

Observations on serial changes in coronary artery disease in Indians

S. Krishnaswami

Department of Cardiology, Christian Medical College Hospital, Vellore 632 004, India

Serial changes noted annually in the hospital recognition of 11,600 patients with acute myocardial infarction (AMI) and 4091 patients who have undergone selective coronary arteriography (SCA), collected by computerized data over a 35-year period are reported. The study shows a steady increase in the number of patients admitted with AMI. The mean age for males is 53 years and for females 58 years. While younger patients are being seen frequently as seen by the standard deviation, the mean age has remained the same over the last 35 years. Serial studies of risk factors show a gradual decline in serum total cholesterol levels. High prevalence of the disease in those with smoking, diabetes mellitus, hypertension and a positive family history of coronary artery disease is seen to persist. Multiple logistic regression analysis reveals greater Odd's ratio of disease for male sex and diabetes and also with lipid levels. The impact of disease prevalence and risk factor prevalence and the need for preventive strategies against modifiable risk factors are emphasized.

THE serious impact of coronary artery disease (CAD) in Indians should make health workers and planners sit up and react. Reports of well-planned community-based studies^{1,2} and clinical investigations have emphasized the magnitude of the problem^{3,4}. Our centre has been successful in identifying various aspects of the disease process at the tertiary care level. We believe that while community-based data are relevant for obtaining prevalence figures, methods necessary for definitive diagnosis which can be obtained from either proven myocardial infarction or selective coronary arteriography are essential to obtain data on persons with confirmed diagnosis of CAD. Community-based data collection using the Rose Questionnaire and the Minnesota Code for ECG are extremely useful, but imprecise.

Computerized data on consecutive patients collected in our department over a period of 35 years from 1961 have provided inferences and conclusions for the many publications in the field of coronary artery disease from our hospital. It was shown in 1989 that Indians had atheromatous coronary artery disease even at low serum cholesterol levels⁵. It was emphasized that the age at presentation was relevant with reference to severity of

disease⁶ and that severity was related to coexisting diabetes mellitus⁷. The fact that triglyceride levels may be important in CAD, especially in older age groups, was brought out in 1996 (ref. 8). While other reports^{1,2,9} have added valuable information on the problem, this communication highlights yet another facet of CAD – the answer to the question, 'what changes have we noticed over 35 years in different aspects of CAD in Indians'.

Material and methods

The report is based on 11,600 consecutive patients admitted from 1961 up to December 1996 (male 10,275 and female 1325) with the diagnosis of acute myocardial infarction and 4091 (male 3587 and female 404) consecutive patients in whom selective coronary arteriography was performed to confirm or exclude coronary artery disease. Of the 4091 patients, 71.6% among male (2568) and 27.1% among female patients had angiographic CAD. The fully-computerized method of data storage of all patients attending our department has made this possible¹⁰, and this has been commended by others also¹¹. Definitions, standards of diagnosis and quality control have been reported earlier⁵.

Statistics. While results have been expressed as mean \pm SD, the relative importance of risk factors has been estimated by logistic regression; Odd's ratios for coronary disease with 95% confidence intervals are presented. This has been done with the data used as categorical as well as continuous variables.

Results and discussion

Numbers. Increasing numbers of patients being hospitalized for myocardial infarction over the past 35 years are seen in Figure 1. Male patients have shown a more striking increase. The steady increase in admissions for tertiary care for CAD when compared to other cardiac conditions has been described earlier¹⁰. It further points out that not only Indians living outside India, but even those living in India need aggressive preventive measures.

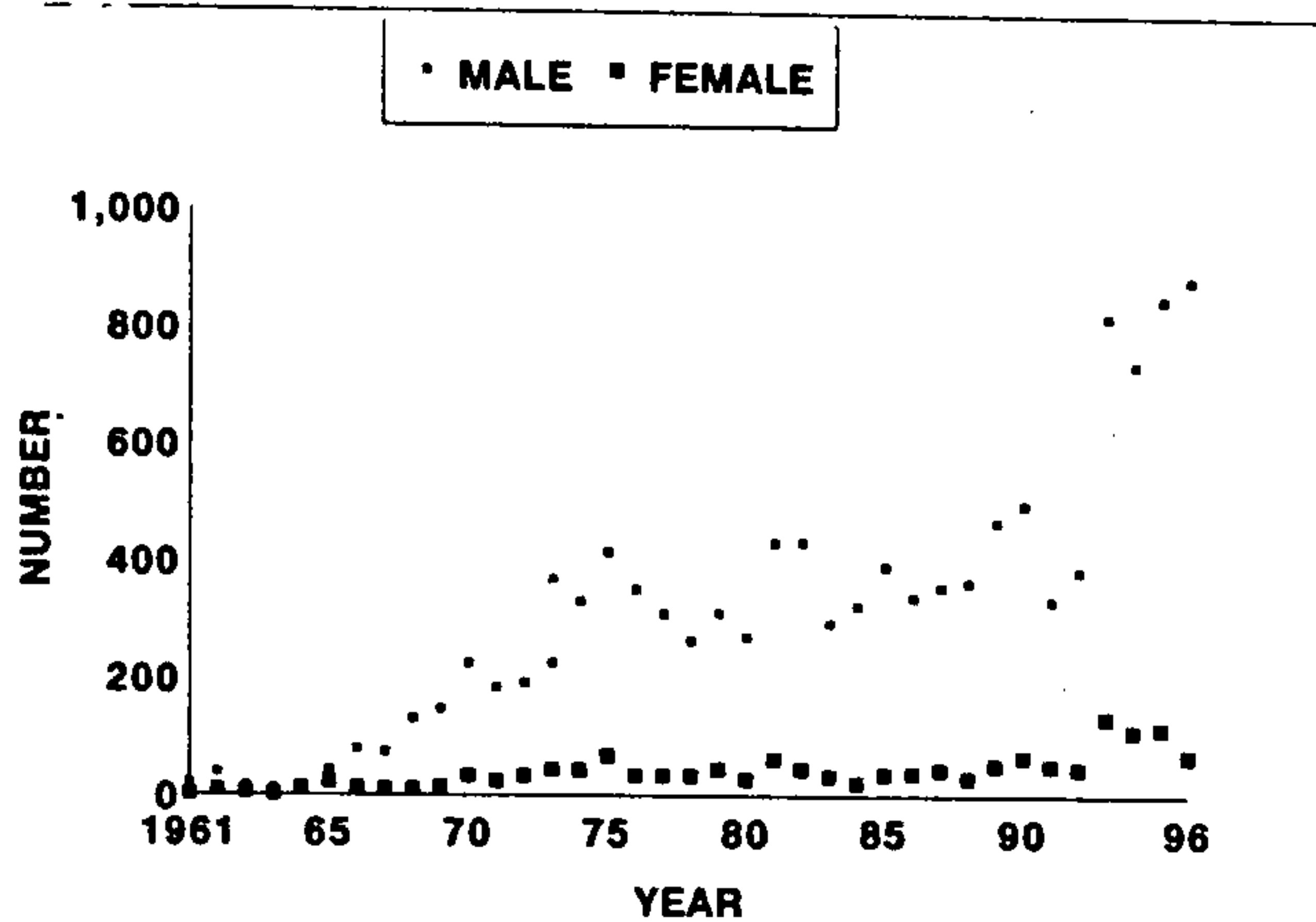


Figure 1. Number of myocardial infarct patients.

