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Stillbirth rates in England and Wales and regional uptake of accreditation training in customised fetal growth assessment

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ABSTRACT

Objective To assess the effect that accreditation training in fetal growth surveillance and evidence based protocols had on stillbirth rates in England and Wales.

Design Analysis of mortality data from Office of National Statistics.

Setting NHS Regions in England and Wales; including three (West Midlands, North East and Yorkshire and the Humber) which between 2008 to 2011 have implemented intensive training programmes in customised fetal growth assessment.

Population Live births and stillbirths in England and Wales between 2007 and 2012.

Main outcome measure Stillbirth

Results There was a significant downward trend (p=0.03) in stillbirth rates between 2007–2012 in England to 4.81/1000, the lowest rate recorded since adoption of the current definition of stillbirth in 1992. This drop was due to downward trends in each of the three English regions with high uptake of accreditation training, and led in turn to the lowest stillbirth rates on record in each of these regions. In contrast, there was no significant change in stillbirth rates in any of the remaining English regions and Wales, in which uptake of training had been low. The three regions responsible for the record drop in national stillbirth rates made up less than a quarter (24.7%) of births in England. The fall in stillbirths was most pronounced in the West Midlands, which had the most intensive training programme, from the preceding average baseline of 5.73/1000 in 2000-2007 to 4.47/1000 in 2012, a 22% drop which is equivalent to 92 fewer deaths a year. Extrapolated to the whole of the UK, this would amount to a saving of over 1000 stillbirths each year.

Conclusion Training and accreditation in fetal growth assessment based on evidence-based protocols results in significant reduction of stillbirths.

SUMMARY

Article Focus

- Stillbirth rates in England and Wales have remained the same for the last 20 years and are the highest in Western Europe.
- Most avoidable stillbirths are associated with antenatally unrecognised fetal growth restriction
- We wanted to assess the effect that a comprehensive training programme in fetal growth assessment, including use of customised growth charts and evidence based protocols, had on stillbirth rates.

Key Messages

- The three regions with high uptake of the programme had a drop in stillbirth rates while rates have remained the same in regions with a low uptake.
- Although they covered less than a quarter of all maternities in England, the improvement in the high uptake areas resulted in a significant reduction in national stillbirth rates
- National roll out and implementation of the programme could save over 1000 stillbirths each year

Strengths and Limitations.

- Analysis of national ONS data helped to avoid random variation due to small numbers at unit or Trust level and allowed trends to become apparent.
- Only crude figures were available but previous regional analysis was able to pinpoint the regional downward trend in regional stillbirth rates as due to fewer deaths with intrauterine growth restriction.
- The study was observational but there have been no other recent initiatives which could have accounted for the reduction in stillbirths over this period, either nationally or in the regions with observed downward trends.

INTRODUCTION

Stillbirth rates in England and Wales have seen little change in the last 20 years and are the highest in Western Europe[1]. Reduction of stillbirths is a government target[2] yet a recent survey conducted by The Times suggested that most NHS Trusts which run maternity units in England have no specific plans in place to cut stillbirth rates [3].

Until recently, two-thirds of stillbirths were categorised as unexplained [4] and tended, by implication to be considered unavoidable [5]. However our understanding has improved with the application of better classification systems and customised birthweight centiles, which identified that most such 'unexplained' stillbirths had preceding intrauterine growth restriction due to placental failure [6 7 8]. A 2007 confidential enquiry peer review of case notes of normally formed stillbirths with fetal growth restriction found that 84% were associated with substandard care and were potentially avoidable. [9] This finding is supported by a recent analysis of the West Midlands maternity database which reported that growth restriction was not only the single strongest risk factor for stillbirth, but that antenatal recognition and timely delivery can lead to significant reduction in risk [10].

However detection of fetal growth problems has been traditionally poor in the NHS, with published reports ranging from 15-24% [11 12], and 18% in a 2006 baseline audit in Birmingham [13]. Therefore a major focus of the West Midlands Perinatal Institute's stillbirth prevention strategy since 2008/9, supported by the Strategic Health Authority and the region's Primary Care Trusts, has been to improve the antenatal recognition of growth restriction in low and high risk pregnancies. The programme was underpinned by customised charts which are adjustable for various maternal characteristics and predict the optimal fetal growth curve for each pregnancy ('Gestation Related Optimal Weight', GROW [14]). The charts are used for serial plotting of fundal height and estimated fetal weight measurements, and have been shown to result in increased antenatal detection of growth problems [15 16 17]. They also lead to fewer false positive assessments and unnecessary ultrasound referrals [15 18], thus being reassuring for the mother as well as diverting scarce resources towards the higher risk pregnancies, where serial ultrasound biometry is indicated.

Training was instituted from 2008 through a series of bespoke accreditation workshops with hands-on teaching and assessment, and the promotion of evidence based protocols and best practice guidelines [19 20 21]. The workshops were offered as a free rolling programme to Trusts in the West Midlands, and were also held on invitation in interested Trusts in other regions.

We wanted to assess the effect that this training programme had on stillbirth rates, using the latest release of ONS death statistics for English regions and Wales [22].

METHODS

Training

Accreditation training in customised growth assessment and protocols was conducted in 2.5 hour workshops and covered:

- rationale of fetal growth assessment;
- national and regional guidelines
- use of the GROW software including data entry and print out
- training in standardised fundal height measurement and serial plotting
- definition of normal, slow, static or accelerated growth
- referral pathways for further investigation by ultrasound and Doppler
- risk assessment and protocols for serial scans in high risk pregnancy
- evaluation through a test with MCQs and short answers including scenarios.

Fortnightly accreditation workshops were commenced in 2008 at the West Midlands Perinatal Institute in Birmingham and were attended by midwives and midwife trainers as well as ultrasonographers and junior and senior obstetricians. The training was also available for staff from Trusts in other regions, through central or locally arranged workshops. Trusts which had accreditation workshops during 2012 were not considered trained in this analysis of pregnancies which delivered up to 2012.

Data analysis

Live births and stillbirths were derived from the ONS mortality statistics release for 2012 [22] and previous releases from 2007 onwards [23]. Data included stillbirths from 24 weeks gestation. Stillbirth rates were calculated for single years as well as three year moving averages. Trend analysis was undertaken using standard chi-square trend test with one degree of freedom. Least-squares linear regression was used to obtain the slopes for each area.

RESULTS

Uptake of training

Eighteen of the 19 maternity units in the West Midlands implemented the GROW software and training programme, and the fortnightly workshops resulted in over 2000 staff being trained between 2008 and 2011. In the whole of England and Wales, staff in 49 of the 148 Trusts (33%) received accreditation training, resulting in 32% of all pregnancies during this period being cared for in units with trained staff (Table 1). However there was wide variation in uptake. In three regions (North East, Yorkshire and The Humber and West Midlands), on average 90% of pregnancies (range 58 – 100%) were cared for in units which had GROW training, while this average was 15% (range 0 - 24%) for the rest of England and Wales.

Stillbirth rates and trends

Table 2 lists births, stillbirths and rates from 2007 to 2012 for English regions and Wales together with trend analysis. There was a significant fall in stillbirth rates over this period in England ($p<0.03$) but not in Wales ($p=0.7$). Amongst English regions, only the West Midlands had a significant downward trend ($p<0.01$) and if this region is excluded, the drop in England becomes non-significant. The two other regions which were high GROW accreditation areas, North East and Yorkshire and The Humber, each showed downward trends in stillbirth rates which, when taken together, also reached statistical significance ($p<0.03$). Training uptake rates for each region (Table 1) were significantly correlated with negative (downward) slopes of stillbirth trends (Table 2): $R= -0.77$, $p<0.01$ (Fig 1).

Three year moving average analysis

In Table 3 and Figures 1-3, three year moving average stillbirth rates are listed for high and low uptake regions of the accreditation programme. Each of the high uptake regions displayed a downward trend (Figure 1), while stillbirth rates in the other regions and Wales remained constant (Figure 2). The high and low uptake areas are combined in Figure 3, which demonstrates that the drop in stillbirths in England was achieved by the three regions with high uptake of GROW training.

DISCUSSION

This is to our knowledge the first analysis of national and regional stillbirth trends and their association with a training and accreditation programme. It indicates that stillbirth rates have dropped in regions with high levels of training (West Midlands, North East, Yorkshire and The Humber), while they stagnated in regions with low uptake. The downward trends in these three regions caused a drop in the national stillbirth rate to its lowest level (since the current ONS stillbirth definitions were introduced in 1992) even though together they account for less than a quarter of births in England (172,429 / 697,598 = 24.7%; Table 1).

Regional programmes

The argument that this relationship is causal is strengthened further when examining associations between stillbirth trends and time and effort. In the North East, GROW accreditation training was adopted between 2008-2011 by the majority of Trusts and facilitated by strong promotion of the RCOG guidelines [19] by the region's lead unit in Newcastle. The 3 year moving average graph (Fig 1) shows a gradual drop accentuated in the last triennium, with the 2012 stillbirth rate (3.91/1000) being the lowest recorded for the region.

In Yorkshire and The Humber, all units participated in 2011 in a 'train the trainer' programme and developed a regional 'best practice' competency document based on the Perinatal Institute's protocols and training tools, which were administered through midwifery supervision. The ensuing year, 2012, saw a sharp drop in stillbirth rates to 5.00/1000, the lowest recorded for the region.

In the West Midlands, the introduction of the GROW accreditation programme in 2008 was complemented by regionally agreed protocols for scanning high risk pregnancies and were from 2008-2011 supported by augmented ultrasound resources in Birmingham, Stoke on Trent and other areas. In addition, a data collection programme reported quarterly on antenatal detection rates of small for gestational age birthweight as a regionally agreed key performance indicator. The Region's stillbirth rates dropped year on year since 2008, with the 2011 rate falling for the first time in 50 years to below the national average [34]. This fall continued in 2012 to 4.47/1000 (Table 2), which is 1.26/1000 or 22% below the preceding (2000-2007) ONS regional average of 5.73/1000, and equivalent to 92 fewer West Midlands deaths. A similar rate reduction applied to the over 800,000 annual deliveries in the United Kingdom would result in over 1000 fewer stillbirths each year.

Significance of fetal growth

The focus on intra-uterine growth in stillbirth prevention is justified as it constitutes the largest single category of deaths, comprising over 50% of normally formed stillbirths [6]. In addition, stillbirths are only one of a range of adverse pregnancy outcomes known to follow fetal growth restriction defined by customised weight-for-

gestation percentiles, including perinatal morbidity [24 25], mortality [26] and cerebral palsy [27]. Most small for gestational age babies are due to late onset placental failure and are born at term [10 28]. Case note peer review has established that the majority of deaths with fetal growth problems are potentially avoidable, through better assessment of risk factors and surveillance of growth during pregnancy. [9] Antenatal recognition of growth restriction halves the stillbirth risk while resulting in babies being delivered at term, on average only 10 days earlier at 270 vs 280 days gestation. [10]

Antenatal detection

A major problem in maternity care has been the lack of antenatal recognition of fetal growth problems, which precludes further investigations to determine the optimal time for delivery of the fetus from an unfavourable intrauterine environment. While no national data are available, we know from controlled studies that antenatal detection improves significantly with implementation of customised charts, training and protocols [15]. West Midlands audits have shown that performance is directly linked with uptake: in the one unit in the region which did not implement the recommended training and protocol, antenatal detection remained at 12%, while units which adopted the protocols and ensured staff were trained achieved detection rates up to 50% within 12 months of implementation [29]. Once a mother carrying a growth restricted baby was referred according to protocol for an ultrasound scan on the basis of fundal height measurement plotted on customised charts, antenatal detection rate averaged 62% and could be as high as 85% [30].

Fetal growth surveillance is a multidisciplinary task and requires collaboration between community and hospital midwives, general practitioner, ultrasonographer and obstetrician/maternal fetal medicine specialist. Care usually starts with the community midwife, who within the NHS is usually the first to see the expectant mother. Her assessment of whether the woman is high or low risk will initiate the relevant care pathway.

