplinary review of the mortality cases in their catchment area. Audits are confidential and supportive, and aim to identify whether the mother and fetus received adequate care or instances in which improvements in care could have been achieved; whether care providers adhered to guidelines, standards and protocols; and how changes and improvements in care can be achieved. Sub-standard care factors identified during the review process are categorised into four groups: none/unlikely, possible, very probably and unknown. Inclusion criteria for this first audit were term stillbirths and neonatal deaths (≥ 37 weeks gestation). Three

mortality classification systems were used: Wigglesworth/Hey, modified ReCoDe and Tulip [27, 41, 42].

Given the thematic focus of this audit and the relatively short history detailed information about trends in the cause of stillbirth or risk factors are not included within the reports [43, 44]. However, term perinatal mortality has reduced by 16% over the audit period from 2010 to 2014: from 2.3 to 1.9 per 1000 total births and all hospitals within the Netherlands participated with the national audit within two years of its inception [43, 44]. Findings from the multidisciplinary reviews provide insight into sub-standard care factors that are of relevance to the term stillbirths as they comprise around two thirds of the deaths included. In over half of the cases reviewed (n=376, 53%) at least one sub-standard factor was noted, mostly related to non-compliance with guidelines or missing local protocols (35%), including issues around the detection of fetal growth retardation and appropriate care provision, and an absence of fetal monitoring during induction of labour. The other main category of sub-standard care factors was where care deviated from usual professional care (41%) which ranged from insufficient medical documentation to a lack of action/consultation following decreased fetal movements.

Overall the reviews categorised 8% of perinatal deaths (between 2010-2012) where the death was felt to have a (very) probable relationship with the sub-standard care received: a reduction from 10% to 5% over the period of review.

A more recent audit over the period 2013-2014 related to asphyxia at term identified a similar proportion of cases with at least one sub-standard care factor (n=124 (50%)).

Discussion

This review highlights the problems faced when comparing the causes of stillbirths between countries using data from the three current national stillbirth audits and provide some insight into trends over time and the impact of the changing population demographics on stillbirth rates. Over the period of each of the national audits there has been a reduction in the stillbirth rate and investigation of the proportion of stillbirths and stillbirth rates by individual risk factors alongside changing population demographics for births can help explain changes in the rate of reduction.

Each audit presented uses a different cause of death classification system for stillbirths and even within country there are changes in the system used over time. The newly developed ICD-PM classification system uses a three stage process to classify perinatal deaths: by timing of death; by their ICD-PM cause; and finally, the main maternal condition at the time of death being assigned to each case ^[45] providing information about the contribution of a maternal conditions to the death. International standardization of the use of this classification would facilitate direct comparisons between countries in the future (*see Flenady article in this issue*). However, a pilot study of the use of ICD-PM showed that over half of antepartum stillbirths were classified as unknown ^[45] reflecting many other classification systems and the findings of this review. This limitation of the current ICD-PM is due to the coding of low birthweight and prematurity as one category and thus the inability of the system to identify fetal growth restriction. It is hoped such issues will be addressed in the perinatal chapter of ICD11.

Both the New Zealand and UK national audits have shown a reduction in the proportion of stillbirths classified as hypoxic peripartum or intrapartum death which may reflect improvements in the quality of intrapartum care provision. However one major difference between the New Zealand and UK data is that whilst the reduction in New Zealand is over recent years and is associated with a significant decrease in both the proportion and rate of stillbirths as well as the proportion of births post-term indicating changes in the management of these births ^[12], the reduction in intrapartum stillbirth rates in the UK has been more gradual and the proportion of post-term stillbirths has increased. Conversely, increasing trends in the proportion of stillbirths due to congenital anomalies are seen in both the UK (from 1993 to 2006) and New Zealand data as a result of changes in antenatal screening programmes to mid trimester screening leading to a consequential increase in late TOPs ^[2]. Data for TOPs were excluded from the UK data after 2007 and so this trend can no longer be monitored.

Changes in the characteristics of births can lead to changing risks for the population and associated stillbirth rates which can explain some of the variation or lack of change over time. So whilst there have been increasing proportions of births and stillbirths in high risk groups such as migrant populations, older mothers and increases in extreme prematurity and levels of obesity, this may have been offset in terms of overall stillbirth rates by reductions in other high risk groups such as teenage mothers, lower smoking rates and mothers with the highest levels of deprivation. It is important to take account of these changing population demographics and birth characteristics when evaluating interventions for reducing stillbirths.

