Asian Indians, coronary artery disease, and physical exercise

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Abstract

Objective—To evaluate the relation of physical activity to different clinical and biochemical risk factors for coronary artery disease among people from different ethnic groups with angiographically proven coronary artery disease.

Subjects—British Asians, Indian Asians, and white people suffering from coronary artery disease, and their respective controls.

Interventions—History, physical examination, coronary angiography (at baseline), laboratory investigations.

Main outcome measures—Relation of physical activity level to serum insulin, glucose, cholesterol, triglycerides, and high density lipoproteins, systolic and diastolic blood pressures, and body mass index in patients and controls.

Results—391 male patients were studied, of whom 260 (66.5%) were classified as sedentary. Mean serum insulin at 0, 1, and 2 hours after 75 g oral glucose was higher among the sedentary population (17.1 *v* 11.6, 88.2 *v* 62.1, and 57.9 *v* 36.2 µU/ml, respectively (all p < 0.0001). Mean body mass index was also higher among the sedentary population (25.53 *v* 23.95, p < 0.0001), as were mean serum triglycerides (1.85 *v* 1.60 mmol/l, p < 0.01) and systolic and diastolic blood pressures (133.9 *v* 129.4, p < 0.05, and 81.1 *v* 79.0, p < 0.01). There was no difference in the mean serum cholesterol and high density lipoprotein between the two groups. British Asians were the most sedentary and Indian Asians the most physically active.

Conclusions—There are marked differences in the level of physical activity among the various ethnic groups in the United Kingdom. In each ethnic group, physical activity reduced mean serum insulin, body mass index, and serum triglycerides and had a favourable effect on systolic and diastolic blood pressures. Promotion of physical activity could be of value for the Asian community in the United Kingdom.

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Cardiovascular disease remains a major cause of death in developed countries. The United Kingdom has one of the highest rates of mortality from coronary artery disease in the world. In recent years, evidence has emerged that migrants from the Indian subcontinent are more likely to die from this cause than the native British population. The cause of this high mortality in Asian Indians is probably multifactorial. This study was designed to evaluate the relation of physical activity to different clinical and biochemical risk factors for coronary artery disease among different ethnic groups with angiographically proven coronary artery disease. The effect of the environment and migration on Asians was also studied by recruiting subjects from India.

Methods

The study was carried out between January 1988 and March 1990 at the University Department of Medicine, Withington Hospital, and the Department of Cardiology, Wythenshawe Hospital, Manchester.

Patients were eligible for inclusion in the study if they had undergone a coronary angiogram to investigate the cause of chest pain and if the angiogram showed a stenosis of more than 50% of the luminal diameter in one of the major epicardial coronary arteries. Patients known to be suffering from familial hypercholesterolaemia and those being investigated primarily for a valve disorder and who on coronary angiography had more than 50% luminal diameter stenosis in one of the major epicardial coronary arteries were excluded.

Subjects included in this study belonged to four different categories:

(1) *British Asians*: Asian patients, who were permanent residents of the United Kingdom (average length of stay 22 to 28 years). Asian patients who were visitors to the United Kingdom and had been referred for coronary angiography were excluded.

(2) *Indian Asians*: Consecutive Indian Asian patients who had diagnostic coronary angiography between 1 January 1990 and 24 January 1990 at the Regional Cardiac Centre, New Delhi, India.

(3) *White patients*: every 23rd white male patient and every 24th white female patient who was investigated for chest pain was included in the study on the following basis: there were 1523 diagnostic coronary angiograms carried out in the year preceding the start of this study, that is, from 1 January 1987 to 31 December 1987, of which 289 were performed on female patients; 65 Asian patients had undergone a coronary angiogram for investigation of chest pain during this period, of whom 12

Table 1   Comparison of measured variables between all male subjects taking exercise (non-sedentary) and those not taking regular exercise (sedentary)

