Ethnic differences in long-term improvement of angina following revascularization or medical management: a comparison between south Asians and white Europeans

M. Justin Zaman1, Angela M. Crook1, Cornelia Junghans1, Natalie K. Fitzpatrick1, Gene Feder2, Adam D. Timmis2, Harry Hemingway1

1Clinical Epidemiology Group, Department of Epidemiology and Public Health, University College London, 1-19 Torrington Place, London WC1E 6BT, UK
2Queen Mary’s School of Medicine and Dentistry, University of London, London E1 4NS, UK

Address correspondence to M. Justin Zaman, E-mail: j.zaman@ucl.ac.uk

ABSTRACT

Background It is not known whether there are disparities in morbidity outcomes between south Asians and whites with established coronary disease.

Methods Six-year prospective cohort study to determine whether improvement of angina symptoms differs between 196 south Asians and 1508 whites following revascularization or medical management.

Results 43.9% of south Asians reported improvement in angina at 6 years compared with 60.3% of whites (age-adjusted OR 0.56, 95% CI 0.41–0.76, adjusted for diabetes, hypertension, smoking, number of diseased vessels, left ventricular function and social class OR 0.59, 95% CI 0.41–0.85). Similar proportions of whites and south Asians underwent percutaneous coronary intervention (PCI) (19.6% versus 19.9%) and coronary artery bypass surgery (CABG) (32.8% versus 30.1%). South Asians were less likely to report improved angina after PCI (OR 0.19, 95% CI 0.06–0.56) or CABG (OR 0.36, 95% CI 0.17–0.74). There was less evidence of ethnic differences in angina improvement when treatment was medical (OR 0.87, 95% CI 0.48–1.57).

Conclusion South Asians were less likely to experience long-term improvements in angina than whites after receipt of revascularization. Further research is needed to identify why these ethnic groups differ in symptomatic prognosis following revascularization for coronary disease and how these differences may be mitigated.

Keywords ethnicity, prognosis, South Asian, stable angina

Background

The cardiovascular mortality1–3 of south Asians are often worse than those of the majority population. This may be explained in most part by a higher incidence of cardiovascular disease, as survival among south Asians following myocardial infarction or coronary revascularization appears no worse.4–6 However, little is known about the ethnic differences in morbidity outcomes among people with established coronary disease as studies on cardiovascular outcomes following coronary revascularization have tended to focus on mortality and hospitalized clinical events rather than chronic symptoms, despite revascularization being undertaken primarily for symptomatic relief of angina.7

Angina is the most prevalent symptomatic manifestation of coronary disease,8 a significant burden in primary care,9 and has considerable economic implications.10 The Health Survey for England on minority health reported that morbidity due to angina pectoris may be higher in some minority ethnic populations such as south Asians, a group comprising those of Indian, Pakistani, Bangladeshi and Sri Lankan origin.11 Age-standardized risk ratios for angina were higher for Pakistani men relative to men in the general
population (2.85) and among Bangladeshi women (2.22) relative to women in the general population. However, the contribution of medical care to this is not known. Ethnic disparities in clinical outcomes have been reported in African-Americans, even after adjustment for receipt of revascularization.12

Our objective was to determine whether the course of angina differed between south Asians and white Europeans 6 years following coronary angiography. We sought to examine the effect of differing treatment modalities on change in angina status by ethnicity, and whether patients appropriate for revascularization reported improved angina at 6 years.

Methods

Population
A total of 4121 consecutive patients were eligible for inclusion in the ACRE (Appropriateness of Coronary Revascularization) study if they underwent emergency or elective coronary angiography at the Barts and London Hospitals Trust, London, between 15 April 1996 and 14 April 1997. There were no exclusion criteria and written informed patient consent was obtained. Ethical approval for the study came from the five local research Ethics Committees.