The three national audits of stillbirths suggest that up to half of all reviewed stillbirths have elements of care that failed to follow standards and guidance although the proportion identified as 'potentially avoidable' or 'where improvements may have made a difference to the outcome' or 'where the death was felt to have a probable relationship with the sub-standard care received' varied between around one tenth and half of all cases. External anonymized reviews of care provision tended to allocate the highest proportions of care as sub-standard, possibly due to their ability to remain impartial. However, areas for improvement were similar across the audits including focus on compliance with national standards and guidelines specifically around the detection of and response to (intrauterine) fetal growth restriction, actions following reduced fetal movements and identification and appropriate actions for high risk women. Improving communication and documentation as well as the knowledge and skills of all staff have also been highlighted as a result of the reviews.

Development of an evidence base from the findings of confidential enquiries and reviews is frequently complicated by the introduction of multiple programmes of work addressing the audit recommendations. Consequently, whilst these may lead to a reduction in stillbirth it is not possible to assess the impact of the separate elements of the programmes. Studies from Norway (where national audit was carried out for many years with a substantial reduction in the stillbirth rate) have shown an association between a reduction in late stillbirth and the introduction of fetal movement information for women and guidelines^[46, 47]. However in order to justify changing maternity practice, evidence from randomized controlled trials is required to confirm the findings and estimate any benefit for mothers and babies. The UK

AFFIRM study ^[48] aims to provide such evidence for reduced fetal movements by implementing new practice guidelines and management of reduced fetal movements as part of a step-wedged randomized controlled trial.

Intervention programmes to reduce stillbirth tend to be focussed on the third trimester ^[46, 47, 49, 50]. However given that around one third of stillbirths occur before 28 weeks gestation and a further third before term in order to achieve ambitious targets for stillbirth reduction interventions to reduce preterm stillbirth also need to be developed. This issue is clearly illustrated by the data from the New Zealand audit which shows that whilst there has been little reduction in the stillbirth rate using their 20 week definition: 5.6 to 5.5 per 1000 total births from 2007 to 2014, using the WHO international stillbirth definition of 28 weeks there is a significant reduction over the same period: 3.5 to 2.3 per 1000 total births ^[1].

Over the years it has proven difficult to ensure that the prevention of stillbirth is high on the healthcare and political agendas. Mothers and babies have not tended to be a priority in terms of health care spending and this has impeded progress in the reduction of stillbirths in some of the world's richest nations. However, the two Lancet series focusing on stillbirth (www.thelancet.com/series/ending-preventable-stillbirths) have raised the profile of this issue and provided information for countries about their ranking against their peers in terms of stillbirth rates. National audits of stillbirths provide evidence about their changing characteristics of women who have a stillbirth and produce targeted recommendations identifying areas of care where improvements are required. These recommendations could have contributed to the declining stillbirth rates observed in the countries with active audit programs and thus

offer incentive for other countries to initiate similar programs. In order to ensure that recommendations are implemented and used to evaluate resulting intervention programmes we need to engage with all relevant stakeholders (politicians, health professionals, commissioners and parents) to work together to improve care and maintain the momentum to reduce stillbirth rates.

Conflict of interest statement: None

References

- [1] Lawn JE, Blencowe H, Waiswa P, Amouzou A, Mathers C, Hogan D, et al. Stillbirths: rates, risk factors, and acceleration towards 2030. *The Lancet*. 2016;387:587-603.
- [2] Joseph K, Kinniburgh B, Hutcheon JA, Mehrabadi A, Basso M, Davies C, et al. Determinants of increases in stillbirth rates from 2000 to 2010. *Canadian Medical Association Journal*. 2013;185:E345-E51.
- [3] Heazell A, Whitworth M, Whitcombe J, Glover S, Bevan C, Brewin J, et al. Research priorities for stillbirth: process overview and results from UK Stillbirth Priority Setting Partnership. *Ultrasound in Obstetrics & Gynecology*. 2015;46:641-7.
- [4] Flenady V, Wojcieszek AM, Middleton P, Ellwood D, Erwich JJ, Coory M, et al. Stillbirths: recall to action in high-income countries. *Lancet*. 2016;387:691-702.
- [5] Dunn PMM, G. Perinatal Audit: A report for the European Association of Perinatal Medicine. London: The Parthenon Publishing Group; 1996.
- [6] Corcoran P, Manning E, O'Farrell I, McKernan J, Meaney S, Drummond L, et al. Perinatal mortality in Ireland: annual report 2014. 2016.
- [7] Flenady V, Middleton P, Smith GC, Duke W, Erwich JJ, Khong TY, et al. Stillbirths: the way forward in high-income countries. *The Lancet*. 2011;377:1703-17.
- [8] Flenady V KJ, Charles A, Gardener G, Ellwood D, Day K, McCowan L, Kent A, Tudehope D, Richardson R, Conway L, Chan A, Haslam R, Khong Y for the Perinatal Society of Australia and New Zealand (PSANZ) Perinatal Mortality Group. PSANZ Clinical Practice Guideline for Perinatal Mortality. Second ed2009.
- [9] Perinatal and Maternal Mortality Review Committee. Perinatal and Maternal Mortality in New Zealand 2007: Third Report to the Minister of Health July 2008 to June 2009. Wellington: Ministry of Health2009.
- [10] Perinatal and Maternal Mortality Review Committee. Ninth Annual Report of the Perinatal and Maternal Mortality Review Committee: Reporting mortality 2013. Wellington: Health Quality & Safety Commission2015.
- [11] Perinatal and Maternal Mortality Review Committee. Tenth Annual Report of the Perinatal and Maternal Mortality Review Committee. Wellington: Health Quality & Safety Commission 2016.
- [12] Alessandri LM, Chambers HM, Blair EM, Read AW. Perinatal and postneonatal mortality among Indigenous and non-Indigenous infants born in Western Australia, 1980-1998. *The Medical Journal of Australia*. 2001;175:185-9.
- [13] Johnston T, Coory M. Reducing perinatal mortality among Indigenous babies in Queensland: should the first priority be better primary health care or better access to hospital care during confinement? *Australia and New Zealand health policy*. 2005;2:1.
- [14] Gilbert NL, Auger N, Tjepkema M. Stillbirth and infant mortality in Aboriginal communities in Quebec. *Health reports*. 2015;26:3.
- [15] Chen L, Xiao L, Auger N, Torrie J, McHugh NG-L, Zoungrana H, et al. Disparities and trends in birth outcomes, perinatal and infant mortality in Aboriginal vs. Non-Aboriginal populations: a population-based study in Quebec, Canada 1996–2010. *PloS one*. 2015;10:e0138562.
- [16] Tomashek KM, Qin C, Hsia J, Iyasu S, Barfield WD, Flowers LM. Infant mortality trends and differences between American Indian/Alaska Native infants and white infants in the United States, 1989-1991 and 1998-2000. *American Journal of Public Health*. 2006;96:2222-7.

