EPIDEMIOLOGY

Like father like son? Sons of patients of European or Indian origin with coronary artery disease reflect their parents' risk factor patterns

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Abstract

Objective—To investigate the extent to which risk factor patterns associated with coronary artery disease (CAD) in patients of Indian origin and in those of North European origin undergoing coronary angiography for suspected angina were reflected in their apparently healthy sons aged 15–30 years.

Design—Prospective study in which risk markers were measured in patients of Indian origin and in matched European patients undergoing angiography and in their sons.

Setting—Patients attending a regional cardiac centre and their families.

Patients—102 consecutive male patients of Indian origin undergoing diagnostic coronary angiography for suspected angina and 89 of their sons aged between 15 and 30 years; 102 age matched male European patients and 82 sons.

Main outcome measures—Father son correlations for risk markers predicting the severity of parental CAD; differences in mean levels of these markers between young males of Indian origin and those of North European origin.

Results—Lp(a) lipoprotein, total cholesterol, and serum insulin were independent predictors of the severity of CAD in patients of Indian origin and in those of North European origin. In both groups, there was strong correlation between paternal and filial serum insulin ($r = 0.41$ Indian origin, $r = 0.49$ North European, $P < 0.001$), Lp(a) lipoprotein ($r = 0.44$ Indian origin, $r = 0.48$ North European, $P < 0.001$), and total cholesterol ($r = 0.39$ Indian origin, $r = 0.45$ North European, $P < 0.001$) concentrations, and the risk factor profiles of the sons were predictive of CAD severity in their fathers. Sons of patients of Indian origin had significantly higher serum insulin (Indian origin 14.3 mU/l v North European 8.4 mU/l, $P = 0.002$) and Lp(a) lipoprotein (Indian origin 19.1 mmol/l v North European 10.5 mmol/l, $P = 0.001$) concentrations than sons of patients of North European origin.

Conclusions—Apparently healthy young men aged 15–30 years from either ethnic community already reflect risk marker patterns associated with coronary artery

disease in their parents, both for genetically determined factors such as Lp(a) lipoprotein and environmentally influenced factors such as insulin and cholesterol. Health promotion measures aimed at reducing the prevalence of CAD should include the adolescent and young adult populations, particularly those with a family history of CAD, or who are from ethnic communities in which this diagnosis is prevalent.

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Keywords: coronary artery disease; risk factor patterns in fathers and sons; ethnic populations.

All groups of Indian origin in the United Kingdom have an increased incidence and prevalence of, and mortality from, coronary artery disease (CAD).¹ Much of the current literature concerning these populations refers to people over the age of 40 years, most of whom were born outside the United Kingdom. It has been emphasised that if current trends in mortality associated with CAD continue, there may be a threefold increase in standardised death rates in the United Kingdom community of Indian origin by the year 2005.² It is important to know to what extent increased risks can be extrapolated to the next generation of individuals of Indian origin, who were born and raised in the United Kingdom.

We have previously shown a consistent association of conventional coronary risk factors with severity of angiographically assessed CAD in patients of Indian origin and in those of North European origin undergoing diagnostic coronary angiography.³ In the present study we have measured an extended range of risk factors for CAD in new cohorts of patients of Indian origin and of North European origin undergoing angiography for suspected angina, and also in their "healthy" male offspring aged 15–30 years. Our aims were to determine the relation of risk markers with the severity of CAD in samples of patients of Indian origin and of those of North European origin, to evaluate differences between young males of Indian origin and of North European origin in respect of the same risk markers, and finally to ascertain the extent to which risk marker differences within

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each group of young relatives is explicable in terms of their parents' risk factor profile and severity of CAD.

Patients and methods

Some 102 of 109 consecutive male patients of Indian origin undergoing diagnostic coronary angiography for suspected angina at our institution between July 1992 and August 1993 were recruited into the study. A total of 102 patients of North European origin investigated for suspected angina over the same period were matched for age and symptom duration with the patients of Indian origin. Ethnicity of the Indian origin group (Gujerati or Punjabi) was established by grandparental origin. Route of migration to the United Kingdom and religion were also recorded. Sons aged 15–30 years of patients in either group were approached and invited to participate in the study. Some 89 offspring of Indian origin (related to 72 patients of Indian origin) and 82 offspring of North European origin (related to 74 patients) were recruited. Six sons of Indian origin and four sons of North European origin declined to participate in the study.