Ethnicity
Self-assigned ethnicity, based on the national 1991 census classification, was obtained by questionnaire on the day of index coronary angiography. Those patients who self-assigned their ethnicity as Bangladeshi, Indian, Pakistani or Sri Lankan we refer to as ‘south Asian’. Of the south Asians in the ACRE study, 41% were Indian, 29% Pakistani, 25% Bangladeshi and 5% Sri Lankan.

Assessment of angina status at baseline and follow-up
On the day of index coronary angiography, patients completed a questionnaire about their general health, coronary heart disease risk factors and angina symptoms using the Canadian Cardiovascular Society (CCS) classification13, which grades angina on a scale ranging from Grade I (chest pain or tightness on strenuous exercise) to Grade IV (inability to carry out any physical activity without discomfort, or pain at rest). All patients who were alive and had consented to follow-up were sent a follow-up questionnaire asking about their angina symptoms (mean date 1 October 2002, response rate 78%). CCS for angina class was available at both baseline and follow-up in 1508 white patients and 196 south Asian patients (Fig. 1). The patients’ primary care physicians were also sent a questionnaire at the time of follow-up asking whether the patient had a current diagnosis of angina in order to cross-check patient questionnaire responses for angina symptoms.

Baseline clinical details
On the day of their index coronary angiography, eligible patients were identified by examination of ward admission and catheter laboratory logbooks. Data were extracted on clinical presentation, present medications, past history of diabetes, total cholesterol (data on TC:HDL ratio were not collected in high enough quality), smoking and hypertension, family history of coronary disease (heart attack, angina or sudden cardiac death in parent/sibling aged under 60), occupation (to assign social class according to the Registrar General’s classification)14 and education from case notes by trained nurses using standardized recording forms. The number of diseased vessels at angiography was calculated from the severity of disease in each of 27 coronary artery segments (as defined by the Coronary Artery Surgery Study). Left ventricular function was elucidated from ventriculography.

Appropriateness ratings
We convened a nine member expert panel (four cardiologists, three cardiothoracic surgeons, a general physician and a primary care physician) to rate the appropriateness of percutaneous coronary intervention (PCI) and coronary artery bypass surgery (CABG); details of the methods, reliability and prognostic validity have been reported elsewhere.15

Follow-up for mortality and hospitalization
At baseline, 99% of patients were flagged for mortality by the Office for National Statistics and were followed up until 14 October 2003. Patients were flagged with the National Health Service-Wide Clearing Service for all-cause hospital inpatient admissions since the date of their index coronary angiogram until 1 October 2002, matched on NHS number, or date of birth, postcode and sex. Details on hospital admission such as revascularization procedures and non-fatal myocardial infarction (ICD-10 code 121) were collected from case notes and from the Patient Administration Systems from the 13 referring hospitals.

Statistical analysis
Baseline coronary risk factor and clinical data were standardized for age and tested for linear trend across angina classes by ethnic group, and tested with an interaction parameter to exclude a significant difference between the trend in whites and the trend in south Asians. To measure course
of angina, follow-up angina score was subtracted from baseline angina score (both 0 to +4), and change in angina was defined and coded as 0 if angina class had not changed or worsened from baseline to follow-up (-4 to 0) and 1 (+1 to +4) if angina had improved. All covariates that were significantly associated with change in angina in the univariate analysis were included in the main analysis. We then performed logistic regression analysis to examine the relationship between ethnicity and change in angina class. We used the likelihood ratio test to select covariates for the final model (at a threshold of $P < 0.1$). Findings are presented as odds ratios with 95% confidence intervals (CIs). We also performed survival analysis to examine the association of change in angina class and death. We plotted Kaplan–Meier curves as a measure of absolute risk and performed Cox proportional hazards regression for relative risk differences. Confounders included in the Cox regression were hypertension, smoking, the number of diseased vessels, left ventricular function and social class. Hazard ratios and 95% CIs are presented alongside the Kaplan–Meier graphs for simplicity.

