

CARDIOVASCULAR MEDICINE

Deprivation and trends in blood pressure, cholesterol, body mass index and smoking among participants of a UK primary care-based cardiovascular risk factor screening programme: both narrowing and widening in cardiovascular risk factor inequalities

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Objectives: To examine recent time trends in blood pressure (BP), total cholesterol, body mass index (BMI) and current smoking among people in the UK of different deprivation groups.

Design: Repeatable survey.

Setting: Primary care-based UK cardiovascular risk factor screening programme (58 Stockport general practices).

Participants: 37 161 women and 33 977 men aged 35–60 years responding to a screening invitation and with a first screening episode during 1989–99.

Results: There were significant decreasing trends in total cholesterol (-0.06 mmol/l/year, 95% confidence interval (CI) -0.07 to -0.06 for women, -0.07 mmol/l/year, 95% CI -0.07 to -0.06 for men), with a significantly faster drop in more deprived groups (-0.005 mmol/year/increasing deprivation group, 95% CI -0.01 to -0.001 for both sexes). There were decreasing trends in current smoking prevalence (odds ratio (OR) 0.97/year, 95% CI 0.96 to 0.97 for women, OR 0.96/year, 95% CI 0.95 to 0.96 for men) with a significantly slower drop in the more deprived groups (OR 1.01/year/increasing deprivation group, 95% CI 1.00 to 1.01 for both sexes). There were significant increasing trends in BMI (0.11 kg/m²/year in women, 95% CI 0.09 to 0.13, 0.10 kg/m²/year in men, 95% CI 0.08 to 0.11), with a significantly slower increase in the more deprived groups among men only (-0.02 kg/m²/year/increasing deprivation group, 95% CI -0.01 to -0.03). Inequality in BP narrowed among men but widened among women.

Conclusion: Inequalities in risk factors between different deprivation groups may be both widening (smoking, BP in women) and narrowing (total cholesterol, BMI and BP in men). Given baseline inequalities in risk factors levels, these trends suggest that inequalities in cardiovascular disease are likely to persist in the future.

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Cardiovascular disease, including coronary heart disease and stroke, is the leading cause of death in the UK and is responsible for about 238 000 deaths annually, or 39% of total mortality.¹ Lower socioeconomic status is strongly associated with both higher prevalence of cardiovascular disease and higher prevalence of various cardiovascular risk factors.

In the UK, decreasing population trends in cardiovascular risk factors such as total cholesterol, smoking and blood pressure (BP) have been observed since at least the early 1990s; however, other factors such as body mass index (BMI) have tended to deteriorate.² Whereas the recent epidemiology of major cardiovascular risk factors for the UK population as a whole is relatively well described, there is a paucity of information about cardiovascular risk factors in specific UK deprivation groups, as, for example, sources such as the Health Survey for England and the Whitehall studies measure socioeconomic status by individual, as opposed to area-based, measures. Previous research has shown the relevance of area of residence as a determinant of cardiovascular risk, independently and in addition to the effect of individually measured socioeconomic status.^{3,4}

Historical trends data about cardiovascular risk factors can help predict future expected disease burden, as previously described for the general UK population.^{5–7} There is, however, a relative paucity of evidence about risk factor time trends in population subgroups, such as deprivation groups. Such evidence is important both for the monitoring of changes in health inequalities and for healthcare service planning and health promotion initiatives. The acquisition of information about historical trends in cardiovascular risk factors therefore can be seen as a research priority.

A previous meta-analysis of studies reported between 1977 and 1996 challenged the overall effectiveness and cost effectiveness of multiple cardiovascular risk factor screening.⁸ One potentially important secondary use of population-based screening programmes is, however, as public health surveillance tools to monitor trends in population risk factors and determinants, as highlighted by the UK government's white paper on public health.⁹ The Stockport Cardiovascular Disease Risk Factor Screening Programme, originally introduced in 1989,¹⁰ provides an example of the potential for secondary use of routine data sources for public health surveillance purposes. Further details about operating protocols and

population coverage of this programme have been previously described.^{11–13}

Briefly, the programme was introduced in 1989 and used a call-recall system operated by the Stockport Health Authority, where all Stockport residents aged between 35–60 were invited every five years to book a screening appointment at their general practice surgery. Cardiovascular risk factors including BP, total cholesterol, BMI and smoking status were assessed by a general practitioner or, more often, by a practice nurse. Between 1989 and 1993, about 10.8% of all patients registered with a general practitioner were excluded from the screening invitation, as they were already known to have hypertension (3.9%), diabetes (1.2%), and conditions including a history of any cardiovascular disease and terminal illness (6.6%)—note that some patients had more than one indication for exclusion.¹¹ Over the 11-year period 1989–99, the population coverage for one (first) screening was about 72.2% for Stockport men aged 35–60 and about 78.4% for Stockport women (see supplemental file 1 on the *Heart* website—<http://www.heartjnl.com/supplemental>).¹³ Individual data on risk factor levels were collated by the Health Authority and anonymised into a usable electronic dataset, which was used in the present study.^{11–12} We therefore conducted a study to examine recent risk factor trends in BP, cholesterol, BMI and smoking status among people of various deprivation groups by using the Stockport cardiovascular risk factor screening dataset 1989–99.

Stockport is a borough of northwest England. In recent years, general population health has been slightly better than that of the general UK population, with a standardised mortality ratio from all causes (all ages) of 96 (95% confidence interval (CI) 94 to 98).¹⁴

METHODS

Information on men and women aged 35–60 who had a first screening episode during the 11-year period between 1989 and 1999 was analysed.