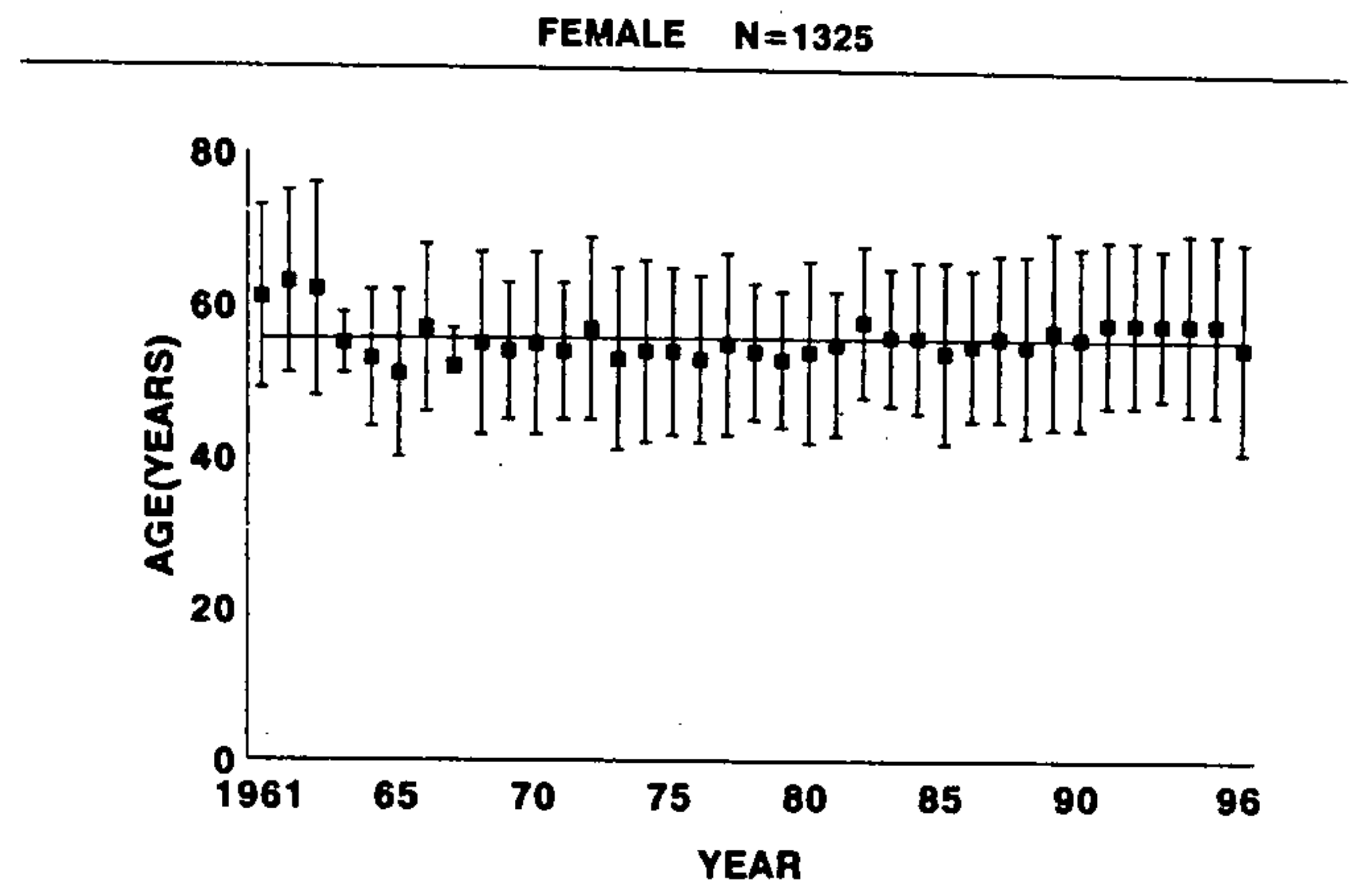


Figure 3. Mean age at myocardial infarction. (Female, $N = 1325$)