Surveillance in low and high risk pregnancy

For low risk mothers, third trimester growth is assessed through serial measurement of fundal height which until recently has had little standardisation in midwifery and medical training. As fundal height varies with maternal size [31], plotting on customised charts is indicated which can predict the expected, optimal fetal growth trajectory after adjustment for each mother's parity, maternal height, maternal weight in early pregnancy and ethnic origin. Where measurements do not follow the expected curve and cross centile lines, protocols prompt referral for ultrasound scan biometry to determine the estimated fetal weight, which is plotted on the same chart adjusted for maternal and pregnancy characteristics. An estimated fetal weight which is small-for-gestational age on a customised chart is an indication for obstetric review and further investigation [20] , to be managed according to evidence based guidelines [19] and individual circumstances.

For mothers at increased risk of intrauterine growth restriction because of past obstetric history or other risk factors, or where fundal height measurement is difficult e.g. due to high maternal body mass index, serial third trimester scans are indicated [19 20 21]. The current weak link in the referral chain is the chronic shortage of sonographers and ultrasound services in the NHS, which can manifest in several ways: referral on the basis of fundal height measurement may be unduly delayed or ignored; or the scan is refused because of the frequently heard claim that ultrasound biometry at term has less accuracy - which is in fact not the case [32]. Case note audits have furthermore shown that most pregnancies with indication for serial ultrasound receive only one scans in the third trimester [13] resulting in detection rates not better than not having a scan at all. However recent evidence suggests that antenatal detection in increased risk pregnancies can be improved significantly with a policy of 4 third trimester scans [33]. Enhanced ultrasound scan policies can be cost neutral when accompanied by implementation of customised charts, as their use for plotting fundal height measurement [15] and estimated fetal weight [18] will reduce false positive diagnoses of 'small for gestational age' and referrals for unnecessary investigations.

As Table 2 shows, crude baseline stillbirth rates vary considerably between regions and are likely to be related to characteristics of the population, including social factors, ethnic mix, and differences in congenital anomaly rates. Our analysis does not seek to compare rates in different regions, but assess year on year trends and relative change. Two of the three regions with high uptake in GROW training had above average stillbirth rates at the beginning of the study interval. As Figures 1 and 3 demonstrate, the drop in stillbirths in these regions has contributed to a reduction in regional inequalities in stillbirth rates.

Strengths and Limitations

The regional analysis helps to reduce random variation due to small numbers at unit or Trust level and allows trends to become apparent. A possible weakness of our study is that only crude ONS figures were available, without subcategories of stillbirths to identify where the improvements occurred. However previous analysis of the more detailed West Midlands database has shown that the downward trend in regional stillbirth rates, already evident in 2011, could be pinpointed to fewer deaths with intrauterine growth restriction, while there was no change in any of the other main stillbirth categories [34].

Another potential criticism of our study is that confounders could have been responsible for the findings. However we are not aware of any other recent or current major initiatives which could have accounted for the reduction in stillbirths over this period, either nationally or in the regions with the observed downward trends.

International perspectives

While this analysis focuses on English regions and Wales, stillbirths are a global problem, with the overwhelming majority occurring in low and middle income countries[35]. Global trends in stillbirth rate reduction lag behind the progress in reducing maternal mortality and deaths in children under 5 years [35]. Prevention will need to consider fundamental local needs, including provision and access to basic maternal and child health services and intrapartum and emergency care. However while these challenges are of a different order of magnitude, fetal growth restriction is also a universal concern, and the obstacles to improvement are in principle not dissimilar to those encountered here: insufficient awareness of the importance of fetal growth, lack of protocols, staff and equipment, and the use of inappropriate growth standards, often imported from high income countries. Recent work has started to address the need for international standards which are also individually customisable, or at least adjustable to the average characteristics of the local population [36 37 38]. It is hoped that mounting awareness in high income settings of the avoidability of many stillbirths will also help to enhance global prevention strategies.

Implications for the health service

Each stillbirth is a tragic loss which causes untold grief and distress to the mother and her family. In addition, stillbirths represent a high cost to the health service and society as a whole. Bereaved parents require intensive social and psychological support; and each mature, normally formed stillborn child represents the largest possible loss to society in terms of lost potential and 'quality adjusted life years' (QALYs).

Our findings suggest that many stillbirths are not only avoidable, but have in fact been avoided, in Trusts which decided to adopt standardised training and evidence based protocols for managing fetuses at risk due to fetal growth restriction. We suggest that commissioners and providers give high priority to ensuring that implementation of such a programme becomes an integral requirement for safe antenatal care.

Word count 2705

What is already known on this topic

- Stillbirths are the largest contributor to perinatal mortality
- The largest proportion stillbirths are fetuses that are growth restricted due to placental disease
- Antenatal recognition of growth delay and timely delivery can reduce stillbirth rates

What this paper adds

- A co-ordinated growth assessment programme had a high uptake in three regions in England
- These areas together achieved significant drops in stillbirth, while rates stagnated in the rest of the country.
- Improvements in these regions, which together care for less than a quarter of pregnancies in England and Wales, resulted in a significant downward trend in national stillbirth rates.

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Ethical approval: Not required

Data sharing: No additional data available.

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Table 1. GROW accreditation and protocol training programme - uptake in Trusts in England and Wales, 2008-2011

	Births in 2012 (ONS)	Number of Trusts	Number (%) of trained Trusts * N	%	Hospital Trusts in Region with accreditation training *	Total births in trained Trusts (% of all births in Region) N	%
ENGLAND AND WALES	733,232	148	49	33.1		237,544	32.4
WALES	35,419	7	0	0.0		0	0.0
ENGLAND	697,598	141	49	34.8		237,544	34.1
North East	30,410	8	5	62.5	Newcastle; Gateshead; North Tees & Hartlepool; Sunderland; South Tyneside	17,723	**57.6**
North West	89,677	21	6	28.6	Bolton; East Lancahire; Southport & Ormskirk; Tameside; Warrington; Wrighton, Wigan & Leigh	21,300	23.8
Yorkshire and the Humber	67,747	12	12	100.0	Airedale; Barnsley; Bradford; Calderdale & Huddersfield ; Doncaster & Bassetlaw; Harrogate ; Hull & East Yorkshire; Leeds; Mid Yorkshire; Rotherham; Sheffield; York;	67,747	**100.0**
East Midlands	55,923	9	2	22.2	Kettering; Northampton	8,797	15.7
West Midlands	74,272	15	14	93.3	Birmingham Women's; Burton; Dudley; George Eliot; Heart of England; Royal Shrewsbury & Telford; Sandwell & West B'ham; South Warwickshire; North Staffordshire; Coventry & Warwickshire; Walsall; Worcester; Wye Valley	68,991	**92.9**
East of England	74,884	17	1	5.9	Hinchingbrooke	2,541	3.4
London	134,941	22	3	13.6	Barts Health; Ealing; Lewisham	22,856	16.9
South East	54,128	11	1	9.1	East Kent	7,552	14.0
South Central	54,216	8	2	25.0	Hampshire; Portsmouth	12,197	22.5
South West	61,400	18	3	16.7	Northern Devon; Royal Devon & Exeter; South Devon	7,840	12.8
High uptake Regions **	172,429	35	31	88.6		154,461	**89.6**
Low uptake (rest of Regions and Wales)	560,588	113	18	15.9		83,083	**14.8**

* since introduction in 2008, to 2011

** North East, Yorkshire & Humber, West Midlands

Table 2 Total births, stillbirths and stillbirth (SB) rate in England, English regions and Wales 2007-2012. Source: ONS [22 23]
Slope by linear regression; p values for trend test.

	2007			2008			2009			2010			2011			2012			2007-2012	
	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Slope	Trend test (p)
ENGLAND AND WALES	693,611	3,598	**5.19**	712,328	3,617	**5.08**	689,591	3,644	**5.28**	726,879	3,714	**5.11**	727,724	3,811	**5.24**	733,232	3,558	**4.85**	-0.04	**0.05**
ENGLAND	658,771	3,414	**5.18**	676,236	3,427	**5.07**	656,880	3,475	**5.29**	690,513	3,506	**5.08**	691,739	3,619	**5.23**	697,598	3,357	**4.81**	-0.06	**0.03**
North East	29,728	146	**4.91**	30,396	179	**5.89**	29,991	142	**4.73**	30,969	143	**4.62**	30,705	178	**5.80**	30,410	119	**3.91**	-0.15	0.1
North West	86,423	476	**5.51**	88,617	450	**5.08**	87,492	469	**5.36**	89,665	466	**5.20**	89,235	483	**5.41**	89,677	466	**5.20**	-0.02	0.7
Yorkshire & Humber	64,567	376	**5.82**	66,724	371	**5.56**	65,559	372	**5.67**	67,343	373	**5.54**	66,831	380	**5.69**	67,747	339	**5.00**	-0.11	0.1
East Midlands	52,716	234	**4.44**	54,447	255	**4.68**	47,741	270	**5.66**	55,525	293	**5.28**	55,662	284	**5.10**	55,923	278	**4.97**	0.10	0.2
West Midlands	70,477	379	**5.38**	72,129	403	**5.59**	71,399	420	**5.88**	72,472	382	**5.27**	73,391	368	**5.01**	74,272	332	**4.47**	-0.20	**<0.01**
East of England	69,619	308	**4.42**	72,042	304	**4.22**	67,638	325	**4.80**	73,346	345	**4.70**	73,565	345	**4.69**	74,884	313	**4.18**	0.00	1.0
London	126,286	781	**6.18**	128,381	730	**5.69**	129,980	719	**5.53**	133,853	742	**5.54**	133,604	761	**5.70**	134,941	755	**5.60**	-0.08	0.1
South East Coast	50,692	239	**4.71**	51,800	235	**4.54**	53,297	240	**4.50**	53,049	256	**4.83**	53,418	257	**4.81**	54,128	227	**4.19**	-0.04	0.6
South Central	51,021	236	**4.63**	52,694	236	**4.48**	46,923	245	**5.22**	53,892	251	**4.66**	54,246	275	**5.07**	54,216	259	**4.78**	0.06	0.4
South West	57,242	239	**4.18**	59,006	264	**4.47**	56,860	273	**4.80**	60,399	255	**4.22**	61,082	288	**4.71**	61,400	269	**4.38**	0.03	0.6
WALES	34,585	171	**4.94**	35,815	165	**4.61**	32,711	169	**5.17**	36,142	190	**5.26**	35,765	167	**4.67**	35,419	181	**5.11**	0.03	0.7

Table 3: 3-year moving average of total births, stillbirths and stillbirth rates England and Wales, 2007-2012