Deprivation status and risk factor measurements

Information on deprivation status was based on the enumeration district of residence (1991 census) Townsend deprivation index score.¹⁵ The Townsend deprivation score measures deprivation at a small area level (census enumeration district) based on information from four separate census-based variables: unemployment (unemployed residents older than 16 as a percentage of all economically active residents older than 16), overcrowding (households with one or more people to a room as a percentage of all households), non-car ownership (households with no car as a percentage of all households) and non-home ownership (households not owning their own home as percentage of all households) (see also <http://www.avon.nhs.uk/phnet/Methods/townsend.htm>). Five deprivation quintiles were defined based on the Stockport distribution of the Townsend score. The range of Townsend scores among study participants was –7.12 to 10.9 (mean –1.69, median –2.39, SD 2.88). The range for the population of England and Wales as a whole was –7.55 to 11.8 (mean 0, median –0.65, SD 3.39). Details of other risk factor measurements are available in supplemental file 2 on the *Heart* website (<http://www.heartjnl.com/supplemental>) and as described previously.¹¹

Statistical analysis

For each deprivation group and by sex, the mean age of participants and the completeness of ascertainment of each risk factor were calculated. The significance of differentials in screening coverage by deprivation group was assessed with

logistic regression, with deprivation group entered as a continuous variable, and when appropriate adjusted for age.

To assess whether risk factor levels differed between deprivation groups, age-standardised risk factor levels by year and sex were calculated by the direct method.^{16–18} Associated 95% CIs were calculated by the normal approximation to the binomial distribution for each age stratum.

To inform the interpretation further and to assess the significance of any risk factor level differences by deprivation group, linear regression models adjusted for age and test year were constructed. No attempt was made to examine interaction effects (correlations) between the risk factors—that is, each risk factor was treated individually in all models. Each continuous risk factor was used as the dependent variable, adjusted for age, test year and deprivation group, entered as a continuous variable (model 1a). The coefficient for deprivation group denotes the (age- and test year-adjusted) overall difference in risk factor levels between a given deprivation group and the group that is immediately more deprived, for all study years 1989–99. For smoking, logistic regression was used, with smoking status (current or non-current) as the dependent binary variable, and age, test year and deprivation group entered as a continuous variable (model 1b). The exponential of the coefficient denotes the (age- and test year-adjusted) overall difference in probability of current smoking status between the given deprivation group and the group immediately more deprived (hereafter “by incremental deprivation groups”), for all study years 1989–99.

To illustrate the effect of deprivation status on trends, both the absolute and the proportional (percentage) difference in risk factor levels between the first (1989) and the last (1999) study year are presented for quintiles 1 (least deprived, or “affluent”) and 5 (“deprived”).

To examine time trends in risk factor levels by deprivation group further, for each continuous risk factor a linear regression model was fitted, with age and test year as the independent variables, and applied to each deprivation group separately (model 2a). Similarly, for smoking, a logistic regression model was constructed, with current smoking status as the dependent variable and adjusted for age and test year, and applied separately to each deprivation group (model 2b). The coefficients for *test year* from these models denote the mean annual age-adjusted change in the risk factor level (continuous variables), or mean annual change in the logit of the probability of smoking status, specific to each deprivation group, for each study year (on average) of the 1989–99 study period.

Convergence or divergence in risk factor trends between deprivation groups (that is, significant differentials in speed of risk factor change over time) was assessed with the significance level of the coefficient for an interaction term *deprivation group* × *test year*, which was added to models also including age, test year and deprivation group as independent variables (models 3a and 3b). The coefficient for this interaction term denotes by how much the level of a continuous risk factor (or the probability of current smoking status) changes by moving simultaneously from one study year to the next, and by one deprivation group to the one immediately more deprived. Interaction variables were centred to avoid possible co-linearity.

Sensitivity analysis

Additionally, alternatively analytical approaches were used to minimise the potential that the results obtained were due to systematic differences in deprivation and age profile of participants in different periods of the programme (1989–93 and 1994–9). In particular, alternative modelling approaches were the following:

- Only including in the models patients aged 35–39 in each study year 1989–99
- Including in the models a study period variable (1989–93 or 1994–9)—that is, adjusting for study period in the models used in analysis
- Restricting analysis to the two study periods sequentially (1989–93 and 1994–9).

RESULTS

There were 37 294 women and 34 122 men aged 35–60 with a first screening episode between 1989 and 1999. Among these, it was possible to ascribe deprivation status to 37 161 women (99.6%) and 33 977 men (99.6%). About two thirds of the data relate to the period 1989–93.

Participant characteristics and ascertainment completeness

Certain systematic differences between participants of various deprivation groups were observed, including in relation to ascertainment for cholesterol, BMI and smoking (diastolic BP ascertainment was complete and systolic BP nearly complete for all groups and both sexes), although the order of magnitude (size) of these otherwise significant differences was small in both absolute and relative terms (table 1). In addition, participants in the 1989–93 study period were significantly older than those of the 1994–9 period. More specifically:

- The mean age of participants was significantly greater among least deprived men than among more deprived men, with an absolute mean difference between the least and most deprived groups of 0.4 years. A similar apparent trend among women was not significant.
- A greater proportion of participants in the 1989–93 study period of the programme belonged to the least deprived groups.
- Ascertainment completeness was systematically higher among the more deprived groups for BMI and smoking, and for cholesterol among women only (absolute

difference between the most and least deprived groups of –0.4%), mirroring previously described findings.¹²

Risk factor levels by deprivation group

As a whole, more deprived women and men consistently during the whole study period 1989–99 had significantly higher levels of (or exposure to) each risk factor. Among women, for any incremental progression in deprivation group there was a significant increase in systolic BP (0.56 mm Hg, 95% CI 0.45 to 0.67), diastolic BP (0.37 mm Hg, 95% CI 0.31 to 0.44), total cholesterol (0.07 mmol/l, 95% CI 0.06 to 0.08) and BMI (0.39 kg/m², 95% CI 0.36 to 0.43) (table 2, model 1a). Similarly, among men, for any ordinal increase in deprivation group there was a significant increase in systolic BP (0.47 mm Hg, 95% CI 0.35 to 0.58), diastolic BP (0.33 mm Hg, 95% CI 0.26 to 0.41), total cholesterol (0.02 mmol/l, 95% CI 0.01 to 0.03) and BMI (0.11 kg/m², 95% CI 0.08 to 0.14). For any ordinal increase in deprivation group, there was a significant increase in probability of current smoking status for both women and men, with odds ratios (ORs) of 1.24 (95% CI 1.22 to 1.26) for men and 1.26 (95% CI 1.24 to 1.28) for women (table 3, model 1b).