Severity of parental CAD was assessed from the numbers of vessels involved and coronary lesions observed. Coronary arteriograms were classified in three groups: minimal disease (no diameter stenosis > 70% in any vessel), single vessel disease (stenosis > 70% in one vessel only), and multivessel disease (stenosis > 70% in two or more vessels). In addition, angiograms were scored for extent of coronary disease by the method of Hughes *et al.*,⁴ which allocates a numerical score based on the number and severity of lesions. Coronary arteriograms were assessed by two observers blinded to patient identity and unaware of biochemical or demographic data.

Demographic details, medical histories, smoking habits, and alcohol intake were recorded at interview with each patient or son. Smoking was recorded as current, ex-smoker (non-smoker for at least six months) or never. Previous medical histories of diabetes or hypertension, or a history of CAD in a first degree relative were also noted. Usual consumption of alcoholic beverages was recorded in standard units. Blood pressure was measured in the sitting position 15 min after the start of the interview and at the end of the interview, and results were averaged. A random zero sphygmomanometer was used, and phase V taken for the diastolic measurement. Weight was measured to the nearest 0.1 kg and height to the nearest 0.1 cm. Body mass index was calculated as weight in kilograms divided by the square of height in metres. Waist and hip circumference measurements were made to the nearest 0.1 cm with a tape measure incorporating a spring balance to ensure consistency of tension. The waist was measured as the smallest circumference between the costal margin and the iliac crest, and hip measurements were taken at the level

of the most lateral point on the greater trochanter.

Venous blood samples were taken between 9 00 and 10 00 am after an overnight fast. Samples from patients were taken six weeks after angiography. Samples were treated with fluoride/EDTA for glucose estimation and collected into dry containers for determination of serum cholesterol and high density lipoprotein (HDL) cholesterol, serum non-esterified fatty acid, serum triglycerides, serum insulin, serum apolipoprotein B, and serum Lp(a) lipoprotein. Plasma or serum samples were separated promptly and stored at –70°C. Total cholesterol, HDL cholesterol, and triglycerides were determined by the CHOD-PAP method (Boehringer Mannheim, Germany). Serum apolipoprotein B concentration was measured by a rate immunoelectrophoretic method⁵ using the Beckmann array, with antisera and standards supplied by the manufacturer (Beckmann Instruments, Palo Alto, California, USA). The method was repeatedly calibrated against a secondary serum standard the apolipoprotein B concentration of which was determined using a primary standard of density 1.040–1.053 g/ml isolated by ultracentrifugation.⁶ Lp(a) lipoprotein concentrations were measured using a two site immunoradiometric method (Pharmacia, Uppsala, Sweden). Non-esterified fatty acid was measured enzymatically (Wako Chemicals, Germany). Serum insulin was measured by radioimmunoassay⁷ using a double antibody solid phase technique (Pharmacia, Uppsala, Sweden), and plasma glucose by the GOD-PAP method (Boehringer Mannheim, Germany). Quality control standards were used for all techniques, and assays were performed within four weeks of taking the sample.

Triglyceride, HDL cholesterol, insulin, Lp(a) lipoprotein, and non-esterified fatty acid concentrations, and coronary stenosis scores were logarithmically transformed to normalise their distributions before analysis of variance (with Newman Keuls test for multiple group comparisons). Distributions of categorical variables were compared using the χ^2 test. Serum concentrations and blood pressure were adjusted using age and body mass index⁸ as covariates; adjusted values were compared and are shown in the tables. Analysis was performed using SPSS software (Statistical Package for Social Sciences, Release 5).

Results

COMPARISON BETWEEN PATIENTS OF INDIAN ORIGIN AND NORTH EUROPEAN ORIGIN

The mean (range) age of the patients of Indian origin was 54.7 (32–72) years and of those of North European origin 53.7 (35–76). Table 1 gives the physical, behavioural, and angiographic features of the patients of Indian origin and of those of North European origin. There were 33 Gujarati Hindus, 14 Gujarati Muslims, 30 Punjabi Sikhs, and 25 Punjabi Muslims in the Indian origin group.