	2007-9			2008-10			2009-11			2010-12		
	Total Births	**Stillbirths**	**SB rate**	**Total Births**	**Stillbirths**	**SB rate**	**Total Births**	**Stillbirths**	**SB rate**	**Total Births**	**Stillbirths**	**SB rate**
ENGLAND AND WALES	2,095,530	10,859	**5.18**	2,128,798	10,975	**5.16**	2,144,194	11,169	**5.21**	2,187,835	11,083	**5.07**
High uptake	500,970	2,788	**5.57**	506,982	2,785	**5.49**	508,660	2,758	**5.42**	514,140	2,614	**5.08**
North East	90,115	467	**5.18**	91,356	464	**5.08**	91,665	463	**5.05**	92,084	440	**4.78**
Yorkshire & Humber	196,850	1,119	**5.68**	199,626	1,116	**5.59**	199,733	1,125	**5.63**	201,921	1,092	**5.41**
West Midlands	214,005	1,202	**5.62**	216,000	1,205	**5.58**	217,262	1,170	**5.39**	220,135	1,082	**4.92**
Low uptake	1,594,028	8,033	**5.04**	1,621,315	8,147	**5.02**	1,635,090	8,368	**5.12**	1,673,036	8,406	**5.02**
North West	262,532	1,395	**5.31**	265,774	1,385	**5.21**	266,392	1,418	**5.32**	268,577	1,415	**5.27**
East Midlands	154,904	759	**4.90**	157,713	818	**5.19**	158,928	847	**5.33**	167,110	855	**5.12**
East of England	209,299	937	**4.48**	213,026	974	**4.57**	214,549	1,015	**4.73**	221,795	1,003	**4.52**
London	384,647	2,230	**5.80**	392,214	2,191	**5.59**	397,437	2,222	**5.59**	402,398	2,258	**5.61**
South East Coast	155,789	714	**4.58**	158,146	731	**4.62**	159,764	753	**4.71**	160,595	740	**4.61**
South Central	150,638	717	**4.76**	153,509	732	**4.77**	155,061	771	**4.97**	162,354	785	**4.84**
South West	173,108	776	**4.48**	176,265	792	**4.49**	178,341	816	**4.58**	182,881	812	**4.44**
Wales	103,111	505	**4.90**	104,668	524	**5.01**	104,618	526	**5.03**	107,326	538	**5.01**

Fig 1. Slopes of regional stillbirth rates 2007-2012 (Table 2) and proportion (%) of mothers cared for in units with training (Table 1). Regression line: R = 0.77, p<0.01

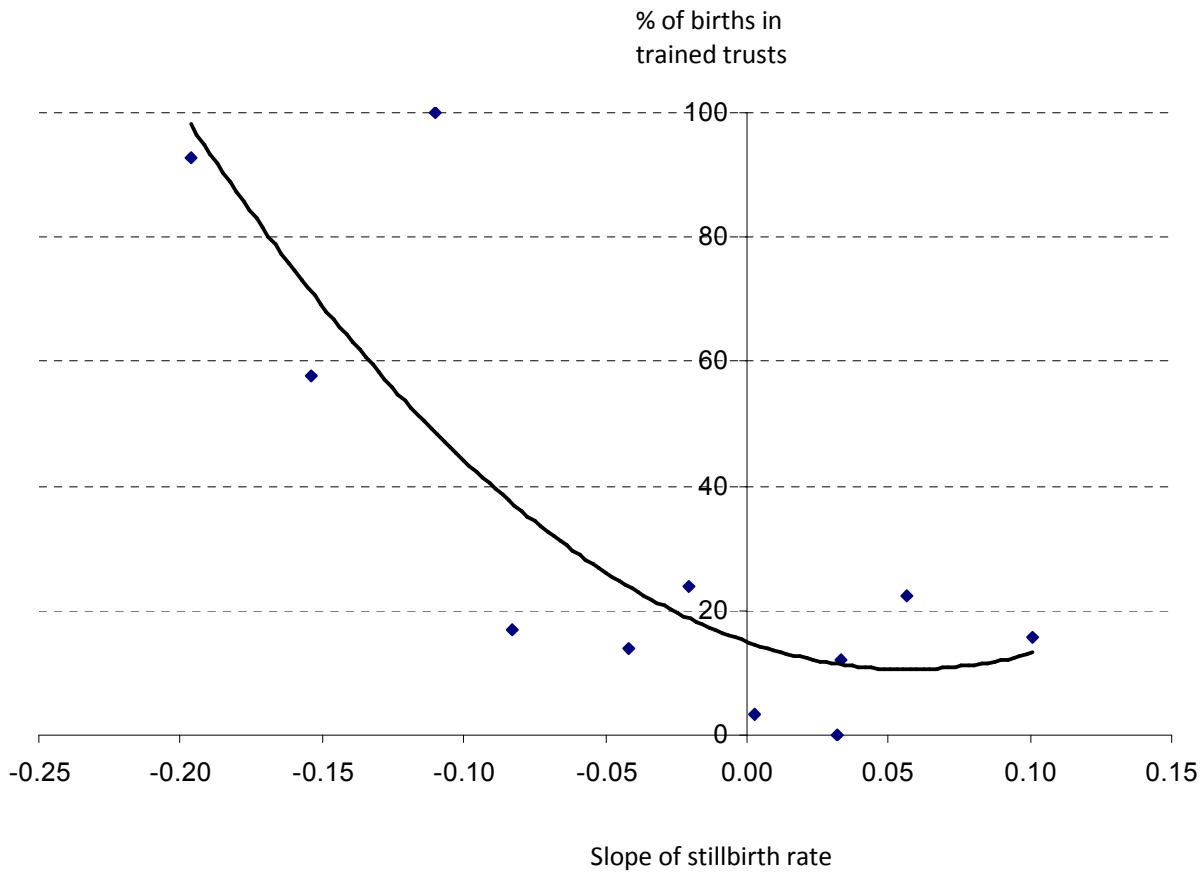
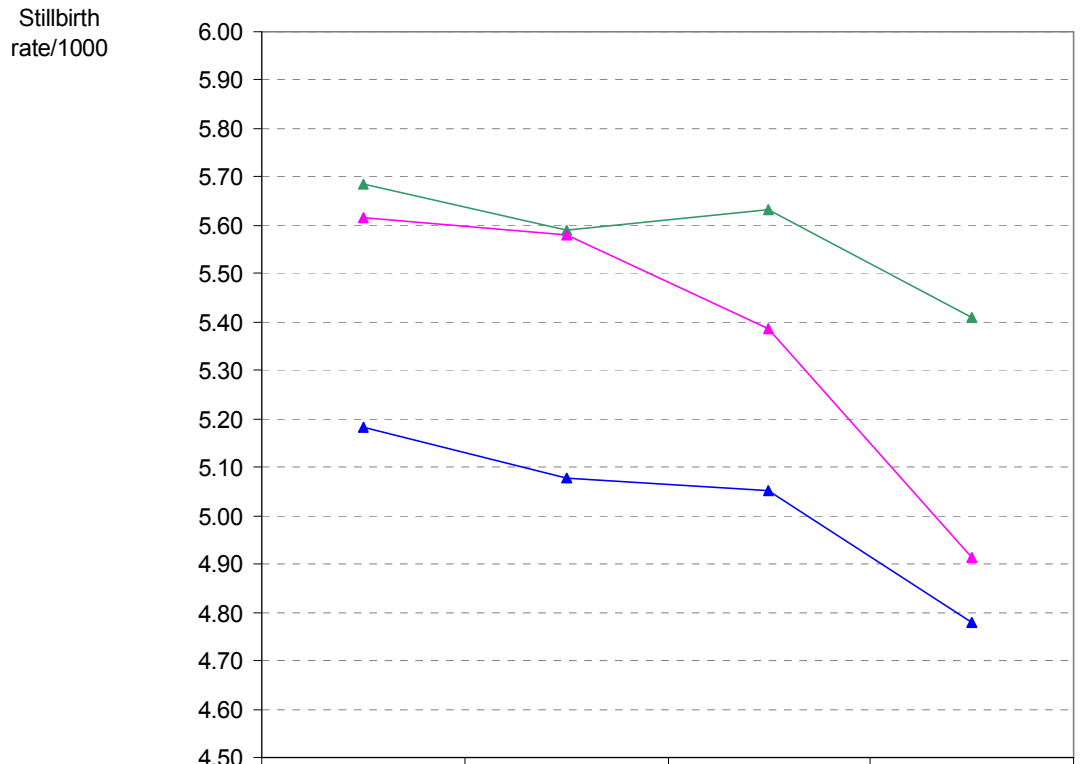
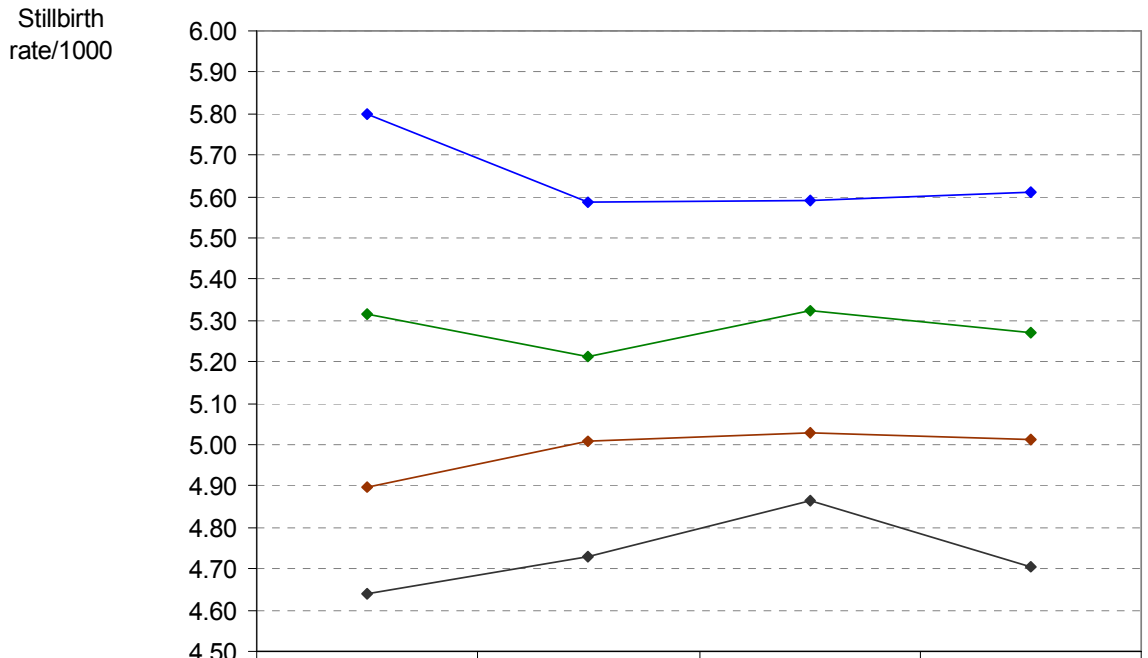


Fig 2. Stillbirth rates in Regions with high uptake of GROW training and protocols, 2007-2012 (3 year moving average)



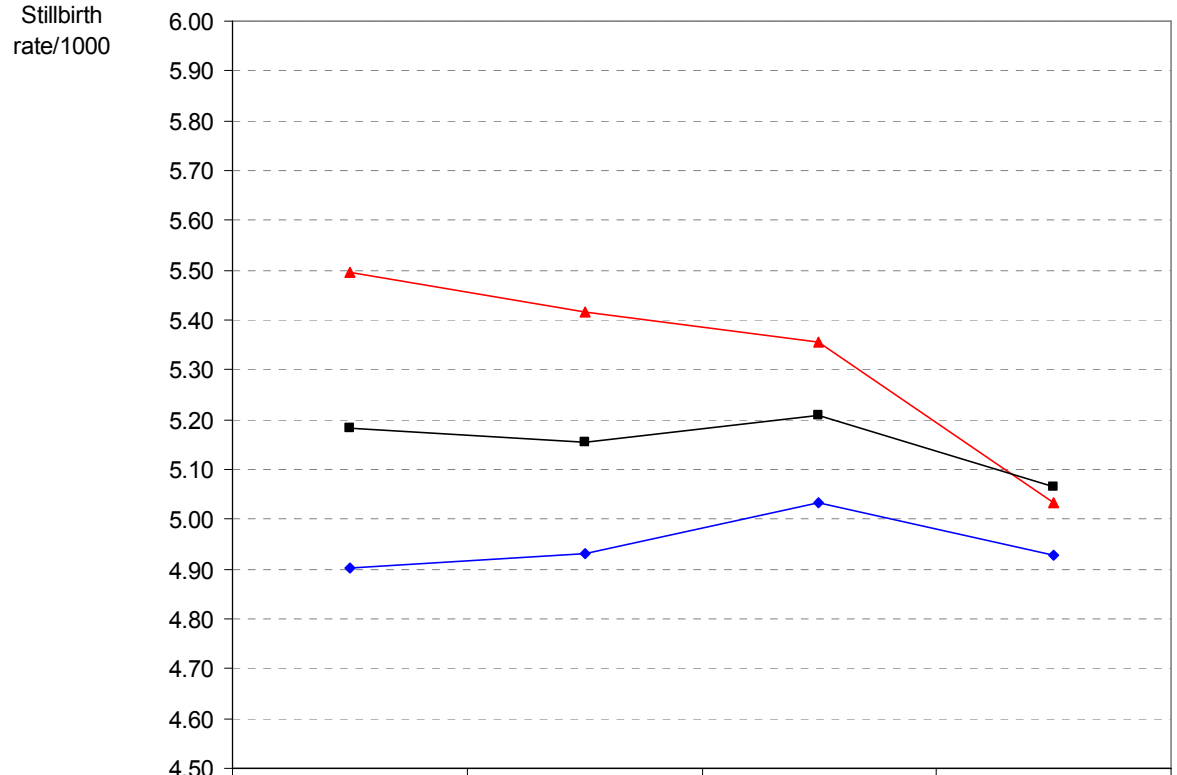
	2007-9	2008-10	2009-11	2010-12
Yorkshire and the Humber	5.68	5.59	5.63	5.41
North East	5.18	5.08	5.05	4.78
West Midlands	5.62	5.58	5.39	4.92