Variable	Sedentary (n=260)	Non-sedentary (n=131)	p value
Log serum insulin 0 h (μU/ml)	17.1 (15.6 to 18.7)	11.6 (10.3 to 12.9)	<0.0001
Log serum insulin 1 h (μU/ml)	88.2 (80.6 to 92.7)	62.1 (54.0 to 70.8)	<0.0001
Log serum insulin 2 h (μU/ml)	57.9 (52.4 to 64.0)	36.2 (29.3 to 37.3)	<0.0001
Body mass index (kg/m^2)	25.5 (0.2)	24.0 (0.2)	<0.0001
Total serum cholesterol (mmol/l)	5.97 (0.06)	5.88 (0.10)	NS
Log serum triglycerides (mmol/l)	1.85 (1.73 to 1.95)	1.60 (1.50 to 1.69)	<0.01
Log serum high density lipoprotein (mmol/l)	1.08 (1.06 to 1.10)	1.12 (1.07 to 1.16)	NS
Systolic blood pressure (mm Hg)	133.9 (1.2)	129.4 (1.8)	<0.05
Diastolic blood pressure (mm Hg)	81.1 (1.1)	79.0 (1.6)	<0.01

Values are means with 95% confidence intervals or SEM.

were females; white people were selected on the assumption that similar numbers would apply during the years of the study with respect to the total number of coronary angiograms performed, the number of such angiograms being performed on Asian patients, and the sex distribution of these patients.

(4) *Controls*: control subjects were recruited from the lists of five local general practices. They were randomly selected and were as far as possible age matched with their respective patient groups. Their medical notes were reviewed and persons with the following conditions were excluded: documented ischaemic heart disease, that is, myocardial infarction or angina; documented peripheral or cerebrovascular disease; hypertension requiring treatment; primary lipid disorders; psychiatric disorders or mental handicap; malignant disease or other severe illness. People registered as temporary residents were also excluded.

Controls from among the Indian Asian group were recruited randomly from the minor surgical outpatient clinic of the same hospital from where the patients were recruited.

HISTORY AND EXAMINATION
A detailed history and physical examination was carried out on each patient. Severe angina was defined for the purposes of the study as a history of angina at rest or on minimal exertion, all other angina being classified as mild to moderate. Social class was defined as professional or managerial, clerical work, skilled work, and unskilled work. The patients were divided on the basis of their physical activity into two groups: *non-sedentary*, defined as those who were either on their feet for most of the day as part of their job or taking regular physical exercise; and *sedentary*, defined as those who were on their feet for less than half the day as part of their job and not taking any form of regular exercise.[1]

BLOOD SAMPLING
The following protocol was employed for both patients and controls. After an overnight fast, subjects attended the hospital clinic between 0830 and 0930 am and a fasting blood sample was taken. They were given 75 g anhydrous dextrose diluted in 500 ml of water and blood samples were taken 60 minutes and 120 minutes later. The 60 minute sample was omitted in the Indian Asian group. Those patients who were on thiazide diuretics were asked not to take their medication for three days before sampling, and those taking β blockers had their treatment substituted with a calcium antagonist one month before the date on which the sample was due to be taken. Non-insulin-dependent diabetics were asked to omit chlorpropamide for 48 hours or all other oral hypoglycaemic agents for 24 hours before blood sampling. Blood samples were not taken from insulin dependent diabetic subjects.

LABORATORY INVESTIGATIONS
All laboratory investigations for British Asians and white people were performed within 24 hours of blood sampling except for insulin estimations. For serum insulin concentrations, serum from the British Asian and white patients was separated immediately and stored at −20°C. Estimations were done within three to five weeks. For Indian Asian subjects, serum glucose was measured within 24 hours of sampling, while the serum for insulin estimation was stored at −20°C and transported to the United Kingdom on dry ice. Serum for lipid estimations was transported in a cool box to the laboratory in the United Kingdom for analysis.

Serum glucose
Serum glucose was measured by an automated glucose oxidase method. Subjects were classified as being normoglycaemic if the serum glucose concentration was < 7.8 mmol/l, or having impaired glucose tolerance (IGT) if their glucose value was ≥ 7.8 mmol/l but < 11.1 mmol/l, and diabetic if ≥ 11.1 mmol/l.

Serum insulin
Serum insulin was measured by radioimmunoassay, using a coated tube obtained from Diagnostic Products, the tests being done in duplicate. The interassay variability was less than 6% throughout the period of estimation. All estimations were performed in the same laboratory (Department of Biochemistry, Wythenshawe Hospital, Manchester) and by the same biochemist.

