

Trends in the age and sex of patients undergoing coronary revascularisation in the United Kingdom 1987-93

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Abstract

Objectives—To describe how coronary revascularisation rates in the United Kingdom (in the public and private sectors) vary by age and sex; how these relations have changed between 1987 and 1993; whether significant differences exist between geographical areas, public and private sectors, and hospitals; and to make comparisons with trends in North America.

Designs—Secondary analysis of data on the age, sex, procedure, NHS/private, and health district of residence of patients.

Setting—Resident population of South East Thames, East Anglian, and North Western health regions and Greater Glasgow, Lanarkshire, and Ayr/Arran health boards (11.6 million; 20% United Kingdom population).

Patients—All 19 665 residents who underwent either coronary artery bypass grafting or percutaneous coronary angioplasty without any concomitant procedure during 1987-8, 1989-90, 1991-2 and 1992-3 in either NHS or independent hospitals.

Main measures—Population based rates of revascularisation by age, sex, area of residence, and NHS/private treatment. Secular trends in the age (mean, standard deviation, range), and sex ratio (male to female) of patients.

Results—Revascularisation rates in men were about four times higher than in women (1992-3: 1340 v 362/10⁶ aged 25 years or more). The highest rates were in those aged 55-64 years (for men) and 55-64 and 65-74 years (for women). In 1992-3 the mean age of female patients was three years older than that for men (61.2 v 58.3) and that for coronary artery grafting was over two years older than for angioplasty (59.4 v 56.9). Between 1987-8 and 1992-3 the male to female ratio decreased (4.2:1 to 3.55:1) and the mean age of patients increased steadily by about six months each year. Intervention rates for the older groups increased faster than those for the younger, particularly in high rate regions. The age and sex mix of patients varied between regions and districts/boards. The mean age of patients varied by nine years and the sex ratio varied twofold between NHS hospitals. The male to female ratio was higher in private than NHS patients (1992-3: 5.5:1 v 3.6:1), suggesting greater access to

care for men than women in the private sector. The trends observed in the United Kingdom are similar to those that have occurred in North America, with the exception of a decrease in the male to female ratio, which has not previously been reported.

Conclusion—The increase in the revascularisation rate has been accompanied by an increasing proportion of women and older people. The extent of these changes varies between geographical areas. The change in the sex ratio has occurred despite an increasing contribution by the private sector, to which women have less access than men.

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There is increasing evidence from the USA and Canada that rates of coronary artery bypass grafting and percutaneous transluminal coronary angioplasty are related to certain sociodemographic factors and that the strength of these associations are changing. Firstly, patients are increasingly likely to be over 65 years of age,¹⁻³ particularly in those areas of the country with the highest intervention rates. Secondly, revascularisation rates for men are higher than for women.⁴⁻⁶ Thirdly, substantial racial inequalities have been reported with white patients more likely to be treated than black patients.^{7,8} Finally, people with private health insurance are more likely to undergo revascularisation than those dependent on public funding.^{9,10}

Reports of revascularisation rates in the United Kingdom have been restricted either to national figures or crude regional rates which take no account of cross boundary flows or the contribution of the private sector.¹¹⁻¹³ Accurate population based rates for four parts of the country have been published,¹⁴ but no information was provided about the age and sex of the patients. The only British study to examine the influence of such factors found a similar relation between intervention rates and gender as reported in North America.¹⁵

The aims of the work reported here are to describe how revascularisation rates in the United Kingdom (in the public and private sectors) vary by age and sex, how these relation have changed between 1987 and 1993, and to see to what extent similar trends to those observed in North America are occurring.

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Table 1 Mean (SD) age (years) of patients undergoing revascularisation in the four study regions (private patients in South East Thames region excluded)