Fig 3. Stillbirth rates in Regions with low uptake of GROW training and protocols, 2007-2012 (3 year moving average)



	2007-9	2008-10	2009-11	2010-12
London	5.80	5.59	5.59	5.61
North West	5.31	5.21	5.32	5.27
Wales	4.90	5.01	5.03	5.01
Other low uptake regions	4.64	4.73	4.86	4.70

Fig 4. Stillbirth rates in high and low uptake Regions and England and Wales, 2007-2012 (3 year moving average)



	2007-9	2008-10	2009-11	2010-12
High uptake regions	5.49	5.42	5.36	5.03
Low uptake regions	4.90	4.93	5.03	4.93
England & Wales	5.18	5.16	5.21	5.07

STROBE Statement—checklist of items that should be included in reports of observational studies

Items 1-22 in checklist complied with in the manuscript, as appropriate for this cohort analysis of published ONS data

	Item No	Recommendation
Title and abstract	1 ✓	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2 ✓	Explain the scientific background and rationale for the investigation being reported
Objectives	3 ✓	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4 ✓	Present key elements of study design early in the paper
Setting	5 ✓	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6 ✓	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7 ✓	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8* ✓	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9 ✓	Describe any efforts to address potential sources of bias
Study size	10 ✓	Explain how the study size was arrived at
Quantitative variables	11 n/a	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12 ✓	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13* ✓	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14* n/a	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15* ✓	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16 ✓	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18 ✓	Summarise key results with reference to study objectives
Limitations	19 ✓	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20 ✓	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21 ✓	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22 ✓	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ open

Association between reduced stillbirth rates in England and Wales and regional uptake of accreditation training in customised fetal growth assessment

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Association between reduced stillbirth rates in England and Wales and regional uptake of accreditation training in customised fetal growth assessment

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ABSTRACT

Objective: To assess the effect that accreditation training in fetal growth surveillance and evidence based protocols had on stillbirth rates in England and Wales.

Design: Analysis of mortality data from Office of National Statistics.

Setting: England and Wales, including three NHS regions (West Midlands, North East and Yorkshire & Humber) which between 2008 to 2011 implemented training programmes in customised fetal growth assessment.

Population: Live births and stillbirths in England and Wales between 2007 and 2012.

Main outcome measure: Stillbirth

Results: There was a significant downward trend (p=0.03) in stillbirth rates between 2007–2012 in England to 4.81/1000, the lowest rate recorded since adoption of the current stillbirth definition in 1992. This drop was due to downward trends in each of the three English regions with high uptake of accreditation training, and led in turn to the lowest stillbirth rates on record in each of these regions. In contrast, there was no significant change in stillbirth rates in the remaining English regions and Wales, where uptake of training had been low. The three regions responsible for the record drop in national stillbirth rates made up less than a quarter (24.7%) of all births in England. The fall in stillbirth rate was most pronounced in the West Midlands, which had the most intensive training programme, from the preceding average baseline of 5.73/1000 in 2000-2007 to 4.47/1000 in 2012, a 22% drop which is equivalent to 92 fewer deaths a year. Extrapolated to the whole of the UK, this would amount to over 1000 fewer stillbirths each year.

Conclusion: A training and accreditation programme in customised fetal growth assessment with evidence-based protocols was associated with a reduction in stillbirths in high uptake areas, which resulted in a national drop in stillbirth rates to their lowest level in 20 years.

SUMMARY

Article Focus

- Stillbirth rates in England and Wales have remained the same for the last 20 years and are the highest in Western Europe.
- Most potentially avoidable stillbirths are associated with antenatally unrecognised fetal growth restriction.
- We wanted to assess the effect that a comprehensive training programme in fetal growth assessment, including use of customised growth charts and evidence based protocols, had on stillbirth rates.

Key Messages

- The three regions with high uptake of the programme had a drop in stillbirth rates while rates have remained the same in regions with a low uptake.
- Although they covered less than a quarter of all maternities in England, the improvement in the high uptake areas resulted in a significant reduction in national stillbirth rates
- National roll out and implementation of the programme has the potential to reduce stillbirths by over 1000 each year

Strengths and Limitations.

- Analysis of national ONS data helped to avoid random variation due to small numbers at unit or Trust level and allowed trends to become apparent.
- Only crude figures were available but previous regional analysis was able to pinpoint the downward trend in regional stillbirth rates as due to fewer deaths with intrauterine growth restriction.
- The study was observational but there have been no other recent initiatives which could have accounted for the reduction in stillbirths over this period, either nationally or in the regions with observed downward trends.

INTRODUCTION

Stillbirth rates in England and Wales have seen little change in the last 20 years and are the highest in Western Europe[1]. Reduction of stillbirths is a government target [2] yet a 2012 survey conducted by The Times suggested that most NHS Trusts which run maternity units in England have no specific plans in place to reduce stillbirth rates [3].

Until recently, two-thirds of stillbirths were categorised as unexplained [4] and tended, by implication, to be considered unavoidable [5]. However our understanding has improved with the application of better classification systems and customised birthweight centiles, which identified that most such 'unexplained' stillbirths had preceding intrauterine growth restriction associated with placental pathology [6 7 8]. A 2007 confidential enquiry peer review of case notes of normally formed stillbirths with fetal growth restriction found that 84% had substandard care and were potentially avoidable with better recognition and assessment of intrauterine growth. [9] This finding is supported by a recent analysis of the West Midlands maternity database which reported that growth restriction was not only the single strongest risk factor for stillbirth, but that antenatal recognition and timely delivery can lead to significant reduction in risk [10].

However antenatal detection of fetal growth problems has been traditionally poor in the NHS, with published reports of detection rates ranging from 15-24% [11 12], and 18% in a 2006 baseline audit in Birmingham [13]. Therefore a major focus of the West Midlands Perinatal Institute's stillbirth prevention strategy since 2008/9, supported by the Strategic Health Authority and the region's Primary Care Trusts, has been to improve the antenatal recognition of growth restriction in low and high risk pregnancies. The programme was underpinned by customised charts which are adjustable for various maternal characteristics and predict the optimal fetal growth curve for each pregnancy ('Gestation Related Optimal Weight', GROW [14]). The charts are used for serial plotting of fundal height and estimated fetal weight measurements, and have been shown to result in increased antenatal detection of growth problems [15 16 17]. They also lead to fewer false positive assessments and unnecessary ultrasound referrals [15 18], thus being reassuring for the mother as well as diverting scarce resources towards higher risk pregnancies, where serial ultrasound measurements are indicated to monitor fetal growth [19].

Training was instituted from 2008 through a series of bespoke accreditation workshops with hands-on teaching and assessment, and the promotion of evidence based protocols and best practice guidelines [19 20 21]. The workshops were offered as a free rolling programme to Trusts in the West Midlands, and were also held on invitation in interested Trusts in other regions.

We wanted to assess the effect that this training programme had on stillbirth rates, using the latest release of national statistics for English regions and Wales [22].

METHODS

Training

Accreditation training in customised growth assessment and protocols was conducted in 2.5 hour workshops and covered:

- rationale of fetal growth assessment;
- national and regional guidelines
- use of the GROW software including data entry and print out of chart
- training in standardised fundal height measurement and serial plotting
- definition of normal, slow, static and accelerated growth
- referral pathways for further investigation by ultrasound and Doppler
- risk assessment and protocols for serial scans in high risk pregnancy
- evaluation through a test with MCQs and short answers including scenarios.

Fortnightly accreditation workshops were commenced in 2008 at the West Midlands Perinatal Institute in Birmingham and were attended by midwives and midwife trainers as well as ultrasonographers and junior and senior obstetricians. The training was also available to staff from Trusts in other regions, through central or locally arranged workshops. Trusts which had accreditation workshops during 2012 were not considered trained in this analysis of pregnancies which delivered up to 2012.

Data analysis

Live births and stillbirths were derived from the Office of National Statistics (ONS) mortality statistics release for 2012 [22] and previous releases from 2007 onwards [23]. All data were fully anonymised and included stillbirths from 24 weeks gestation. Stillbirth rates were presented for single years as well as three year moving averages to smooth out short term fluctuations and highlight longer term trends. Trend analysis was undertaken using standard chi-square trend test with one degree of freedom. Least-squares linear regression was used to obtain the slopes for the stillbirth rates of each region.

RESULTS

Uptake of training

Eighteen of the 19 maternity units in the West Midlands implemented the GROW software and training programme, and the fortnightly workshops resulted in over 2000 staff being trained between 2008 and 2011. In the whole of England and Wales, staff in 49 of the 148 Trusts (33%) received accreditation training, resulting in 32% of all pregnancies during this period being cared for in units with trained staff (Table 1). However there was wide variation in uptake. In three regions (North East, Yorkshire and The Humber and West Midlands), on average 89.6% of pregnancies (range 58 – 100%) were cared for in units which had GROW training, while this average was 14.8% (range 0 - 24%) for the rest of England and Wales (Table 1).

Stillbirth rates and trends

Table 2 lists births, stillbirths and stillbirth rates from 2007 to 2012 for English regions and Wales together with trend analysis. There was a significant fall in stillbirth rates over this period in England ($p<0.03$) but not in Wales ($p=0.7$). Amongst English regions, only the West Midlands had a significant downward trend ($p<0.01$) and if this region is excluded, the drop in England becomes non-significant. The two other regions which were high GROW accreditation areas, North East and Yorkshire and The Humber, each showed downward trends in stillbirth rates which, when taken together, also reached statistical significance ($p<0.03$). These three regions were the only ones which achieved a negative (downward) slope of -0.10 or lower (West Midlands: -0.20; North East: -0.15; Yorkshire & Humber: -0.11; Table 2). The training uptake rates in the regions were significantly correlated with negative slopes of stillbirth trends (Table 2): $R= 0.77$, $p<0.01$ (Figure 1). The year-on-year stillbirth rate for the three high uptake regions is compared graphically with the remaining, low uptake regions in Figure 2.

Three year moving average analysis

In Table 3 and Figures 3 and 4, three year moving average stillbirth rates are listed for high and low uptake regions of the accreditation programme. Each of the high uptake regions displayed a downward trend (Figure 3), while stillbirth rates in the other regions and Wales remained stagnant (Figure 4). The moving average rates in high and low uptake regions are compared in Figure 5, demonstrating that the drop in stillbirths in England and Wales was achieved by the three regions with high uptake of GROW training.