Serum cholesterol
A totally enzymatic method was used to estimate serum cholesterol. Hydrogen peroxide formed during the oxidation of cholesterol was used in conjunction with peroxidase, an aminophenazone, and phenol, to form quinoneimine dye. These methods have been described in detail by Siedel et al,[2] Fredrickson et al,[3] and Trinder.[4]

Serum triglycerides
Serum triglycerides were determined after enzymatic hydrolysis with lipases. The indicator used was a quinoneimine formed from hydrogen peroxide, 4-aminoantipyrine, and 4-chlorophenol under the catalytic influence of peroxidase as described by Trinder et al.[4]

Table 2 Comparison of measured variables between white men taking regular exercise (non-sedentary) and those not taking regular exercise (sedentary)

Variable	Patients			Controls		
	Sedentary (n=55)	Non-sedentary (n=32)	p value	Sedentary (n=51)	Non-sedentary (n=30)	p value
Log serum insulin 0 h (μU/ml)	16.0 (7.9 to 19.4)	8.4 (7.1 to 9.8)	<0.001	7.6 (6.3 to 9.0)	7.6 (5.7 to 10.0)	NS
Log serum insulin 1 h (μU/ml)	84.8 (75.1 to 99.4)	54.9 (43.8 to 68.1)	<0.01	52.4 (45.6 to 62.8)	47.9 (37.7 to 60.9)	NS
Log serum insulin 2 h (μU/ml)	56.3 (46.0 to 68.7)	27.7 (22.1 to 34.4)	<0.001	27.9 (21.9 to 35.5)	24.5 (18.9 to 31.8)	NS
Body mass index (kg/m²)	26.3 (0.4)	24.6 (0.5)	<0.01	25.1 (0.3)	24.4 (0.4)	NS
Total serum cholesterol (mmol/l)	6.18 (0.13)	6.56 (0.23)	NS	6.11 (0.11)	6.02 (0.18)	NS
Log serum triglycerides (mmol/l)	1.78 (1.50 to 2.00)	1.80 (1.50 to 2.10)	NS	1.27 (1.12 to 1.43)	1.33 (1.18 to 1.50)	NS
Log serum high density lipoprotein (mmol/l)	1.07 (1.01 to 1.13)	1.08 (1.00 to 1.10)	NS	1.28 (1.20 to 1.36)	1.29 (1.19 to 1.40)	NS
Systolic blood pressure (mm Hg)	141.8 (3.0)	130.8 (4.6)	<0.05	138.3 (2.3)	134.6 (2.8)	NS
Diastolic blood pressure (mm Hg)	83.8 (16.6)	78.2 (28.8)	<0.05	82.5 (1.1)	82.1 (1.3)	NS

Values are means with 95% confidence intervals or SEM.

High density lipoprotein cholesterol
The method used was based on a manganese phosphotungstate precipitation procedure as outlined by Burstein *et al*.[5]

Low density lipoprotein cholesterol
Serum low density lipoprotein cholesterol was calculated by the formula: total cholesterol − HDL cholesterol − 0.46 × triglycerides (all values being expressed in mmol/l).

Apolipoproteins (apoA-I, apoB, Lp(a))
These were measured by Rocket immunoelectrophoresis using home produced (sheep) antisera. Pooled human sera was employed as a standard, values being assigned using commercially available reference sera. Amido black stain was used to visualise the rockets. The interassay coefficient of variation was 6%.

Apolipoprotein E
ApoE phenotypes were measured by a modification of the method described by Kane and Gowland[6] with localisation of the isoforms by the enzyme linked antibody following nitrocellulose blotting. Measurements of apoA-I, apoB, Lp(a), and apoE phenotype were performed in the same laboratory (Department of Biochemistry, Christie Hospital, Manchester), by the same biochemist.

STATISTICAL ANALYSIS
All statistical analysis for this study was performed under the supervision of the head of department, statistical unit, Withington Hospital. Group means were compared using the unpaired Student *t* test; where appropriate, raw data were log transformed to normalise distributions. Distributions were compared using χ^2 tests. Simple regression analysis was performed

to examine the relations between various cardiovascular risk factors within the study groups. The relative risk of coronary atherosclerosis in each ethnic group was computed on a univariate analysis. Multiple regression analysis was performed in an attempt to assess the relative influence of each risk factor on the presence of coronary atherosclerosis within and between each ethnic group.

Data analysis and comparison
Data on all the variables were analysed for white people, British Asians, and Indian Asians together, and statistical values determined; however, the demographic data and the data on lipids, glucose, and insulin were compared between either British Asians and white people, or British Asians and Indian Asians. This was done to highlight the effect of migration in British Asians and to compare British Asians with the white natives of their country of migration.

