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The impact of screening for cardiovascular disease risk factors on population health and inequality. Evidence from the Stockport Screening Programme, United Kingdom.

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Abstract

Background: Population based screening for cardiovascular disease risk factors can potentially reduce coronary heart disease mortality and morbidity. There is little contemporary evidence that has examined the actual impact of such a programme on population health and on reducing inequality in health between affluent and deprived areas.
Methods: 82,015 residents of Stockport Health Authority, UK age 35-60 took up an invitation to be screened for cardiovascular disease risk factors from 1989 -1999. We compared uptake of screening and coronary heart disease (CHD) mortality and hospital admissions (1997 – 2003) between screened and unscreened male and female populations from affluent and deprived areas.
Results: Males and females in the unscreened population were more likely to die from CHD (IRR=3.60; p<0.001, IRR=4.64, p<0.001) and to have a hospital episode (IRR=1.75, p<0.001, IRR=1.94, p<0.001) than those in the screened population. This was independent of age and deprivation. The highest rates of CHD mortality and hospital admissions were found for unscreened deprived populations, the lowest for screened affluent populations. For both males and females mean rates of CHD mortality and hospital admissions were significantly lower for those who were screened and living in deprived areas compared to those who were unscreened and living in affluent areas.
Conclusions: Screening for cardiovascular disease risk factors improved the cardiovascular health of the population by targeting and treating 'high risk' groups, including those living in deprived areas. The potential of screening to reduce health inequality by promoting faster and more substantial health improvement in deprived areas was not observed in this study.

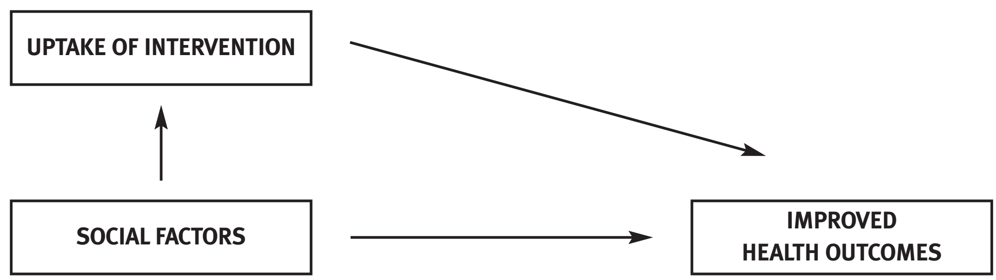
Key words: cardiovascular risk, screening, health inequality, coronary heart disease.

Introduction
The control of known risk factors is a proven means of reducing the burden of coronary heart disease at the population level[1-5]. Population screening for cardiovascular disease risk factors in the primary care setting is one mechanism for achieving improvements in cardiovascular health, since it is a means of systematically identifying levels of risk, but there are a number of issues that cast some doubt as to its likely effectiveness in this regard. Firstly given that in the UK, as in many European countries, high risk individuals are concentrated in areas and in social groups that are characterised by high levels of deprivation, targeting the 'at risk' population involves comprehensive coverage and equitable uptake of screening. And yet a common observation is that preventative medicine is less likely to be accessible to those in most need, living in the most deprived areas (the 'Inverse Care Law') and this has been identified as a widespread and enduring aspect of the provision of primary health care in the UK and in other European countries [6-13]. There is some evidence that coverage and equity of uptake of screening can be improved by changing the method of delivery in primary care. For example increased coverage of cervical screening in the UK in the 1990's was associated with the introduction of a centrally organised (Health Authority) call - recall system to replace opportunistic screening and the attachment of financial incentives to the achievement of target coverage levels in primary care [14,15]. Increasing uptake in deprived areas was associated with an increase in the number of practice nurses, a decrease in the number of GP's over 65 and more accurate lists of patients registered at practices [15].

Secondly prevention of heart attacks and stroke by screening for those most at risk (e.g. from hypertension, obesity, smoking etc) may not necessarily be dependent on improving coverage and reducing inequity in uptake of screening procedures. Identification of 'high risk' individuals will have little effect on population health and inequality unless hypertension is effectively treated and/or risk factors can be modified. This contrasts with cervical screening because a cervical smear, once administered, can prevent occurrence of cervical cancer through early detection and treatment of abnormal cells [16]. Thus if coverage increases and uptake becomes more equitable, both improvements in population health and a narrowing of health inequality should follow. Figure 1 illustrates the difference in the potential impact of these two preventative measures for reducing health inequality.