- [17] Ministry of Health. New Zealand Maternity Clinical Indicators 2014. Wellington 2016.
- [18] Ministry of Health. Annual Update of Key Results 2014/15: New Zealand Health Survey. Wellington 2015.
- [19] Perinatal and Maternal Mortality Review Committee. Fifth Annual Report of the Perinatal and Maternal Mortality Review Committee: Reporting mortality 2009. Wellington: Health Quality & Safety Commission 2011.
- [20] Perinatal and Maternal Mortality Review Committee. Perinatal and Maternal Mortality in New Zealand 2008: Fourth Report to the Minister of Health July 2009 to June 2010. Wellington: Ministry of Health 2010.
- [21] Perinatal and Maternal Mortality Review Committee. Seventh Annual Report of the Perinatal and Maternal Mortality Review Committee: Reporting mortality 2011. Wellington: Health Quality and Safety Commission 2013.
- [22] Perinatal and Maternal Mortality Review Committee. Eighth Annual Report of the Perinatal and Maternal Mortality Review Committee: Reporting Mortality 2012. Wellington: Health Quality & Safety Commission 2014.
- [23] The Royal Australian and New Zealand College of Obstetricians and Gynaecologists. Clinical Guideline. Intrapartum Fetal Surveillance. 3rd ed 2014.
- [24] Manktelow BN, Smith, L.K., Evans, T.A., Hyman-Taylor, P., Kurinczuk, J.J., Field, D.J., Smith, P.W., Draper, E.S., on behalf of the MBRRACE-UK Collaboration. Perinatal Mortality Surveillance Report UK Perinatal Deaths for births from January to December 2013. Leicester: The Infant Mortality and Morbidity Group, Department of Health Sciences, University of Leicester; 2015.
- [25] Draper ES, Kurinczuk, J.J., Kenyon, S. (Eds.) on behalf of MBRRACE-UK. MBRRACE-UK Perinatal Confidential Enquiry. Term, singleton, normally formed, antepartum stillbirth. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester; 2015.
- [26] Maternal and Child Health Research Consortium. Confidential Enquiry into Stillbirths and Deaths in Infancy: 4th Annual Report, 1 January–31 December 1995. London: Maternal and Child Health Research Consortium; 1997.
- [27] Hey E, Lloyd D, Wigglesworth J. Classifying perinatal death: fetal and neonatal factors. *BJOG: an international journal of obstetrics & gynaecology*. 1986;93:1213-23.
- [28] Cole SK, Hey, E.N., Thomson, A.M. Classifying perinatal death: an obstetric approach. *British Journal of Obstetrics and Gynaecology*. 1986;93:1204-12.
- [29] Frøen JF, Pinar H, Flenady V, Bahrin S, Charles A, Chauke L, et al. Causes of death and associated conditions (Codac)—a utilitarian approach to the classification of perinatal deaths. *BMC pregnancy and childbirth*. 2009;9:1.
- [30] Bythell M, Bell R, Taylor R, Zalewski S, Wright C, Rankin J, et al. The contribution of late termination of pregnancy to stillbirth rates in northern England, 1994–2005. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2008;115:664-6.
- [31] Office for National Statistics. Births in England and Wales: 2015. Live births, stillbirths, and the intensity of childbearing measured by the total fertility rate. 2016. p. 1-8.
- [32] Craig RM, J., (eds). . Health Survey for England 2013: Health, social care and lifestyles. Leeds: Health and Social Care Information Centre; 2014.
- [33] Maternal and Child Health Research Consortium. Confidential Enquiry into Stillbirths and Deaths in Infancy: 5th Annual Report, 1 January–31 December 1996. London: Maternal and Child Health Research Consortium; 1998.

