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Research paper

Lessons for intermediate- and low-prevalence areas in England from the Ethnicity Questions and Antenatal Screening for sickle cell/thalassaemia (EQUANS) study

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ABSTRACT

This study evaluated a temporary research-based intervention of universal antenatal screening for sickle cell/thalassaemia in two areas of England: one of intermediate (1.29 per 10 000) and the other of low (0.18 per 10 000) expected fetal prevalence for sickle cell disease (SCD). The study also assessed the comprehensiveness of coverage in levels of laboratory tests requested for risk groups for SCD identified by an ethnicity-screening question. The design was a 10-month (September 2002 to June 2003) questionnaire study with random allocation to two ethnicity-screening questions and comparison with: (1) laboratory results; (2) numbers of laboratory screens requested; (3) numbers of laboratory screens undertaken; (4) an equivalent period before intervention; and (5) ethnic-monitoring data. Altogether 2922 pregnant women were recruited at their first booking with a midwife (of 3255 recorded as invited, from a possible 12 424 women recorded as booking). Outcomes showed that, in a move from a selective screening programme to a temporary, research-based universal screening programme, the intermediate-prevalence area increased screening coverage from 20.7% to 42.6% of the antenatal population. Carriers of sickle cell, thalassaemia and other haemoglobinopathies identified during the study period increased from 86 to 118, representing a proportional increase of 0.36% (95% confidence interval 0.01% to 0.71%, $P = 0.045$). In the low-prevalence area, with a selective screening programme, the proportion identified as at risk using specifically designed ethnicity-screening questions, as opposed to generic ethnic monitoring using locally devised categories, increased from 2.2% to 13.0% ($P < 0.001$). Only 10% of those identified as at risk by the ethnicity-screening questions were offered a laboratory

haemoglobinopathy screen. In conclusion it would appear that, in a low-prevalence area, use of evidence-based ethnicity-screening questions increases the proportion of clients identified as at risk of carrying genes associated with sickle cell or thalassaemia. In order to minimise the rates of failing to offer laboratory screening in a low-prevalence area, midwives require specific training on the screening process, and which risk groups to offer a laboratory screen.

Keywords: ethnicity, health policy, screening, sickle cell, thalassaemia

Introduction

Sickle cell disease (SCD) and the thalassaemias are inherited haemoglobin disorders considered to be of increasing public health importance in most countries with multi-ethnic populations, including the UK (World Health Organization, 1988, 1994). Before recent National Screening Committee initiatives were introduced in England, antenatal screening for sickle cell and thalassaemia was beset with problems of inconsistent local screening and counselling policies (Atkin and Ahmad, 1998; Bain and Chapman, 1998), difficulties in interagency collaboration and lack of health worker knowledge about the haemoglobinopathies (Atkin *et al*, 1998). In the current context, antenatal screening programmes for carrier states potentially fulfil the criteria to constitute a public health service (UK National Screening Committee, 2006). For instance, antenatal screening for the haemoglobinopathies does have an attainable purpose (Lappé *et al*, 1972), being potentially able to identify and facilitate informed choices for women and couples identified as being at higher risk (NHS Sickle Cell and Thalassaemia Screening Programme, 2006). The haemoglobinopathies are well recognised and amenable to the steadily improving treatment of both infants (Gaston *et al*, 1986; Vichinsky *et al*, 1988) and adults (Anderson *et al*, 2002; Ceci *et al*, 2002; Charache *et al*, 1995; Okpala *et al*, 2002; Quinn *et al*, 2004; Rees *et al*, 2003; Smith *et al*, 1996). This is important, as it has been argued that the first stage in an ethically acceptable screening programme for the haemoglobinopathies should be the improvement in clinical services for those with sickle cell or beta-thalassaemia (World Health Organization, 1994).

The haemoglobinopathies and carrier states mainly affect people of African, Caribbean, Middle Eastern, South Asian, South East Asian and Mediterranean descent (Bain, 2001; Serjeant and Serjeant, 2001). More rarely, carriers may be found in the Northern European population (Lehman and Huntsman, 1974). Early public health guidance on screening for sickle cell suggested according priority to informing 'well-defined populations' (Lappé *et al*, 1972, p.1130). There is a strong, though gradually dissociating, relationship between ethnicity and the risk of carrying genes associated with SCD/thalassaemia (Andrews *et al*, 1994; Department of Health, 1993), and there are challenges in using a social construct such as ethnicity to define populations at risk (Dyson, 1998, 1999). Nevertheless evidence-based rates for ethnic-specific prevalence have been produced for England (Davies *et al*, 2000; Hickman *et al*, 1999). Against this background, the *NHS Plan* for England promised 'a new national linked antenatal and neonatal screening programme for haemoglobinopathy and sickle cell disease by 2004' (Department of Health, 2000).