Risk factor level trends

Indicative changes between least and most deprived groups between 1989 and 1999

Table 4 shows absolute and proportional change between the least and most deprived groups between 1989 and 1999. Inequalities in current smoking levels increased during the study period for both sexes. For all other risk factors, there was a degree of reduction in inequalities in men. In women only, inequalities widened in relation to systolic and diastolic BP, although there was reduction in relation to cholesterol and BMI.

All participants

Figures 1–5 show age-standardised risk factor trends by sex and age group. Among women of all deprivation groups

Table 1 Main characteristics of participants, by deprivation group

	Affluent	2	3	4	Deprived	p Value for trend
Women						
Number	7407	7466	7416	7426	7446	
Mean age (years)	45.8	45.8	45.7	45.2	45.9	0.224*
IQR	39–53	39–53	39–53	38–51	39–54	
% of first screening episodes during 1989–93	71.2	70.4	68.4	68.0	66.8	<0.001†
Mean age during 1989–93	46.8					
Median (IQR)	45.0 (40.0–54.0)					
Mean age during 1994–1999	43.1					
Median (IQR)	40.0 (35.0–50.0)					<0.001
BMI ascertainment	74.5%	76.5%	81.3%	85.4%	84.3%	<0.001†
Cholesterol ascertainment	54.6%	50.3%	47.0%	54.1%	55.0%	0.009†
Smoking status ascertainment	74.9%	76.6%	81.5%	86.0%	85.3%	<0.001†
Men						
Number	6770	6851	6737	6827	6792	
Mean age (years)	45.9	45.8	45.5	45.0	45.5	
IQR	40–53	40–53	39–52	37–51	39–53	<0.001*
% of first screening episodes during 1989–93	68.7	67.7	65.7	62.9	61.4	<0.001†
Mean age during 1989–93	46.6					
Median (IQR)	45.0 (40.0–54)					
Mean age during 1994–1999	43.6					
Median (IQR)	41.0 (35.0–50.0)					<0.001
BMI ascertainment	78.7%	79.8%	85.2%	87.1%	84.9%	<0.001†
Cholesterol ascertainment	60.6%	56.3%	59.2%	60.2%	57.2%	0.092†
Smoking status ascertainment	79.2%	79.8%	85.4%	87.8%	85.0%	<0.001†

*From regression; †from regression adjusted for age. BMI, body mass index; IQR, interquartile range.

Table 2 Increase in mean risk factor levels by one level increase in deprivation group (DG) (model 1a), risk factor level time trends by DG (model 2a) and differential risk factor trends by one level increase in DG (model 3a)

	Men			Women		
	Mean	95% CI	p Value	Mean	95% CI	p Value
Systolic blood pressure						
Model 1a (overall difference between incremental DGs)						
DG trend difference*	0.47	0.35 to 0.58	<0.001	0.56	0.45 to 0.67	<0.001
Model 2a (DG-specific risk factor level time trends)†						
Affluent	0.30	0.18 to 0.43	<0.001	-0.10	-0.23 to 0.28	0.124
2	0.13	0 to 0.25	0.052	-0.07	-0.20 to 0.06	0.294
3	0.23	0.10 to 0.35	0.001	0.04	-0.09 to 0.17	0.550
4	0.27	0.14 to 0.40	<0.001	-0.03	-0.16 to 0.10	0.617
Deprived	0.20	0.07 to 0.33	0.002	0.17	0.04 to 0.31	0.009
All DGs	0.23	0.18 to 0.29	<0.001	0.01	-0.05 to 0.07	0.750
Model 3a (time trend difference between incremental DGs)						
DG × time‡	-0.02	-0.06 to 0.02	0.418	0.05	0.01 to 0.09	0.010
Diastolic blood pressure						
Model 1a (overall difference between incremental DGs)						
DG trend difference*	0.33	0.26 to 0.41	<0.001	0.37	0.31 to 0.44	<0.001
Model 2a (DG-specific risk factor level time trends)†						
Affluent	0.23	0.14 to 0.31	<0.001	-0.01	-0.09 to 0.07	0.755
2	0.18	0.10 to 0.26	<0.001	0.09	0.01 to 0.17	0.022
3	0.18	0.10 to 0.26	<0.001	0.10	0.02 to 0.18	0.011
4	0.18	0.10 to 0.26	<0.001	0.03	-0.05 to 0.11	0.443
Deprived	0.10	0.02 to 0.18	0.020	0.11	0.03 to 0.19	0.005
All DGs	0.18	0.15 to 0.22	<0.001	0.08	0.04 to 0.11	<0.001
Model 3a (time trend difference between incremental DGs)						
DG × time‡	-0.03	-0.05 to 0.00	0.034	0.02	0.00 to 0.05	0.069
Cholesterol						
Model 1a (overall difference between incremental DGs)						
DG trend difference*	0.02	0.01 to 0.03	<0.001	0.07	0.06 to 0.08	<0.001
Model 2a (DG-specific risk factor level time trends)†						
Affluent	-0.06	-0.08 to -0.05	<0.001	-0.06	-0.07 to -0.05	<0.001
2	-0.06	-0.07 to -0.05	<0.001	-0.06	-0.07 to -0.04	<0.001
3	-0.07	-0.08 to -0.06	<0.001	-0.06	-0.07 to -0.05	<0.001
4	-0.07	-0.08 to -0.05	<0.001	-0.08	-0.09 to -0.06	<0.001
Deprived	-0.09	-0.10 to -0.08	<0.001	-0.08	-0.09 to -0.06	<0.001
All DGs	-0.07	-0.07 to -0.06	<0.001	-0.06	-0.07 to -0.06	<0.001
Model 3a (time trend difference between incremental DGs)						
DG × time‡	-0.005	-0.01 to -0.001	0.012	-0.005	-0.01 to -0.001	0.016
Body mass index						
Model 1a (overall difference between incremental DGs)						
DG trend difference*	0.11	0.08 to 0.14	<0.001	0.39	0.36 to 0.43	<0.001
Model 2a (DG-specific risk factor level time trends)†						
Affluent	0.12	0.09 to 0.16	<0.001	0.10	0.06 to 0.14	<0.001
2	0.13	0.10 to 0.16	<0.001	0.08	0.04 to 0.12	<0.001
3	0.08	0.05 to 0.11	<0.001	0.14	0.10 to 0.18	<0.001
4	0.10	0.06 to 0.13	<0.001	0.08	0.04 to 0.12	<0.001
Deprived	0.06	0.02 to 0.09	<0.001	0.11	0.07 to 0.16	<0.001
All DGs	0.10	0.08 to 0.11	<0.001	0.11	0.09 to 0.13	<0.001
Model 3a (time trend difference between incremental DGs)						
DG × time‡	-0.02	-0.03 to -0.01	0.002	0.01	-0.01 to 0.02	0.419