DISCUSSION

This is to our knowledge the first analysis of national and regional stillbirth trends and their association with a training and accreditation programme. It indicates that stillbirth rates have dropped in regions with high levels of training (West Midlands, North East, Yorkshire and The Humber), while they stagnated in regions with low uptake. The downward trends in these three regions resulted in a drop in the national stillbirth rate to its lowest level (since the current ONS stillbirth definitions were introduced in 1992) even though together these regions account for less than a quarter of births in England (172,429 / 697,598 = 24.7%; Table 1).

Significance of fetal growth

The focus on intra-uterine growth in stillbirth prevention is justified as intrauterine growth restriction, defined as birthweight below the 10th customised centile, constitutes the largest single category of the stillbirth classification by relevant conditions at death, comprising over 50% of normally formed stillbirths [6]. In addition, stillbirths are only one of a range of adverse pregnancy outcomes known to follow intrauterine growth restriction, which also include perinatal morbidity [24 25], mortality [26] and cerebral palsy [27]. Most pregnancies with fetal growth restriction are due to late onset placental pathology and are born at term [10 28]. Case note peer review has established that the majority of deaths with fetal growth problems are potentially avoidable, through better assessment of risk factors and surveillance of growth during pregnancy. [9] Antenatal recognition of growth restriction leads to appropriate investigations and improved outcome [29 30 31]. It halves the stillbirth risk while resulting in babies being delivered on average only 10 days earlier at term, at 270 vs 280 days gestation.[10]

Antenatal detection

An ongoing problem in maternity care has been the lack of antenatal recognition of fetal growth problems, which precludes further investigations to determine the optimal time for delivery of the fetus from an unfavourable intrauterine environment. While no national data are available, we know from controlled studies that antenatal detection improves significantly with implementation of customised charts, training and protocols [15]. West Midlands audits have shown that improved antenatal recognition is directly linked with uptake of training: in the one unit in the region which did not implement the recommended training and protocol, antenatal detection remained at 12%, while units which adopted the protocols and ensured staff were trained achieved detection rates up to 50% within 12 months of implementation [32]. Once a mother carrying a suspected growth restricted baby was referred according to protocol for an ultrasound scan on the basis of fundal height measurement plotted on customised charts, antenatal detection rate averaged 62% and could be as high as 85% [33].

Fetal growth surveillance in the UK is a multidisciplinary task and requires collaboration between community and hospital midwives, general practitioner, ultrasonographer and obstetrician or maternal fetal medicine specialist. Care usually starts with the community midwife, who within the NHS is usually the first to see the expectant mother. Her assessment of whether the woman is low or high risk will initiate the relevant care pathway.

Surveillance in low and high risk pregnancy

For low risk mothers, third trimester growth is assessed through serial measurement of fundal height which until recently has had little standardisation in midwifery and medical training. As fundal height varies with maternal size [34], plotting on customised charts is recommended according to RCOG guidelines [19] which can predict the expected, optimal fetal growth trajectory after adjustment for each mother's parity, maternal height, maternal weight in early pregnancy and ethnic origin. Where measurements do not follow the expected curve and/or cross centile lines, protocols should prompt referral for ultrasound scan biometry to determine the estimated fetal weight, which is plotted on the same chart adjusted for maternal and pregnancy characteristics. An estimated fetal weight which is small-for-gestational age on a customised chart, or repeated measurements which show slow growth, are indication for obstetric review and further investigations [19 20], to be managed according to individual circumstances and evidence based guidelines [19].

For mothers at increased risk of intrauterine growth restriction because of past obstetric history or other risk factors, or where fundal height measurement is difficult e.g. due to a maternal body mass index of 35 or more, serial third trimester scans are indicated [19 20 21]. The current weak link in the referral chain is the chronic shortage of sonographers and ultrasound services in the NHS, which can manifest in several ways: referral on the basis of fundal height measurement may be unduly delayed or ignored; or the scan may be refused because of the frequently heard claim that ultrasound biometry at term has less accuracy – a claim which is in fact not supported by evidence [35]. Case note audits have furthermore shown that most pregnancies with an indication for serial ultrasound scans receive only one scan in the third trimester, [13] resulting in detection rates no better than that obtained in pregnancies which receive no scan at all. Recent evidence suggests that antenatal detection in increased risk pregnancies can be improved with a policy of 4 three weekly scans in the third trimester, up to and including term [36]. Enhanced ultrasound scan policies can be cost neutral when accompanied by implementation of customised charts, as their use for plotting fundal height measurement [15] and estimated fetal weight [18] will reduce false positive diagnoses of 'small for gestational age' and referrals for unnecessary investigations.

As Table 2 shows, crude baseline stillbirth rates vary considerably between regions; they are likely to be related to characteristics of the population including social factors, ethnic mix, and differences in congenital anomaly rates. Our analysis does not seek to compare rates in different regions, but assess year on year trends

and relative change. Two of the three regions with high uptake in GROW training had above average stillbirth rates at the beginning of the study period. As Figures 2 and 3 demonstrate, the drop in stillbirths in these regions has contributed to a reduction in regional inequalities.

Strengths and Limitations

The regional analysis helps to reduce random variation due to small numbers at unit or Trust level and allows trends to become apparent. A possible weakness of our study is that only crude ONS figures were available, without subcategories of stillbirths to identify where the improvements occurred. However previous analysis of the more detailed West Midlands database has shown that the downward trend in regional stillbirth rates, already evident in 2011, could be pinpointed to fewer deaths associated with intrauterine growth restriction, while there was no change in any of the other main stillbirth categories [37].

Another potential criticism of our study is that confounders could have been responsible for the findings. However we are not aware of any other recent or current major initiatives which could have accounted for the reduction in stillbirths over this period, either nationally or in the regions with the observed downward trends.

Our study was observational and looked at the effect of voluntary engagement in a training and protocol programme. While a randomised trial design is usually considered the gold standard, it is not likely to be practical in this field, neither in terms of the power and sample size required when assessing effects on relatively rare outcomes, nor in the equipoise needed for withholding training and implementation of already established, evidence based guidelines.

An examination of the nine criteria by Sir Austin Bradford Hill [38] to establish causality demonstrates that each criterion is fulfilled (Table 4), including that of temporality emphasised by Rothman [39]. While Hill acknowledged that neither of his criteria represent indisputable evidence for or against a cause and effect hypothesis, they do help to determine '….whether there is any other answer equally, or more likely than cause and effect' [38]. The evidence here suggests that the association between the intervention (accreditation training and implementation of evidence based protocols) and outcome (reduction in stillbirth rates) may indeed be causal.

Regional programmes

The argument that this relationship is likely to be causal is strengthened further when examining associations between stillbirth trends and time and effort. In the North East, GROW accreditation training was adopted between 2008-2011 by the majority of Trusts, and was facilitated by the preceding strong promotion of the 2002 RCOG guidelines [19] by the region's lead unit in Newcastle. The 3 year moving average graph (Fig 3)

shows a gradual drop accentuated in the last triennium, with the 2012 stillbirth rate (3.91/1000) being the lowest recorded for the region (Table 2).

In Yorkshire and The Humber, all units participated in 2011 in a 'train the trainer' programme and developed a regional 'best practice' competency document based on the Perinatal Institute's protocols and training tools, which were administered through midwifery supervision. The ensuing year, 2012, saw a drop in stillbirth rates to 5.00/1000 (Fig 1), the lowest recorded for the region to date.

In the West Midlands, the introduction of the GROW accreditation programme in 2008 was complemented by regionally agreed protocols for scanning high risk pregnancies and were from 2008-2011 supported by augmented ultrasound resources in Birmingham, Stoke on Trent and several other areas. In addition, a data collection programme reported quarterly on antenatal detection rates of small for gestational age birthweight as a regionally agreed key performance indicator. The Region's stillbirth rates dropped year on year, with the 2011 rate falling for the first time in 50 years to below the national average [37]. This fall continued in 2012 to 4.47/1000 (Table 2), which is 1.26/1000 or 22% below the preceding (2000-2007) ONS regional average of 5.73/1000, and equivalent to 92 fewer West Midlands deaths. A similar rate reduction applied to the more than 800,000 annual deliveries in the UK would result in over 1000 fewer stillbirths each year.

International perspectives

While this analysis focuses on English regions and Wales, stillbirths are a global problem, with the overwhelming majority occurring in low and middle income countries[40]. Global trends in stillbirth rate reduction lag behind the progress in reducing maternal mortality and deaths in children under 5 years [40]. Prevention will need to consider fundamental local needs, including provision and access to basic maternal and child health services and intrapartum and emergency care. However while these challenges are of a different order of magnitude, fetal growth restriction is also a universal concern, and the obstacles to improvement are in principle not dissimilar to those encountered here: insufficient awareness of the importance of fetal growth, lack of protocols, staff and equipment, and the use of inappropriate growth standards, often imported from high income countries. Recent work has started to address the need for international standards which are also individually customisable, or at least adjustable to the average characteristics of the local population [41 42 43]. It is hoped that mounting awareness in high income settings of the avoidability of many stillbirths will also help to enhance global prevention strategies.

Implications for the health service

Each stillbirth is a tragic loss which causes untold grief and distress to the mother, father and extended family. In addition, stillbirths represent a high cost to the health service and society as a whole. Bereaved parents

require intensive social and psychological support. Each mature, normally formed stillborn child represents the largest possible loss to society, in terms of lost potential; conversely, prevention of stillbirths, although not yet measured in those terms, would likely to represent the maximum possible gain in 'quality adjusted life years' (QALYs) [44].

Our findings suggest that many stillbirths are not only avoidable, but have in fact been avoided, in Trusts which adopted standardised training and evidence based protocols for identification and management of fetuses at risk due to fetal growth restriction. We suggest that commissioners and providers give high priority to ensuring that implementation of such a programme becomes an integral requirement for safe antenatal care, and is monitored by antenatal detection rates of fetal growth restriction as a key indicator of service the quality of the service.

Word count 3092

What is already known on this topic

- Stillbirths are the largest contributor to perinatal mortality
- The largest proportion stillbirths are fetuses that are growth restricted due to placental disease
- Antenatal recognition of growth delay and timely delivery can reduce stillbirth rates

What this paper adds

- A co-ordinated growth assessment programme had a high uptake in three regions in England
- These areas together achieved significant drops in stillbirth, while rates remained static in the rest of the country.
- Improvements in these three regions, which together care for less than a quarter of pregnancies in England and Wales, resulted in a significant downward trend in national stillbirth rates.

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Association between reduced stillbirth rates in England and Wales and regional uptake of accreditation training in customised fetal growth assessment

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ABSTRACT

Objective: To assess the effect that accreditation training in fetal growth surveillance and evidence based protocols had on stillbirth rates in England and Wales.

Design: Analysis of mortality data from Office of National Statistics.

Setting: England and Wales, including three NHS regions (West Midlands, North East and Yorkshire & Humber) which between 2008 to 2011 implemented training programmes in customised fetal growth assessment.

Population: Live births and stillbirths in England and Wales between 2007 and 2012.

Main outcome measure: Stillbirth

Results: There was a significant downward trend (p=0.03) in stillbirth rates between 2007–2012 in England to 4.81/1000, the lowest rate recorded since adoption of the current stillbirth definition in 1992. This drop was due to downward trends in each of the three English regions with high uptake of accreditation training, and led in turn to the lowest stillbirth rates on record in each of these regions. In contrast, there was no significant change in stillbirth rates in the remaining English regions and Wales, where uptake of training had been low. The three regions responsible for the record drop in national stillbirth rates made up less than a quarter (24.7%) of all births in England. The fall in stillbirth rate was most pronounced in the West Midlands, which had the most intensive training programme, from the preceding average baseline of 5.73/1000 in 2000-2007 to 4.47/1000 in 2012, a 22% drop which is equivalent to 92 fewer deaths a year. Extrapolated to the whole of the UK, this would amount to over 1000 fewer stillbirths each year.

Conclusion: A training and accreditation programme in customised fetal growth assessment with evidence-based protocols was associated with a reduction in stillbirths in high uptake areas, which resulted in a national drop in stillbirth rates to their lowest level in 20 years.