Patients of Indian origin had more widespread coronary disease and greater waist hip ratios; patients of North European origin drank more alcohol, were more likely to be current smokers, and were more likely to have single vessel disease. Glucose, total cholesterol, HDL cholesterol, and triglyceride concentrations, and

blood pressure measurements were similar in the two groups after adjusting for age and body mass index (table 2). Mean apolipoprotein B concentration was higher in patients of North European origin; insulin, Lp(a) lipoprotein, and non-esterified fatty acid concentrations were higher in patients of Indian origin. Diabetes mellitus was about twice as prevalent in patients of Indian origin.

Insulin concentration was positively correlated with waist hip ratio, triglycerides, and non-esterified fatty acid in both groups, and more weakly correlated with Lp(a) lipoprotein, especially in patients of Indian origin (table 3). There was a negative correlation between insulin and HDL cholesterol.

Table 4 shows an association between extent of coronary disease and insulin, total cholesterol, triglycerides, and Lp(a) lipoprotein, and a negative association with HDL cholesterol in patients of Indian origin and in those of North European origin. Waist hip ratio also correlated with the extent of disease in patients of Indian origin and to a lesser extent in those of North European origin. Neither non-esterified fatty acid nor apolipoprotein B correlated with extent of coronary disease in either group, nor was there a clear relation with smoking status (data not shown) or blood pressure.

We further investigated joint associations between potential predictor variables and disease extent by multiple regression analysis using the log transformed coronary score as dependent variable. Potential predictor variables were those with an apparently significant association with coronary score on univariate analysis plus variables such as smoking habit which might be expected on "a priori" grounds to be associated with coronary disease. Variables were entered in order of decreasing strength of univariate correlation. Table 5 summarises the results of multivariate

Table 1 Physical, behavioural, and angiographic details of patients of Indian origin (IO) and of those of North European (NE) origin with suspected angina

Variable	IO (n = 102)	NE (n = 102)
Age (years)	54.7 (53.2–56.2)	53.7 (52.4–55.0)
Body mass index (kg/m ²)	25.4 (24.5–26.3)	26.3 (25.7–26.9)
Waist hip ratio	0.94 (0.92–0.96)	0.89 (0.87–0.91)
Manual worker (%)	54 (47–61)	55 (49–61)
Current smokers (%)	44 (39–49)	59 (54–63)
Alcohol consumption (U/week)	6.41 (4.96–7.86)	9.00 (7.67–10.3)
Normal coronaries (%)	26 (20–29)	19 (14–22)
Single vessel disease (%)	28 (23–33)	48 (40–56)
Multivessel disease (%)	46 (38–54)	33 (25–41)
Coronary atheroma score	18.3 (16.9–19.7)	14.9 (13.6–16.2)
Left ventricular score	6.9 (6.4–7.5)	6.8 (6.3–7.2)

Values are mean or percentage (95% confidence intervals).

Table 2 Blood pressure and biochemical features of patients of Indian origin (IO) and of those of North European (NE) origin

Variable	IO (n = 102)	NE (n = 102)
Systolic blood pressure (mm Hg)	133.3 (129.5–137.1)	135.1 (131–138.3)
Diastolic blood pressure (mm Hg)	78.0 (76.5–79.4)	79.2 (76.0–82.6)
Fasting glucose (mmol/l)	4.6 (4.2–5.1)	4.1 (3.7–4.6)
Insulin (μmol/l)	17.6 (16.4–19)	13.5 (12.4–14.8)
Total cholesterol (mmol/l)	6.0 (5.8–6.2)	5.9 (5.7–6.2)
High density lipoprotein cholesterol (mmol/l)	1.1 (1.0–1.1)	1.1 (1.1–1.3)
Triglyceride (mmol/l)	2.2 (2.0–2.3)	2.1 (2.0–2.3)
Apolipoprotein B (mg/dl)	104.7 (101.1–108.19)	113.4 (108.8–118.1)
Lp(a) lipoprotein (mg/dl)	27.2 (25.8–28.5)	19.5 (18.3–20.4)
Non-esterified fatty acid (mEq/l)	0.67 (0.59–0.76)	0.40 (0.33–0.47)
Diabetes (%)	29 (23–35)	14 (10–18)

Values are mean or percentage (95% confidence intervals) (adjusted for age and body mass index).