The carrier states can reliably be identified by standard laboratory methods (British Society for Haematology, 1988); dedicated counselling services have been developed (Anionwu, 1996; Gould *et al*, 2000). One area of concern is whether screening for sickle cell and thalassaemia can meet the standard of equal access, one of the suggested criteria of an ethical screening programme (Lappé *et al*, 1972).

Given the uneven distribution of carriers in a multi-ethnic population, three main public health approaches to antenatal screening for sickle cell/thalassaemia have been identified: no policy; a universal strategy, that is to say, all pregnant women are offered laboratory screens for sickle cell/thalassaemia; and a selective or targeted strategy in which an ethnicity-screening question is administered to all women, following which those identifying themselves in a group at high risk are offered a laboratory screening test. This selective laboratory screening offers a haemoglobinopathy screen to all women with a low mean cell haemoglobin (MCH) and to all women, regardless of their MCH result, from those ethnic groups deemed at high risk of carrying genes associated with sickle cell/thalassaemia (Zeuner *et al*, 1999). Since selective programmes are more likely to fail the woman than universal programmes, it could be argued that, in order to meet the ethical criterion of equality of access for screening suggested by Lappé *et al* (1972), universal screening should be offered in all areas irrespective of prevalence (Zeuner *et al*, 1999). One-fifth of all children born with a major haemoglobinopathy in England are born in lower-prevalence areas (Modell and Anionwu, 1996). Lower-prevalence areas are more likely to operate a targeted policy, but there is a concern that all areas, including lower-prevalence areas, should have a clear policy on antenatal screening for sickle cell/thalassaemia

(Streetly, 2000). In order to operate a targeted policy, an assessment of the viability of an ethnicity question as a primary screening tool is required (Aspinall *et al*, 2003). The most cost-effective strategy for a selective screening programme is to minimise the selective failure-to-screen rates (Zeuner *et al*, 1999). Failure to screen in a selective programme could include a failure to ask an ethnicity-screening question; a failure to obtain an answer; a failure to obtain a usable answer; and a failure to conduct a laboratory screen. This paper aims to establish the extent of failure to screen in a low-prevalence area and, in moving from a selective to a temporary universal programme, in an area of intermediate prevalence, in this context an area of low prevalence with pockets of high expected fetal prevalence of SCD.

Methods

The Ethnicity Questions and Antenatal Screening for Sickle Cell/Thalassaemia (EQUANS) Study aimed to evaluate two ethnicity-screening questions in antenatal screening programmes in low, mixed and high sickle cell prevalence areas. The study took place in antenatal settings in four areas of England with contrasting expected rates of fetal prevalence for SCD (Dyson *et al*, 2006; see Box 1).

Box 1 Areas of varying expected fetal prevalence used in this study

- *Very high prevalence*: expected fetal prevalence of sickle cell disease (SCD) 29.75 per 10 000
- *High prevalence*: expected fetal prevalence of SCD 8.2 per 10 000
- *Intermediate prevalence*: expected fetal prevalence of SCD 1.29 per 10 000
- *Low prevalence*: expected fetal prevalence of SCD 0.18 per 10 000

Prior to the study, three potential questions asking about ethnic/family origins had been developed in a secondary review of evidence (Aspinall and Dyson, 2002). These questions were further developed in the field through:

1 reducing the three candidate questions to two by means of a pilot study with students and health professionals that assessed the acceptability of the questions
2 discussions, with midwifery teams administering the ethnicity-screening questions in antenatal settings, to assess the feasibility of midwives completing the research instrument, which led to a reduction in the number of questions within the research instrument
3 the addition to both questions of the same introductory paragraph, explaining the sickle cell and thalassaemia-related reason for asking the question
4 incorporating the two amended questions into a 10-page research instrument that addressed time taken; language spoken; whether interpretation was used; the ethnicity of the screening midwife; pathology laboratory results for the woman (and, if applicable, the father); and questions and a quality rating scale assessing, upon re-interview, the reliability of the ethnicity data
5 piloting of the research instrument for one month in one routine antenatal practice setting.

The two ethnicity questions were labelled ethnicity questions A and B. Ethnicity question A was a classification question similar in structure to the 2001 Census question for England and Wales (Aspinall *et al*, 2003). Ethnicity question B contained an initial question to identify those with ancestors outside the UK/Eire, and five free-text boxes to write in countries of ethnic/family origin. Across the four geographical areas, Dyson *et al* (2006) found that the category question missed fewer real carriers and that the answer given by the mother to the category-based ethnicity-screening question was also more reliable upon re-interview.