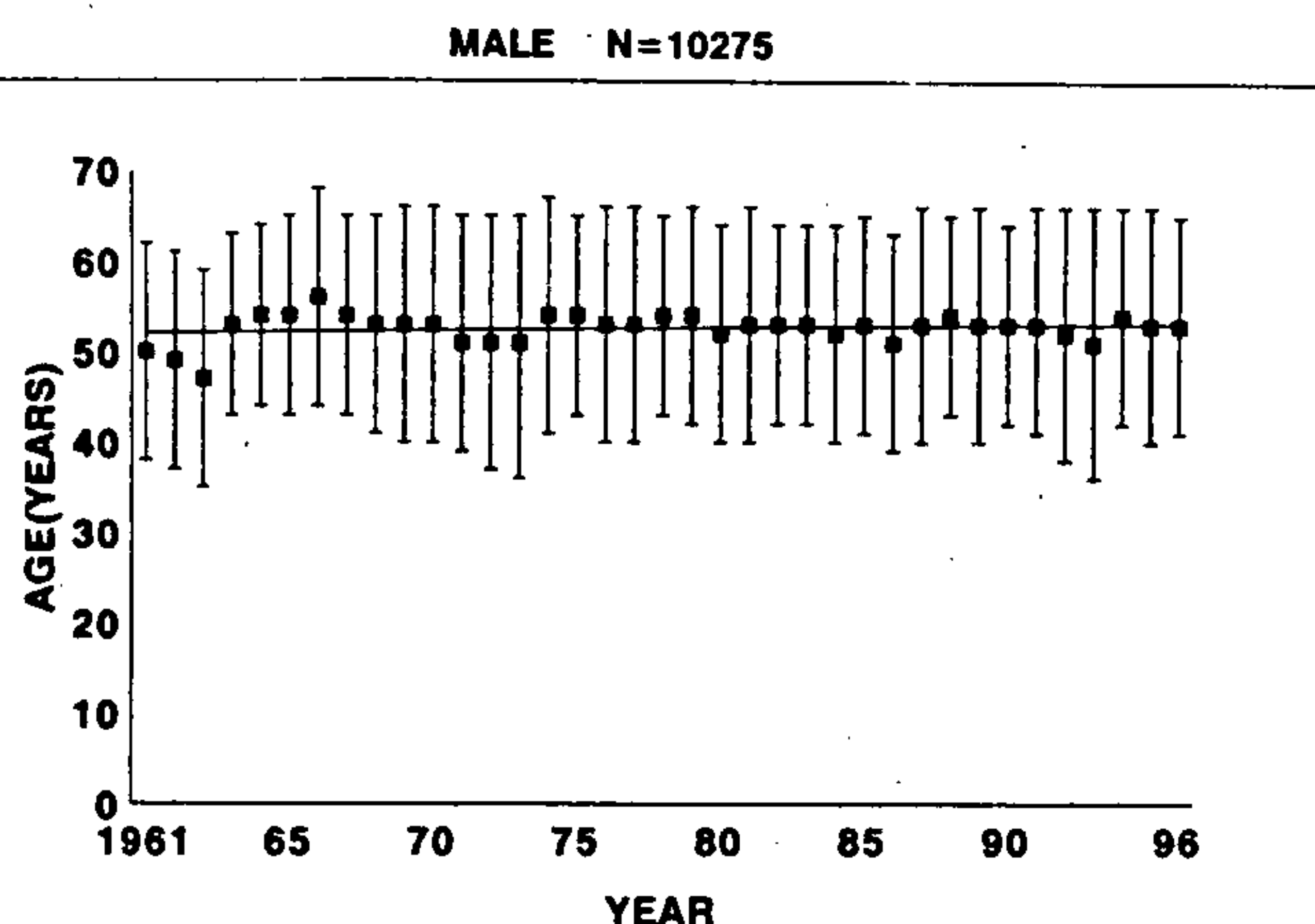


Figure 2. Mean age at myocardial infarction. (Male, $N = 10,275$)

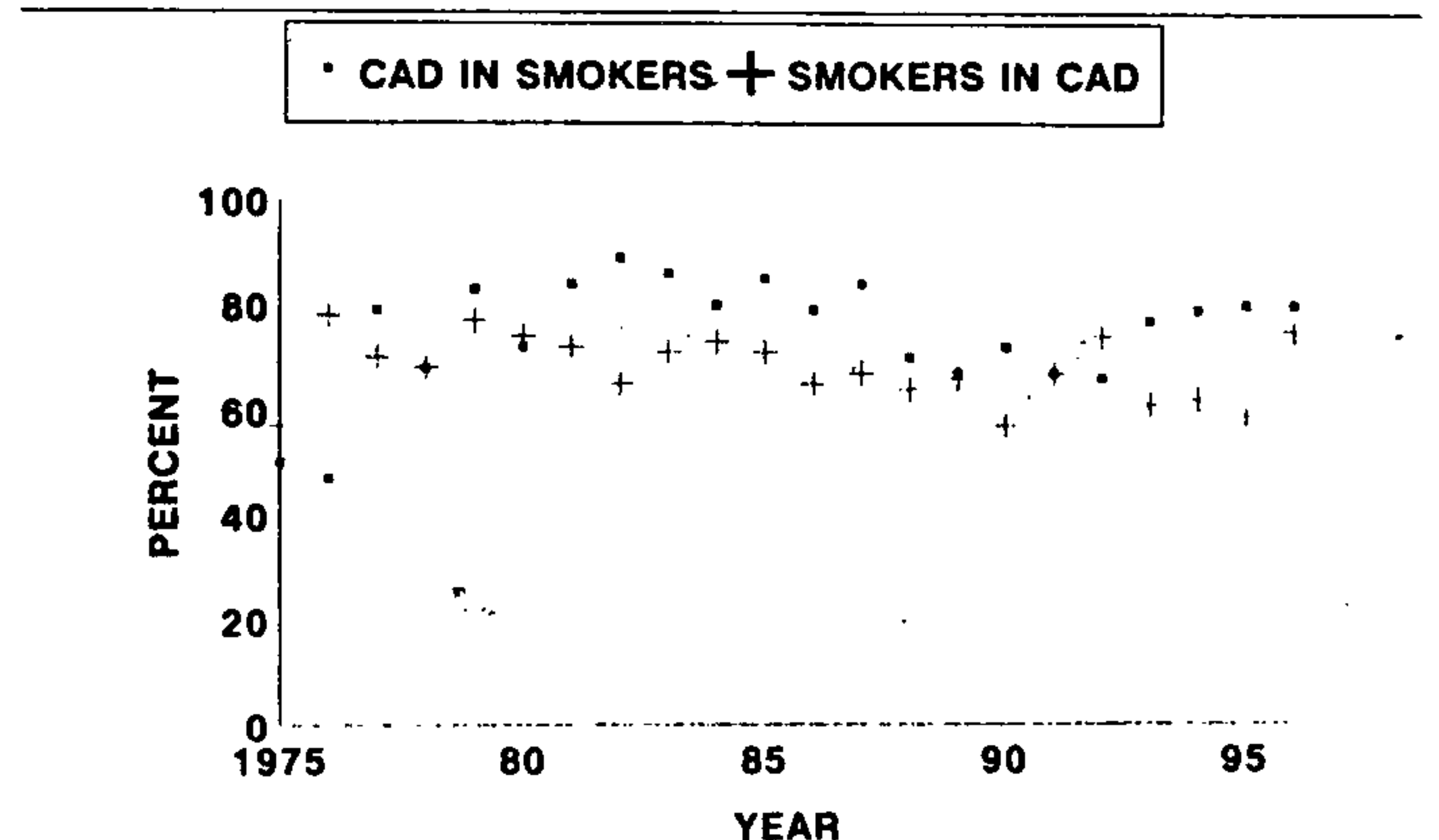


Figure 4. Risk factor – Smoking.

Age at myocardial infarction. Figures 2 and 3 show serial changes with reference to mean age at first myocardial infarction. For the past 35 years, the mean age for male patients has averaged 53 years without any change. The lower limits of the standard deviation have been at 40 years and at times even as low as 36 years. For women patients with myocardial infarction the mean age has been 58 years. Increasing recognition of CAD in women by either the presence of myocardial infarction or by coronary arteriography is a disturbing trend seen in recent years from our data of patients and also from the published literature.

With increasing life expectancy, the future planning of health care in our country must include our observations on the increasing numbers as well as the persisting age pattern.