- [34] Maternal and Child Health Research Consortium. Confidential Enquiry into Stillbirths and Deaths in Infancy: 6th Annual Report, 1 January–31 December 1997. London: Maternal and Child Health Research Consortium; 1999.
- [35] National Institute for Health and Care Excellence. Diabetes in pregnancy: Management of diabetes and its complications from pre-conception to the postnatal period. 2008.
- [36] National Institute for Health and Care Excellence. Antenatal care for uncomplicated pregnancies. 2008.
- [37] Whitworth M, Fisher M. Green-top Guideline 57: Reduced Fetal Movements. 2011.
- [38] Royal College of Obstetricians and Gynaecologists. Green-top Guideline Number 55 Late Intrauterine Fetal Death and Stillbirth. London: RCOG; 2010.
- [39] De Reu P, Nijhuis J, Oosterbaan H, Eskes T. Perinatal audit on avoidable mortality in a Dutch rural region: a retrospective study. *European Journal of Obstetrics & Gynecology and Reproductive Biology*. 2000;88:65-9.
- [40] Buitendijk S, Zeitlin J, Cuttini M, Langhoff-Roos J, Bottu J. Indicators of fetal and infant health outcomes. *European Journal of Obstetrics & Gynecology and Reproductive Biology*. 2003;111:S66-S77.
- [41] Gardosi J, Kady SM, McGeown P, Francis A, Tonks A. Classification of stillbirth by relevant condition at death (ReCoDe): population based cohort study. *Bmj*. 2005;331:1113-7.
- [42] Korteweg F, Gordijn S, Timmer A, Erwich J, Bergman K, Bouman K, et al. The Tulip classification of perinatal mortality: introduction and multidisciplinary inter-rater agreement. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2006;113:393-401.
- [43] Eskes M, Waelpuut AJ, Erwich JJH, Brouwers HA, Ravelli AC, Achterberg PW, et al. Term perinatal mortality audit in the Netherlands 2010–2012: a population-based cohort study. *BMJ open*. 2014;4:e005652.
- [44] Perined. Perinatale audit van à terme sterfte in 2013 & 2014. Utrecht: Perined Foundation; 2016.
- [45] Allanson E, Tunçalp Ö, Gardosi J, Pattinson R, Francis A, Vogel J, et al. The WHO application of ICD-10 to deaths during the perinatal period (ICD-PM): results from pilot database testing in South Africa and United Kingdom. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2016;123:2019-28.
- [46] Tveit JV, Saastad E, Stray-Pedersen B, Bordahl PE, Flenady V, Fretts R, et al. Reduction of late stillbirth with the introduction of fetal movement information and guidelines - a clinical quality improvement. *BMC Pregnancy Childbirth*. 2009;9:32.
- [47] Saastad E, Tveit JV, Flenady V, Stray-Pedersen B, Fretts RC, Bordahl PE, et al. Implementation of uniform information on fetal movement in a Norwegian population reduced delayed reporting of decreased fetal movement and stillbirths in primiparous women - a clinical quality improvement. *BMC Res Notes*. 2010;3:2.
- [48] Norman JE, et al. Can Promoting Awareness of Fetal movements and Focussing Interventions Reduce Fetal Mortality - a stepped wedge cluster randomised trial? -Study protocol 2014.
- [49] Sovio U, White IR, Dacey A, Pasupathy D, Smith GC. Screening for fetal growth restriction with universal third trimester ultrasonography in nulliparous women in the Pregnancy Outcome Prediction (POP) study: a prospective cohort study. *The Lancet*. 2015;386:2089-97.

[50] Bricker L, Mahsud-Dornan S, Dornan JC. Detection of foetal growth restriction using third trimester ultrasound. *Best Practice & Research Clinical Obstetrics & Gynaecology*. 2009;23:833-44.