Results

Baseline correlates of angina
In order to validate the measure of angina across both ethnic groups, we examined angina class versus baseline variables. South Asians with worse angina symptoms were more likely to smoke, have lower mean systolic blood pressure, be in a lower social class, have a higher body mass index and have a worse doctor-defined angina class (Table 1). Whites with worse angina symptoms revealed similar trends and were in addition more likely to have diabetes, a history of myocardial infarction and be on calcium antagonists, nitrates or ACE inhibitors. There was no evidence of any significant differences between the trends in whites and the trends in south Asians.

Change in angina status between ethnic groups
South Asians were more likely to have a diagnosis of angina on the 6-year follow-up primary care physician questionnaire than whites (71/216 (32.9%) versus 403/1691 (23.8%), age-adjusted OR 1.52, 95% CI 1.11–2.07). Fewer south Asians (43.9% (86/196)) reported an improvement in angina symptoms at 6 years compared with whites (60.3% (910/1508), age-adjusted OR 0.56, 95% CI 0.41–0.76). Adjusting for diabetes, hypertension, smoking, the number of diseased vessels, left ventricular function and social class did not attenuate this finding (Fig. 2).

Angina status and relation to revascularization
Similar proportions of each ethnic group underwent PCI (south Asians 19.9% (100/502), whites 19.6% (583/2974))
Table 1 Clinical correlates of angina class at time of coronary angiography by ethnic group