*Model 1: effect of one group ordinal change in DG adjusted for age, survey year and DG (continuous variable);

†model 2: mean annual change per survey year by DG, adjusted for age; ‡model 3: mean change between survey years and ordinal increase in DG (DG × test year) adjusted for age, survey year and DG.

significant increasing time trends in diastolic BP (0.08 mm Hg/year, 95% CI 0.04 to 0.11) and BMI (0.11 kg/m²/year, 95% CI 0.09 to 0.13) and decreasing time trends in total cholesterol (-0.06 mmol/l/year, 95% CI -0.07 to -0.06) were seen. Among men of all deprivation groups significantly increasing time trends in systolic BP (0.23 mm Hg/year, 95% CI 0.18 to 0.29), diastolic BP (0.18 mm Hg/year, 95% CI 0.15 to 0.22) and BMI (0.10 kg/m²/year, 95% CI 0.08 to 0.11) and decreasing trends in total cholesterol (-0.07 mmol/l/year, 95% CI -0.07 to -0.06) (table 2, model 2a) were seen. For smoking, overall there was a significant decreasing time trend in probability of prevalence of current smoking (OR 0.97, 95% CI 0.96 to 0.97 for women; and OR 0.96, 95% CI 0.95 to 0.96 for men) (table 3, model 2b).

Deprivation group trends

As indicated by a significant interaction term for *deprivation group × test year* among women, systolic BP increase was faster in more deprived groups (by 0.05 mm Hg/year/increasing deprivation group, or by 0.25 mm Hg/year between the least and the most deprived groups) (table 2, model 3a). For both sexes, cholesterol dropped faster in more deprived groups (by -0.005 mmol/l/year/increasing deprivation group, or -0.025 mmol/l/year between the least and the most deprived groups). For men, diastolic BP increased more slowly among more deprived groups (by -0.03 mm Hg/year / increasing deprivation group, or -0.15 mm Hg/year between the least and the most deprived deprivation groups). In men only, BMI also increased more slowly in more deprived

Table 3 Probability of smoking by ordinal increase in deprivation group (DG) (model 1b), probability of change in current smoking status over time by DG (model 2b) and differential convergence or convergence of time trends in probability of current smoking (model 3b)

	Men			Women		
	OR	95% CI	p Value	OR	95% CI	p Value
Model 1b (overall difference between a given DG and the one immediately more deprived)						
DG trend difference*	1.24	1.22 to 1.26	<0.001	1.26	1.24 to 1.28	<0.001
Model 2b (trends by DG)†						
Affluent	0.94	0.93 to 0.96	<0.001	0.96	0.94 to 0.97	<0.001
2	0.94	0.92 to 0.96	<0.001	0.97	0.95 to 0.99	0.001
3	0.97	0.95 to 0.99	<0.001	0.96	0.94 to 0.98	<0.001
4	0.96	0.94 to 0.98	0.001	0.95	0.93 to 0.97	<0.001
Deprived	0.95	0.92 to 0.98	0.001	0.98	0.95 to 1.00	0.094
All DGs	0.96	0.95 to 0.96	<0.001	0.97	0.96 to 0.97	<0.001
Model 3b (time trend difference between a given DG and the one immediately more deprived)						
DG × time‡	1.01	1.00 to 1.01	0.020	1.01	1.00 to 1.01	0.016

*Model 1: effect of one group ordinal change in DG adjusted for age, survey year and DG (continuous variable);

†model 2: mean annual change by DG adjusted for age; ‡model 3: mean change by test year and ordinal increase in DG (DG × test year) adjusted for age, test year and DG.

OR, odds ratio.

Table 4 Absolute and percentage difference in risk factor levels between study baseline (1989) and end period (1999) for most and least deprived groups and percentage ascertainment completeness along with sample size for each observation