SUMMARY

Article Focus

- Stillbirth rates in England and Wales have remained the same for the last 20 years and are the highest in Western Europe.
- Most potentially avoidable stillbirths are associated with antenatally unrecognised fetal growth restriction.
- We wanted to assess the effect that a comprehensive training programme in fetal growth assessment, including use of customised growth charts and evidence based protocols, had on stillbirth rates.

Key Messages

- The three regions with high uptake of the programme had a drop in stillbirth rates while rates have remained the same in regions with a low uptake.
- Although they covered less than a quarter of all maternities in England, the improvement in the high uptake areas resulted in a significant reduction in national stillbirth rates
- National roll out and implementation of the programme has the potential to reduce stillbirths by over 1000 each year

Strengths and Limitations.

- Analysis of national ONS data helped to avoid random variation due to small numbers at unit or Trust level and allowed trends to become apparent.
- Only crude figures were available but previous regional analysis was able to pinpoint the downward trend in regional stillbirth rates as due to fewer deaths with intrauterine growth restriction.
- The study was observational but there have been no other recent initiatives which could have accounted for the reduction in stillbirths over this period, either nationally or in the regions with observed downward trends.

INTRODUCTION

Stillbirth rates in England and Wales have seen little change in the last 20 years and are the highest in Western Europe[1]. Reduction of stillbirths is a government target [2] yet a 2012 survey conducted by The Times suggested that most NHS Trusts which run maternity units in England have no specific plans in place to reduce stillbirth rates [3].

Until recently, two-thirds of stillbirths were categorised as unexplained [4] and tended, by implication, to be considered unavoidable [5]. However our understanding has improved with the application of better classification systems and customised birthweight centiles, which identified that most such 'unexplained' stillbirths had preceding intrauterine growth restriction associated with placental pathology [6 7 8]. A 2007 confidential enquiry peer review of case notes of normally formed stillbirths with fetal growth restriction found that 84% had substandard care and were potentially avoidable with better recognition and assessment of intrauterine growth. [9] This finding is supported by a recent analysis of the West Midlands maternity database which reported that growth restriction was not only the single strongest risk factor for stillbirth, but that antenatal recognition and timely delivery can lead to significant reduction in risk [10].

However antenatal detection of fetal growth problems has been traditionally poor in the NHS, with published reports of detection rates ranging from 15-24% [11 12], and 18% in a 2006 baseline audit in Birmingham [13]. Therefore a major focus of the West Midlands Perinatal Institute's stillbirth prevention strategy since 2008/9, supported by the Strategic Health Authority and the region's Primary Care Trusts, has been to improve the antenatal recognition of growth restriction in low and high risk pregnancies. The programme was underpinned by customised charts which are adjustable for various maternal characteristics and predict the optimal fetal growth curve for each pregnancy ('Gestation Related Optimal Weight', GROW [14]). The charts are used for serial plotting of fundal height and estimated fetal weight measurements, and have been shown to result in increased antenatal detection of growth problems [15 16 17]. They also lead to fewer false positive assessments and unnecessary ultrasound referrals [15 18], thus being reassuring for the mother as well as diverting scarce resources towards higher risk pregnancies, where serial ultrasound measurements are indicated to monitor fetal growth [19].

Training was instituted from 2008 through a series of bespoke accreditation workshops with hands-on teaching and assessment, and the promotion of evidence based protocols and best practice guidelines [19 20 21]. The workshops were offered as a free rolling programme to Trusts in the West Midlands, and were also held on invitation in interested Trusts in other regions.

We wanted to assess the effect that this training programme had on stillbirth rates, using the latest release of national statistics for English regions and Wales [22].

METHODS

Training

Accreditation training in customised growth assessment and protocols was conducted in 2.5 hour workshops and covered:

- rationale of fetal growth assessment;
- national and regional guidelines
- use of the GROW software including data entry and print out of chart
- training in standardised fundal height measurement and serial plotting
- definition of normal, slow, static and accelerated growth
- referral pathways for further investigation by ultrasound and Doppler
- risk assessment and protocols for serial scans in high risk pregnancy
- evaluation through a test with MCQs and short answers including scenarios.

Fortnightly accreditation workshops were commenced in 2008 at the West Midlands Perinatal Institute in Birmingham and were attended by midwives and midwife trainers as well as ultrasonographers and junior and senior obstetricians. The training was also available to staff from Trusts in other regions, through central or locally arranged workshops. Trusts which had accreditation workshops during 2012 were not considered trained in this analysis of pregnancies which delivered up to 2012.

Data analysis

Live births and stillbirths were derived from the Office of National Statistics (ONS) mortality statistics release for 2012 [22] and previous releases from 2007 onwards [23]. All data were fully anonymised and included stillbirths from 24 weeks gestation. Stillbirth rates were presented for single years as well as three year moving averages to smooth out short term fluctuations and highlight longer term trends. Trend analysis was undertaken using standard chi-square trend test with one degree of freedom. Least-squares linear regression was used to obtain the slopes for the stillbirth rates of each region.

RESULTS

Uptake of training

Eighteen of the 19 maternity units in the West Midlands implemented the GROW software and training programme, and the fortnightly workshops resulted in over 2000 staff being trained between 2008 and 2011. In the whole of England and Wales, staff in 49 of the 148 Trusts (33%) received accreditation training, resulting in 32% of all pregnancies during this period being cared for in units with trained staff (Table 1). However there was wide variation in uptake. In three regions (North East, Yorkshire and The Humber and West Midlands), on average 89.6% of pregnancies (range 58 – 100%) were cared for in units which had GROW training, while this average was 14.8% (range 0 - 24%) for the rest of England and Wales (Table 1).

Stillbirth rates and trends

Table 2 lists births, stillbirths and stillbirth rates from 2007 to 2012 for English regions and Wales together with trend analysis. There was a significant fall in stillbirth rates over this period in England ($p<0.03$) but not in Wales ($p=0.7$). Amongst English regions, only the West Midlands had a significant downward trend ($p<0.01$) and if this region is excluded, the drop in England becomes non-significant. The two other regions which were high GROW accreditation areas, North East and Yorkshire and The Humber, each showed downward trends in stillbirth rates which, when taken together, also reached statistical significance ($p<0.03$). These three regions were the only ones which achieved a negative (downward) slope of -0.10 or lower (West Midlands: -0.20; North East: -0.15; Yorkshire & Humber: -0.11; Table 2). The training uptake rates in the regions were significantly correlated with negative slopes of stillbirth trends (Table 2): $R= 0.77$, $p<0.01$ (Figure 1). The year-on-year stillbirth rate for the three high uptake regions is compared graphically with the remaining, low uptake regions in Figure 2.

Three year moving average analysis

In Table 3 and Figures 3 and 4, three year moving average stillbirth rates are listed for high and low uptake regions of the accreditation programme. Each of the high uptake regions displayed a downward trend (Figure 3), while stillbirth rates in the other regions and Wales remained stagnant (Figure 4). The moving average rates in high and low uptake regions are compared in Figure 5, demonstrating that the drop in stillbirths in England and Wales was achieved by the three regions with high uptake of GROW training.

DISCUSSION

This is to our knowledge the first analysis of national and regional stillbirth trends and their association with a training and accreditation programme. It indicates that stillbirth rates have dropped in regions with high levels of training (West Midlands, North East, Yorkshire and The Humber), while they stagnated in regions with low uptake. The downward trends in these three regions resulted in a drop in the national stillbirth rate to its lowest level (since the current ONS stillbirth definitions were introduced in 1992) even though together these regions account for less than a quarter of births in England (172,429 / 697,598 = 24.7%; Table 1).

Significance of fetal growth

The focus on intra-uterine growth in stillbirth prevention is justified as intrauterine growth restriction, defined as birthweight below the 10th customised centile, constitutes the largest single category of the stillbirth classification by relevant conditions at death, comprising over 50% of normally formed stillbirths [6]. In addition, stillbirths are only one of a range of adverse pregnancy outcomes known to follow intrauterine growth restriction, which also include perinatal morbidity [24 25], mortality [26] and cerebral palsy [27]. Most pregnancies with fetal growth restriction are due to late onset placental pathology and are born at term [10 28]. Case note peer review has established that the majority of deaths with fetal growth problems are potentially avoidable, through better assessment of risk factors and surveillance of growth during pregnancy. [9] Antenatal recognition of growth restriction leads to appropriate investigations and improved outcome [29 30 31]. It halves the stillbirth risk while resulting in babies being delivered on average only 10 days earlier at term, at 270 vs 280 days gestation.[10]

Antenatal detection

An ongoing problem in maternity care has been the lack of antenatal recognition of fetal growth problems, which precludes further investigations to determine the optimal time for delivery of the fetus from an unfavourable intrauterine environment. While no national data are available, we know from controlled studies that antenatal detection improves significantly with implementation of customised charts, training and protocols [15]. West Midlands audits have shown that improved antenatal recognition is directly linked with uptake of training: in the one unit in the region which did not implement the recommended training and protocol, antenatal detection remained at 12%, while units which adopted the protocols and ensured staff were trained achieved detection rates up to 50% within 12 months of implementation [32]. Once a mother carrying a suspected growth restricted baby was referred according to protocol for an ultrasound scan on the basis of fundal height measurement plotted on customised charts, antenatal detection rate averaged 62% and could be as high as 85% [33].

Fetal growth surveillance in the UK is a multidisciplinary task and requires collaboration between community and hospital midwives, general practitioner, ultrasonographer and obstetrician or maternal fetal medicine specialist. Care usually starts with the community midwife, who within the NHS is usually the first to see the expectant mother. Her assessment of whether the woman is low or high risk will initiate the relevant care pathway.

Surveillance in low and high risk pregnancy

For low risk mothers, third trimester growth is assessed through serial measurement of fundal height which until recently has had little standardisation in midwifery and medical training. As fundal height varies with maternal size [34], plotting on customised charts is recommended according to RCOG guidelines [19] which can predict the expected, optimal fetal growth trajectory after adjustment for each mother's parity, maternal height, maternal weight in early pregnancy and ethnic origin. Where measurements do not follow the expected curve and/or cross centile lines, protocols should prompt referral for ultrasound scan biometry to determine the estimated fetal weight, which is plotted on the same chart adjusted for maternal and pregnancy characteristics. An estimated fetal weight which is small-for-gestational age on a customised chart, or repeated measurements which show slow growth, are indication for obstetric review and further investigations [19 20] , to be managed according to individual circumstances and evidence based guidelines [19] .

For mothers at increased risk of intrauterine growth restriction because of past obstetric history or other risk factors, or where fundal height measurement is difficult e.g. due to a maternal body mass index of 35 or more, serial third trimester scans are indicated [19 20 21]. The current weak link in the referral chain is the chronic shortage of sonographers and ultrasound services in the NHS, which can manifest in several ways: referral on the basis of fundal height measurement may be unduly delayed or ignored; or the scan may be refused because of the frequently heard claim that ultrasound biometry at term has less accuracy – a claim which is in fact not supported by evidence [35]. Case note audits have furthermore shown that most pregnancies with an indication for serial ultrasound scans receive only one scan in the third trimester, [13] resulting in detection rates no better than that obtained in pregnancies which receive no scan at all. Recent evidence suggests that antenatal detection in increased risk pregnancies can be improved with a policy of 4 three weekly scans in the third trimester, up to and including term [36]. Enhanced ultrasound scan policies can be cost neutral when accompanied by implementation of customised charts, as their use for plotting fundal height measurement [15] and estimated fetal weight [18] will reduce false positive diagnoses of 'small for gestational age' and referrals for unnecessary investigations.

As Table 2 shows, crude baseline stillbirth rates vary considerably between regions; they are likely to be related to characteristics of the population including social factors, ethnic mix, and differences in congenital anomaly rates. Our analysis does not seek to compare rates in different regions, but assess year on year trends

and relative change. Two of the three regions with high uptake in GROW training had above average stillbirth rates at the beginning of the study period. As Figures 2 and 3 demonstrate, the drop in stillbirths in these regions has contributed to a reduction in regional inequalities.