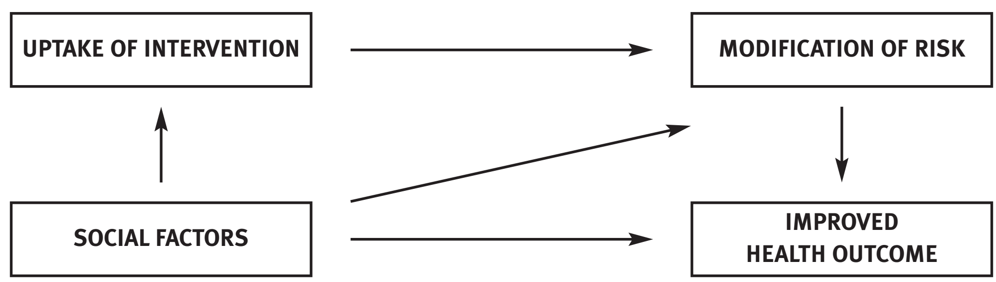
A systematic review of randomised controlled trials conducted up until the 1980's examined the effectiveness of multiple risk factor interventions in reducing risk factors for cardiovascular disease and/or the prevalence of CVD morbidity and mortality[17]. 14 trials were considered robust enough to be included in the meta – analysis. The conclusions of this review were that drug treatments for lowering blood pressure and cholesterol were moderately effective in reducing risk, especially for 'high risk' individuals, but that health promotion activities designed to change high risk behaviours such as smoking and diet had little discernable effect. No direct relationship was found between such interventions and reductions in either morbidity or mortality. Similar conclusions were drawn from the South-East London Screening Study (SELSS) [18] a long-term community based controlled trial conducted in two local group general practices with a nine year follow up period. No significant differences were found between the screened and the control group in consultation and hospital admission rates, certified sickness absence from work or mortality nine years after the initial screening.

Figure 1(a). Direct model of prevention: e.g. cervical screening.



In model 1(a) social factors directly affect both uptake of the intervention and health outcomes. The intervention leads to treatments that are effective in improving outcomes. Thus if coverage becomes more equitable, reductions in health inequality can be achieved, even though higher risk is located in lower socioeconomic groups.

Figure 1(b). Indirect model of prevention: e.g. screening for cardiovascular disease risk factors



In model 1(b) the effectiveness of the intervention is mediated by available mechanisms for modifying multiple risk factors some of which (e.g. behavioural change) are themselves strongly influenced by social factors. Thus if coverage becomes more equitable, this will not necessarily reduce health inequality unless drug treatments and health promotion activities are effective in changing risk factors in disadvantaged groups.

Whilst this study is widely quoted as evidence of the ineffectiveness of population screening for reducing cardiovascular disease mortality and morbidity [19-21] the negative results could arise because of 'dilution bias'[22]. 'Dilution bias' implies that the relationship between an intervention and an outcome measure is diluted by other intervening variables that cannot be controlled for in experimental studies based in the community and extending over a long period of time. The generalisability of studies conducted in the 1970's and 1980's to the present day is also questionable; because treatment regimens and health promotion techniques for behavioural change were more rudimentary than they are today [23,24]. A more recent trial examining health screenings in general practice as a means of improving cardiovascular disease risk factors showed that participants in the intervention group, receiving both drug treatment and health education, had significantly lower cardiovascular disease risk scores, BMI and serum cholesterol at 5 years follow up [25]. The authors concluded that screening was necessary to identify those at risk, since almost none of those with elevated cardiovascular risk were aware of their condition prior to screening.

The extent to which screening for cardiovascular disease risk factors in primary care can reduce health inequality has not been established. Whilst there is no existing body of literature that measures the impact of a such a population screening programme on inequality of health outcomes, a recently published study in Norway examined change in cardiovascular disease risk factors in a population screening programme between 1974 and 1988 and showed that this varied by gender and by the risk factor being considered. The Norwegian Counties study [26] followed 48,422 individuals across three screening episodes over this period. Using educational level as the basis for measuring inequality, they found that the higher the educational level, the lower the level of BMI, blood pressure, smoking and cholesterol, a pattern that persisted throughout the duration of the study. Educational gradient decreased over time for cholesterol and smoking in men, but the gradient increased for systolic blood pressure for women. In common with a number of other studies reported here, these findings will not reflect the development of more effective regimens for the treatment of hypertension and cholesterol over the last 18 years.

In this paper we use contemporary longitudinal evidence to focus on the extent to which population screening for CHD risk factors is associated with reductions in CHD morbidity and mortality and whether there is also evidence that such a screening programme is likely to have an impact on inequality for these health outcomes.

The hypotheses based on the generality of previous evidence collected at earlier time points are that a) there will be no significant difference in the prevalence of CHD mortality and morbidity between screened and unscreened populations of males and females and b) that CHD mortality and morbidity will be significantly higher in deprived than in affluent areas irrespective of the screening status of individuals living in these areas.

Methods

The Stockport Cardiovascular Disease Risk Factor Screening Programme

Ten years of screening data has been collected by Stockport Primary Care Trust (Health Authority as was) located in the North West of England, UK. Here a systematic and centrally administered programme of screening for cardiovascular disease risk factors targeted the whole of the eligible population (aged 35-60) between 1989-1999. All adults in Stockport coming to a 35th, 40th, 45th, 50th 55th or 60th birthday were sent an invitation by the Health Authority to make an appointment to be screened. Practice nurses from all 60 of the general practices in Stockport were trained to identify CVD risk factors, in blood pressure measurement technique, assessment and counselling for modifiable CVD risk factors.