This paper reports on detailed results from the intermediate- and low-prevalence areas that took part in the study. The paper addresses the following research questions:

1 how many additional carriers were identified by universal rather than selective laboratory screening in the intermediate-prevalence area?
2 in the low-prevalence area, with a selective screening programme, how many mothers were identified as at risk using specifically designed ethnicity-screening questions compared to those identified using locally devised ethnic categories?
3 in the low-prevalence area what proportion of those identified at risk by a screening question were actually offered a laboratory screen?

Favourable ethical reviews were obtained from a multi-centre research ethics committee (MREC) and from the local research ethics committees in the intermediate- and low-prevalence areas.

Thirty-one half-day training workshops were held with 151 community midwives so that they could act as data collectors. In both areas the midwifery service was fully funded for the extra time costs of the project and for time taken in asking the ethnicity-screening question. The intermediate-prevalence area was funded to offer universal antenatal screening for sickle cell/thalassaemia for the period of the study. The monies

provided included full funding of extra costs incurred by midwifery, laboratory, counselling and GP services. The low-prevalence area continued its previous strategy of selective screening including the use of ethnicity as a marker of potential risk. In both places, laboratories used full blood counts and high performance liquid chromatography (HPLC), standard laboratory methods for haemoglobinopathy laboratory screening (British Society for Haematology, 1988).

Data were collected from clients in two stages. In the first stage a three-part questionnaire was used. This covered ethnicity information and laboratory results. In the second stage, clients were asked again to assign their ethnic/family origins so that this result could be compared with the original answer. Data were also obtained via the trusts' standard ethnic monitoring data systems, laboratory records of the numbers of antenatal screenings for haemoglobinopathies undertaken, and the numbers of carriers of significant haemoglobinopathies found. The data were entered into Microsoft Excel and analysed using SAS. *Z* tests were used to compare the proportions, and *P* values were deemed significant at the 5% level; 95% confidence intervals (CIs) are presented. Power and sample size calculations were undertaken in relation to the primary outcome measure of the overall study, namely reliability of the two ethnicity questions.

It was intended that each consenting client would be randomly assigned to one of two groups and would be asked, at the antenatal booking interview, one of the two ethnicity questions. However, after four months of the study, the majority (73%) of clients were not being invited into the study, and carriers were therefore not being offered the screening questions and/or not being offered laboratory screening (Dyson *et al*, 2007). Insufficient carriers were, therefore, even being invited to complete an ethnicity-screening question in order to make a statistical assessment of the two ethnicity-screening questions, a situation which is arguably indicative of the challenges of selective screening, at least in a research-based setting. The research design was, consequently, amended, with MREC approval, to permit the recruitment of carriers not previously recruited by the midwives at the later point of contact with the haemoglobinopathy counsellor.

Findings

Intermediate-prevalence area

During the 10-month period of the study 9282 women booked to deliver, of whom 2194 (23.6%) were recorded as being invited into the EQUANS study and 2027 (21.8%) agreed to participate (see Table 1).

A total of 2027 women were recruited to the study, and completed the EQUANS ethnicity-screening question; 1419 (70.0%) assigned themselves to low-risk groups, 534 (26.3%) to high-risk groups, with 74 (3.7%) cases of missing data.

The intermediate area comprised three maternity units. One of these units had no records of ethnic data for the periods in question. This unit covered a population recorded as 98% white English/Scottish/Welsh in the 2001 Census. If the 1262 cases for which there were no ethnic data collected by this one maternity unit are excluded, then information was missing from routine ethnic data collection in 92/8020 (1.1%) cases in the other two units.

Table 1 Comparison of level of ethnicity data capture, standard ethnic data and EQUANS ethnicity questions, intermediate-prevalence area

	Ethnic monitoring	EQUANS study		
	Antenatal population	Compared to whole antenatal population	Compared to those recorded as invited into the study	Compared to those recruited to the study
Data collected	9190	1953	1953	1953
Data missing (%)[a]	92 (1)	7329 (79.0)	241 (11.0)[c]	74 (3.7)
Data missing (%)[b]	1354 (14.6)			
Total	9282	9282	2194	2027

[a] Excludes one entire maternity unit unable to provide any ethnicity data.
[b] Includes figures from an entire maternity unit unable to provide any ethnicity data.
[c] Includes two who declined to be screened, but who completed ethnicity data.

During the study period 6802/9282 (73.3%) of the women booked for delivery were recorded by standard ethnic monitoring as 'white'. This compares to 9041 booking in the equivalent period before the study of whom 6866 (75.9%) were either 'white' [sic], 'British' [sic] or 'white: British/Irish/other/any other background' (see Box 2).