Results
There were 111 British Asians who underwent coronary angiography during the study period, of whom 83 males and 12 females agreed to take part. From the white group (n = 95), 87 males and eight females agreed to take part. As the total number of females was small, they were excluded from the study. Thirty consecutive Asian Indian patients who were found suitable and who consented were also included in the study. The proportion of controls who, after selection, took part in the study was 84% for the white group and 63% for British Asians.

SEDENTARY *v* NON-SEDENTARY SUBJECTS
Of all the patients included in this study, 260 were classified as sedentary and 131 as non-sedentary. Subgroup analysis showed that

Table 3 Comparison of measured variables between British Asian males taking regular exercise (non-sedentary) and those not taking regular exercise (sedentary)

Variable	British Asian patients			British Asian controls		
	Sedentary (n=61)	Non-sedentary (n=19)	p value	Sedentary (n=66)	Non-sedentary (n=14)	p value
Log serum insulin 0 h (μU/ml)	31.8 (26.0 to 36.5)	18.9 (15.1 to 21.7)	<0.001	19.6 (17.4 to 22.1)	13.5 (11.1 to 16.6)	<0.01
Log serum insulin 1 h (μU/ml)	127.7 (106.6 to 152.9)	125.2 (77.4 to 135.6)	NS	93.6 (81.4 to 107.7)	73.6 (62.8 to 86.4)	<0.05
Log serum insulin 2 h (μU/ml)	94.6 (80.6 to 111.0)	50.90 (37.7 to 68.7)	<0.001	60.9 (54.0 to 68.7)	42.5 (34.4 to 47.4)	<0.05
Body mass index (kg/m²)	25.9 (0.3)	24.3 (0.7)	<0.05	24.9 (0.3)	23.1 (0.5)	<0.01
Total serum cholesterol (mmol/l)	6.21 (0.14)	5.96 (1.80)	NS	5.65 (0.11)	5.88 (0.29)	NS
Log serum triglycerides (mmol/l)	2.50 (2.20 to 2.70)	1.95 (1.60 to 2.30)	<0.05	1.82 (1.60 to 2.00)	1.85 (1.60 to 2.10)	NS
Log serum high density lipoprotein (mmol/l)	1.00 (0.90 to 1.00)	1.09 (1.03 to 1.16)	NS	1.05 (1.01 to 1.09)	1.11 (1.00 to 1.20)	NS
Systolic blood pressure (mm Hg)	132.5 (2.6)	122.1 (4.1)	<0.05	124.7 (2.2)	109.7 (3.1)	<0.01
Diastolic blood pressure (mm Hg)	79.9	76.3	NS	78.8	73.5	<0.05

Values are means with 95% confidence intervals or SEM.

Table 4 Comparison of measured variables between Indian Asian males taking regular exercise (non-sedentary) and those not taking regular exercise (sedentary)

Variable	Indian Asian patients			Indian Asian controls		
	Sedentary (n=14)	Non-sedentary (n=16)	p value	Sedentary (n=10)	Non-sedentary (n=20)	p value
Log serum insulin 0 h (µU/ml)	16.7 (12.6 to 21.3)	19.8 (15.1 to 21.7)	NS	16.1 (14.0 to 18.5)	13.1 (11.4 to 15.1)	NS
Log serum insulin 1 h (µU/ml)	—	—		—	—	
Log serum insulin 2 h (µU/ml)	64.0 (42.9 to 95.5)	74.4 (55.1 to 100.4)	NS	79.0 (46.9 to 132.9)	36.2 (29.6 to 44.2)	<0.01
Body mass index (kg/m^2)	25.1 (0.7)	22.9 (0.6)	<0.05	25.6 (0.5)	23.4 (0.7)	<0.05
Total serum cholesterol (mmol/l)	5.61 (0.30)	5.28 (0.20)	NS	5.12 (0.43)	5.00 (0.19)	NS
Log serum triglycerides (mmol/l)	2.33 (1.90 to 1.10)	1.59 (1.30 to 1.80)	<0.01	1.58 (1.06 to 2.30)	1.29 (1.10 to 1.40)	NS
Log serum high density lipoprotein (mmol/l)	1.04 (0.90 to 1.00)	1.17 (1.00 to 1.20)	NS	1.28 (1.05 to 1.50)	1.19 (1.90 to 1.30)	NS
Systolic blood pressure (mm Hg)	132.6 (5.7)	142.7 (4.2)	NS	138.0 (6.2)	129.7 (4.0)	NS
Diastolic blood pressure (mm Hg)	80.2 (2.1)	81.6 (1.7)	NS	82.6 (2.4)	79.4 (1.2)	NS