Table 3 Univariate correlation coefficients of serum insulin, plasma lipids, and blood pressure (adjusted for age and body mass index) in patients of Indian origin (IO) and in those of North European (NE) origin

Variable	Waist hip	Insulin	Systolic blood pressure	Diastolic blood pressure	Cholesterol	High density lipoprotein cholesterol	Triglyceride	Lp(a) lipoprotein	Non-esterified fatty acid
Insulin									
NE	0.46								
IO	<i>0.35</i>								
Systolic blood pressure									
NE	0.27	0.16							
IO	<i>0.31</i>	0.29							
Diastolic blood pressure									
NE	<i>0.38</i>	0.21	0.83						
IO	0.26	0.10	0.76						
Cholesterol									
NE	0.16	0.29	0.22	0.26					
IO	0.24	–0.10	0.06	0.23					
High density lipoprotein cholesterol									
NE	0.10	–0.26	–0.10	0.10	0.44				
IO	<i>–0.34</i>	–0.34	–0.23	–0.24	0.53				
Triglyceride									
NE	0.24	0.41	0.24	0.14	0.31	–0.34			
IO	<i>0.34</i>	0.40	0.09	0.10	0.25	<i>–0.40</i>			
Lp(a) lipoprotein									
NE	0.10	0.26	0.05	0.11	0.26	–0.27	0.10		
IO	0.13	<i>0.32</i>	0.19	0.16	<i>0.30</i>	<i>–0.38</i>	0.37		
Non-esterified fatty acid									
NE	0.09	0.38	–0.03	0.15	0.09	–0.16	<i>0.31</i>	0.06	
IO	0.16	0.39	0.26	0.29	–0.07	–0.36	<i>0.36</i>	0.16	
Apolipoprotein B									
NE	–0.07	0.02	0.12	0.05	0.44	<i>–0.51</i>	0.61	0.18	0.19
IO	<i>–0.03</i>	0.06	–0.10	0.06	0.57	<i>–0.46</i>	0.59	0.14	0.26

Values in **bold** indicate $P < 0.001$ and those in *italic* $P < 0.01$.

Table 4 Selected variables according to the severity of coronary artery disease (CAD) in patients of Indian origin (IO) and in those of North European (NE) origin (adjusted for age and body mass index)

Variable	No lesion (NE = 19; IO = 26)	Single vessel disease (NE = 49; IO = 29)	Multivessel disease (NE = 34; IO = 47)	Analysis of variance CAD of groups within each ethnic group (P value for trend)*
Waist hip ratio				
NE	0.87 (0.83–0.92)	0.87 (0.83–0.92)	0.91 (0.89–0.93)	0.08
IO	0.88 (0.87–0.89)	0.89 (0.88–0.90)	0.93 (0.92–0.93)	0.007
Systolic blood pressure (mm Hg)				
NE	136.9 (129.8–144.0)	131.2 (125.0–137.4)	138.1 (131.9–144.4)	0.16
IO	124.2 (118.0–130.4)	137.5 (130.3–144.7)	135.7 (130.0–141.4)	0.02
Insulin (mU/l)				
NE	7.5 (6.1–9.0)	10.6 (8.3–12.9)	21.9 (18.8–25.0)	0.0001
IO	13.2 (10.8–15.1)	9.3 (7.4–11.1)	28.1 (24.5–31.8)	0.0001
Cholesterol (mmol/l)				
NE	5.5 (5.3–5.7)	5.7 (5.5–5.7)	6.6 (6.2–7.0)	0.001
IO	5.5 (5.3–5.7)	5.7 (5.5–6.0)	6.4 (6.1–6.7)	0.0001
High density lipoprotein cholesterol (mmol/l)				
NE	1.3 (1.1–1.4)	1.2 (1.0–1.3)	1.1 (0.9–1.2)	0.003
IO	1.3 (1.1–1.4)	1.1 (1.0–1.3)	1.0 (0.9–1.2)	0.004
Triglyceride (mmol/l)				
NE	2.0 (1.8–2.1)	2.0 (1.9–2.1)	2.4 (2.2–2.6)	0.003
IO	2.3 (2.1–2.4)	2.2 (2.0–2.5)	2.5 (2.3–2.7)	0.01
Lp(a) lipoprotein (mg/dl)				
NE	9.8 (8.9–10.8)	14.9 (13.2–16.5)	33.3 (30.6–36.4)	0.001
IO	16.5 (14.4–18.6)	18.0 (15.6–21.2)	39.7 (37.2–42.8)	0.001
Non-esterified fatty acid (mEq/l)				
NE	0.67 (0.57–0.77)	0.52 (0.46–0.56)	0.45 (0.39–0.52)	0.28
IO	0.48 (0.44–0.53)	0.36 (0.32–0.42)	0.75 (0.66–0.83)	0.08
Apolipoprotein B (mmol/l)				
NE	121.9 (114.8–129.0)	106.1 (99.8–112.4)	115.0 (108.9–121.2)	0.17
IO	98.2 (92.8–103.6)	107.0 (100.1–113.9)	107.0 (101.3–112.7)	0.26