Each screen lasted 25-35 minutes. Blood pressure was recorded using a 35cm x 12.5cm adult cuff . Blood pressure measurement technique was standardised using British Hypertension Society guidelines. Body Mass Index, serum cholesterol concentration, smoking status, diabetes/glucose intolerance and alcohol consumption were in addition recorded on a standardised data collection card, which was also used to collect information about age, sex, occupation and employment status. All those identified as hypertensive (>150 mmHg) were referred to the GP for further treatment. Those identified as high risk in relation to one or other of the risk factors associated with lifestyle change were given health promotion advice. On completion of screening, supporting literature about the reduction of coronary heart disease risk was given to every patient. Data for each screen was then fed back into the central screening database.

The employment domain of the Department of Environment, Transport and Regions (DETR) Index of Multiple Deprivation (IMD) 2000 [27] was used to categorize small areas in Stockport (electoral wards) according to levels of relative deprivation. The IMD combines information from 6 domains of deprivation – income, employment, health deprivation and disability, education skills and training, housing and geographical access to services – into a single score. The most appropriate indices to measure material deprivation are the employment and income indices and the former was selected for this analysis because it provided the best fit for regression models. This score, based on % unemployed, was highly correlated with the DETR2000 Income Index (r=0.96) and with the 1991 Townsend Score [28] (r=0.96), which was used extensively to measure material deprivation in the UK before the advent of the IMD. Initially electoral wards (n=21) were categorised according to their level of deprivation using quartiles based on the 2000 DETR Employment Index which were labelled as affluent, relatively affluent, relatively deprived and deprived. For the purpose of this analysis these have been combined into two categories of affluent (n=11) and deprived (n=10).

Uptake was calculated for 5 year periods: 1989-1993, 1990-4, 1991-5, 1992-6, 1993-7, 1994 - 8, 1995-9. During a five year period the whole of the eligible population (aged 35-60) will have been invited for screening at least once. Rates were calculated for the whole of Stockport and for 21 electoral wards in its constituency for males and females separately. Comparisons were drawn across time and between affluent and deprived areas. T tests identified significant differences in uptake for the eligible populations of affluent and deprived wards.

Individual level mortality statistics and hospital admissions data for all circulatory diseases (ICD9 390-459; ICD10 100-199) and coronary heart disease (ICD9 410-414; ICD10 120-125) were collected for the age group 35-70 for the years 1997-2003. The screened population was calculated as all those having at least one screen in the duration of the screening programme (1989-1999). The unscreened population was defined as the Stockport population eligible for screening, who did not participate in the screening programme.

Poisson regression analyses with CHD, all circulatory diseases and admission rates as the dependent variables were used to compare the relative probability of dying or of being admitted to hospital between the screened and the unscreened population, controlling for age (categorised as 35-49, 50-59 and 60-69) and deprivation (residence in a deprived or affluent ward). Analyses were carried out for all wards (N=21; 168 observations) affluent wards (N=11; 88 observations) and deprived wards (N=10; 80 observations). Results were expressed in terms of incidence rate ratios (IRR) which are indicative of relative risk.

Longitudinal descriptive analyses were used as a means to interpret the findings of these analyses and consider their implications for health inequality. Changes over time (1997-2003) in CHD mortality and hospital admissions were compared between screened and unscreened populations in affluent and deprived areas and by gender; t tests identified significant differences in rates of mortality and hospital admissions in the above categories.

To test for the extent to which observed results could be attributed to the screening programme, a longitudinal observation of changes in cardiovascular risk factors from first to third screen was conducted adjusting for age and regression towards the mean and comparing 'high risk' and 'normal risk' cohorts. A more detailed description of methods and analysis used in this study are reported elsewhere [29].

Results

44130 people were screened once from 1989-1999, 30,736 people were screened twice and 8149 people were screened three times. A detailed analysis of the screened population (Table 1) revealed that they were representative of the eligible population in Stockport Health Authority as regards gender, age and socio economic status [30].

Uptake of Screening

Uptake of screening remained relatively constant over the period of the screening programme (1989-1999) for both men and women.

For men mean uptake of screening was 50.8% and 51.2% in affluent and deprived areas respectively at the beginning of the screening programme, peaking at 53.8% and 54.4% in 1993/4 and declining to 51% in both types of area in 1998/9. There were no significant differences between uptake in affluent and deprived areas for any year, although it was slightly greater in deprived areas. Uptake was, on average, higher for women, starting at 58% in affluent areas and 61.8% in deprived areas, peaking at 61.4% and 64.2% respectively and declining to 57% and 60% at the finish of the programme. Similar to men, although uptake was higher in deprived areas, it was not significantly greater than in affluent areas in any one year.