Figure 1: Stillbirth rates over time in countries with weight classifications

Figure 2: Stillbirth rates over time in countries with gestational age classifications

Table 1 Cause of death by PSANZ-PDC cause of death classification: New Zealand 2007- 2014

	Year								<i>p trend</i>
	Stillbirth proportion (%)								
	2007	2008	2009	2010	2011	2012	2013	2014	
Cause of death									
Congenital anomalies	9.6	7.4	7.2	10.3	7.9	10.9	6.8	10.5	P=0.50
Infection	5.5	3.7	3.7	4.7	2.7	2.8	3.3	3.7	P=0.15
Hypertension	3.6	3.2	5.7	5.0	3.6	2.5	2.6	2.8	P=0.15
Antepartum haemorrhage	11.7	12.9	13.0	13.5	14.5	9.7	14.3	10.2	P=0.59
Maternal condition	5.5	3.4	6.2	6.7	3.9	5.9	7.2	6.5	P=0.18
Specific perinatal condition	10.4	13.7	14.7	13.2	15.5	13.1	12.7	13.2	P=0.58
Hypoxic peripartum death	4.6	4.0	2.7	2.1	2.4	3.1	1.0	2.2	P=0.01
Fetal growth restriction	10.9	14.0	11.0	11.4	11.2	13.1	14.3	9.8	P=0.99
Spontaneous preterm	10.4	10.6	10.2	12.0	9.7	11.6	8.1	13.5	P=0.56
Unexplained antepartum death	27.9	27.2	25.4	21.1	28.5	27.2	29.6	27.7	P=0.49
No obstetric antecedent	0	0	0	0	0	0	0	0	-

Table 2: Proportions of stillbirths associated with known risk factors: New Zealand 2007 to 2014

	Year								<i>p trend</i>
	Stillbirth proportion (%)								
	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>	<i>2011</i>	<i>2012</i>	<i>2013</i>	<i>2014</i>	<i>p trend</i>
Mother Ethnic									
NZ European	42.8	37.2	39.4	36.1	37.9	38.4	39.4	40.6	P=0.81
Maori	30.2	27.9	27.4	30.5	28.8	24.1	26.7	27.1	P=0.23
Pacific Islands	13.6	16.5	15.7	15.8	12.1	15.6	14.7	14.5	P=0.76
Indian	3.6	3.2	3.2	6.2	5.8	5.0	5.9	5.5	P=0.02
Asian	3.3	5.0	4.7	6.7	6.1	8.4	4.9	5.8	P=0.07
Other	6.5	10.1	9.5	4.7	9.4	8.4	8.5	6.5	P=0.69
Deprivation									
Quintile 1 (least deprived)	11.2	13.2	11.0	9.1	17.3	9.4	9.4	12.6	P=0.84
2	13.1	12.7	13.2	14.7	16.7	17.5	11.7	15.7	P=0.33
3	15.8	16.6	16.5	15.8	16.4	18.1	22.5	16.3	P=0.22
4	24.6	18.5	23.4	21.1	21.8	19.4	17.3	23.4	P=0.17
Quintile 5 (most deprived)	34.7	36.4	33.2	37.5	27.9	34.4	36.8	31.7	P=0.20
Unknown	0.5	2.6	2.7	1.8	0	1.3	2.3	0.3	

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
<hr/>									
Gestational age									
category									
20-23 weeks	24.6	32.5	26.4	31.4	34.5	30.6	34.2	-	P=0.01
24-27	14.8	12.1	14.5	12.9	10.9	15.9	12.4	-	P=0.74
28-31	11.2	9.8	11.7	9.4	10.3	9.4	10.4	9.5	P=0.48
32-36	17.5	14.5	15.0	19.6	16.7	16.9	20.5	17.5	P=0.20
37-40	26.5	26.4	27.7	22.6	24.8	24.4	19.5	22.2	P=0.01
≥41 weeks	5.5	4.7	4.5	4.1	2.7	2.8	2.9	0.9	P<0.001
Unknown	0	0	0.2	0	0	0	0	0	
<hr/>									
	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
<hr/>									
Birth weight									
category									
<500g	24.9	29.0	24.2	30.5	33.0	32.8	35.8	35.7	P<0.001
500-999g	18.9	19.3	20.4	15.8	16.7	18.8	17.3	18.2	P=0.45
1000-1499g	9.8	5.5	7.7	8.8	7.0	8.7	5.9	6.8	P=0.34
1500-1999g	6.8	8.2	6.5	9.4	7.3	3.8	5.5	5.5	P=0.07
2000-2499g	7.4	8.4	6.7	7.6	9.4	10.0	10.1	8.6	P=0.14
2500-2999g	9.3	11.3	12.2	10.6	12.4	8.7	10.1	9.5	P=0.55
3000-3499g	11.2	9.8	11.7	8.2	6.7	10.3	4.9	8.3	P=0.01
3500-3999g	6.0	4.5	4.5	6.5	4.5	5.0	5.9	4.6	P=0.84
4000-4499g	3.6	2.4	3.5	0.9	2.1	0.6	2.3	1.8	P=0.04
≥4500g	1.4	0.8	0.5	0.9	0.0	0.3	0.7	0.0	P=0.03
Unknown	0.8	0.8	2.0	0.9	0.9	0.9	1.6	0	
<hr/>									