Box 2 Ethnic monitoring

The availability of the inappropriate categories of 'white' and 'British' is noteworthy. These categories were more heavily used in the pre-study period (in 2780 extra instances) than in the study period. It is possible that 'white' conceals those of Greek, Cypriot, Turkish, Bosnian, Kosovan, North African, Arab and Iranian descent at risk of carrying genes associated with sickle cell or thalassaemia. It is possible that 'British' conceals those of *any* minority ethnic groups who, given the chance to choose a nationality category, opted to assert their nationality over their ethnicity.

Similarly, the number of clients identified as at risk using the census ethnic-monitoring categories was 2388/9282 (25.7%) and using the EQUANS ethnicity-screening questions was 534/2027 (26.3%) (difference 0.6%, 95% CI –1.5% to 2.7%, $P = 0.565$). One policy approach is to consider cases of missing ethnicity data as a reason to initiate a laboratory screen. The number of clients identified as at risk, including cases of missing ethnicity data, using the census ethnic-monitoring categories was 2480/9282 (26.7%) and using the EQUANS ethnicity-screening questions was 657/2027 (32.4%) (difference 5.7%, 95% CI 3.5% to 7.9%, $P < 0.001$) (see Table 2).

A record was kept by the laboratory in the intermediate-prevalence area of the number of laboratory screenings conducted and the number of haemoglobinopathy carriers identified both during the 10 months of the study while the temporary research initiative of universal screening was being conducted, and for the equivalent 10 months of the year before during the previous selective screening policy. The coverage of different ethnic groups during the two time periods of screening was also recorded by the laboratory (see Tables 3 and 4).

This selective screening policy had previously produced coverage of 20.7% of the whole antenatal population. During the period of implementing the temporary universal screening strategy, 42.6% of women of the whole antenatal population who could have been offered a laboratory haemoglobinopathy screening were recorded as having been offered such a screen by their community midwives and having a laboratory haemoglobinopathy screening. The number of haemoglobinopathy carriers identified increased from 86 during the selective programme to 118 during the temporary universal programme, representing a proportional increase of 0.36% (95% CI 0.01% to 0.71%, $P = 0.045$) (see Tables 5 and 6).

Low-prevalence area

During the 10-month period of the study, 3142 women booked for delivery, 1061 (33.8%) were recorded as invited, and 895 (28.5%) were recruited to the EQUANS study (see Table 7). Of these 895 recruited to the study, 749 (83.7%) assigned themselves to low-risk groups and 129 (14.4%) to high-risk groups, with 17 (1.9%) missing data. The latter figure compares to 38/3142 (1.2%) missing cases in the generic routine ethnic data collection in the low-prevalence area.

Of the 3142 women booked by the midwives, 3034 (96.6%) were recorded, in the trust's standard ethnic monitoring data, as 'white'[sic]. This compares to 3196 booking in the equivalent period before the study of whom 3093 (96.8%) were 'white'. With the selective screening programme operated by the low-prevalence area, the proportion identified as at risk using specifically designed ethnicity-screening questions, as opposed to generic ethnic monitoring using locally devised categories, increased from 2.2% to 13.0% (difference 10.8%, 95% CI 8.5% to 13.0%, $P < 0.001$). Including missing ethnic data as constituting risk, the increase was from 108/3142 (3.4%) to 133/895 (14.9%) (difference 11.5%, 95% CI 9.0% to 13.8%, $P < 0.001$) (see Table 8).

There are arguably two ways to assess the extent of antenatal screening in terms of coverage. One is to look at overall records of laboratory screenings conducted in relation to risk groups as identified by the trust's own ethnic data (see Table 9). The second is to examine the laboratory screenings recorded as conducted in relation to those risk groups identified by the EQUANS ethnicity-screening questions in the one-third of the total antenatal population who were recruited to the EQUANS study (see Table 10).

During the period of the study, the number of laboratory antenatal haemoglobinopathy screening undertaken across the whole antenatal population increased from 10/3196 (0.3%) to 21/3142 (0.7%) compared to the equivalent pre-study period. The number of carriers identified increased from three to six. At the time of the study, the trust was using an ethnic question with the categories: white, mixed, black, Indian, Far East, Middle East, and not recorded. The proportion of risk groups having a laboratory haemoglobinopathy screening, as measured by the trust's own ethnic data, increased significantly from 10/103 (9.7%) pre-study to 21/108 (19.4%) during the study (difference 9.7%, 95% CI 0.33% to 19.1%, $P = 0.046$).