Table 1. Representativeness of the Screened Population in Stockport Health Authority, UK

Age and gender	1991 Census % total population Eligible	Screened	1999 % registered population Eligible	Screened
Males				
35-44	22.1	18.5	22	18
45-64	27.6	27.3	28.2	29.2
Females				
35-44	22	21.8	21.7	20.3
45-64	28.4	32.4	28.1	32.5
Social Class (males)	Stockport screening sample (first screens 1991) Social Class (self)		Stockport Population 1991 Census Social class (head of household)	
	%		%	
Social Class I &II	42		42	
Social Class III	48		42	
Social Class IV & V	10		15	
Unclassified	0		2	

Table 2. Cross Sectional Analysis of the Association Between Screening and CHD Mortality and Morbidity Outcomes

	Mortality				Morbidity (HES)			
MALES	**CHD**		**All circulatory**		**CHD**		**All circulatory**	
Explanatory variable	IRR	P Value	IRR	P Value	IRR	P Value	IRR	P Value
All Wards (21) N=168								
Unscreened	3.60	0.001	3.34	0.001	1.75	0.001	1.77	0.001
Deprived	1.73	0.001	1.71	0.001	1.44	0.001	1.48	0.001
Age 50-59	2.27	0.001	2.42	0.001	2.24	0.001	2.27	0.001
Age 60-70	8.66	0.001	9.09	0.001	4.29	0.001	4.67	0.001
Affluent wards (11) N=88								
Unscreened	3.54	0.001	3.23	0.001	1.77	0.001	1.77	0.001
Age 50-59	2.35	0.001	2.33	0.001	2.25	0.001	2.36	0.001
Age 60-70	9.47	0.001	9.24	0.001	4.47	0.001	5.00	0.001
Deprived Wards (10) N=80								
Unscreened	3.63	0.001	3.43	0.001	1.74	0.001	1.77	0.001
Age 50-59	2.25	0.001	2.49	0.001	2.25	0.001	2.20	0.001
Age 60-70	8.17	0.001	8.99	0.001	4.13	0.001	4.39	0.001
FEMALES								
Explanatory variable	IRR	P Value	IRR	P Value	IRR	P Value	IRR	P Value
All Wards (21)								
Unscreened	4.64	0.001	4.17	0.001	1.94	0.001	1.84	0.001
Deprived	2.05	0.001	2.00	0.001	1.74	0.001	1.75	0.001
Age 50-59	1.86	0.034	2.34	0.001	1.80	0.001	1.93	0.001
Age 60-70	6.43	0.000	8.99	0.001	3.92	0.001	4.35	0.001
Affluent wards (11)								
Unscreened	4.43	0.001	3.23	0.001	2.53	0.001	2.44	0.001
Age 50-59	2.02	ns	1.99	0.024	3.75	0.001	3.12	0.001
Age 60-70	6.91	0.001	7.76	0.001	9.17	0.001	7.79	0.001
Deprived Wards (10)								
Unscreened	4.80	0.001	4.70	0.001	2.00	0.001	1.93	0.001
Age 50-59	1.84	ns	2.58	0.001	1.77	0.001	1.81	0.001
Age 60-70	6.42	0.001	8.04	0.001	3.56	0.001	3.99	0.001

Cross sectional analysis of the association between screening and CHD morbidity and mortality outcomes