Serial changes in risk factors. Analysis of our data has made it possible to study and speculate on this important aspect.

Smoking. Among smokers (both past and present), prevalence of CAD has averaged 78% (Figure 4). The same figure shows that among patients with CAD, an average of 64% were smokers. The figure also shows that the prevalence of smokers among those with CAD is showing a downward trend starting at 80% and now at about 60%. The possible speculative inference is that media messages regarding the risks from smoking are beginning to influence the public. More needs to be done by concerted effort to reduce the danger associated with this modifiable risk factor.

Positive family history of ischaemic heart disease. This is an important non-modifiable risk factor. Positive family history was present in approximately 35% of patients with CAD, while CAD itself was found in 80% of those with a positive family history (Figure 5). The serial changes show the same prevalence of CAD in those with a positive family history, but a downward trend in the prevalence of a positive family history as a

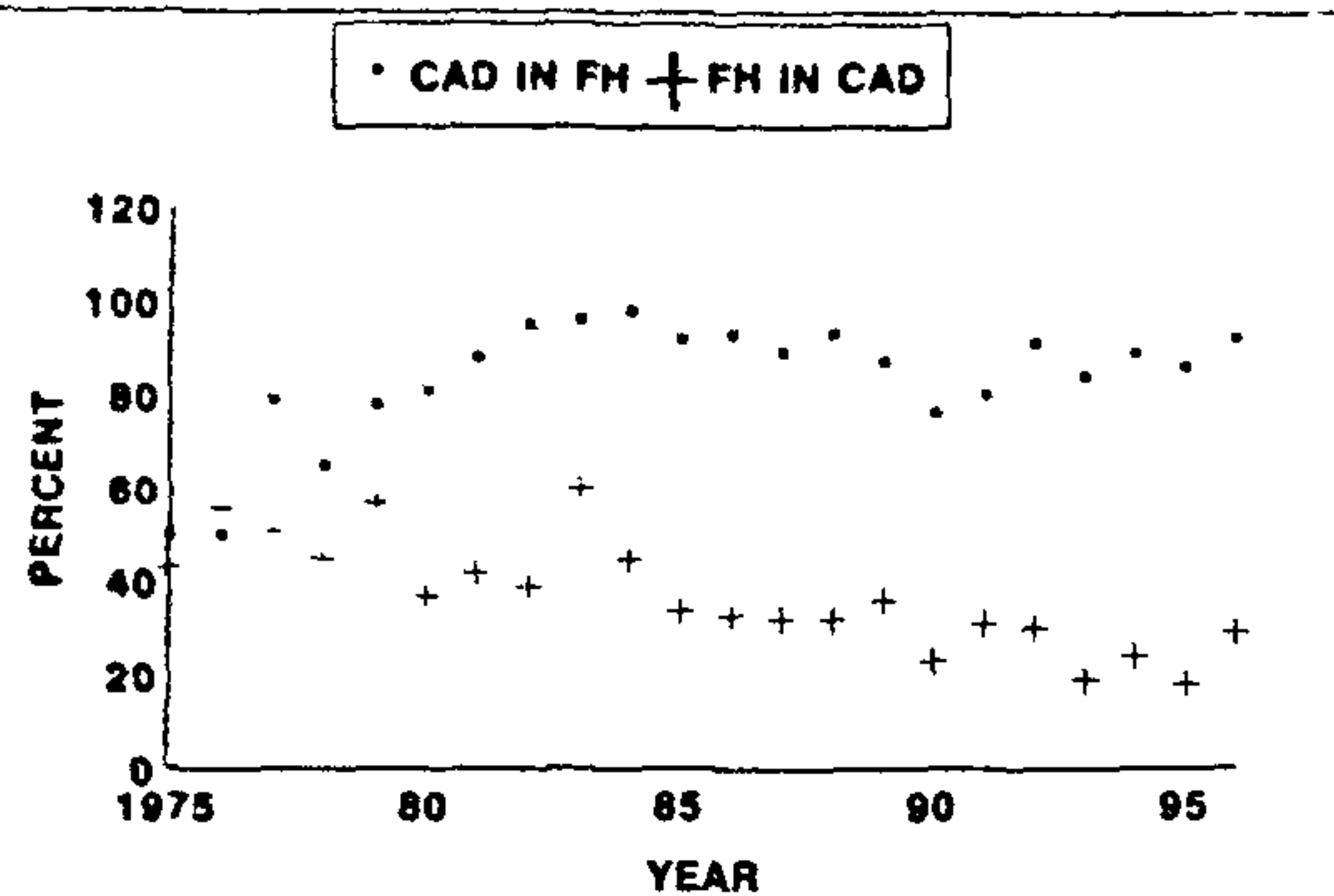


Figure 5. Risk factor - family history.