Values are mean (95% confidence intervals).

*Followed by Newman-Keuls test.

analysis. In each group Lp(a) lipoprotein, total cholesterol, and insulin contributed independently to the prediction of extensive CAD, irrespective of the order in which the variables were entered. HDL cholesterol in patients of Indian origin and triglyceride concentrations in those of North European origin also contributed.

SONS OF PATIENTS OF INDIAN ORIGIN COMPARED WITH SONS OF PATIENTS OF NORTH EUROPEAN ORIGIN

Eighteen, 30, and 41 of the young Indian origin group were sons of patients with minimal, single vessel, or multivessel disease respectively; the corresponding values in the North

European origin group were 19, 27, and 36. Twenty eight of the young Indian origin group were Gujarati Hindu, 21 Punjabi Muslim, 16 Gujarati Muslim, and 24 Punjabi Sikhs. Seventy four (83%) of the young Indian origin group were born in the United Kingdom. Table 6 gives the physical and behavioural features of the young adult groups. The waist hip ratio was greater in young adults of Indian origin, and alcohol intake was increased in those of North European origin. Current smoking habits were similar. Insulin and Lp(a) lipoprotein concentrations were higher in the young Indian origin group (table 7).

FATHER SON COMPARISONS

There was correlation in both ethnic groups between parental and filial insulin, Lp(a) lipoprotein, and total cholesterol concentrations (table 8). A relatively weaker correlation was observed for HDL cholesterol in each group, and for non-esterified fatty acid and waist hip ratio in participants of Indian origin.

Table 5 Explanatory value of metabolic and physical variables as predictors of the severity of coronary artery disease in patients of Indian origin (IO) and in those of North European (NE) origin*

	Cumulative adjusted r^2
Variables for patients IO	
Lp(a) lipoprotein (+)	0.21
Cholesterol (+)	0.35
Serum insulin (+)	0.41
High density lipoprotein cholesterol (–)	0.45
Waist hip ratio (+)	0.46
Triglyceride (+)	0.47
Variables for patients of NE origin	
Lp(a) lipoprotein (+)	0.24
Serum insulin (+)	0.38
Cholesterol (+)	0.45
Triglyceride (+)	0.50
High density lipoprotein cholesterol (–)	0.51
Waist hip ratio (+)	0.52

*Variables in **bold** are significant independent predictors ($P < 0.01$) of the severity of coronary artery disease on multivariate analysis, ranked in descending order of the magnitude of their incremental contribution to cumulative adjusted r^2 .

+, positive correlation.

–, negative correlation.