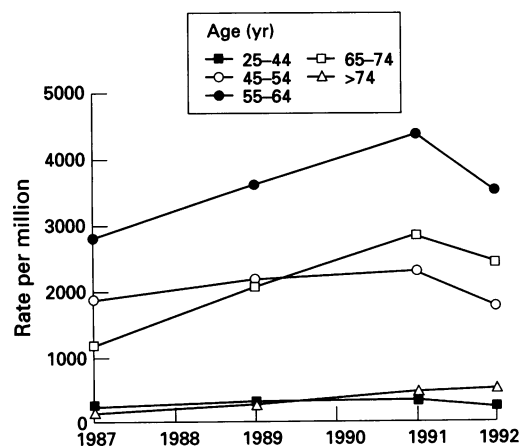
	Men	Women	Overall
Coronary artery bypass grafting			
1987-8	56.1 (8.6)	59.3 (8.7)	56.7 (8.8)
1989-90	57.2 (8.9)	60.1 (9.4)	57.8 (9.1)
1991-2	58.3 (9.1)	61.7 (8.8)	58.9 (9.1)
1992-3	58.8 (9.3)	62.1 (8.7)	59.5 (9.3)
Percutaneous coronary angioplasty			
1987-8	54.4 (9.0)	57.3 (9.8)	55.2 (9.2)
1989-90	55.2 (9.2)	57.5 (10.1)	57.7 (9.5)
1991-2	56.5 (10.0)	59.6 (9.8)	57.3 (10.1)
1992-3	57.2 (9.7)	59.7 (10.2)	57.9 (9.9)
Both procedures			
1987-8	55.8 (8.7)	58.7 (9.1)	56.3 (8.9)
1989-90	56.7 (9.1)	59.2 (9.7)	57.2 (9.2)
1991-2	57.7 (9.4)	60.9 (9.3)	58.4 (9.5)
1992-3	58.3 (9.5)	61.2 (9.4)	58.9 (9.5)

Methods

The study sought to determine the number of procedures for geographically defined populations, allowing for cross boundary flows. Data were collected for the residents of three English health regions (South East Thames, East Anglian, North Western) and three Scottish health boards (Greater Glasgow, Lanarkshire, Ayr/Arran). For the purposes of this paper, the area covered by the three Scottish boards will be referred to as a "region". The study regions covered 11.6 million people in 1992 (20% of the United Kingdom population) and were selected to ensure representation of historical levels of provision and population density. Data for four financial years were studied (1987-8, 1989-90, 1991-2, 1992-3). All residents who underwent either coronary artery bypass grafting (OPCS codes K40-46) or percutaneous transluminal coronary angioplasty (K49-50) without any other procedure were included.

All NHS and private hospitals providing revascularisation services for the residents of the four regions were identified. This was achieved by obtaining aggregated data from all providers in the United Kingdom to establish the patterns of patient flow. Data on individual patients were then collected from all the major providers such that at least 97% of all procedures carried out on the study population were included. This meant obtaining

Figure 1 Age specific rates of coronary revascularisation in men per million population (private patients included except in South East Thames region).



data from 10 NHS and six private hospitals within the regions and six NHS hospitals in other regions. Private hospitals outside the study regions made little contribution in three regions. In the fourth region (South East Thames), however, we were unable to obtain data from four hospitals which may have made a significant contribution, so analyses for that region had to be restricted to NHS patients.

The following data for each patient were obtained from all 22 hospitals: sex, age, procedure, provider unit, and district/board of residence. Data were obtained from a variety of sources including clinical computer systems, manual registers, card indexes, clinicians' summary charts, theatre registers, and case notes. Often patients' addresses had first to be manually assigned a postcode before a health district code could be identified. Data were entered into a dBase file and transferred to a spreadsheet using Lotus 1-2-3. Patients whose age was unknown (about 2%) were distributed across the age range according to the age distribution of those patients whose ages were known.

Data on the resident populations were obtained from official sources.¹⁶ District utilisation rates directly standardised for age and sex (25-44, 45-54, 55-64, 65-74, 75 years or older) were calculated for each procedure for each year and for NHS and private patients separately. The mean ages and the sex ratios for each of the main provider units and for NHS and private patients separately were calculated. Statistical analyses of differences in rates were carried out using the *z* test to compare means and proportions, and trends were analysed using least squares regression with the Durbin Watson statistic (*D*) calculated to test for autocorrelation. A value for *D* close to 2 indicates that the errors are uncorrelated and a significant trend exists.

Results

TRENDS IN THE AGE OF PATIENTS

The mean age of patients increased over the six year period by about six months each year (table 1). This trend was significant at $P = 0.01$ or less for both sexes and the two procedures, with the *D* statistic ranging from 1.97 to 3.3. The mean age of women was about three years older than that for men (1992-3 61.2 *v* 58.3 years; $z = 9.1$; $P < 0.00001$) and the mean age for bypass grafting was about two years older than that for angioplasty (1992-3 59.5 *v* 57.9 years; $z = 9.1$; $P < 0.0001$). These differences have been fairly constant over the six years studied.