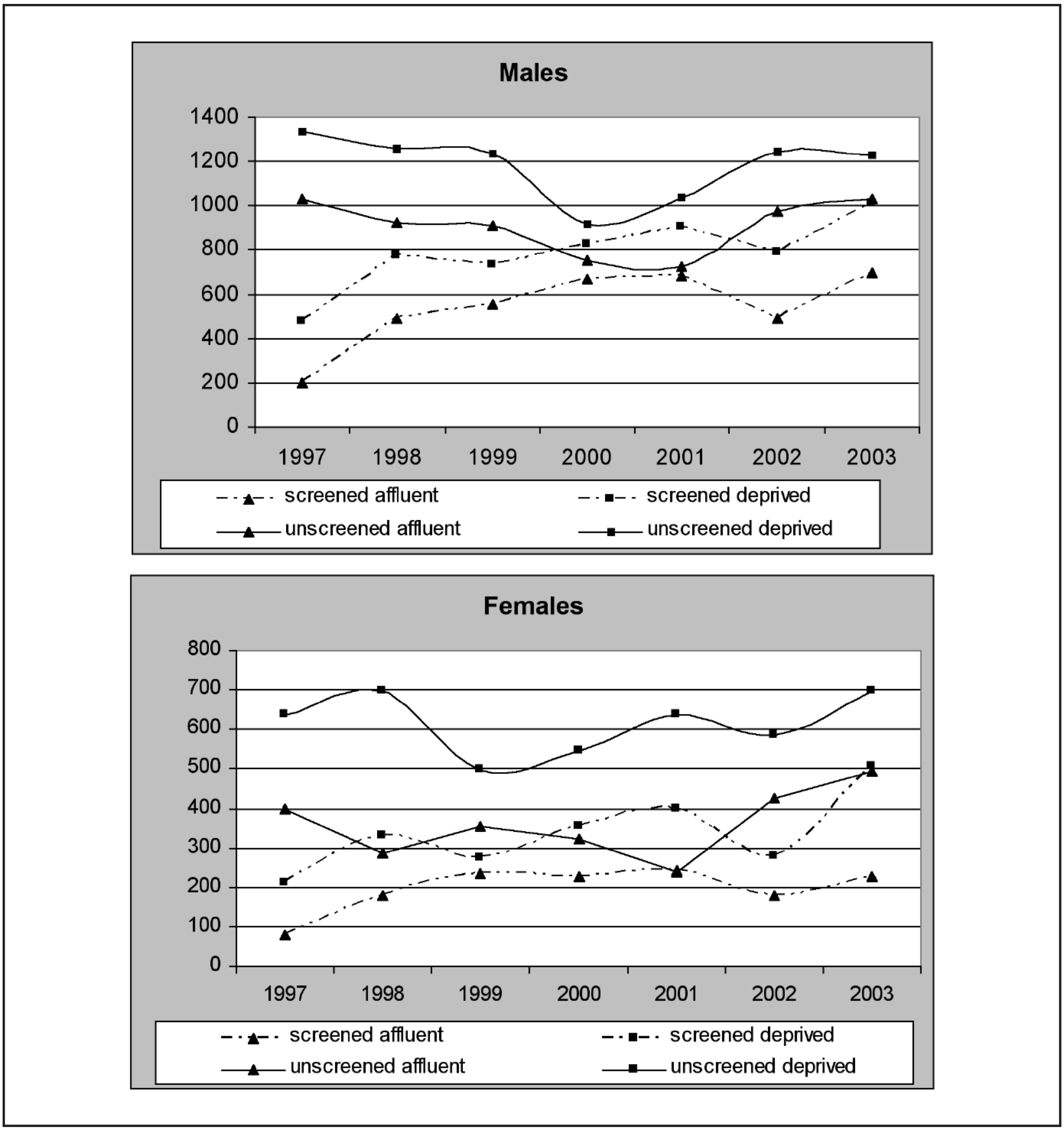
Table 2 shows that males in the unscreened population were more than $3^1/_2$ times more likely to die of coronary heart disease (IRR=3.60; p<0.001) and over $1^1/_2$ times more than likely to be admitted to hospital (IRR=1.75, p<0.001) than those in the screened population. Females in the unscreened population were over $4^1/_2$ times more likely to die from coronary heart disease (IRR=4.64, p<0.001) and almost twice as likely to be admitted to hospital (IRR-1.94, p<0.001) than those in the screened population.A similar pattern is revealed for all circulatory diseases.

Change in CHD outcomes for screened and unscreened populations in affluent and deprived areas (1997-2003)

These are illustrated by hospital admissions data because numbers are more substantial, but the patterns described below were replicated for mortality (data available on request).

Figure 2 shows change in rates of hospital admission for CHD (1997 -2003), comparing the screened and the unscreened population in

Figure 2. Change in CHD Hospital Admissions for screened and unscreened populations (aged 35-70 yrs) living in affluent and deprived areas in Stockport Health Authority



affluent and deprived areas. This shows that male CHD hospital admissions were consistently lower for those in affluent areas who had been screened (X = 540/100,000 pop) and consistently higher for those in deprived areas who had not been screened (X = 1180/100,000 pop). However rates of admission were significantly lower than this for males in deprived areas who were screened (X = 787/100,000 pop, t =-7.1, df=18, p<0.001) Rates of hospital admission for this population were also lower than those for unscreened men living in affluent areas (X = 906/100,000pop) and the mean difference between the two groups was significant (t=-3.5, df=19, p<0.01).

This same pattern was observed for women; rates were lowest for screened women living in affluent areas (X = 196/100,000 pop) and highest for unscreened women living in deprived areas (X = 613/100,000 pop). Screened women in deprived areas (X =336/100,000 pop) had significantly lower rates of CHD hospital admission than both unscreened women living in deprived areas (t=-2.1, df = 19 p<0.05) and unscreened women living in affluent areas (X = 360/100,000 pop)(t=-6.2, df=p<0.001).

It is interesting to note that for both males and females differences in rates of CHD Hospital Admissions between affluent and deprived areas were most marked in the final years of the screening programme (1997-1999 inc).

Screening effectiveness

Table 3 shows that the screening programme was associated with significant reductions in systolic and diastolic blood pressure, cholesterol, smoking and alcohol consumption from screen 1 to 3 for those defined as 'high risk' at baseline after taking into account age and regression towards the mean.

Discussion

Impact of screening on population health

This study has shown that population screening for cardiovascular disease risk factors was associated with reduced hospital admissions for and mortality from coronary heart disease and that this was independent of age and residence in a deprived area. Screening was a more powerful predictor of variations in outcome than deprivation. Thus the hypothesis based on earlier studies that screening had no impact on CHD outcomes was not confirmed.