Table 6 Physical, behavioural, and demographic features of sons (aged 15–30 years) of patients of Indian origin (IO) and of those of North European (NE) origin

Variable	IO (n = 89)	NE (n = 82)
Age (years)	22.1 (21.2–23.2)	22.8 (21.9–23.8)
Current smokers (%)	53 (47–59)	48 (39–54)
Alcohol (U/week)	7.71 (6.05–8.59)	10.3 (8.38–12.1)
Body mass index (kg/m ²)	24.1 (23.6–24.6)	24.0 (23.6–24.6)
Waist hip ratio	0.87 (0.85–0.89)	0.83 (0.81–0.85)
Manual workers (%)	31 (26–36)	36 (29–43)
Students (%)	27 (20–34)	24 (18–30)
Non-manual workers (%)	42 (38–46)	40 (36–44)

Values are mean or percentage (95% confidence intervals).

Table 7 Blood pressure and biochemical features of sons (aged 15–30 years) of patients of Indian origin (IO) and of those of North European (NE) origin

Variable	IO (n = 89)	NE (n = 82)
Systolic blood pressure (mm Hg)	119.6 (115.9–123.4)	125.2 (121.2–125.1)
Diastolic blood pressure (mm Hg)	67.9 (65.5–70.1)	71.6 (69.1–74.2)
Plasma glucose (mmol/l)	4.4 (4.1–4.6)	4.2 (3.9–4.5)
Insulin (mU/l)	14.3 (12.9–15.8)	8.43 (7.29–9.60)
Cholesterol (mmol/l)	4.2 (4.0–4.4)	4.1 (4.0–4.2)
High density lipoprotein cholesterol (mmol/l)	1.2 (1.2–1.3)	1.3 (1.2–1.3)
Triglyceride (mmol/l)	1.6 (1.5–1.7)	1.6 (1.5–1.6)
Apolipoprotein B (mmol/l)	88.6 (83.4–93.9)	84.6 (79.8–89.6)
Lp(a) lipoprotein (mg/dl)	19.1 (16.8–21.8)	10.5 (8.3–12.8)
Non-esterified fatty acid (mEq/l)	0.39 (0.29–0.49)	0.28 (0.21–0.35)

Values are mean or percentage (95% confidence intervals) (adjusted for age and body mass index).

Table 8 Correlation of physiological and metabolic factors (adjusted for age and body mass index) in fathers and sons of Indian origin (IO) and in those of North European (NE) origin

Variable	NE	IO
Waist hip ratio	0.13	0.31
Cholesterol	0.45	0.39
High density lipoprotein cholesterol	0.37	0.28
Triglyceride	0.25	0.12
Serum insulin	0.49	0.41
Non-esterified fatty acids	0.23	0.40
Apolipoprotein B	0.16	–0.03
Fasting glucose	0.11	–0.15
Systolic blood pressure	0.05	–0.09
Diastolic blood pressure	0.01	0.02
LP(a) lipoprotein	0.48	0.44

Values in **bold** indicate $P < 0.001$ and those in *italic* $P < 0.01$.

When sons were classified according to the severity of CAD in their fathers (table 9), differences were seen in the mean concentrations of the sons' total and HDL cholesterol, and especially of insulin and Lp(a) lipoprotein.

Discussion

We have shown that the extent of CAD in samples from the Indian origin and North European origin populations in Leicester undergoing coronary angiography is correlated in particular with concentrations of Lp(a) lipoprotein, insulin, and total cholesterol. The pattern of association was similar in each ethnic group. We have found a correlation, in both groups, between parental con-

centrations of total and HDL cholesterol, insulin and Lp(a) lipoprotein, and the plasma or serum concentrations of these markers in their apparently healthy sons aged 15–30. Finally, we have demonstrated that while levels of most potential risk markers are broadly similar in young adults from the two groups, mean Lp(a) lipoprotein and insulin concentrations are significantly higher in those of Indian origin.

Our findings in respect of the correlation between the extent of angiographically determined coronary disease and risk marker levels are compatible with our own previous study³ and with the studies of Hughes *et al.*⁴ Lowry *et al.*⁹ and Dhawan and Bray.¹⁰ The present study emphasises the predictive importance of Lp(a) lipoprotein and insulin in each ethnic group, and suggests that about half the observed variation in angiographic coronary disease score can be explained by these two variables plus cholesterol and triglyceride (table 5).