Increases in the mean age of patients were reflected in the relative increases in age specific rates. Rates among those aged less than 55 years hardly altered, whereas for those aged 55-64 years the rate increased by about 50%; it doubled for the 65-74 year old patients and trebled for the oldest group (figs 1 and 2). This trend was more pronounced in regions with higher overall intervention rates (South East Thames, Greater Glasgow). The

Figure 2 Age specific rates of coronary revascularisation in women per million population (private patients included except in South East Thames region).

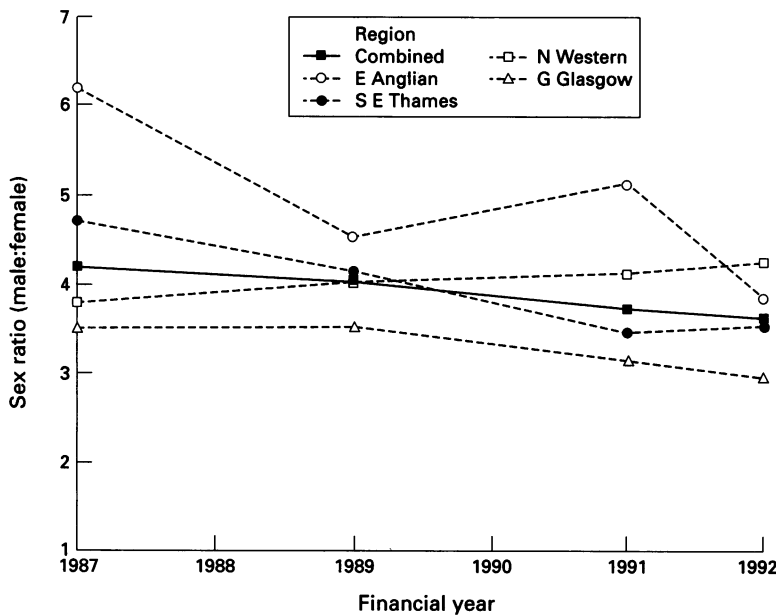
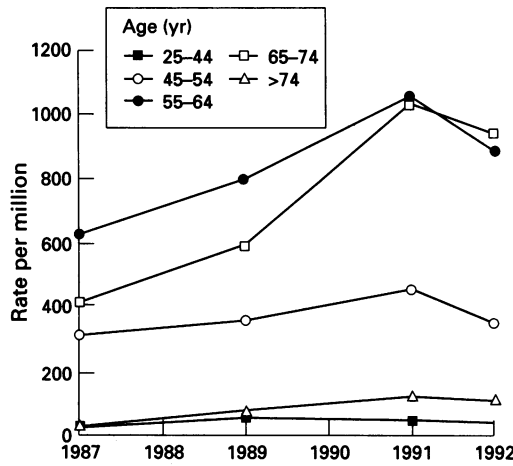


Figure 3 Sex ratio (male to female) of patients undergoing coronary revascularisation (private patients included except in South East Thames region).

observed decrease in some age specific rates in 1992-3 may be due to random fluctuations rather than any significant change in the trends of preceding years. Data for 1993-4 will clarify this.

TRENDS IN THE SEX RATIO OF PATIENTS

Revascularisation rates in men were about four times higher than in women (1992-3 1340 v 362/10⁶ aged 25 years or more). Although men continued to outnumber women in 1992-3 (3.55:1), this was signifi-

Table 2 Variation in the mean age and sex ratio (male to female) of patients (n = 46) between districts

	1987-8	1989-90	1991-2	1992-3
Age (years)				
Range	52.1-62.8	53.8-60.1	54.2-61.9	54.0-62.9
Mean (SD)	56.5 (2.2)	57.1 (1.8)	58.4 (1.7)	58.8 (2.0)
Sex ratio				
Range	1.5-13.0	2.1-13.3	2.0-6.9	2.0-8.2
Mean (SD)	5.1 (2.4)	4.5 (1.9)	3.9 (1.2)	4.5 (2.8)

Table 3 Variation in the age and sex ratio (male to female) of patients between NHS hospitals (n = 10)

	1987-88	1989-90	1991-2	1992-3
Age (years)				
Range	53.4-58.4	53.8-59.1	56.0-60.4	56.7-61.4
Mean (SD)	56.1 (1.4)	56.8 (1.6)	58.2 (1.4)	58.7 (1.5)
Sex ratio				
Range	3.1-6.0	2.6-4.6	2.7-4.8	2.5-5.1
Mean (SD)	4.4 (0.84)	3.9 (0.62)	3.6 (0.76)	3.6 (0.85)

cantly less than in 1987-8 (4.20:1) (fig 3). This significant downward trend ($D = 2.07$; $P = 0.005$) was accounted for by changes in the use of bypass grafting (4.75:1 to 3.99:1) rather than angioplasty (2.98:1 to 2.86:1).