Risk factor	Men		Women		Absolute difference	% difference	1989	1999	Absolute difference	% difference
	1989	1999	1989	1999						
Cholesterol										
Affluent	% ascertained	46.3%	51.8%						43.8%	37.6%
	Number	327	114						355	79
	Mean (mmol/l)	5.953	5.700	-0.253	-4.3%	5.819	5.356	-0.463	-8.0%	
	95% CI	5.832 to 6.074	5.214 to 6.186			5.714 to 5.924	5.042 to 5.670			
Deprived	% ascertained	48.0%	46.3%						44.5%	38.3%
	Number	303	222						354	103
	Mean (mmol/l)	6.189	5.310	-0.879	-14.2%	6.031	5.252	-0.779	-12.9%	
	95% CI	6.050 to 6.328	5.145 to 5.475			5.924 to 6.137	5.026 to 5.477			
Systolic blood pressure										
Affluent	% ascertained	100%	100%						99.8%	100%
	Number	707	220						808	210
	Mean (mm Hg)	129.2	131.8	2.6	2.0%	126.1	122.0	4.1	3.3%	
	95% CI	128.1 to 130.3	129.6 to 134.0			125.0 to 127.2	119.3 to 124.7			
Deprived	% ascertained	100%	100%						100%	100%
	Number	631	319						795	269
	Mean (mm Hg)	131.3	129.7	1.6	1.2%	127.6	126.5	1.1	0.9%	
	95% CI	130.2 to 132.5	127.8 to 131.6			126.5 to 128.8	123.7 to 129.1			
Diastolic blood pressure										
Affluent	% ascertained	100%	100%						100%	100%
	Number	707	220						810	210
	Mean (mm Hg)	80.0	81.7	1.7	2.1%	77.5	75.3	2.2	2.8%	
	95% CI	79.3 to 80.7	80.1 to 83.3			76.9 to 78.1	73.7 to 76.9			
Deprived	% ascertained	100%	100%						100%	100%
	Number	631	479						795	269
	Mean (mm Hg)	81.7	80.9	0.8	1.0%	78.6	79.4	0.8	1.0%	
	95% CI	81.0 to 82.4	79.7 to 82.1			77.9 to 79.3	78.0 to 80.8			
Body mass index										
Affluent	% ascertained	58.3%	92.3%						56.4%	89.5%
	Number	412	203						457	188
	Mean (kg/m ²)	25.48	26.79	1.31	5.1%	24.36	25.32	0.96	3.9%	
	95% CI	25.20 to 25.76	26.25 to 27.33			23.97 to 24.75	24.33 to 26.31			
Deprived	% ascertained	75.3%	92.5%						75.6%	92.2%
	Number	475	416						601	248
	Mean (kg/m ²)	26.08	26.7	0.62	2.4%	25.99	26.97	0.98	3.8%	
	95% CI	25.72 to 26.43	25.68 to 26.70			25.54 to 26.44	25.99 to 27.95			
Smoking										
Affluent	% ascertained	59.0%	92.3%						56.5%	85.7%
	Number	417	203						458	189
	Mean (% current smokers)	43.0%	24.7%	-18.3%	-42.6%	32.4%	12.7%	-19.7%	-60.8%	
	95% CI	38.1% to 47.9%	17.5% to 31.9%			28.0% to 36.7%	6.3 to 19.1			
Deprived	% ascertained	75.9%	92.2%						76.6%	92.6%
	Number	479	294						609	249
	Mean (% current smokers)	65.8%	59.7%	-6.1%	-9.3%	51.3%	43.3%	-8%	-15.6%	
	95% CI	61.4% to 70.2%	53.3% to 66.2%			47.4% to 55.3%	35.4% to 51.2%			

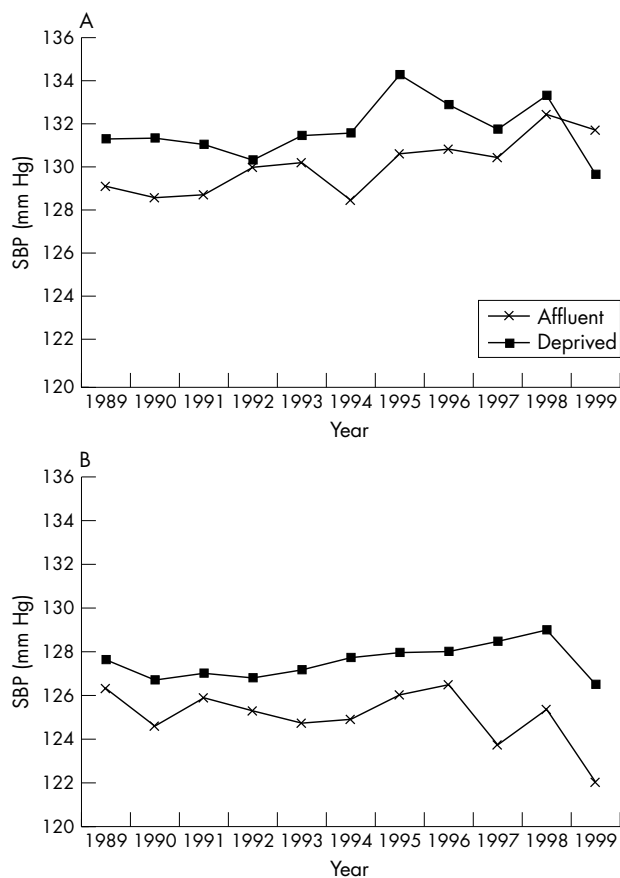


Figure 1 Age-standardised mean systolic blood pressure (SBP) in the most and least deprived groups in (A) men (-0.02 mm Hg/year/incremental deprivation group, $p = 0.418$) and (B) women (0.05 mm Hg/year/incremental deprivation group, $p = 0.010$).

groups (by -0.02 kg/m²/year/increasing deprivation group, or -0.1 kg/m²/year between the least and the most deprived groups). For both men and women, the current smoking status drop was slower among the most deprived groups (with the probability of current smoking status being higher by 1%/year/increasing deprivation group, or 5% between the least and the most deprived groups) (table 3, model 3b).

Sensitivity analysis

Modelling by approach 1 (confining modelling to participants aged 35–39 only) overall produced non-significant trends due to loss of power.

Modelling by approach 2 (including a study period, 1989–93 and 1994–9, variable in modelling) produced little difference in the results obtained by models not including adjustment for study period, denoting that time trends were overall independent of study period.

Modelling by approach 3 (restricting analysis sequentially to either the 1989–93 or the 1994–9 study period) overall produced some discordant results between the two study periods, also with some null (non-significant) trends for some risk factors and study periods due to loss of power, as with approach 1.