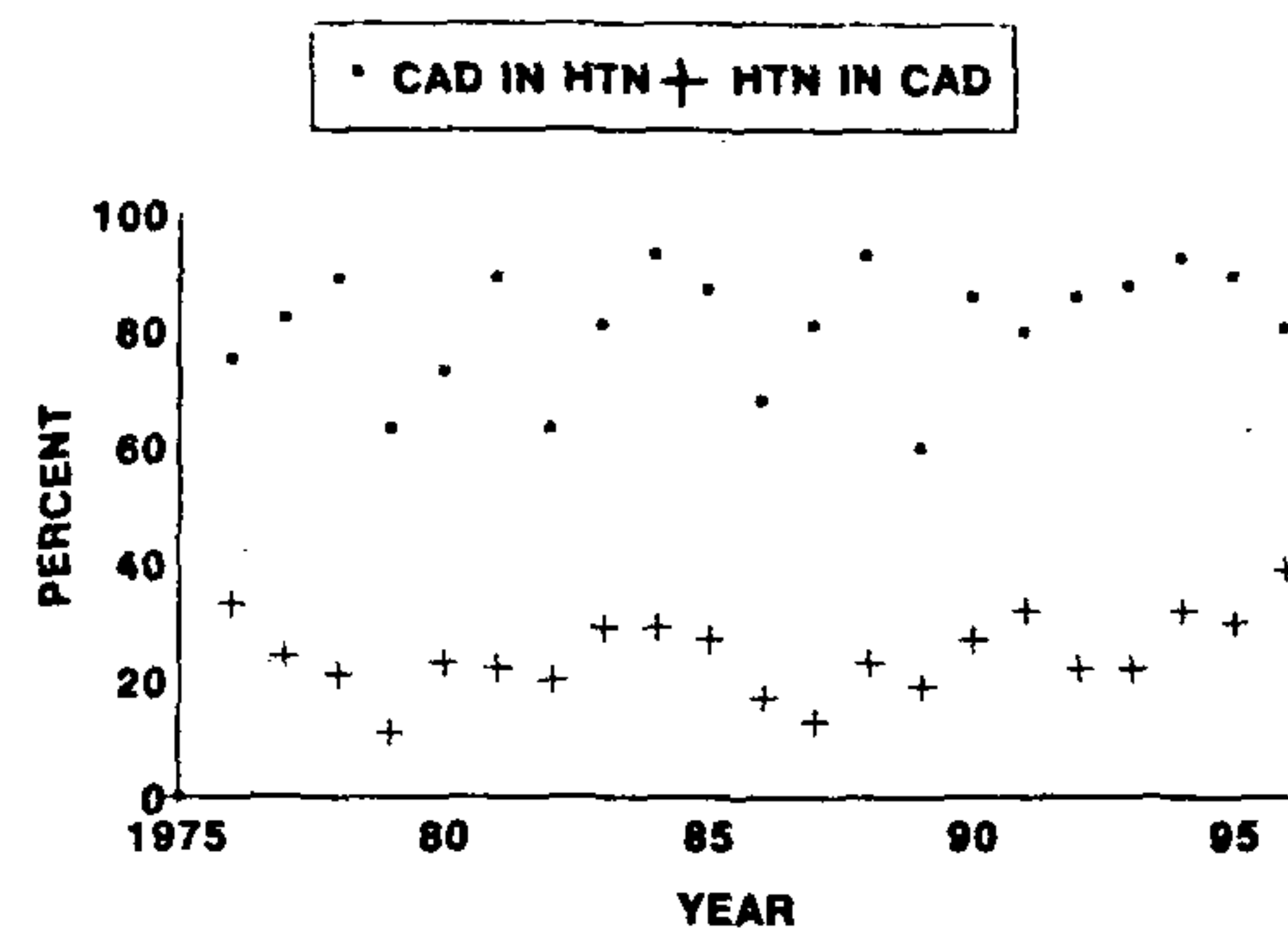


Figure 7. Risk factor - hypertension.

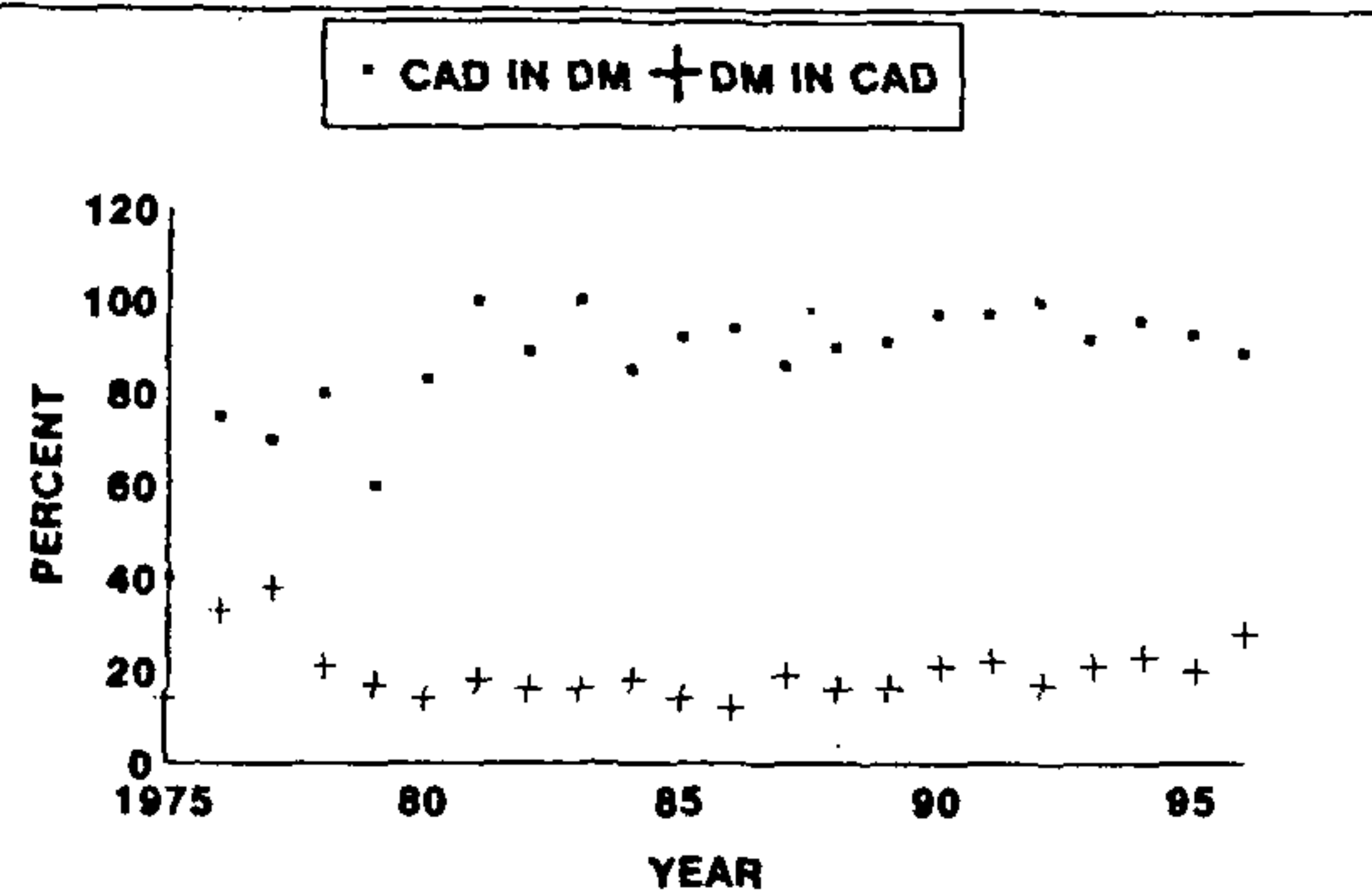


Figure 6. Risk factor - diabetes.

contributor to the development of CAD. The reasons for this observed change are not clear.

Diabetes mellitus. The links between diabetes mellitus and CAD in our patients are shown in Figure 6. Over the years, the percentage of diabetics among those with CAD is seen at around 24. Among diabetics, however, the percentage of those with CAD is very high at a mean of 80. It has been noted earlier also that this number increases steadily with the age of the patients rather than with the actual known duration of clinical diabetes⁷.

Hypertension. The relationship between hypertension and CAD in our patients is shown in Figure 7. Over the years, hypertension was found in about 20% of individuals with CAD, while CAD itself averaged at 75% in hypertensives.