The ratio of men to women differed between regions: it was highest in East Anglian (until 1991-2) and lowest in Greater Glasgow (difference significant at $P < 0.0001$). The ratio decreased in all regions except North Western, in which it increased from 3.8:1 to 4.2:1, representing a significant upward trend ($D = 2.3$; $P = 0.007$).

VARIATION BETWEEN DISTRICTS IN THE AGE AND SEX RATIO OF PATIENTS

The mean age and sex ratio of patients varied between the 46 districts studied. The mean age varied by about nine years (table 2). The amount of variation between districts, as indicated by the standard deviation (SD), did not change significantly over the six years studied. There was also a considerable variation between districts in the sex ratio of patients, though this did show signs of decreasing until 1991-2 (the SD decreased from 2.4 to 1.2). This trend was not maintained in 1992-3, however.

VARIATION BETWEEN HOSPITALS IN THE AGE AND SEX RATIO OF PATIENTS

Differences between hospitals in the age and sex mix of patients have not altered significantly over time (table 3). Although these data are restricted to patients from the study population and do not therefore include the whole workload of the participating hospitals, the study population accounts for most of their work.

DIFFERENCES IN THE AGE AND SEX RATIO OF NHS AND PRIVATE PATIENTS

The mean age and the sex ratio of NHS and private patients were compared for the three regions for which data on the two sectors were available (table 4). Although the mean age of NHS and private patients was similar, private patients were more likely to be men.

Table 4 Comparison of mean age and sex ratio (male to female) of NHS and private patients (East Anglian, South East Thames, and Greater Glasgow regions)

	Mean age (years)		Sex ratio	
	NHS	Private	NHS	Private
1987-8	56.3	55.2	3.8	7.7
1989-90	56.9	56.9	4.2	6.2
1991-2	57.8	57.7	3.9	7.2
1992-3	58.6	57.9	3.6	5.5

Discussion

The rate of coronary revascularisation is clearly related to age and sex. Rates in men are about four times higher than in women and the highest rates occur in those aged 55–64 years (for men) and 55–64 and 65–74 years (for women). The mean age of female patients is three years older than that for men. These differences are not surprising and were already well recognised by clinicians. What was less clear was whether these age and sex differences have been changing in recent years. This paper shows that some significant changes have been taking place that will affect the demand for revascularisation services in the future.

Patients undergoing revascularisation have been steadily getting older. Their mean age increased by about six months each year between 1987 and 1993. This aging of the patient population can be seen in the trends in age specific rates. Rates for the older groups have increased faster than those for the younger groups. These changes have taken place despite the increasing use of angioplasty, the recipients of which tend to be younger (by 18 months to two years) than bypass patients.

Another trend has been the steadily increasing proportion of female patients, who tend to be older than the men. It is unlikely, however, that the increasing intervention rates in women have caused the increase in the mean age. It is more probable that the greater safety of the interventions has led to clinicians being more prepared to treat older people and a growing realisation of the effectiveness of the procedures has led to an increase in the readiness of general practitioners to refer. Given that coronary heart disease tends to affect women at an older age than men, then as the age of those treated increases, the proportion of women would be expected to increase also.

These changes have not been the same everywhere. Significant differences have been observed between regions and districts, between the NHS and private sector, and between hospitals. Variations between regions and districts will be considered in a separate paper. The difference noted between NHS and private patients has not previously been reported. The high proportion of men among the private patients presumably reflects a gender difference in subscribers to private health insurance. Assuming the sex ratio among NHS patients is a truer reflection of the need each sex has for revascularisation, use of services is clearly distorted in the private sector by patients' ability to pay.

The observed differences in the age and sex mix of patients between hospitals may distort interhospital comparisons of outcome and

costs. Clearly, more detailed information on patients, such as clinical severity, is needed before meaningful comparisons of hospitals can be made, but these data show that even such basic factors as age and sex vary significantly.

Our results for the United Kingdom mirror the trends reported in North America. Patients undergoing revascularisation are getting older, particularly in areas with higher intervention rates.^{1–3} Rates for men are higher than for women,^{4–6} though no North American studies have reported the reduction in the difference in rates between the sexes as observed in the United Kingdom. The circumstantial evidence in the United Kingdom that people with private health insurance are more likely to undergo revascularisation than those dependent on public funding is consistent with a North American report.⁹

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