DISCUSSION

The findings show that in the study setting and during the whole study period 1989–99, more deprived middle-aged people overall possessed an adverse risk factor profile compared with the least deprived group. The findings also

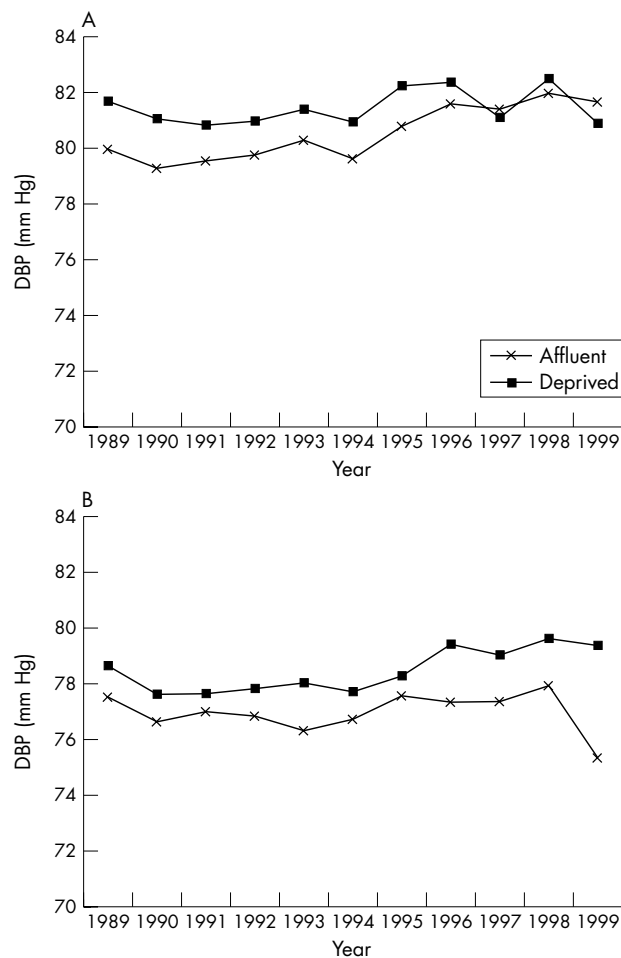


Figure 2 Age-standardised mean diastolic blood pressure (DBP) in the most and least deprived groups in (A) men (-0.03 mm Hg/year/incremental deprivation group, $p = 0.034$) and (B) women (0.02 mm Hg/year/incremental deprivation group, $p = 0.069$).

apparently show both a similar and a dissimilar pattern of time trends in risk factor levels for the examined five risk factors between deprivation groups, with some evidence of inequality in trends, which, however, is not consistently in favour of either the least or the most deprived. Given the significant differences in risk factor level status at baseline in favour of the least deprived groups, this means that overall inequalities in cardiovascular risk factors, and ultimately cardiovascular disease, are likely to continue in the future.

Change (decrease) in cholesterol was observed to be faster among the more deprived groups for both sexes. Although the exact reasons for this observation are difficult to postulate, the finding may relate to the eventual late diffusion of more healthy dietary habits among the more deprived groups during the study period (for example, a switch to use of low fat dairy products or substitution of animal-derived with plant-derived fat), at the same time when the diet of the least deprived groups did not improve further. Similarly, for men only, the observed changes in BMI and BP were also in favour of the most deprived groups. This finding can also be postulated most likely to relate to the adoption during the study period of a more sedentary lifestyle and a diet higher in calories at a comparatively faster pace among the least affluent groups. The findings in general are potent reminders of the evolving nature of health inequality in cardiovascular risk factors. They also strongly advocate the use of observations spanning different time periods when

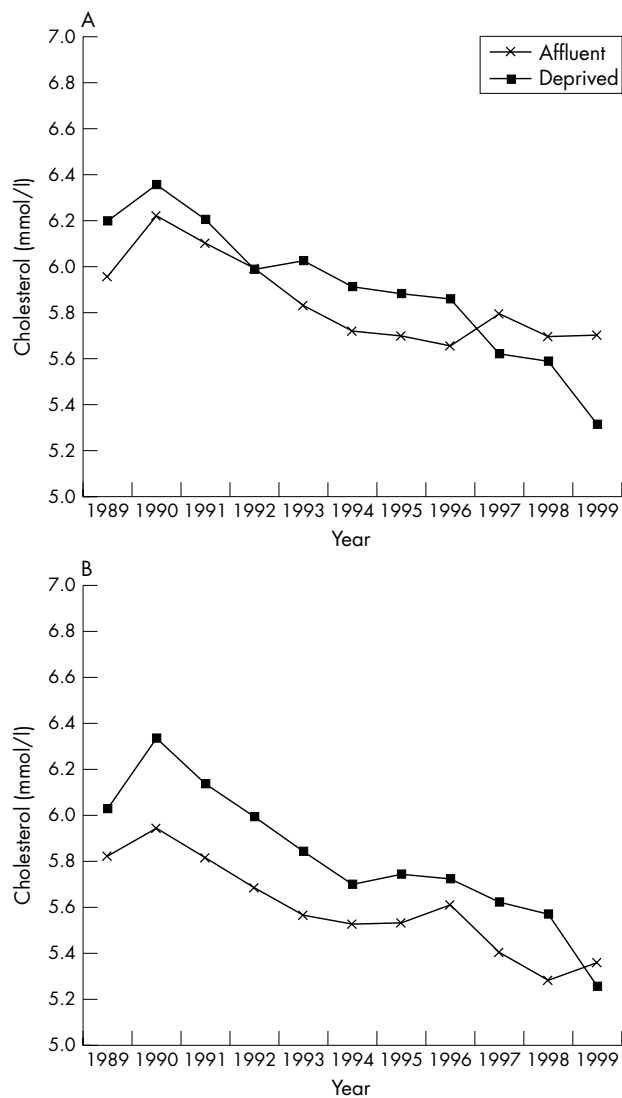


Figure 3 Age-standardised mean cholesterol in the most and least deprived groups in (A) men (-0.005 mmol/l/year/incremental deprivation group, $p = 0.012$) and (B) women (-0.005 mmol/l/year/incremental deprivation group, $p = 0.015$).

studying inequality patterns and more research in time trends in inequality.