Table 2 Comparison of haemoglobinopathy screening, selective and temporary universal, using EQUANS ethnicity questions in an intermediate-prevalence area for expected fetal prevalence of sickle cell disease

	September 2002 to June 2003, temporary universal screening	
	Using Census 2001 categories	Using evidence-based EQUANS ethnicity-screening questions A and B
Number (%) identified as risk group	2388/9282 (25.7)	534/2027 (26.3)
Numbers (%) of missing ethnic data (and therefore to be offered screening)	92/9282 (1.0)	74/2027 (3.7)
Number (%) identified as risk group and missing ethnic data, combined	2480/9282 (26.7)	657/2027 (32.4)
Screens (%) as a proportion of risk groups (including missing data) identified[a]		1896/2553 (74.3)

[a] There is a method of estimating coverage of at-risk groups during a temporary universal programme by means of triangulating several pieces of data. Numbers of all groups given a laboratory screen (3954) minus the number of low-risk groups (as measured by the EQUANS ethnicity-screening questions: all those writing or ticking white British/white North European or indicating a mixture of white groups not at risk of haemoglobinopathies), recorded as being given a laboratory screen (1471), which comes to 2483. This is a proxy figure for the number of risk groups screened during the period of temporary universal screening.

The number of risk groups who should have been screened (2553) comprises four figures, namely:

1 the 2388 placing themselves into all ethnic categories other than white in terms of the trust's use of census categories for routine ethnic monitoring
2 the 48 respondents to the standard ethnic-monitoring data who ticked the subdivision of white, any other white background. They are included in this calculation because the EQUANS screening questions were designed precisely to capture risk groups likely to be using this category such as Greek, Turkish, Cypriot, Mediterranean, Arab, North African and Persian
3 the 92 cases of missing data
4 a figure of 25, representing 2% of the 1262 in the area for whom no ethnic data were available. The 2% figure is based on census figures of minority ethnic groups for the relevant area.

However, we need some estimate of the number of the number of low-risk groups not in the EQUANS study who were screened. To estimate this number, we refer to a further piece of information, namely the ethnic origin recorded in laboratory records (recorded using the categories Asian, African-Caribbean and Other). According to laboratory records for the period, of the 3954 screened, 1343 were Asian, 307 African/Caribbean and 2304 Others. The sum of all those in the EQUANS study not in the categories British Asian or black British is 1762. This leaves 542 Others who were screened who were not in the EQUANS study. The number in risk groups given a laboratory screen was therefore 2438–542 = 1896. The proportion of those in risk groups screened was therefore 1896/2553 = 74.3%

A total of 129/895 (14.4%) clients placed themselves into risk categories based on their answers to the specifically designed EQUANS ethnicity-screening questions. However, of the 21 given a laboratory screen for sickle cell during the EQUANS study, only 15 were recruits to the study, and indeed one of the 15 screened had in fact self-assigned to a low-risk group. In total, therefore, 14/129 (10.8%) of at risk clients, as measured by the more evidence-based ethnicity-screening questions (Aspinall and Dyson, 2002), in the EQUANS study were recorded as having a haemoglobinopathy laboratory screening. A further 17 cases had screening ethnicity data missing. Thus only 14 out of 146 (9.6%) of risk groups, plus those at risk by virtue of missing screening question data, were recorded as having a laboratory haemoglobinopathy screening.

Screening data

There were examples in both intermediate- and low-prevalence areas of other points of the screening process where screening protocols were not followed. In the intermediate-prevalence area there were 42 occasions where the laboratory reported 'no blood sample received' and four where there were 'insufficient data to match blood sample and patient'. Of the 878 participants in the low-prevalence area for whom there were usable ethnicity data, there was no recorded information on whether or not they had been screened for sickle cell for 48 respondents. Of the 830 remaining, 740 (89%) assigned themselves to low-risk categories and 90 (11%) to high-risk categories. Of these 90, 12 (13.3%) were recorded as being screened. If the 15

Table 3 Laboratory records of number of haemoglobinopathy laboratory screens undertaken and ethnic monitoring data for the overall antenatal population, during selective and temporary universal screening programmes

	Pre-EQUANS September 2001 to June 2002			During EQUANS September 2002 to June 2003		
	Screened	Antenatal population	% Screened	Screened	Antenatal population	% Screened
African and Caribbean	232	229	101.3[a]	307	336	91.4
South Asian	1283	1669	76.9	1343	1754	76.6
Other[b]	355	369	96.2	833[c]	438	190[d]

[a] We are unable to reconcile these figures, which may be due to differences between census categories used for ethnic data collection and ethnic categories used for screening.
[b] Including missing cases.
[c] This figure is 2304 laboratory screens on All Others (except African, Caribbean and South Asian) minus 1471 of these which were on those 'white' categories at low risk, which leaves 833.
[d] This figure suggests that the EQUANS ethnic categories produced a much-improved delineation of other groups at risk for haemoglobinopathies than census categories.