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
Type of birth									
Singleton	89.9	91.0	92.0	89.7	84.5	89.1	86.6	89.5	P=0.07
Multiple	10.1	9.0	8.0	10.3	15.5	10.9	13.4	10.5	P=0.07

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
Time of death									
Antepartum	70.2	69.9	71.1	68.0	70.6	70.3	76.2	67.1	P=0.80
Intrapartum	14.2	19.8	19.5	20.8	21.2	19.7	16.9	23.1	P=0.07
Unknown	15.6	10.3	9.5	11.1	8.2	10.0	6.8	9.8	

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
Maternal BMI									
Underweight (<18.5)	-	1.6	2.5	1.8	3.3	-	1.0	3.4	P=0.46
Normal (18.50– 24.99)	-	28.2	37.9	37.2	37.0	-	36.5	38.2	P=0.04
Overweight (25.00–29.99)	-	21.9	21.2	24.6	31.5	-	28.0	25.5	P=0.03
Obese Class I (30.00–34.99)	-	12.7	12.7	12.3	13.9	-	14.0	14.8	P=0.30
Obese Class II (35.00–39.99)	-	9.0	8.0	8.8	7.6	-	8.5	9.5	P=0.77

Obese Class III (≥40)	-	5.3	5.0	7.3	3.0	-	9.1	7.4	P=0.05
Unknown	-	21.4	12.7	7.9	3.6		2.9	1.2	

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
Maternal age									
<20 years	8.5	13.2	10.5	7.9	7.0	9.7	8.8	8.0	P=0.14
20-24 years	20.8	19.0	18.5	26.1	19.4	20.3	18.2	19.4	P=0.67
25-29 years	23.8	20.3	23.4	22.6	22.7	20.3	23.8	24.0	P=0.75
30-34 years	23.8	24.5	23.4	23.5	22.7	26.2	25.7	27.4	P=0.21
35-39 years	17.8	17.4	19.7	15.8	23.0	16.2	14.3	16.3	P=0.31
≥40 years	5.5	5.5	4.5	4.1	5.2	7.2	9.1	4.6	P=0.22
Unknown								0.3	

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
Smoking status									
Current smoker	28.7	29.8	26.7	34.6	27.0	26.9	25.1	25.5	P=0.11
Non-smoker	64.8	65.2	69.8	64.5	72.1	72.8	74.9	74.2	P<0.001
Unknown	6.6	5.0	3.5	0.9	0.9	0.3	0	0.3	

Table 3: Stillbirth rates associated with known risk factors: New Zealand 2007 to 2014

	Year								<i>p trend</i>
	Stillbirth rate (per 1000 births)								
	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
Mother Ethnic									
NZ European	5.30	4.80	5.32	4.13	4.40	4.44	4.61	5.25	P=0.46
Maori	6.60	6.40	7.51	6.99	6.67	5.44	6.08	6.8	P=0.69
Pacific Islands	7.40	8.90	9.23	7.72	5.85	7.54	7.3	8.0	P=0.57
Indian	6.10	5.30	5.94	8.83	8.13	6.51	6.65	6.48	P=0.23
Asian	2.80	4.30	4.14	4.52	3.82	4.36	2.5	2.93	P=0.65
Other	4.20	6.70	6.63	2.65	5.56	5.08	4.77	3.87	P=0.42
	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
Deprivation									
Quintile 1 (least deprived)	4.1	5.16	4.32	3.01	5.76	3.07	3.16	4.4	P=0.82
2	4.5	4.54	4.72	4.35	4.94	5.12	3.38	4.96	P=0.46
3	4.8	5.13	5.46	4.39	4.51	4.8	5.86	4.66	P=0.84
4	6.0	4.7	7.05	5.22	5.47	4.68	4.29	6.2	P=0.57
Quintile 5 (most deprived)	7.2	7.61	8.05	7.59	5.69	6.8	7.14	6.8	P=0.08
	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>

Gestational age									
category									
20-23 weeks	-	-	-	-	-	-	-	-	-
24-27	177.6	164.87	206.41	147.65	145.16	200.0	146.72	-	P=0.38
28-31	76.1	64.64	89.18	58.08	65.26	57.8	67.8	67.8	P=0.63
32-36	16.4	13.5	15.27	16.28	13.97	13.53	16.71	15.6	P=0.74
37-40	2.0	2.06	2.36	1.6	1.76	1.67	1.32	1.61	P=0.05
≥41 weeks	1.6	1.49	1.54	1.18	0.82	0.84	0.92	0.33	P=0.004