The findings confirm the strong socioeconomic pattern of cardiovascular risk factors, also observed in many other studies, including the population-based samples of the Health Survey for England (1991–1999)¹ and the Health Survey for Scotland,¹⁹ supporting the external validity of the dataset. Similarly, for cholesterol concentration, BMI and smoking status, the observed population risk factor time trends are in agreement with those observed in the population-based samples of the Health Survey for England (1991–1999)¹ and the Health Survey for Scotland,¹⁹ reflecting downward trends for cholesterol and smoking status but increasing BMI trends. The lack of any significant decreasing trends in systolic and diastolic BP is, however, in contrast to information from population-based epidemiological surveys of high quality—for example, the Health Survey for England. This difference raises the question as to whether the difference can be due to bias, a “real” effect or chance. Selection bias is theoretically possible, as patients with a known diagnosis of hypertension and other cardiovascular

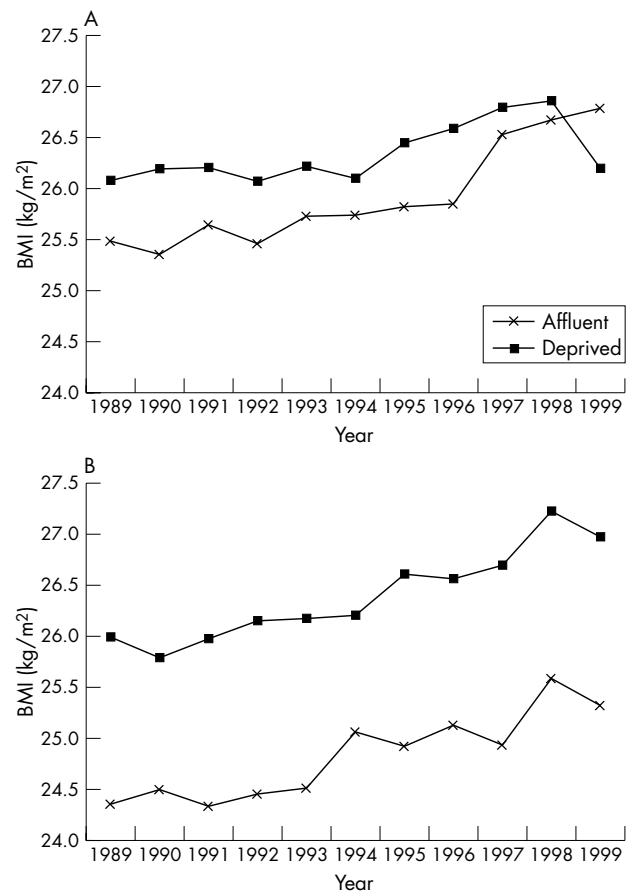


Figure 4 Age-standardised mean body mass index (BMI) in the most and least deprived groups in (A) men (-0.02 kg/m²/year/incremental deprivation group, $p = 0.002$) and (B) women (0.01 kg/m²/year/incremental deprivation group, $p = 0.419$).

conditions were excluded from the study, unlike population-based surveys such as the Health Survey for England that randomly include such patients. For this exclusion to have been responsible for the findings, however, would mean that population levels of BP continued to rise in all participants other than those with hypertension and other cardiovascular conditions. Artefactual explanations are also likely—for example, systematic differences in measurement progressing during the study period (for example, timing allowed to achieve a resting state, body posture, observer technique and training, number of BP readings and calculation of mean values from more than one reading).

A crucial question in relation to the generalisability of the study findings is whether participants in screening were representative of the Stockport population as a whole and whether they were representative of all screening participants. Coverage estimates by deprivation group (see supplemental file 1 on the *Heart* website—<http://www.heartjnl.com/supplemental>) show overall small variation in coverage, for both 1989–93 and overall (1989–99). Similarly, there were systematic differences between participants in ascertainment completeness, mean age and proportion of participants who had their first screen in the prevalence round of the programme (table 1). Given, however, that deprivation group differences in both population coverage and data ascertainment completeness are small overall, in both absolute and relative terms, the representativeness of the study's sample is likely to be good in relation to the eligible Stockport population of 35–60 year olds. Similarly, when considering

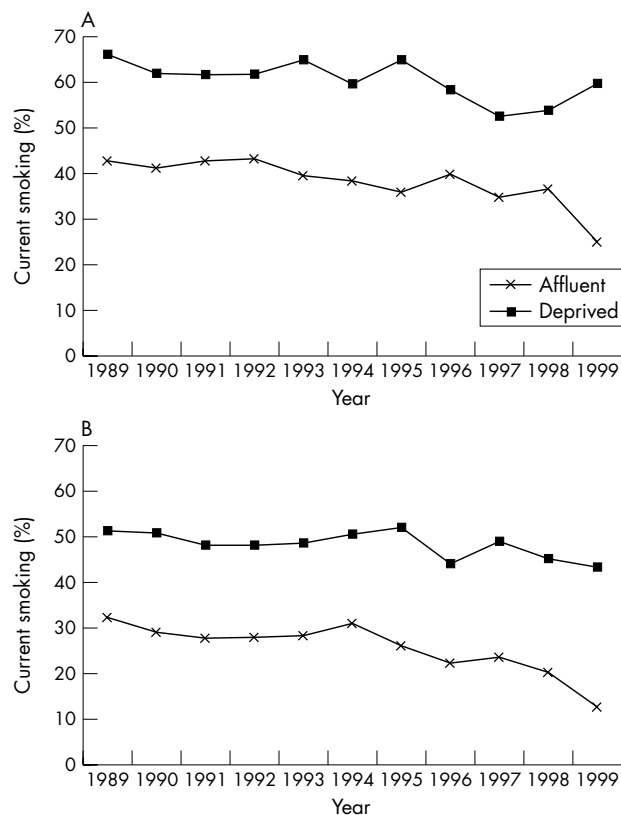


Figure 5 Age-standardised mean prevalence of current smoking in the most and least deprived groups in (A) men (odds ratio 1.01/year/incremental deprivation group, $p = 0.020$) and (B) women (OR 1.01/year/incremental deprivation group, $p = 0.016$).

the generalisability of the study, the age of participants (35–60 years) should be borne in mind, as, for example, people older than 60 years are less healthy and may be more deprived on average. Extending the study's findings in relation to change in risk factor levels and trends in inequality to such age groups would therefore be inappropriate.