Table 4 Laboratory records of number of haemoglobinopathy laboratory screens undertaken and carriers identified during selective and temporary universal screening programmes

	Pre-EQUANS September 2001 to June 2002		During EQUANS September 2002 to June 2003	
	Screened	Carriers	Screened	Carriers
Asian	1283	60	1343	60
African/Caribbean (%)	232	22 (9.5)	307	42 (13.7)
Other	355	4	2304	16

'don't knows' who should be offered a screen based on uncertain ethnic data are excluded, 12 out of 105 (11.4%) of those at high risk of carrying genes associated with sickle cell and thalassaemia were recorded as having a laboratory screening.

Discussion

Intermediate-prevalence area

The number of carriers identified increased from 86 to 118, an increase in terms of absolute numbers of 37.2%. There are several possible explanations that need to be explored here. First, the extra carriers could have been generated from an increase in the overall minority ethnic population. Using the UK Census 2001 categories, the antenatal population placing themselves into ethnic groups at higher risk for sickle cell/thalassaemia was 2158/9041 (23.9%) before the study, and 2388/9282 (25.7%) during the study (difference 1.8%, 95% CI 0.61% to 3.1%, $P = 0.004$).

Second, the increase does not seem attributable to better coverage of the key risk groups of African, Caribbean and Asian clients. An assessment was made, based on a comparison of ethnic-monitoring data based on UK Census 2001 categories collected by midwives and laboratory records of the number of women being recorded as having a laboratory haemoglobinopathy screening. In the period of selective screening before the study, the intermediate area had achieved complete coverage of African/Caribbean groups (232 were

Table 5 Comparison of haemoglobinopathy screening, selective and temporary universal, using trust's own ethnic data in an intermediate-prevalence area for expected fetal prevalence of sickle cell disease

	September 2001 to June 2002, selective screening	September 2002 to June 2003, temporary universal screening
Total antenatal bookings	9041	9282
Risk groups for sickle cell/thalassaemia[a]	2158	2388
Change in risk group population (%)	–	+10.6
Missing data	70	92
Number identified as missing ethnic data + risk group by trust's own routine ethnic data (% of antenatal population 'at risk')	70 + 2158 = 2228 (24.6)	92 + 2388 = 2480 (26.7)
HBO antenatal screens	1870	3954
Coverage of all antenatal population (%)	20.7	42.6
Carriers recorded by the laboratory	86	118
Increase in carriers identified (%)	–	37.2
Carriers recorded as % of antenatal population	0.95	1.3
Carriers recorded as % of risk groups	4.0	4.9

[a] Based on ethnic monitoring figures using Census 2001 categories provided by the local trust, excluding one rural maternity unit unable to provide any ethnic data for 1262 clients. Risk groups, defined here as all ethnic groups except those under the category white (British/Irish/any other white background). The latter of the three subdivisions, any other white background, is likely to contain both those at risk and those not at risk. This is itself one impetus to devise a screening question specifically sensitive to haemoglobinopathy risk groups. It is not included in the definition of risk groups here as the category is not specifically devised to capture haemoglobinopathy risk.

Table 6 Comparison of numbers of carriers of haemoglobinopathies identified during selective screening and research-based temporary universal screening, intermediate-prevalence area

	Pre-EQUANS, selective screening	During EQUANS, temporary universal screening	% Difference (95% confidence intervals)	Significance using *Z* test
Haemoglobinopathy carriers identified as a proportion of the antenatal population (%)[a]	86/7746 (1.1)	118/8020 (1.5)	0.36 (0.01–0.71)	$P = 0.045$

[a] Excluding the population from a maternity unit unable to supply ethnic data.

recorded as screened against only 229 recorded in the antenatal population), and a 1283/1669 (76.9%) coverage of South Asian groups. During the study, the coverage of African/Caribbean clients was 307/336 (91.4%) and of South Asian clients was 1343/1754 (76.6%).