Our analyses suggest that the findings observed here are likely to be due to the effectiveness of the screening programme as a means of targeting and bringing down the level of risk for the 'high risk' group, rather than reducing levels of risk for the whole population [29] . In his seminal article ' Sick individuals and sick populations' Geoffrey Rose distinguished between preventative strategies aimed at the whole of the population, such as legislation to lower the salt content of processed foods, and those aimed at high risk individuals such as the pharmacological management of hypertension and cholesterol [31]. Rose proposed that it was only the former that could shift the population mean of disease and death in a downward direction. The evidence presented in this study adds to that collected from national and international meta analyses of both types of

Table 3. Change in risk factor levels from screens 1 to 3 in a selected cohort of individuals defined as 'high risk' at baseline: comparison of the mean age adjusted observed changes with RTM effect and 95% confidence intervals.

	Male BPSYS	Female BPSYS	Male BPDIAS	Female BPDIAS	Male BMI	Female BMI	Male Cholesterol	Female Cholesterol	Male Alcohol	Female
Alcohol *Observed change*	9.49 (7.20,11.77)	11.30 (8.93,13.68)	5.29 (4.34,6.24)	5.62 (4.51,6.74)	ns	ns	0.70 (0.53,0.86)	0.49 (0.29,0.69)	7.06 (4.66,9.46)	6.08 (4.33,7.73)
Estimated age effect	7.27 (5.06,9.48)	11.99 (9.96,14.02)	3.05 (1.65,4.45)	4.59 (3.37,5.81)	ns	1.08 (0.39,1.77)	ns	1.05 (0.85,1.25)	ns	ns
Age-adjusted observed change	16.76 (16.56,16.96)	23.29 (23.11,23.47)	8.34 (8.26,8.42)	10.21 (10.12,10.30)	ns	1.08 (0.35,0.39)	0.70 (0.53,0.86)	1.54 (1.52,1.56)	7.06 (4.66,9.46)	6.08 (4.33,7.73)
Estimated RTM effect	14.12 (13.19,15.08)	15.70 (14.79,16.65)	7.79 (7.29,8.31)	9.37 (8.84,9.92)	0.94 (0.83,1.07)	1.31 (1.16,1.47)	0.27 (0.22,0.32)	0.39 (0.33,0.47)	4.88 (4.31,5.50)	4.89 (4.31,5.53)
Difference between age adjusted observed change and	2.65 (2.50,2.80)	7.59 (7.45,7.73)	0.55 (0.49,0.61)	0.84 (0.77,0.90)	-0.94 (1.07,0.83)	-0.23 (0.24,0.22)	0.43 (0.43,0.44)	1.15 (1.13,1.17)	2.183 (2.149,2.217)	1.185 (1.139,1.231)

intervention suggesting that 'high risk' strategies, particularly the treatment of systolic blood pressure above 160mmHg, have potential to reduce the burden of disease in a population [32]. However the success of this strategy in improving population health is dependent on establishing adequate coverage levels for a screening programme. The Stockport screening programme reached 55% of men and 64% of women at its peak; more complete coverage has been achieved for other screening programmes in England and Wales, for example cervical screening, by introducing financial incentives for the achievement of screening targets in primary care and a more complete coverage of the population could be dependent on the introduction of such incentives. Even though coverage of the screening programme was comparatively low, there was equity of uptake of screening between populations of affluent and deprived areas across the whole time period and trends indicated slightly higher uptake in deprived areas. This is likely to have been the consequence of the considerable investment made in employing and training practice nurses dedicated to administering the screening interviews before the commencement of the programme. Numbers increased from 19 to 106 in the year preceding the start of the programme. The presence of a practice nurse is strongly associated with increases in uptake of cervical screening and immunisation in deprived areas [15,33]. Thus increasing coverage and ensuring equitable access to a preventative intervention may be dependent on different policy initiatives in the primary care setting.

Screening and health inequality

The predicted pattern of the better health outcomes for populations of affluent areas irrespective of screening status was not found. As expected, screened individuals in affluent areas had the lowest rates of CHD morbidity and unscreened individuals in deprived areas had the highest rates. But the screened population from deprived areas had better CHD outcomes than both the unscreened populations of these areas and the unscreened population of affluent areas.

The fact that the screened population in deprived areas had better CHD outcomes than the unscreened population could be attributed to factors other than the screening process, in that those selecting into the screening programme could represent the more affluent and healthier people living in these areas. The evidence suggests otherwise. There was a strong correlation between deprivation at ward level and lower social class and unemployment at the individual level, meaning that those individuals in the screening programme were representative of area level of deprivation. Our analysis presented in Table 3 shows that the programme was associated with reducing levels of risk for high risk individuals, suggesting for example that once hypertensive individuals were identified by the screening programme, measures taken to reduce systolic and diastolic blood pressure were effective in reducing levels of risk in both affluent and deprived populations. What implications does this have for reducing health inequality? One goal of current public health policy in the UK is to remedy health disadvantage by improving the health of the worst off [34]. This was clearly achieved by the screening programme, since screened individuals living in deprived areas had better CHD outcomes than unscreened individuals living in deprived areas. Another goal of policies directed at health inequality is to narrow the health gap between affluent and deprived populations [34]. This requires not only absolute improvement in levels of health in poorer groups, but a rate of improvement that outstrips that of the higher social groups. This was only partially achieved by the screening programme since CHD outcomes were better for screened individuals living in deprived areas than for unscreened individuals living in affluent areas, but the health gap between screened individuals in affluent and deprived areas did not diminish in the outcomes data that were available for this study. Complimentary population based programmes based on food, fiscal and social policy may well be required if reductions in health inequality are to be achieved.