<p>| CCS class | South Asians | | | | | | Whites | | | | | | P for interaction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th>I (n = 10)</th>
<th>III (n = 71)</th>
<th>III (n = 128)</th>
<th>IV (n = 125)</th>
<th>P for trend</th>
<th>I (n = 166)</th>
<th>III (n = 446)</th>
<th>III (n = 685)</th>
<th>IV (n = 905)</th>
<th>P for trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean, years)</td>
<td>56.2</td>
<td>54.0</td>
<td>55.9</td>
<td>56.5</td>
<td>0.150</td>
<td>58.4</td>
<td>60.3</td>
<td>61.5</td>
<td>61.8</td>
</tr>
<tr>
<td>Male</td>
<td>7 (70)</td>
<td>52 (73)</td>
<td>106 (83)</td>
<td>93 (74)</td>
<td>0.905</td>
<td>139 (84)</td>
<td>324 (73)</td>
<td>518 (76)</td>
<td>590 (65)</td>
</tr>
<tr>
<td>Ever smoked</td>
<td>2 (22)</td>
<td>29 (42)</td>
<td>60 (48)</td>
<td>65 (56)</td>
<td>0.014</td>
<td>113 (69)</td>
<td>306 (70)</td>
<td>488 (73)</td>
<td>674 (77)</td>
</tr>
<tr>
<td>Hypertensive</td>
<td>3 (30)</td>
<td>26 (37)</td>
<td>50 (39)</td>
<td>54 (43)</td>
<td>0.317</td>
<td>49 (30)</td>
<td>145 (33)</td>
<td>200 (29)</td>
<td>287 (32)</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>141.2</td>
<td>135.7</td>
<td>133.2</td>
<td>130.6</td>
<td>0.051</td>
<td>134.5</td>
<td>136.3</td>
<td>134.3</td>
<td>132.5</td>
</tr>
<tr>
<td>Total cholesterol (mean, mmol l(^{-1}))</td>
<td>5.69</td>
<td>5.80</td>
<td>5.53</td>
<td>5.61</td>
<td>0.458</td>
<td>5.48</td>
<td>5.67</td>
<td>5.65</td>
<td>5.63</td>
</tr>
<tr>
<td>Diabetes</td>
<td>3 (30)</td>
<td>18 (25)</td>
<td>42 (33)</td>
<td>45 (36)</td>
<td>0.280</td>
<td>12 (7)</td>
<td>35 (8)</td>
<td>71 (10)</td>
<td>102 (11)</td>
</tr>
<tr>
<td>Body Mass Index (mean, kg m(^{-2}))</td>
<td>25.3</td>
<td>25.8</td>
<td>25.6</td>
<td>26.7</td>
<td>0.092</td>
<td>27.6</td>
<td>27.4</td>
<td>27.2</td>
<td>28.1</td>
</tr>
<tr>
<td>Family history of coronary heart disease</td>
<td>3 (33)</td>
<td>28 (42)</td>
<td>38 (34)</td>
<td>38 (35)</td>
<td>0.584</td>
<td>82 (52)</td>
<td>182 (43)</td>
<td>285 (45)</td>
<td>436 (51)</td>
</tr>
<tr>
<td>Lower social class</td>
<td>3 (43)</td>
<td>42 (61)</td>
<td>79 (68)</td>
<td>87 (73)</td>
<td>0.047</td>
<td>91 (56)</td>
<td>235 (54)</td>
<td>377 (57)</td>
<td>519 (59)</td>
</tr>
<tr>
<td>Left school &lt;16</td>
<td>3 (43)</td>
<td>33 (58)</td>
<td>61 (62)</td>
<td>41 (44)</td>
<td>0.186</td>
<td>28 (18)</td>
<td>66 (16)</td>
<td>91 (14)</td>
<td>94 (11)</td>
</tr>
<tr>
<td>Medication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspirin</td>
<td>8 (80)</td>
<td>53 (75)</td>
<td>94 (73)</td>
<td>95 (76)</td>
<td>0.898</td>
<td>136 (82)</td>
<td>334 (75)</td>
<td>511 (75)</td>
<td>691 (76)</td>
</tr>
<tr>
<td>ACE inhibitor</td>
<td>1 (10)</td>
<td>18 (25)</td>
<td>33 (26)</td>
<td>28 (22)</td>
<td>0.839</td>
<td>27 (16)</td>
<td>90 (20)</td>
<td>138 (20)</td>
<td>210 (23)</td>
</tr>
<tr>
<td>Statin</td>
<td>0</td>
<td>11 (15)</td>
<td>21 (16)</td>
<td>18 (14)</td>
<td>0.733</td>
<td>35 (21)</td>
<td>107 (24)</td>
<td>151 (22)</td>
<td>193 (21)</td>
</tr>
<tr>
<td>Beta-blocker</td>
<td>5 (50)</td>
<td>32 (45)</td>
<td>60 (47)</td>
<td>73 (58)</td>
<td>0.153</td>
<td>76 (46)</td>
<td>212 (48)</td>
<td>316 (46)</td>
<td>540 (60)</td>
</tr>
<tr>
<td>Calcium antagonist</td>
<td>5 (50)</td>
<td>32 (45)</td>
<td>60 (47)</td>
<td>73 (58)</td>
<td>0.153</td>
<td>76 (46)</td>
<td>212 (48)</td>
<td>316 (46)</td>
<td>540 (60)</td>
</tr>
<tr>
<td>Nitrate</td>
<td>5 (50)</td>
<td>34 (48)</td>
<td>76 (59)</td>
<td>70 (56)</td>
<td>0.505</td>
<td>78 (47)</td>
<td>282 (63)</td>
<td>431 (63)</td>
<td>657 (73)</td>
</tr>
<tr>
<td>Clinical presentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous myocardial infarction</td>
<td>5 (50)</td>
<td>29 (41)</td>
<td>51 (40)</td>
<td>55 (44)</td>
<td>0.897</td>
<td>62 (37)</td>
<td>163 (37)</td>
<td>295 (43)</td>
<td>399 (44)</td>
</tr>
<tr>
<td>Worse doctor-defined CCS (CCS class III-IV)</td>
<td>2 (22)</td>
<td>20 (30)</td>
<td>56 (47)</td>
<td>68 (63)</td>
<td>&lt;0.001</td>
<td>23 (15)</td>
<td>110 (26)</td>
<td>245 (41)</td>
<td>501 (60)</td>
</tr>
<tr>
<td>Previous percutaneous coronary intervention</td>
<td>1 (10)</td>
<td>3 (4)</td>
<td>9 (7)</td>
<td>13 (10)</td>
<td>0.230</td>
<td>15 (9)</td>
<td>27 (6)</td>
<td>45 (7)</td>
<td>117 (13)</td>
</tr>
<tr>
<td>Previous CABG</td>
<td>1 (10)</td>
<td>1 (1)</td>
<td>8 (6)</td>
<td>20 (16)</td>
<td>0.003</td>
<td>12 (7)</td>
<td>29 (7)</td>
<td>67 (10)</td>
<td>148 (16)</td>
</tr>
<tr>
<td>Angiographic findings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero/mild/moderate diseased vessels</td>
<td>3 (30)</td>
<td>22 (31)</td>
<td>35 (27)</td>
<td>32 (26)</td>
<td>0.943</td>
<td>35 (21)</td>
<td>110 (25)</td>
<td>144 (21)</td>
<td>224 (25)</td>
</tr>
<tr>
<td>1 diseased vessel</td>
<td>4 (40)</td>
<td>18 (26)</td>
<td>30 (23)</td>
<td>27 (22)</td>
<td>0.003</td>
<td>12 (7)</td>
<td>29 (7)</td>
<td>67 (10)</td>
<td>148 (16)</td>
</tr>
<tr>
<td>2 diseased vessels</td>
<td>2 (20)</td>
<td>19 (27)</td>
<td>27 (21)</td>
<td>18 (15)</td>
<td>0.320</td>
<td>32 (19)</td>
<td>87 (20)</td>
<td>142 (21)</td>
<td>181 (20)</td>
</tr>
<tr>
<td>3 diseased vessels/LMS</td>
<td>1 (10)</td>
<td>11 (16)</td>
<td>36 (28)</td>
<td>45 (37)</td>
<td>0.489</td>
<td>48 (29)</td>
<td>128 (29)</td>
<td>187 (28)</td>
<td>265 (29)</td>
</tr>
<tr>
<td>Impaired left ventricle</td>
<td>1 (13)</td>
<td>6 (10)</td>
<td>30 (28)</td>
<td>29 (31)</td>
<td>0.249</td>
<td>24 (19)</td>
<td>80 (22)</td>
<td>125 (22)</td>
<td>168 (23)</td>
</tr>
</tbody>
</table>