Third, it is plausible that, even in such a short time as one year, the profile of the highest-prevalence

Table 7 Comparison of level of ethnicity data capture, standard ethnic data and EQUANS ethnicity questions, low-prevalence area

	Ethnic monitoring	EQUANS study		
	Antenatal population	Compared to whole antenatal population	Compared to those recorded as invited into the study	Compared to those recruited to the study
Data collected	3104	878	878	878
Data missing (%)	38 (1.2)	2264 (72.1)	183 (17.2)	17 (1.9)
Total	3142	3142	1061	895

Table 8 Comparison of risk groups identified by trust's own ethnic data and EQUANS ethnicity-screening questions, low-prevalence area

	Trust's ethnic data (%)[a]	EQUANS ethnicity screening questions (%)	% Difference (95% confidence intervals)	Significance using *Z* test
Ethnic minorities	70/3142 (2.23)	116/895 (13.0)	10.8 (8.5–13.0)	$P < 0.001$
Total risk (ethnic minorities plus missing data)	108/3142 (3.44)	133/895 (14.9)	11.5 (9.0–13.8)	$P < 0.001$

[a] Trust's own ethnic monitoring data, based on the categories: white, mixed, black, Indian, Far East, Middle East, and not recorded. None of these categories were further disaggregated.

communities may have changed. The black British African, as opposed to the black British Caribbean or black British Other, increased from 144 before the study to 232 during the study, an increase of 61%. The increase in the number of African/Caribbean clients screened increased, though less substantially at 32.3%. Since the increase in carriers of African/Caribbean descent was 22 to 42, while the number of carriers of South Asian descent remained constant at 60, it seems possible that a change in the underlying ethnic composition of the antenatal population contributed to the increase in carriers identified.

Fourth, the number of carriers identified from all 'Other' ethnic communities increased from 4 to 16. This may be because the study successfully prompted the greater identification of those at risk of carrying genes associated with sickle cell or thalassaemia from among other risk groups, such as those of mixed, Mediterranean or Arab origins. However, it may also be due to the large number of extra screenings which identified carriers

Low-prevalence area

There was a fourfold increase in the proportion of risk groups identified by evidence-based ethnicity-screening questions compared to previous ethnicity data. This may be attributable to the structure of the question itself, or to a 'Hawthorne effect' of the new question, in conjunction with the training that preceded the research intervention, producing a higher level of alertness among screening midwives. This suggests the importance of developing and using an ethnicity question specifically designed for targeted screening for the haemoglobinopathies, rather than the UK 2001 Census categories which are inferior for the purpose, or other trust-specific attempts at ethnic data collection that are even less sensitive. It also suggests a challenge for continuing professional education (PEGASUS, 2007) in maintaining enhanced alertness in routine service provision.

Moreover, only a small proportion of those identified as belonging to risk groups actually had a laboratory haemoglobinopathy screening. A national survey has suggested that, prior to national screening

Table 9 Comparison of selective haemoglobinopathy screening using trust's own ethnic data, before and during EQUANS study, low-prevalence area

	September 2001 to June 2002, selective screening	Sepember 2002 to June 2003, selective screening in research period
Total antenatal bookings	3196	3142
Ethnic minorities[a]	67	70
Missing data	36	38
Change in ethnic minority[a] population (%)	–	+4
Haemoglobinopathy antenatal screens undertaken by the laboratory	10	21
Haemoglobinopathy antenatal screens as a proportion of ethnic minorities[a] identified (%)	10/67 (14.9)	21/70 (30)
Haemoglobinopathy antenatal screens as a proportion of risk groups (ethnic minorities[a] plus missing cases) identified (%)	10/103 (9.7)	21/108 (19.4)
Coverage of all antenatal population (%)	10/3196 (0.3)	21/3142 (0.7)
Number identified as risk group (ethnic minorities[a] plus missing ethnic data) by trust's own routine ethnic data (%)	103/3196 (3.2)	108/3142 (3.4)
Carriers recorded by the laboratory	3	6
Carriers as % of antenatal population	0.09	0.18
Carriers as % of ethnic minorities	4.48	5.5

[a] As measured by the trust's own ethnic-monitoring data, based on the categories: white, mixed, black, Indian, Far East, Middle East, and not recorded. None of these categories were further disaggregated.

policies in England, there was confusion between the professional asking the ethnicity-screening question and the laboratory scientist as to who was effecting the selectivity in a targeted programme (Sedgwick and Streetly, 2001). In this low-prevalence area, only a small proportion of midwives administering the EQUANS screening question, and identifying the client as from a haemoglobinopathy risk group, turned this information into a request for a laboratory haemoglobinopathy screen. It is not clear how laboratory scientists could ethically be responsible for effecting selective screening, since they do not have the face-to-face contact with the client that would enable informed consent for this screening procedure to be gained. Subsequent to advice deriving from the EQUANS study, the screening question adopted incorporates specific instructions to the health professional to offer a laboratory screen for the haemoglobinopathies to those groups identified as at risk. This is accompanied by instructions regarding the samples of blood to take, tests to request, labels to attach and where to send samples and accompanying paperwork (NHS Sickle Cell and Thalassaemia Screening Programme for England, 2007).