While it is accepted that patients undergoing coronary angiography are not necessarily representative of the whole community, the validity of raised total cholesterol, low HDL cholesterol, raised Lp(a) lipoprotein,^{11,12} and raised fasting insulin concentrations^{13,14} as CAD risk markers has been established by several studies using a variety of end points. The classification of coronary disease as minimal, single vessel, or multivessel,¹⁵ though crude, has proved to be a robust predictor of survival.¹⁶

Family history has long been acknowledged as a predictor of CAD, and recent studies have further validated the concept.^{17,18} The concordance in risk marker patterns between parents with known CAD and their healthy children that we have demonstrated is likely to be a result of a combination of genetic and cultural factors. Lp(a) lipoprotein concentrations are thought to be largely determined as a consequence of genetic polymorphism.¹⁹ While polymorphism may also have a role in determining cholesterol and insulin concentrations, these are also susceptible to modification by factors such as diet and exercise.²⁰

Table 9 Selected variables in sons of fathers of Indian origin (IO) and of North European (NE) origin classified according to severity of coronary artery disease (CAD) (adjusted for age and body mass index)

Offspring variable	No lesion (NE = 19; IO = 18)	Single vessel disease (NE = 27; IO = 30)	Multivessel disease (NE = 36; IO = 41)	Analysis of variance of parental CAD in each ethnic group (P value for trend)*	Analysis of variance of parental CAD with the remaining variables as covariates†
Waist hip ratio					
NE	0.85 (0.81–0.89)	0.83 (0.81–0.85)	0.86 (0.84–0.88)	0.19	0.29
IO	0.85 (0.81–0.89)	0.88 (0.84–0.92)	0.89 (0.85–0.93)	0.07	0.36
Cholesterol (mmol/l)					
NE	4.1 (3.8–4.4)	4.4 (4.2–4.7)	4.7 (4.4–5.0)	0.01	0.09
IO	4.3 (4.0–4.6)	4.7 (4.4–5.0)	4.9 (4.6–5.1)	0.02	0.11
High density lipoprotein cholesterol (mmol/l)					
NE	1.3 (1.2–1.5)	1.2 (1.1–1.2)	1.2 (1.1–1.2)	0.01	0.04
IO	1.4 (1.2–1.5)	1.3 (1.2–1.4)	1.2 (1.1–1.2)	0.03	0.08
Insulin (μmol/l)					
NE	8.9 (5.1–12.6)	11.2 (8.1–14.6)	16.0 (13.6–18.3)	0.004	0.03
IO	8.7 (4.2–13.2)	14.5 (10.2–19.2)	20.5 (17.2–23.9)	0.001	0.01
Lp(a) lipoprotein (mg/dl)					
NE	10.7 (4.9–17.8)	14.7 (10.8–18.6)	22.1 (17.5–22.8)	0.006	0.01
IO	13.0 (5.4–21.3)	21.5 (15.1–28.9)	32.5 (27.1–37.8)	0.001	0.004

*Followed by Newman Keuls test. Variables were logarithmically transformed as described in the text. Values are mean (95% confidence intervals). †These are the remaining variables in table 9.

Indeed, one of the reasons we were anxious to study the children of patients with angina was the possibility that reduced physical activity resulting from angina might itself alter the risk factor pattern. The replication of risk factor patterns in the asymptomatic younger generation discounts this hypothesis. In a recent pilot study we were able to show a significant correlation between insulin (but not Lp(a) lipoprotein) concentrations and levels of habitual physical activity in young relatives of CAD patients.²¹

Several studies²²⁻²³ have emphasised the importance of insulin resistance and central obesity as risk factors for CAD in the Indian origin community. Suggested causative factors have included heredity, physical inactivity, and possibly fetal or neonatal malnutrition.²⁴ Previous studies have largely concentrated on older adults; the raised mean insulin and Lp(a) lipoprotein concentrations shown here in the young Indian origin group, for the most part born and raised in the United Kingdom, have worrying implications for the future incidence of CAD, particularly as other risk marker levels are now comparable to their North European peers. Whether reduction of insulin concentrations by diet and exercise will reduce the incidence of CAD remains to be seen. Our results strongly support the concept that health promotion measures aimed at reducing the prevalence of CAD should include the adolescent and young adult populations, particularly those with a family history of CAD, or who come from communities in which this diagnosis is prevalent.

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