A potential limitation of the study is the use of an area-based measure of socioeconomic status, measured at one point in time (1991). Changes in either local demography or deprivation geography may introduce misclassification error and potentially bias. Analysis of demographic and deprivation changes in the intercensal years between 1991 and 2001 has provided evidence of a trivial degree of change.²⁰ We therefore believe that these factors have not biased the results. It should also be noted that about two thirds of the data relate to the period 1989–93—that is, near the census year. Other limitations are the relatively incomplete ascertainment for some risk factors (BMI, smoking and, particularly, cholesterol) and the potential for risk measurement errors, which due to the non-research design of the study can be considered substantial.

As described, participants in the 1989–93 study period were significantly older and less deprived than the participants in the 1994–9 period. Nevertheless, adjustment for age (which is a feature of all analyses presented here) and adjustment or restriction for deprivation group (which also is a feature of all analyses) can be expected to account for a large amount of potential bias that could have been introduced by this factor. Moreover, the sensitivity analysis approaches used overall failed to provide significant results that could have pointed to alternative time trends. Lastly, visual inspection of the mean

values for each year (1989–99) did not detect any apparent “step” effect between study periods. We therefore believe that the main approach used (analysing all study years together, and adjusting for age and deprivation) was the best method to analyse the dataset in a valid and informative way.

Socioeconomic status can be measured directly (by measuring a person's income, occupation or education) or indirectly by using area-based measures (based on the predominant characteristics of the population of a small area).²¹ An area-based measurement (Townsend deprivation score) was used in this study, in common with other previous UK research in the field of socioeconomic inequalities in health, because information about individual measures of socioeconomic status of participants was incomplete and potentially inaccurate. Although in theory the use of a direct individual marker of socioeconomic status may have been preferable, area-based UK deprivation indices have been shown to predict poor health outcomes at the individual level,²² including coronary heart disease.²³ If full account had been taken of both individual socioeconomic status and deprivation status, socioeconomic differences in risk factor levels would possibly have been even higher, as deprivation is a significant predictor of cardiovascular disease risk, even after adjustment for socioeconomic status measured individually.³ Although Stockport as a whole is more deprived than England and Wales, the range of Townsend deprivation score among study participants was large and comparable with the national range.

Prospective use of routinely collected data has been advocated as a method to help support surveillance and monitoring of risk factor trends in the population.²⁴ Our analysis proves that indeed there is a very important potential for using data relating to the first screening assessment in the Stockport cardiovascular risk factors screening programme, both historically (prospectively) and at present. Information about the studied population could have been of use to health promotion and public health initiatives, at least locally and probably nationally, and could have similarly been used to further inform prospective and timely estimation of the population impact of changes in risk factors. It is of note that population-based data on trends of total cholesterol were not available in the Health Survey for England until 1993, and between 1989–99 such data from the same source are available for only five of the 11 years during 1989–99.

Conclusion

This study provides further evidence that socioeconomic status (measured in this instance with small area deprivation) has an independent effect on the level of exposure to conventional cardiovascular risk factors. Changes in risk factor levels by deprivation group over time differed and were associated with both widening and narrowing of inequalities. This means that overall historical and current inequalities in cardiovascular risk factor levels (and ultimately cardiovascular disease) are likely to persist. The use of routinely available data for monitoring of population trends is supported.

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Supplemental files 1 and 2, including tables, appear on the *Heart* website—<http://www.heartjnl.com/supplemental>

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Authors' contributions: GL identified the research question, with support from RFH. GL developed the statistical methods, with supervisory support by PMcE. PL and MH have over a number of years helped run the Stockport Cardiovascular Risk Factor Screening Programme, and collect and collate data that enabled the analysis to be carried out. GL wrote the first draft of the manuscript. All authors contributed to the writing of the paper and read and approved the final manuscript. The work leading to this report has been carried out as partial fulfilment of study for the degree of MD, University of Manchester, for GL. RFH is GL's supervisor for the named degree and P McElduff is GL's advisor

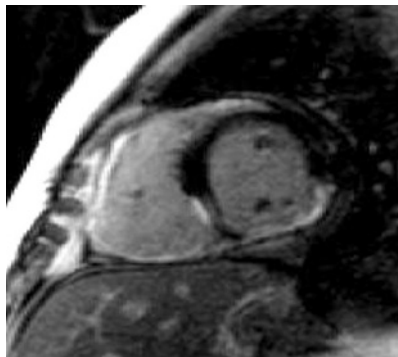
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IMAGES IN CARDIOLOGY

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Cardiac magnetic resonance directed intervention following right ventricular infarction



A 45 year old man presented 30 hours after suffering an inferior ST elevation myocardial infarction (MI). On admission he was in cardiogenic shock with signs of severe right ventricular compromise, a junctional rhythm and acute renal failure. Initial creatine kinase was 4000 iu/l and echocardiography confirmed an akinetic right ventricle and inferior wall of the left ventricle. He was stabilised with supportive medical treatment and a cardiac magnetic resonance (CMR) scan performed to look for viability in the infarct zone and ischaemia in the non-infarcted territory. The late gadolinium images provided a graphic illustration of a right ventricular full thickness MI with no evidence of viability. The dobutamine stress MR images revealed reversible ischaemia in the territory supplied by the left anterior descending artery. This information was used to recommend interventional therapy only to the territory that evidence suggested would benefit from revascularisation. In this case, the right coronary artery was occluded at angiography and, since this supplied non-viable myocardium, it need not be opened. The left anterior descending artery had a severe stenosis and, in view of the reversible ischaemia, revascularisation was recommended. This case provides a rare image of right ventricular infarction and illustrates the valuable use of CMR in directing appropriate interventional therapy.

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