Lipids. The relationship between lipid levels and CAD has been studied at great length and has contributed enormously to the literature^{3-5,12}. Current thinking is that

total cholesterol, LDL-cholesterol and HDL-cholesterol levels are relevant and triglycerides are gaining importance as a contributory factor. Currently, lipoprotein(a) [Lp(a)] as an important marker for CAD and early occurrence of acute myocardial infarction is being explored vigorously¹³. The total cholesterol levels have shown a downward trend over the years both in patients with CAD and in normals (Figures 8-11). The reason could again be attributed only to media coverage of this topic, since, unlike western nations, very little has been done in our country in the form of public health education by health workers. The other lipid factors have not shown any serial or trend changes. We had emphasized as early as 1989 that Indians get CAD with 'normal' as well as low levels of cholesterol⁵. Data on Lp(a) levels in our patients are not available. However work is now in progress in this area. It is important to point out that international groups have been steadily lowering the 'desirable' levels of serum cholesterol (both total and LDL-cholesterol) over the past 30 years and it is unlikely that the last word has been spoken as yet¹².

From the above data, it is apparent that smoking was the most prevalent of the risk factors studied.

The relative importance of the coronary risk factors in our patients was first published in 1984 using multivariate analysis¹⁴ and again in 1996 (ref. 8). Updating the data now allows us to obtain some additional inferences. The results of logistic regression analysis of eleven factors known/suspected to contribute to the development of CAD, with the presence or absence of CAD as the dependent variable, have been tabulated (Table 1). Methodological details have been published earlier⁸. Application of logistic regression methods for cases and controls as well as cross-sectional studies has been accepted¹⁵ and is readily applicable to our data. Of these, age, sex and family history of CAD have been considered as non-modifiable risk factors while others can be modified by treatment, preventive methods or by changes in lifestyle. In the table, column 1 shows the

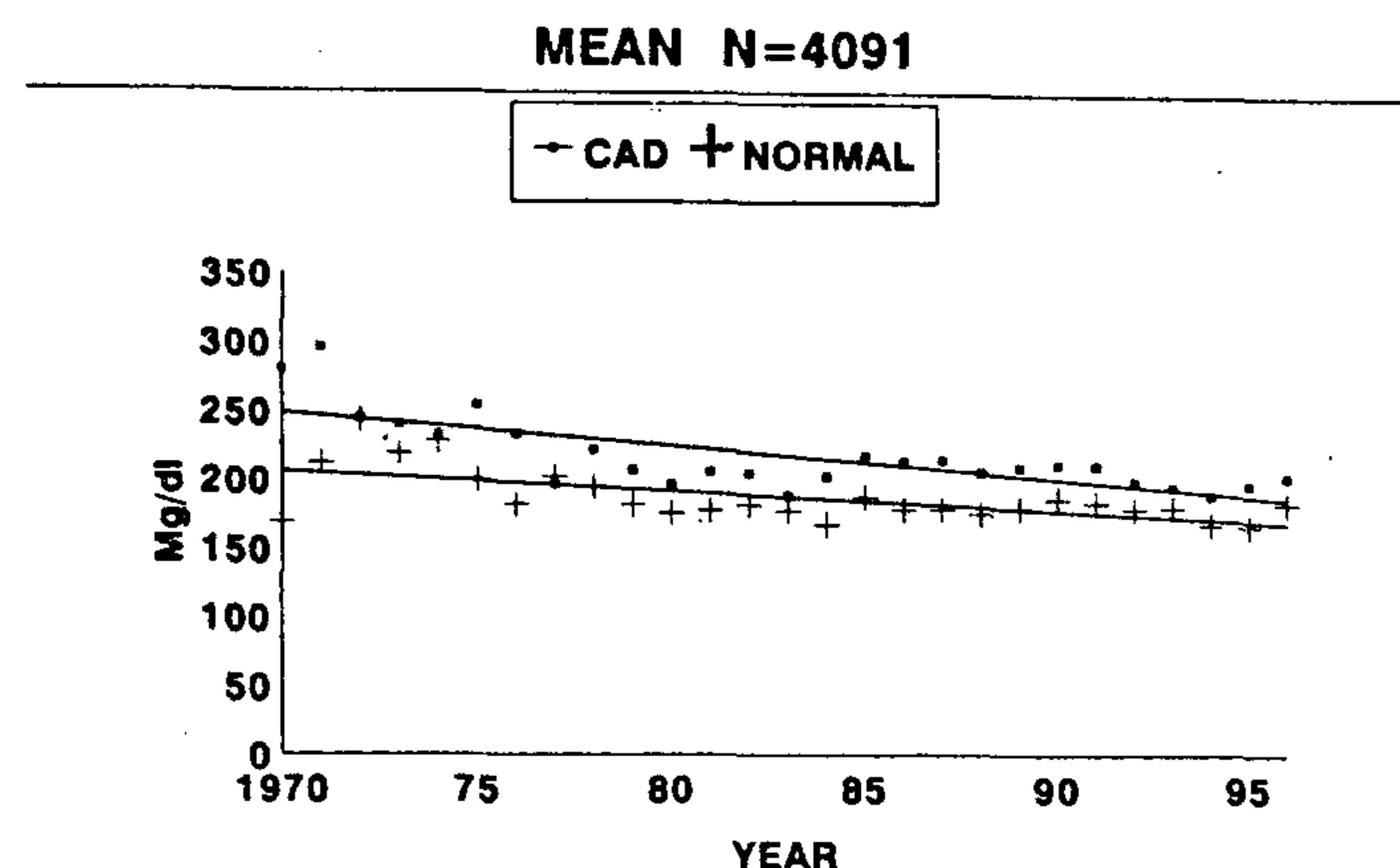
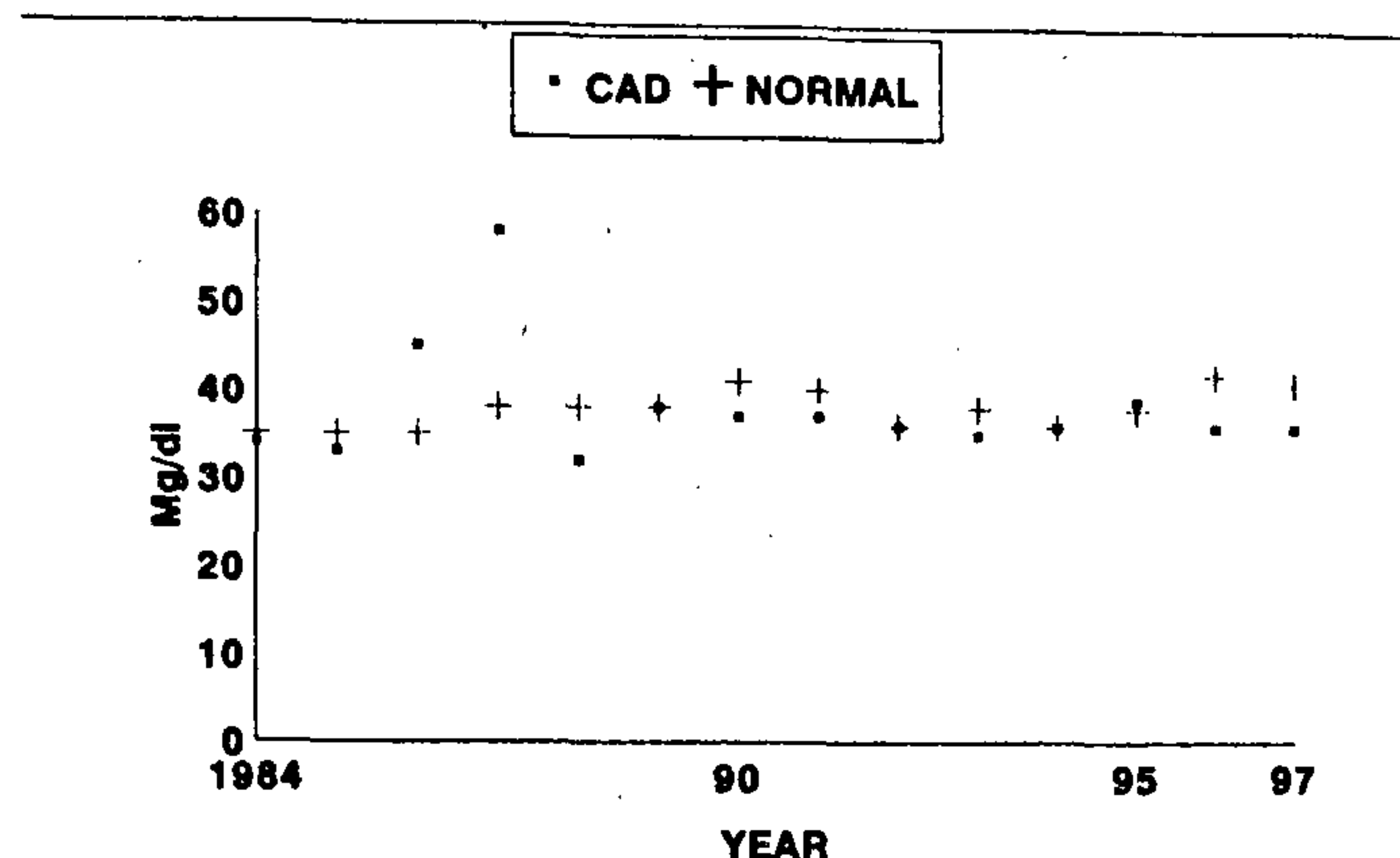
Figure 8. Total cholesterol levels. (Mean, $N = 4091$)