Strengths and Limitations

The regional analysis helps to reduce random variation due to small numbers at unit or Trust level and allows trends to become apparent. A possible weakness of our study is that only crude ONS figures were available, without subcategories of stillbirths to identify where the improvements occurred. However previous analysis of the more detailed West Midlands database has shown that the downward trend in regional stillbirth rates, already evident in 2011, could be pinpointed to fewer deaths associated with intrauterine growth restriction, while there was no change in any of the other main stillbirth categories [37].

Another potential criticism of our study is that confounders could have been responsible for the findings. However we are not aware of any other recent or current major initiatives which could have accounted for the reduction in stillbirths over this period, either nationally or in the regions with the observed downward trends.

Our study was observational and looked at the effect of voluntary engagement in a training and protocol programme. While a randomised trial design is usually considered the gold standard, it is not likely to be practical in this field, neither in terms of the power and sample size required when assessing effects on relatively rare outcomes, nor in the equipoise needed for withholding training and implementation of already established, evidence based guidelines.

An examination of the nine criteria by Sir Austin Bradford Hill [38] to establish causality demonstrates that each criterion is fulfilled (Table 4), including that of temporality emphasised by Rothman [39]. While Hill acknowledged that neither of his criteria represent indisputable evidence for or against a cause and effect hypothesis, they do help to determine '….whether there is any other answer equally, or more likely than cause and effect' [38]. The evidence here suggests that the association between the intervention (accreditation training and implementation of evidence based protocols) and outcome (reduction in stillbirth rates) may indeed be causal.

Regional programmes

The argument that this relationship is likely to be causal is strengthened further when examining associations between stillbirth trends and time and effort. In the North East, GROW accreditation training was adopted between 2008-2011 by the majority of Trusts, and was facilitated by the preceding strong promotion of the 2002 RCOG guidelines [19] by the region's lead unit in Newcastle. The 3 year moving average graph (Fig 3)

shows a gradual drop accentuated in the last triennium, with the 2012 stillbirth rate (3.91/1000) being the lowest recorded for the region (Table 2).

In Yorkshire and The Humber, all units participated in 2011 in a 'train the trainer' programme and developed a regional 'best practice' competency document based on the Perinatal Institute's protocols and training tools, which were administered through midwifery supervision. The ensuing year, 2012, saw a drop in stillbirth rates to 5.00/1000 (Fig 1), the lowest recorded for the region to date.

In the West Midlands, the introduction of the GROW accreditation programme in 2008 was complemented by regionally agreed protocols for scanning high risk pregnancies and were from 2008-2011 supported by augmented ultrasound resources in Birmingham, Stoke on Trent and several other areas. In addition, a data collection programme reported quarterly on antenatal detection rates of small for gestational age birthweight as a regionally agreed key performance indicator. The Region's stillbirth rates dropped year on year, with the 2011 rate falling for the first time in 50 years to below the national average [37]. This fall continued in 2012 to 4.47/1000 (Table 2), which is 1.26/1000 or 22% below the preceding (2000-2007) ONS regional average of 5.73/1000, and equivalent to 92 fewer West Midlands deaths. A similar rate reduction applied to the more than 800,000 annual deliveries in the UK would result in over 1000 fewer stillbirths each year.

International perspectives

While this analysis focuses on English regions and Wales, stillbirths are a global problem, with the overwhelming majority occurring in low and middle income countries[40]. Global trends in stillbirth rate reduction lag behind the progress in reducing maternal mortality and deaths in children under 5 years [40]. Prevention will need to consider fundamental local needs, including provision and access to basic maternal and child health services and intrapartum and emergency care. However while these challenges are of a different order of magnitude, fetal growth restriction is also a universal concern, and the obstacles to improvement are in principle not dissimilar to those encountered here: insufficient awareness of the importance of fetal growth, lack of protocols, staff and equipment, and the use of inappropriate growth standards, often imported from high income countries. Recent work has started to address the need for international standards which are also individually customisable, or at least adjustable to the average characteristics of the local population [41 42 43]. It is hoped that mounting awareness in high income settings of the avoidability of many stillbirths will also help to enhance global prevention strategies.

Implications for the health service

Each stillbirth is a tragic loss which causes untold grief and distress to the mother, father and extended family. In addition, stillbirths represent a high cost to the health service and society as a whole. Bereaved parents

require intensive social and psychological support. Each mature, normally formed stillborn child represents the largest possible loss to society, in terms of lost potential; conversely, prevention of stillbirths, although not yet measured in those terms, would likely to represent the maximum possible gain in 'quality adjusted life years' (QALYs) [44].

Our findings suggest that many stillbirths are not only avoidable, but have in fact been avoided, in Trusts which adopted standardised training and evidence based protocols for identification and management of fetuses at risk due to fetal growth restriction. We suggest that commissioners and providers give high priority to ensuring that implementation of such a programme becomes an integral requirement for safe antenatal care, and is monitored by antenatal detection rates of fetal growth restriction as a key indicator of service the quality of the service.

Word count 3092

What is already known on this topic

- Stillbirths are the largest contributor to perinatal mortality
- The largest proportion stillbirths are fetuses that are growth restricted due to placental disease
- Antenatal recognition of growth delay and timely delivery can reduce stillbirth rates

What this paper adds

- A co-ordinated growth assessment programme had a high uptake in three regions in England
- These areas together achieved significant drops in stillbirth, while rates remained static in the rest of the country.
- Improvements in these three regions, which together care for less than a quarter of pregnancies in England and Wales, resulted in a significant downward trend in national stillbirth rates.

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Table 1. GROW accreditation and protocol training programme - uptake in Trusts in England and Wales, 2008-2011

	Births in 2012 (ONS)	Number of Trusts	Number (%) of trained Trusts * N	%	Hospital Trusts in Region with accreditation training *	Total births in trained Trusts (% of all births in Region) N	%
ENGLAND AND WALES	733,232	148	49	33.1		237,544	32.4
WALES	35,419	7	0	0.0		0	0.0
ENGLAND	697,598	141	49	34.8		237,544	34.1
North East	30,410	8	5	62.5	Newcastle; Gateshead; North Tees & Hartlepool; Sunderland; South Tyneside	17,723	**57.6**
North West	89,677	21	6	28.6	Bolton; East Lancahire; Southport & Ormskirk; Tameside; Warrington; Wrighton, Wigan & Leigh	21,300	23.8
Yorkshire and the Humber	67,747	12	12	100.0	Airedale; Barnsley; Bradford; Calderdale & Huddersfield ; Doncaster & Bassetlaw; Harrogate ; Hull & East Yorkshire; Leeds; Mid Yorkshire; Rotherham; Sheffield; York;	67,747	**100.0**
East Midlands	55,923	9	2	22.2	Kettering; Northampton	8,797	15.7
West Midlands	74,272	15	14	93.3	Birmingham Women's; Burton; Dudley; George Eliot; Heart of England; Royal Shrewsbury & Telford; Sandwell & West B'ham; South Warwickshire; North Staffordshire; Coventry & Warwickshire; Walsall; Worcester; Wye Valley	68,991	**92.9**
East of England	74,884	17	1	5.9	Hinchingbrooke	2,541	3.4
London	134,941	22	3	13.6	Barts Health; Ealing; Lewisham	22,856	16.9
South East	54,128	11	1	9.1	East Kent	7,552	14.0
South Central	54,216	8	2	25.0	Hampshire; Portsmouth	12,197	22.5
South West	61,400	18	3	16.7	Northern Devon; Royal Devon & Exeter; South Devon	7,840	12.8
High uptake Regions **	172,429	35	31	88.6		154,461	**89.6**
Low uptake (rest of Regions and Wales)	560,588	113	18	15.9		83,083	**14.8**

* since introduction in 2008, to 2011
** North East, Yorkshire & Humber, West Midlands

Table 2 Total births, stillbirths and stillbirth (SB) rate in England, English regions and Wales 2007-2012. Source: ONS [22 23]
Slope by linear regression; p values for trend test.

	2007			2008			2009			2010			2011			2012			2007-2012	
	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Slope	Trend test (p)
ENGLAND AND WALES	693,611	3,598	**5.19**	712,328	3,617	**5.08**	689,591	3,644	**5.28**	726,879	3,714	**5.11**	727,724	3,811	**5.24**	733,232	3,558	**4.85**	-0.04	**0.05**
ENGLAND	658,771	3,414	**5.18**	676,236	3,427	**5.07**	656,880	3,475	**5.29**	690,513	3,506	**5.08**	691,739	3,619	**5.23**	697,598	3,357	**4.81**	-0.06	**0.03**
North East	29,728	146	**4.91**	30,396	179	**5.89**	29,991	142	**4.73**	30,969	143	**4.62**	30,705	178	**5.80**	30,410	119	**3.91**	-0.15	0.1
North West	86,423	476	**5.51**	88,617	450	**5.08**	87,492	469	**5.36**	89,665	466	**5.20**	89,235	483	**5.41**	89,677	466	**5.20**	-0.02	0.7
Yorkshire & Humber	64,567	376	**5.82**	66,724	371	**5.56**	65,559	372	**5.67**	67,343	373	**5.54**	66,831	380	**5.69**	67,747	339	**5.00**	-0.11	0.1
East Midlands	52,716	234	**4.44**	54,447	255	**4.68**	47,741	270	**5.66**	55,525	293	**5.28**	55,662	284	**5.10**	55,923	278	**4.97**	0.10	0.2
West Midlands	70,477	379	**5.38**	72,129	403	**5.59**	71,399	420	**5.88**	72,472	382	**5.27**	73,391	368	**5.01**	74,272	332	**4.47**	-0.20	**<0.01**
East of England	69,619	308	**4.42**	72,042	304	**4.22**	67,638	325	**4.80**	73,346	345	**4.70**	73,565	345	**4.69**	74,884	313	**4.18**	0.00	1.0
London	126,286	781	**6.18**	128,381	730	**5.69**	129,980	719	**5.53**	133,853	742	**5.54**	133,604	761	**5.70**	134,941	755	**5.60**	-0.08	0.1
South East Coast	50,692	239	**4.71**	51,800	235	**4.54**	53,297	240	**4.50**	53,049	256	**4.83**	53,418	257	**4.81**	54,128	227	**4.19**	-0.04	0.6
South Central	51,021	236	**4.63**	52,694	236	**4.48**	46,923	245	**5.22**	53,892	251	**4.66**	54,246	275	**5.07**	54,216	259	**4.78**	0.06	0.4
South West	57,242	239	**4.18**	59,006	264	**4.47**	56,860	273	**4.80**	60,399	255	**4.22**	61,082	288	**4.71**	61,400	269	**4.38**	0.03	0.6
WALES	34,585	171	**4.94**	35,815	165	**4.61**	32,711	169	**5.17**	36,142	190	**5.26**	35,765	167	**4.67**	35,419	181	**5.11**	0.03	0.7

Table 3: Three year moving average of total births, stillbirths and stillbirth rates, England, English regions and Wales, 2007-2012, according to high or low uptake of GROW training, 2007-2012.