The unscreened population

Health and inequality outcomes related to screening should be seen in the context of patterns of change for the unscreened population. For example Figure 2 illustrates that, whilst rates of morbidity were considerably higher for the unscreened population, they continued to fall over the time period covered by the screening programme, particularly for men, without the intervention of screening. This indicates that screening for CHD risk factors is only part of the process of improving cardiovascular health for the population; there are a plethora of possible health care or community based interventions that are aimed at the reduction of CHD risk, that could underlie the fall in CHD morbidity in the unscreened male population. Identification of the optimum combination of interventions for improving CHD outcomes at the population level would be a fruitful topic for further research.

Limitations of the study

The population of Stockport Health Authority (as was) is relatively affluent in comparison to the rest of North West England, and has a small proportion of minority ethnic groups. The population has average mortality rates for CHD compared with England and Wales and lower than average when compared with North West England. Equity of screening uptake may well be more difficult to achieve in areas where deprivation is more predominant and where minority ethnic groups constitute a greater proportion of the population.

Hospital Episode statistics have been used in this study as a proxy for morbidity and these more accurately reflect health care utilisation rather than the burden of disease in a population. Nevertheless the use of hospital episodes data is in this case appropriate because it indicates the extent to which screening for cardiovascular disease risk prevents new episodes requiring hospital treatment. In the case of coronary heart disease this represents with reasonable precision the incidence of new cases.

Changes in the measurement and treatment of cardiovascular risk have occurred in primary care since the end of this screening programme and these emphasise the contextual nature of this study which, like others, is bound by the parameters of knowledge and methods available at the time. For example the Framingham score combining risk from a number of different sources can now be used to identify high risk individuals [35] and this method appears to have the potential to bring about more substantial reductions in CHD and stoke than a strategy based on high risk as defined by hypertension alone [32].

The time series of CHD mortality and Hospital Episode statistics available for the study (1997-2003) did not cover the full duration of the screening programme, limiting the extent to which patterns of change in health inequality over the whole programme could be studied. For example there did appear to be some narrowing of the health gap between affluent and deprived areas in the last three years of the programme, but this was not sustained when the programme finished. A longer time series of data would have enabled us to comment with more precision on the effect of screening on health inequality.

Canclusions

Screening for cardiovascular disease risk factors is one preventative strategy that improves the cardiovascular health of the population by targeting and treating 'high risk' groups. In general there is reluctance in public health circles to acknowledge that health care has a role to play in improving the health of disadvantaged groups. This is typified by Roos et al [36] who state that 'A universal health care system is definitely the right policy tool for delivering care to those in need and for this it must be respected and supported. However investments in health care should never be confused with, or sold as, policies whose primary aim is to improve population health or to reduce health inequality. Claims to that effect are misleading at best, dangerous and highly wasteful at worst.'

This is based on the premise that health care systems cannot directly address material and social disadvantage and their powerful association with the poorer health of deprived populations. Our study has shown that a population screening programme does have the potential to improve the health of high risk individuals living in both affluent and deprived areas, although it cannot tackle the underlying economic and social drivers of health status. A more reasonable conclusion to our study is thus better represented by the observations of Stamler [37], who states that: the prevention and control of CHD 'is a sustained and complex process, motley, variegated, involved, proceeding at multiple societal levels. The health care services sector is one of those levels, an important one, and screening – soundly employed – is one (among many) of its useful tools'.

Acknoledgements

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References

1) Critchley J, Capewell S. Prospective cohort studies of coronary heart disease in the UK: a systematic review of past, present and planned studies. J Cardiovasc Risk 2003;10:111-9.
2) Kuulasmaa K, Tunstall-Pedoe H, Dobson A, et al. Estimation of contribution of changes in classic risk factors to trends in coronary-event rates across the WHO MONICA project populations. Lancet 2000;355:675-87.
3) Morris R, Whincup PH, Lampe FC, Walker M, Wannamethee SG, Shaper AG. Geographic variation in incidence of coronary heart disease in Britain: the contribution of established risk factors. Heart 2001;86:277-83.
4) Sytkowski P, Kannel M, D'Agostino R. Changes in risk factors and the decline in mortality from cardiovascular disease. N Engl J Med 1990;322:1635-41.
5) Vartiainen E, Jousilahti P, Alfthan G, Sundvall J, Pietinen P, Puska P. Cardiovascular risk factor changes in Finland, 1972-1997. Int J Epidemiol 2000;29:49-56.
6) Watt G. The inverse care law today. Lancet 2002;360(9328):252.