Values are means with 95% confidence intervals or SEM.

while the British Asians were the most sedentary of all the patients and controls included in the study (122 of 155; 78.7%), followed by the white group (106 of 167, 63.5%), with the Indian Asians being the least sedentary (24 of 60; 40%) (table 1). A comparison of sedentary versus non-sedentary subjects showed that the log insulin concentration at 0, 1, and 2 hours, body mass index, log triglyceride concentration, and the systolic and diastolic blood pressures were all higher in the sedentary group (table 1). However, total cholesterol and log high density lipoprotein cholesterol were not significantly different in the two groups.

WHITE PATIENTS *v* WHITE CONTROLS
Of 87 white patients who took part in this study, 55 were classified as sedentary and 32 as non-sedentary. Sedentary white patients had a higher log insulin concentration at 0, 1, and 2 hours after oral glucose, a higher body mass index, and higher systolic and diastolic blood pressures than their non-sedentary counterparts (table 2). There was no difference, however, in total cholesterol, log triglycerides, or log high density lipoprotein cholesterol between the two groups.

In the white control group, 51 subjects were classified as sedentary and 30 as physically active. There was no difference in any of the above variables between the two groups (table 2).

BRITISH ASIAN PATIENTS AND CONTROLS
The British Asian patient group comprised of 80 patients, of whom 61 were sedentary and 19 non-sedentary. The log insulin concentrations at 0 and 2 hours after oral glucose, body mass index, log triglycerides, and the systolic blood pressure were all significantly higher in the sedentary group (table 3). However, log insulin at 1 hour, total cholesterol, high density lipoprotein cholesterol, and diastolic blood pressure were not significantly different between the two groups (table 3).

Among the British Asian controls there were 66 who were sedentary and 14 who were non-sedentary. In contrast to the white controls, the sedentary British Asian controls tended to have higher log insulin concentrations at all the three measurement times, a greater body mass index, and higher systolic and diastolic blood pressures. However, the lipid levels in these two groups, that is, total cholesterol, log triglycer-

ides, and log high density lipoproteins, were comparable (table 3).

INDIAN ASIAN PATIENTS AND CONTROLS
There were 30 Indian Asian patients and 30 controls. Fourteen of these 30 patients were sedentary, as were 10 of the 30 controls. Body mass index and log triglyceride concentrations were higher in the sedentary than in the non-sedentary patients (table 4). Log insulin concentration at 2 hours after oral glucose and body mass index were higher in sedentary controls than in non-sedentary controls (table 4).

SUMMARY
A significant difference was seen in subjects who were taking regular exercise compared with their sedentary counterparts. Across all ethnic groups, body mass index, serum insulin at 0, 1, and 2 hours after oral glucose, and serum triglycerides all tended to be lower in subjects taking regular exercise. Systolic and diastolic blood pressures also tended to be lower among the non-sedentary subjects, though not in the Indian Asians.

Discussion
There were marked differences between the physical activity levels in the three ethnic groups. British Asians included the most sedentary patients and controls and Indian Asians the least. In each ethnic group, physical activity was associated with reduced serum insulin, body mass index, and triglycerides, and had a favourable effect on systolic and diastolic blood pressure. The only known environmental influences on insulin resistance are dietary energy intake[7] and physical activity.[8] It is thus probable that the high serum insulin values, and hence the other disturbances associated with this in British Asians, are aggravated by relatively low levels of physical activity. Asians overall had lower levels of physical activity than white people in the study by Hughes.[9] In contrast, our study shows that subjects in India are *more* physically active than their counterparts in Britain. Though the sample size in this study was small, most of the patients and controls were recruited from an urban setting in India and were probably less active than their rural counterparts, who are mainly employed in unmechanised farming. This view is supported by a study by Jajoo *et al*[10] from a rural population of Central India which showed that the

great majority of their subjects, both men and women, were physically active. In their study, only 84 of 1338 men were sedentary. They also showed that the prevalence of coronary artery disease (from electrocardiographic evidence) was much lower in subjects taking physical exercise than in those who were largely sedentary.

On the basis of these observations, therefore, the promotion of increased physical activity in health education campaigns could be rewarding for the Asian community in the United Kingdom.

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