The proportion of risk groups missed is greater still if clients for whom there are no ethnicity data are to be regarded by default as of higher risk and offered a laboratory screening. In a low-prevalence area, failure to achieve good coverage in asking the ethnicity question and offering screening has a costly and negative impact on the efficiency of the overall screening programme. This is because *if* the missing data are distributed relative to the proportions of high-risk and lower-risk groups in the overall local antenatal population, then 'white English' clients will form the majority of cases in the missing data and will, by virtue of missing data being attributed a high-risk status, incur the costs of screening which would not have arisen if the data had been available. Thus, although selective screening has been the policy chosen for low-prevalence areas in England on the basis of balancing equity with economic efficiency (NHS Sickle Cell and Thalassaemia

Table 10 Comparison of selective haemoglobinopathy screening, using EQUANS ethnicity questions, before and during EQUANS study, low-prevalence area

	September 2002 to June 2003, selective screening in research period
Number (%) identified as risk group by evidenced-based ethnicity questions A and B	129/895 (14.4)
Screens as a proportion (%) of risk groups identified by ethnicity questions A and B	14/129 (10.8)
Numbers (%) of missing ethnic data (and therefore to be offered screening) by ethnicity questions A and B	17/895 (1.9)
Number (%) identified as risk group and missing ethnic data by ethnicity questions A and B	133/895 (14.9)
Screens as a proportion (%) of risk groups (excluding missing data) identified	21/129 (16.3)
Screens as a proportion (%) of risk groups (including missing data) identified	21/146 (14.4)

Screening Programme for England, 2006), poorly executed selectivity would incur unnecessary costs.

Conclusion

Minimising failure to screen rates is a key aspect of a selective antenatal screening programme for sickle cell and thalassaemia. In an area of intermediate prevalence for SCD, the move from selective to a temporary, research-based, universal antenatal screening produced a failure-to-screen rate of 57.4%. Of those offered the ethnicity-screening questions, there was an additional failure to capture ethnic data of 3.7%. Nevertheless, the move towards a partially implemented universal screening identified an increased number of carriers of haemoglobinopathies over the comparative period before universal screening. The most likely reason seems to be changes in the underlying population. Other reasons include the possibility that universal screening improves the coverage of minority ethnic groups most at risk of carrying genes associated with these conditions; changes in the categories used; the greater sensitivity of evidence-based ethnicity-screening questions over census ethnicity questions, and the discovery of some carriers in groups previously subsumed under the broad category of 'white'. All of the possible reasons suggest that the best way to underpin a culturally competent service for those in areas of intermediate prevalence is to move to a universal offer of a laboratory antenatal screening for sickle cell and thalassaemia, as has subsequently occurred (NHS Sickle Cell and Thalassaemia Screening Programme for England, 2006).

In an area of low prevalence, the research initiative was associated with a doubling of haemoglobinopathy screenings. Double the usual numbers of carriers were identified compared to an equivalent period before the study. The use of evidence-based ethnicity-screening questions produced a fourfold increase in the proportion of clients identified as being from risk groups. Some of this difference may be because clients declined to be screened, but the large discrepancy suggests that most were not offered a haemoglobinopathy test. Moreover, where no ethnicity data are obtained, the procedure should be to regard women as at risk and offer screening. The total number of at-risk women, including those with missing ethnicity information, identified during the EQUANS study was 108, of whom only 21 (19.4%) were offered screening. The capture of ethnicity data needs to be accompanied by an instruction to offer screening for named groups. The apparent low level of carriers in low-prevalence areas may be a product of a combined failure to ask an ethnicity-screening question that is fit for purpose, obtain ethnicity-screening data, initiate an offer of screening for those women identified as from high-risk groups and those for whom ethnicity-screening information is missing. This suggests that areas of low prevalence for haemoglobinopathies require considerable support in terms of continuing professional education, in order to meet the needs of a diverse society. It also suggests that commissioners of screening services may, in the past, have seriously underestimated levels of need in their area.

CONTRIBUTORS

SD was chief investigator, managed the research, undertook all preparation of ethics applications, contributed to research design, took the lead in authoring the paper, and is the guarantor. KC and SG managed the laboratory screening and produced the laboratory data. SH undertook all database and data dictionary design, data preparation, data validation and all statistical analysis. FS and PS collected questionnaire data from the mothers, and VJ data from the carriers. FS and PS were local lead researchers.

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CONFLICTS OF INTEREST

None declared.

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