Figure 10. HDL-cholesterol levels.

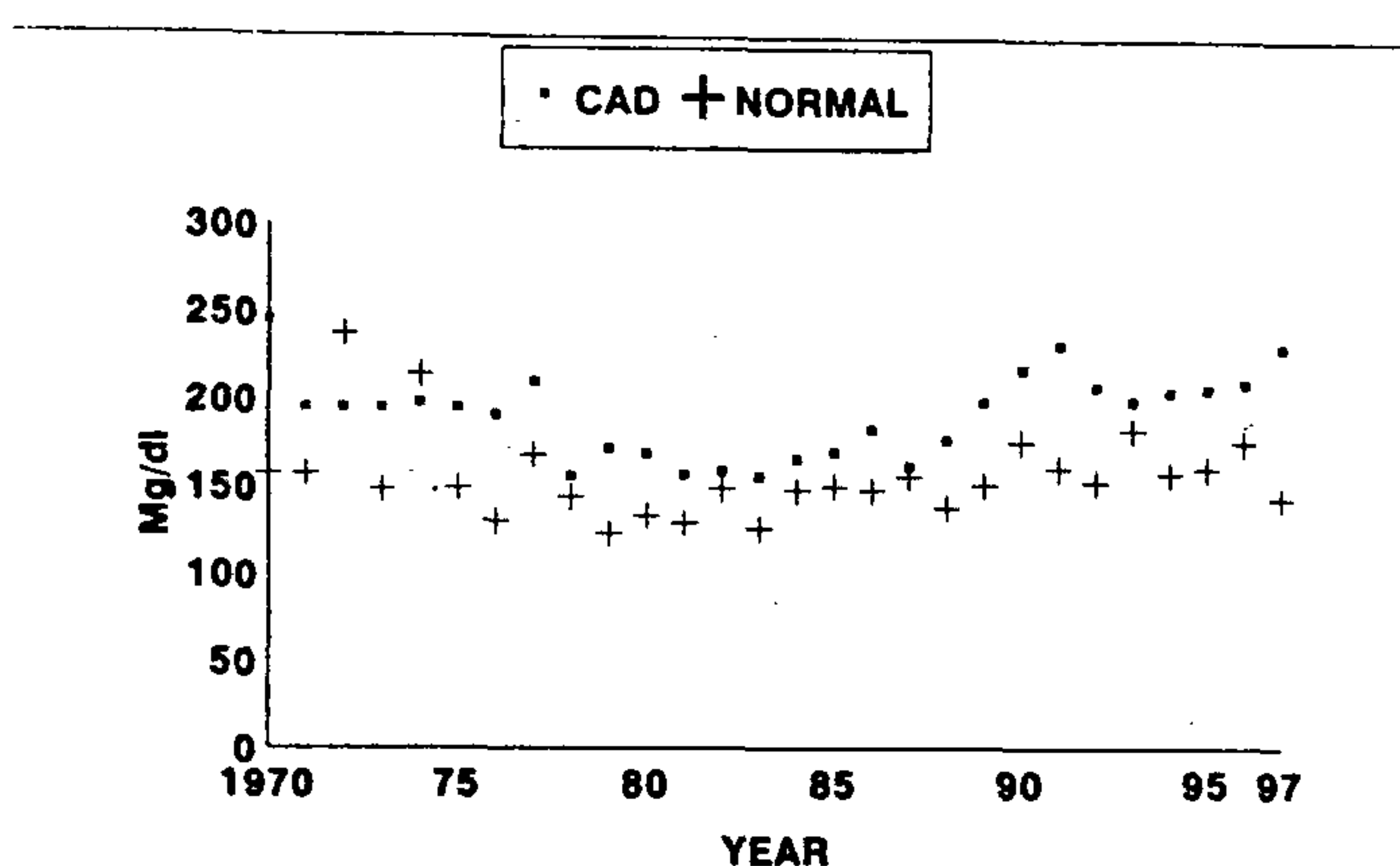


Figure 9. Triglyceride levels.