	2007-9			2008-10			2009-11			2010-12		
	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate	Total Births	Stillbirths	SB rate
ENGLAND AND WALES	2,095,530	10,859	**5.18**	2,128,798	10,975	**5.16**	2,144,194	11,169	**5.21**	2,187,835	11,083	**5.07**
High uptake	500,970	2,788	**5.57**	506,982	2,785	**5.49**	508,660	2,758	**5.42**	514,140	2,614	**5.08**
North East	90,115	467	**5.18**	91,356	464	**5.08**	91,665	463	**5.05**	92,084	440	**4.78**
Yorkshire & Humber	196,850	1,119	**5.68**	199,626	1,116	**5.59**	199,733	1,125	**5.63**	201,921	1,092	**5.41**
West Midlands	214,005	1,202	**5.62**	216,000	1,205	**5.58**	217,262	1,170	**5.39**	220,135	1,082	**4.92**
Low uptake	1,594,028	8,033	**5.04**	1,621,315	8,147	**5.02**	1,635,090	8,368	**5.12**	1,673,036	8,406	**5.02**
North West	262,532	1,395	**5.31**	265,774	1,385	**5.21**	266,392	1,418	**5.32**	268,577	1,415	**5.27**
East Midlands	154,904	759	**4.90**	157,713	818	**5.19**	158,928	847	**5.33**	167,110	855	**5.12**
East of England	209,299	937	**4.48**	213,026	974	**4.57**	214,549	1,015	**4.73**	221,795	1,003	**4.52**
London	384,647	2,230	**5.80**	392,214	2,191	**5.59**	397,437	2,222	**5.59**	402,398	2,258	**5.61**
South East Coast	155,789	714	**4.58**	158,146	731	**4.62**	159,764	753	**4.71**	160,595	740	**4.61**
South Central	150,638	717	**4.76**	153,509	732	**4.77**	155,061	771	**4.97**	162,354	785	**4.84**
South West	173,108	776	**4.48**	176,265	792	**4.49**	178,341	816	**4.58**	182,881	812	**4.44**
Wales	103,111	505	**4.90**	104,668	524	**5.01**	104,618	526	**5.03**	107,326	538	**5.01**

Table 4. Examination of association according to Sir Austin Bradford Hill's nine causality criteria [38]

Criterion for Causality	Findings and associated characteristics of current study
Strength of association	Significant downward trend in stillbirth rates which had remained static for the last 20 years. Each of the high uptake regions dropped to their lowest ever rates (Table 2).
Temporality	Reduced stillbirth rates followed implementation of accreditation training and protocol. Yorkshire & Humber drop in 2012 followed training initiative in 2011
Consistency	Reduction in stillbirths shown in the three regions with high uptake (Fig 3), and not in the regions with low uptake (Fig 4). See also significant correlation in Fig 1.
Plausibility	Confidential case reviews have shown that unrecognised fetal growth restriction was the most common cause of stillbirth [9]. Population based study has shown that IUGR is the strongest risk factor for stillbirth, and its antenatal recognition reduces risk [10]
Dose response	The region with the most intensive training programme (West Midlands) had the steepest drop and downward trend in stillbirth rates (Fig 3).
Experimental evidence	Antenatal recognition of intrauterine growth restriction results in earlier delivery [10] and reduces stillbirth risk [10 30 31]
Coherence	Improved recognition allows the implementation of appropriate investigations [15 29] and timely delivery [10]
Specificity	The regions which demonstrated reduction in stillbirth rates during the period of investigation had high uptake in training and protocols, but no other known interventions which applied selectively to them and no other regions.
Analogy	Growth restriction associated with placental failure has been shown to lead to fetal death in various animal models

STROBE Statement—checklist of items that should be included in reports of observational studies

Items 1-22 in checklist complied with in the manuscript, as appropriate for this cohort analysis of published ONS data

	Item No	Recommendation
Title and abstract	1 ✓	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2 ✓	Explain the scientific background and rationale for the investigation being reported
Objectives	3 ✓	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4 ✓	Present key elements of study design early in the paper
Setting	5 ✓	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6 ✓	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7 ✓	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8* ✓	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9 ✓	Describe any efforts to address potential sources of bias
Study size	10 ✓	Explain how the study size was arrived at
Quantitative variables	11 n/a	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12 ✓	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

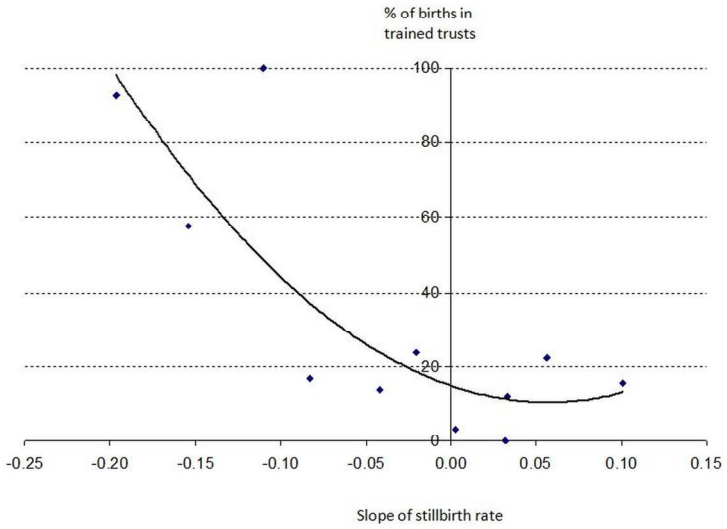
Continued on next page

Results		
Participants	13* ✓	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14* n/a	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15* ✓	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16 ✓	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18 ✓	Summarise key results with reference to study objectives
Limitations	19 ✓	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20 ✓	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21 ✓	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22 ✓	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

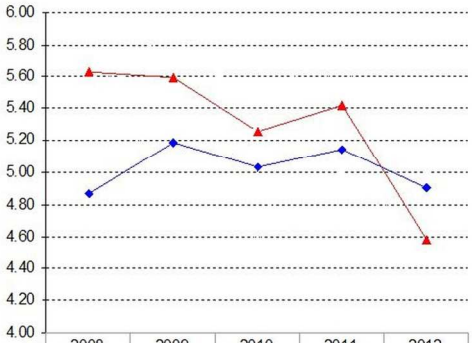
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Fig 1. Slopes of regional stillbirth rates 2007-2012 (Table 2) and proportion (%) of mothers cared for in units with training (Table 1). Regression line: R = 0.77, p<0.01



143x90mm (300 x 300 DPI)

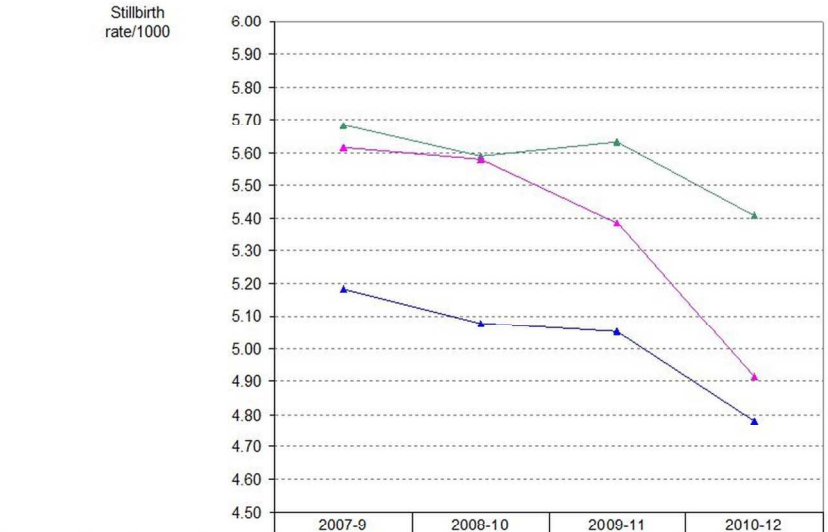
Fig 2. Yearly stillbirth rates in the three regions with high uptake of GROW training and protocols ('High Uptake') vs the rest ('Low Uptake'), 2008-2012 (see Table 1). Analysis of trend: High Uptake : p<0.01; Low Uptake: p=0.9



	2008	2009	2010	2011	2012
North East	5.89	4.73	4.62	5.80	3.91
Yorks & Humber	5.56	5.67	5.54	5.69	5.00
West Midlands	5.59	5.88	5.27	5.01	4.47
High Uptake	5.63	5.59	5.26	5.42	4.58
Low Uptake	4.86	5.19	5.03	5.14	4.90
England & Wales	5.08	5.28	5.11	5.24	4.85

134x90mm (300 x 300 DPI)

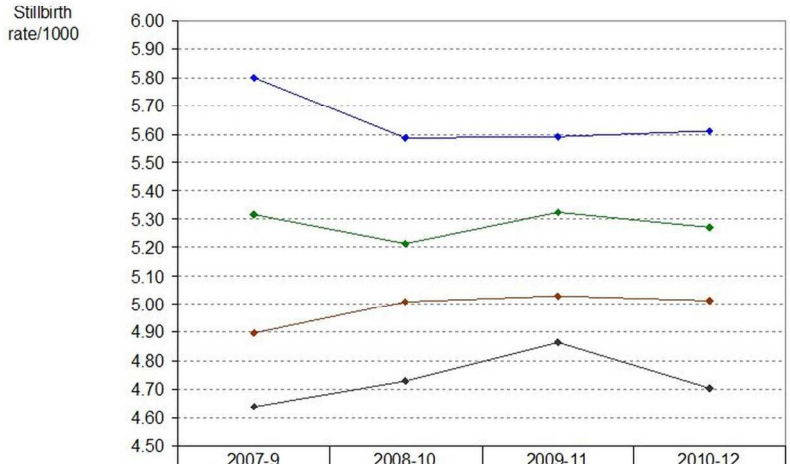
Fig 3. Stillbirth rates in Regions with high uptake of GROW training and protocols, 2007-2012 (3 year moving average)



	2007-9	2008-10	2009-11	2010-12
Yorkshire and the Humber	5.68	5.59	5.63	5.41
North East	5.18	5.08	5.05	4.78
West Midlands	5.62	5.58	5.39	4.92

128x90mm (300 x 300 DPI)

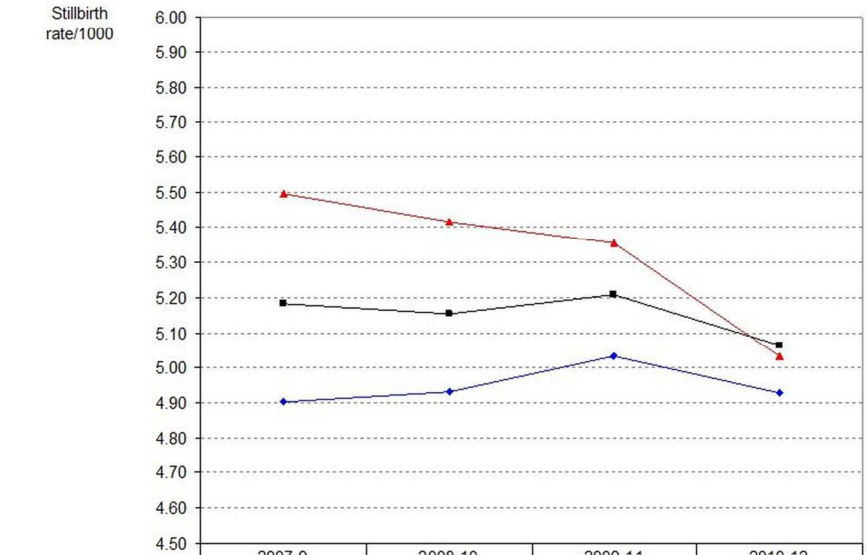
Fig 4. Stillbirth rates in Regions with low uptake of GROW training and protocols, 2007-2012 (3 year moving average)



	2007-9	2008-10	2009-11	2010-12
London	5.80	5.59	5.59	5.61
North West	5.31	5.21	5.32	5.27
Wales	4.90	5.01	5.03	5.01
Other low uptake regions	4.64	4.73	4.86	4.70

128x90mm (300 x 300 DPI)

Fig 5. Stillbirth rates in high and low uptake Regions and England and Wales, 2007-2012 (3 year moving average)



	2007-9	2008-10	2009-11	2010-12
High uptake regions	5.49	5.42	5.36	5.03
Low uptake regions	4.90	4.93	5.03	4.93
England & Wales	5.18	5.16	5.21	5.07

121x90mm (300 x 300 DPI)