P-value for trend is age-standardized. Values for categorical variables are numbers of patients with percentages of total number with data for that variable (all cells were more than 75% complete for data); continuous variables are as stated. P-value for interaction examines whether trends across CCS by ethnic group are different, a high P-value implying no significant difference and thus suggesting equivalent trends in both ethnic groups, hence taking into account smaller numbers in the South Asian group. Table does not include patients CCS = 0 (n = 32 for South Asians and n = 265 for whites).
Numbers (%) with improved angina

<table>
<thead>
<tr>
<th></th>
<th>White</th>
<th>South Asian</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>910/1508 (60.3)</td>
<td>86/196 (43.9)</td>
</tr>
<tr>
<td>All</td>
<td>910/1508 (60.3)</td>
<td>86/196 (43.9)</td>
</tr>
<tr>
<td>Medical</td>
<td>370/899 (42.9)</td>
<td>129/297 (43.3)</td>
</tr>
<tr>
<td>PCI</td>
<td>164/279 (58.8)</td>
<td>123/345 (35.3)</td>
</tr>
<tr>
<td>CABG</td>
<td>370/530 (70.9)</td>
<td>32/65 (49.2)</td>
</tr>
</tbody>
</table>

Odds ratio (95% CI)

- All: 0.56 (0.41, 0.76)*
- Medical: 0.48 (0.29, 0.81)**
- PCI: 0.87 (0.48, 1.57)**
- CABG: 0.19 (0.06, 0.56)**
- South Asians: 0.36 (0.17, 0.74)**

Log odds ratio

*Age adjusted
**Adjusted for age, diabetes, hypertension, the number of diseased vessels, total cholesterol, left-ventricular function and social class

Fig. 2 Odds of improvement in angina in south Asians compared with white patients within whole study population and by management strategy.