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
Birth weight									
category									
<500g	-	-	-	-	-	-	-	-	-
500-999g	200.6	233.23	258.68	167.18	189.0	198.68	182.76	193.44	P=0.16
1000-1499g	83.1	50.6	77.31	71.43	64.79	72.35	54.05	64.9	P=0.42
1500-1999g	31.2	38.08	33.64	40.92	30.0	15.75	22.79	28.3	P=0.06
2000-2499g	11.3	13.07	11.65	10.97	13.21	13.17	13.78	12.81	P=0.18
2500-2999g	3.9	4.87	5.8	4.15	4.9	3.39	3.79	3.81	P=0.16
3000-3499g	1.9	1.72	2.23	1.3	1.05	1.6	0.76	1.36	P=0.07
3500-3999g	1.0	0.81	0.88	1.05	0.75	0.8	0.93	0.81	P=0.42
4000-4499g	1.5	1.08	1.78	0.37	0.91	0.26	0.96	0.86	P=0.10
≥4500g	2.7	1.61	1.18	1.79	-	-	1.33	-	P=0.39

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
Type of birth									

Singleton	5.2	5.4	5.96	4.84	4.59	4.7	4.56	5.11	P=0.09
Multiple	18.2	17.53	17.75	18.46	28.16	20.01	23.29	20.3	P=0.03

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p trend</i>
Maternal age									
<20 years	6.1	9.32	8.82	5.84	5.62	7.92	7.86	8.55	P=0.87
20-24 years	6.6	6.05	6.29	7.34	5.48	5.61	5.08	6.12	P=0.18
25-29 years	5.5	4.81	6.03	4.74	4.77	4.08	4.69	5.0	P=0.21
30-34 years	4.6	5.12	5.35	4.45	4.29	4.73	4.63	5.09	P=0.91
35-39 years	5.5	5.5	6.89	4.69	6.88	4.93	4.28	5.46	P=0.19
≥40 years	8.2	8.58	7.21	5.24	6.57	8.53	10.58	5.94	P=0.82

Table 5: Proportions of stillbirths associated with known risk factors: UK 2004 to 2014

	Year								<i>p trend</i>
	Stillbirth proportion (%)								
	2004	2005	2006	2007	2008	2009	2013	2014	
Type of birth									
Singleton	90.6	89.9	92.7	92.7	92.8	-	93.5	91.3	p=0.002
Multiple	8.9	8.5	7.3	7.3	7.2	-	6.5	8.3	p=0.05
Unknown	0.4	1.9	0	0	0	-	0	0.4	
	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
Maternal BMI									
<18.5	-	2.2	2.7	2.9	2.9	2.5	2.8	2.6	P=0.45
18.5-24.9	-	40.3	43.7	44.3	38.3	39.6	39.0	40.4	P=0.09
25-29.9	-	27.2	27.7	26.8	26.5	25.6	28.2	27.5	P=0.39
30-34.9	-	12.2	14.7	15.6	13.0	13.4	14.7	13.9	P=0.08
≥35	-	18.1	11.2	10.4	8.9	9.1	9.4	10.4	P<0.001
	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
Intrapartum death	9.0	8.7	8.5	-	8.8	8.0	8.8	8.5	p=0.62
	2004	2005	2006	2007	2008	2009	2013	2014	<i>P trend</i>
Ethnicity									
White	66.9	69.6	-	-	66.1	68.3	65.8	66.1	P=0.01
Black	10.3	9.1	-	-	10.7	9.6	7.4	7.9	P<0.001
Asian	14.0	12.6	-	-	14.7	13.9	14.4	14.7	P=0.06
Mixed	-	1.2	-	-	1.6	1.5	4.5	4.7	P<0.001
Other	5.3	4.1	-	-	3.8	3.2	2.1	2.0	P<0.001
Unknown/missing	2.9	3.3			3.2	3.6	5.7	4.6	

	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
Deprivation									
Quintile 1 (least deprived)	-	11.3	11.5	-	11.9	11.8	14.4	15.1	P<0.001
2	-	13.7	12.9	-	12.4	13.7	17.7	18.3	P<0.001
3	-	17.3	17.1	-	16.8	17.0	19.3	20.4	P<0.001
4	-	23.3	23.4	-	22.8	22.2	23.9	21.4	P=0.30
5 (most deprived)	-	33.9	34.1	-	35.3	33.6	24.1	23.7	P<0.001
Unknown		0.4	1.1		0.8	1.6	0.6	1.1	
Birthweight category	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
<1500g	45.6	44.6	44.9	43.3	-	-	39.8	40.1	P<0.001
1500-2499g	21.1	21.4	22.7	22.9	-	-	22.2	23.1	P=0.12
2500-3499g	22.4	22.9	23.4	24.0	-	-	27.2	26.6	P<0.001
≥3500g	8.4	7.9	7.2	8.8	-	-	9.7	8.9	P=0.006
Unknown	2.5	3.1	1.7	1.0			1.1	1.3	
Gestational age category	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
<24 weeks	-	-	-	-	-	-	-	-	
24-27 weeks	26.9	26.9	25.6	-	24.5	24.4	22.5	22.2	P<0.001
28-31 weeks	15.9	15.8	17.4	-	17.2	16.3	15.9	16.5	P=0.99
32-36 weeks	23.5	22.7	24.0	-	23.9	24.4	24.4	24.6	P=0.09
37-41 weeks	31.2	31.3	30.7	-	33.3	32.2	36.2	35.1	P<0.001