7) Tudor Hart J,Thomas C, Gibbons B, et al.Twenty five years of case finding and audit in a socially deprived community. BMJ 1991;302:1509-13.
8) Baker D, Klein R. Explaining outputs of primary care: population and practice factors. BMJ 1991;303:225-9.
9) Ibbotson T, Wyke S, McEwen J, Macintyre S, Kelly M. Uptake of cervical screening in general practice: effect of practice organisation, structure and deprivation. J Med Screen 1996;3:35-9.
10) Lorant V, Boland B, Humblet P, Deliege D. Equity in prevention and health care. J Epidemiol Community Health 2002;56(7):510-6.
11) Majeed FA, Cook DG, Anderson HR, Hilton S, Bunn S, Stones C. Using patient and general practice characteristics to explain variation in cervical smear uptake rates. BMJ 1994;308:1272-6.
12) Rohlfs I, Borrell C, Pasarin I, Plasencia A. The role of sociodemographic factors in preventive practices. The case of cervical and breast cancer. EurJ Public Health 1999;9(4):278-84.
13) Sharland M, Atkinson P, Maguire H, Begg N. Lone parent families are an independent risk factor for lower rates of childhood immunisation in London. Communicable Disease Report 1997;7(11):169-72.
14) Quinn M, Babb P, Jones J, Allen E. Effect of screening on incidence of and mortality from cancer of the cervix in England: evaluation based on routinely collected statistics. BMJ 1999;318:904-8.
15) Baker D, Middleton E. Cervical screening and health inequality in England in the 1990's. J Epidemiol Community Health 2002;57:417-23.
16) Briss P, Rodewald L, Hineman A, Shefer A, The Task Force on Community Preventive Services. Reviews of evidence regarding interventions to improve vaccination coverage in children, adolescents and adults. Am J Prev Med 2000;18(1S):97-140.
17) Ebrahim S, Davey Smith G. Systematic review of randomised controlled trials of multiple risk factor interventions for preventing coronary heart disease. BMJ 1997;314:1666-9.
18) Holland W, Creese A, D'Souza M, Partridge J, Shannon D, Stone D, et al. A controlled trial of multiphasic screening in middle-age: Results of the South-East London screening study. Int J Epidemiol 1977;6(4):357-63.
19) Townsend P, Whitehead M, Davidson N, editors. Inequalities in Health: The Black Report and the Health Divide. London: Penguin Books, 1982.
20) Fowler G. Commentary: GP 'check - ups' still of limited value. Int J Epidemiol 2001;30:942-3.
21) McCormack J, Schrabanek P. Coronary heart disease is not preventable by population interventions. Lancet 1988;ii:839-41.
22) Lindholm L, Rosen M. What is the "golden standard" for assessing population - based interventions? - problems of dilution bias. J Epidemiol Community Health 2000;54:617-22.
23) Leeder S. Commentary: Learning in Lambeth - the South East London Screening Study Revisited. Int J Epidemiol 2001;30:944-5.
24) Yusuf F. Two decades of progress in preventing vascular disease. Lancet 2002;360:2-3.
25) Engberg M, Christensen B, Karlsmose B, Lous J, Lauritzen T. General health screenings to improve cardiovascular risk profiles: a randomized controlled trial in general practice with 5-year follow up. J Fam Pract 2002;51(6):546-52.
26) Strand B, Tverdal A. Trends in educational inequalities in cardiovascular risk factors: a longitudinal study among 48,000 middle aged Norwegian men and women. Eur J Epidemiol 2006;21(10):731-9.
27) DETR. Indices of Deprivation 2000. London: DETR, 2000.
28) Townsend P, Simpson D, Tibbs N. Inequalities in the city of Bristol: a preliminary review of statistical evidence. International Journal of Health Services 1985;15:637-63.
29) McCluskey S, Baker D, Middleton E, Lewis P. Reductions in cardiovascular risk in association with population screening - a ten year longitudinal study. Journal of Public Health 2007;10.1093/pubmed/Fdm 045.
30) Baker D, Hann M. Evaluation of the Stockport Cardiovascular Disease Screening Database as a tool for research and evaluation projects: National Primary Care Research and Development Centre, University of Manchester, 2002.
31) Rose G. Sick individuals and sick populations. Int J Epidemiol 1985;14(1):32-9.
32) Ezzati M, Vander Hoorn S, Rodgers A, Lopez AD, Mathers CD, Murray CJL. Estimates of global and regional potential health gains from reducing multiple major risk factors. Lancet 2003;362:271-80.
33) Middleton E, Baker D. Comparison of social distribution of immunisation with measles, mumps and rubella vaccine, England, 1991-2001. BMJ 2002;326:854.
34) Graham H. Tackling inequalities in health in England: remedying health disadvantages, narrowing health gaps or reducing health gradients? J Soc. Pol. 2004;33(1):115-31.
35) Jackson R. Guidelines on preventing cardiovascular disease in clinical practice. BMJ 2000;320:659-60.
36) Roos N, Brownwell M, Menec V. Universal Medical Care and Health Inequalities. In: Evans R, editor. Healthier Societies: from analysis to action. New York: Oxford University Press, 2006.
37) Stamler J. Commentary: On the report of the South-East London Screening Study. Int J Epidemiol 2001;30:946-7.