Worse angina symptoms at baseline were associated with higher rates of all-cause mortality in both south Asians (log-rank test \( P = 0.009 \)) and white patients (log-rank test \( P < 0.001 \)) on survival analysis (Fig. 3). Age-adjusted mortality rates did not differ by ethnicity in the ACRE cohort (64/502 deaths in south Asians, 587/2974 in whites, HR 0.96 (95% CI 0.75–1.22)).

Discussion

Main findings

This is the first study to report on long-term differences between south Asians and whites in symptomatic outcomes of
coronary disease. Our findings reveal that south Asians were less likely to experience long-term improvement in angina symptoms following coronary revascularization when compared with whites. Relief of angina symptoms determines quality of life through return to work and perceived health status.\textsuperscript{16} We found lesser improvement in angina symptoms among south Asians compared with whites both in those deemed appropriate (from our pre-defined, validated definition of appropriateness) for revascularization, and in those undergoing revascularization ultimately. Though south Asian patients are less likely to receive revascularization than white patients,\textsuperscript{6} by accounting for appropriateness in our study, access to treatment alone cannot account for the lesser improvement in angina symptoms among south Asians observed in this study. In studies examining access to angiography, south Asians have been reported to be more likely to have coronary angiography than whites.\textsuperscript{17}

The importance of adding patient-defined, symptomatic outcomes to standard mortality outcomes should be underlined, especially considering that coronary revascularization for angina, either by PCI or CABG, is performed primarily for relief of symptoms.\textsuperscript{7} Few studies examine symptomatic outcomes following revascularization and as our study revealed no differences in long-term mortality between these two ethnic groups following angiography, the examination of symptomatic outcomes becomes more relevant.

**What is known already**

There are no studies on symptomatic outcomes following specialist management of chronic coronary disease in south Asians. Revascularization of smaller coronary arteries has been associated with less favourable clinical outcomes in south Asians\textsuperscript{18} and we found that the rate of repeat PCIs in south Asians was greater than among whites. Diabetes may also alter the perception of cardiac pain if associated with neuropathy.\textsuperscript{19} However, adjusting for the greater prevalence of diabetes and lower body mass index in south Asians in ACRE compared with white patients did not attenuate the observed differences in angina symptoms’ improvement between the ethnic groups.

**Limitations of this study**

Our present study could not discriminate subgroups of south Asians, a heterogeneous group composed of different nationalities and religions (e.g. Indians, Bangladeshis, Muslims and Hindus). Evidence exists of differences in baseline risk factors between these subgroups.\textsuperscript{4} There is however less evidence on differences in symptoms between subgroups—the Health Survey for England suggested that certain subgroups (Pakistani men and Bangladeshi women) have a higher burden of angina, though these data were not adjusted for differences in risk factor profile. Any differences in symptoms between subgroups may however be related to socio-economic factors such as education and income.

**Conclusions**

We found that south Asians were less likely to have improved angina symptoms than whites 6 years after undergoing coronary revascularization, even after having taken into account appropriateness for revascularization and differences in clinical characteristics. To fully confirm and understand this ethnic inequality in symptomatic outcomes
will require further research in order to elucidate the reasons underlying this difference and how it can be reduced.

**Supplementary data**

Supplementary data are available at *Journal of Public Health* online.

**Acknowledgements**

The authors would like to thank the patients of the ACRE study.

**Funding**

The ACRE study was funded by the North Thames NHS research and development programme (RFG 258) and the British Heart Foundation (PG/97216). M.J.Z. is the recipient of a British Heart Foundation Clinical PhD studentship (FS/04/062); H.H. is supported by a Department of Health Public Health Career Scientist Award.

**Competing interests**

None declared.

**Author’s contributions**

M.J.Z. had the original idea, did all the statistical analysis, wrote the first draft and is the guarantor. C.J. and A.M.C. were involved in further analysis. G.F., A.D.T. and N.K.F. were involved in the discussion and interpretation. H.H. contributed to the first draft and analysis, and was involved in the discussion and interpretation. All authors participated in the discussion and interpretation of the final results and contributed to the final paper.

**References**