≥42 weeks	1.0	0.8	1.0	-	0.7	0.8	1.1	1.7	P=0.002
Unknown	1.5	2.5	1.2		0.4	1.9	0	0	

	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
Maternal age									
category									
<20 years	9.4	8.3	7.5	-	7.0	7.5	5.3	4.6	P<0.001
20-24 years	18.6	17.6	18.2	-	19.9	19.1	16.7	18.1	P=0.31
25-29 years	23.3	24.5	25.3	-	23.5	24.2	26.2	25.6	P=0.01
30-34 years	25.8	25.4	25.2	-	24.5	24.4	27.2	28.7	P<0.001
35-39 years	16.9	17.7	18.1	-	17.1	17.0	17.8	16.9	P=0.79
≥40 years	4.9	4.3	5.3	-	5.7	5.5	5.3	6.2	P=0.004
Unknown	0.8	1.8	0		2.3	2.2	1.5	0	

Table 6: Stillbirth rates associated with known risk factors: UK 2007 to 2014

	Year								<i>p trend</i>
	Stillbirth rate (per total births)								
	2004	2005	2006	2007	2008	2009	2013	2014	
Type of birth									
Singleton	5.3	5.1	4.9	4.9	4.8	-	4.07	3.96	p<0.001
Multiple	17.1	15.6	12.2	12.3	11.7	-	9.13	11.04	p=0.003
	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
Ethnicity									
White	4.8	4.2	4.0	3.9	4.2	4.5	3.82	3.78	p=0.08
Black	13.6	9.6	9.7	10.7	9.9	9.2	7.02	7.49	p=0.03
Asian	9.8	8.8	7.9	7.8	7.4	7.0	6.28	6.32	p<0.001
Chinese	-	3.4	2.6	5.1	4.3	4.5			p=0.28
Mixed	-	5.6	4.8	6.4	5.4	4.6	4.1	4.06	p=0.02
Other	-	5.5	5.7	5.6	5.9	4.9	4.63	4.11	p=0.09
	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
Deprivation									
Quintile 1 (least deprived)	-	3.5	3.7	3.6	3.9	4.0	3.11	3.23	p=0.53
2	-	4.2	4.0	4.5	3.9	4.4	3.7	3.82	p=0.18
3	-	4.8	4.8	4.8	4.7	4.8	4.14	4.35	p=0.04
4	-	5.5	5.6	5.4	5.3	5.2	5.09	4.52	p<0.001
5 (most deprived)	-	6.2	6.4	6.5	6.5	6.3	5.08	4.97	p=0.23
	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
Birthweight category									

<1500g	174.0	165.1	163.2	164.3	-	-	163.64	163.31	P=0.16
1500-2499g	18.6	18.5	19.1	19.4	-	-	17.03	16.39	P=0.33
2500-3499g	2.42	2.4	2.39	2.4	-	-	2.43	2.19	P=0.54
≥3500g	1.21	1.09	0.97	1.11	-	-	1.08	0.92	P=0.11

	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
Gestational age									
category									
<24 weeks	-	-	-	-	-	-	-	-	
24-27 weeks	237.4	254	265.5	246.7	247.1	-	212.77	226.19	P=0.22
28-31 weeks	94.2	95	92.7	90.2	89.1	-	77.56	83.01	P=0.003
32-36 weeks	22	21	20.4	20	19.2	-	16.4	16.24	P<0.001
37-41 weeks	2	2	1.9	1.9	1.9	-	1.71	1.66	P<0.001
≥42 weeks	1.2	1	1.3	1.1	0.8	-	1.28	1.60	P=0.43

	2004	2005	2006	2007	2008	2009	2013	2014	<i>p trend</i>
Maternal age									
category									
<20 years	7.59	6.6	5.6	5.6	5.6	6.3	5.28	5.11	p=0.01
20-24 years	5.61	5.1	4.9	5.1	5.2	5.1	4.11	4.67	p=0.08
25-29 years	5.29	5.2	5.0	5.1	4.4	4.6	3.93	3.81	p<0.001
30-34 years	4.93	4.8	4.5	4.7	4.6	4.7	3.77	3.89	p=0.02
35-39 years	6.0	6.0	5.6	5.3	5.3	5.5	4.69	4.27	p=0.001
≥40 years	8.86	7.2	8.1	7.7	7.8	7.6	5.42	6.29	p=0.05