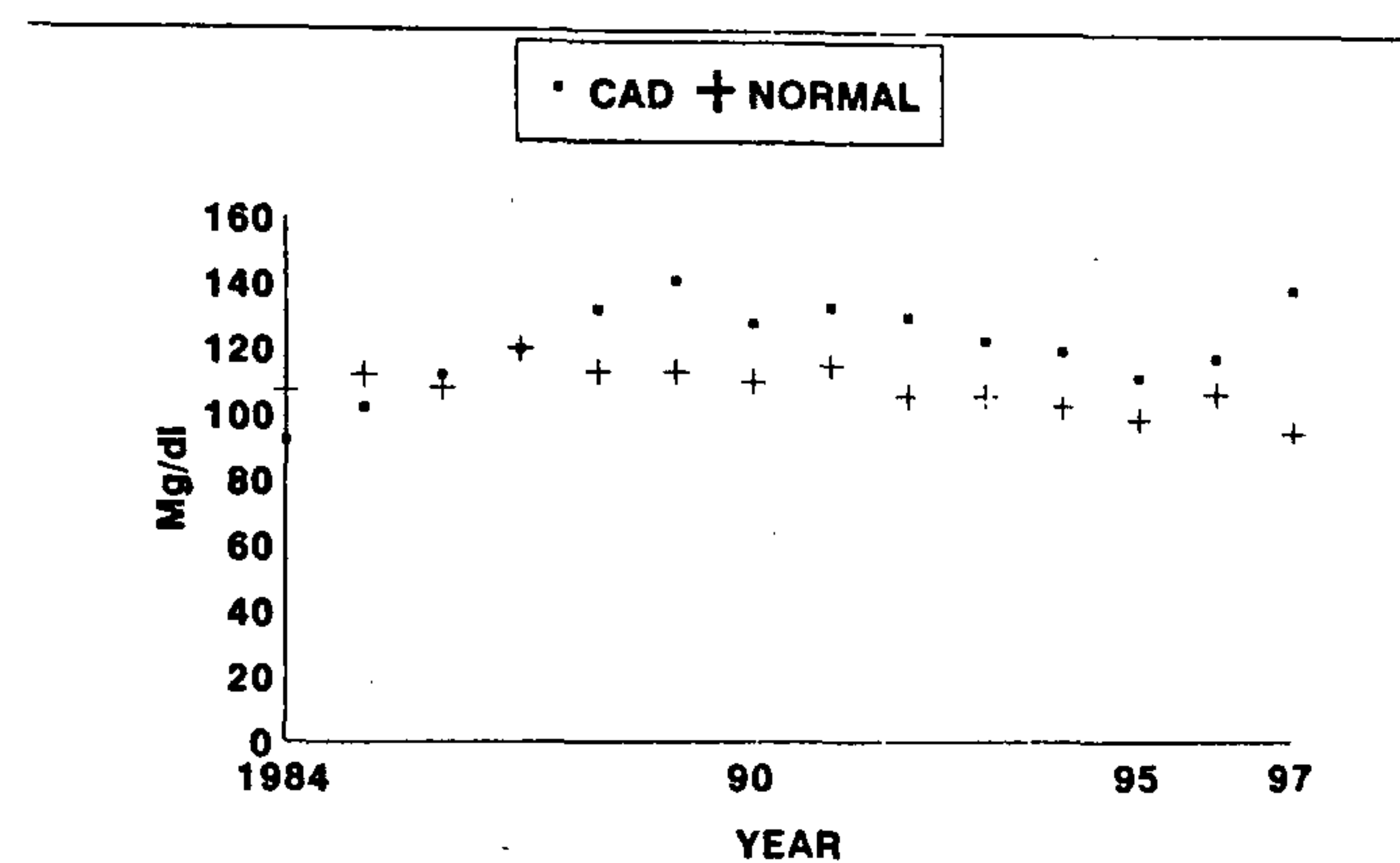


Figure 11. LDL-cholesterol levels.

Odd's ratio while columns 2 and 3 show the low and high 95% confidence limits. For this analysis, smoking, family history, diabetes, hypertension and gender were entered as dichotomous (present or absent) variables, while all the others were converted to categorical variables dividing at the mean level for those with normal coronary arteries, as 1 for those with values above the mean and 0 for those with values below the mean level. For HDL-cholesterol, levels below 35 mg/dl were labelled as 1 and those higher than 36 mg/dl were marked as 0 because of its known protective effect. Age was divided at below 45 years and above 46 years. It will be seen that male gender, diabetes, hypertension, positive family history and smoking were associated with an Odd's ratio for coronary artery disease above 1. It is of interest to note that none of the lipid values showed an association with coronary disease and the body mass index was also not significant.

To maintain our observations as a record of serial changes, in column 4 the logistic regression analysis for

the first 2000 patients undergoing selective coronary arteriography has also been shown. Again male gender and diabetes stand out as relevant risk factors in our group similar to the larger group of 4000 patients. A larger database on women is still being constituted, both at the national and the international level and should be available soon.

Column 5 shows the same logistic regression analysis using the variables of age, BMI, cholesterol, triglyceride, HDL and LDL-cholesterol as continuous variables. This would identify the variation in risk of coronary artery disease with a unit variation of various metabolic risk factors. It will now be noticed from the table that in most cases the Odd's ratios are higher than those presented above. It is possible that the cut-off value at the level of mean for those with normal coronary arteries may not be the true mean required for such logistic regression analysis. Other explanations also should be considered, for example, that all the factors studied so far are only facilitatory in the development of CAD and none of them is truly causative. Again in each individual his or her combination of risk factors may be exclusively relevant.

Table 1. Results of logistic regression of eleven risk factors in 11,600 patients with coronary artery disease

	Odd's ratio (dichotomous)	95% confidence limits	Odd's ratio <i>n</i> = 2000 (dichotomous)	Odd's ratio (continuous)
Male	6.17	4.14-9.2	5.5	6.26
Age	1.06	1.04-1.07	1.04	1.70
Smoking	1.49	1.18-1.89	1.49	1.48
Family history	1.55	1.15-2.09	1.33	1.67
Diabetes	3.97	2.84-5.55	11.86	4.29
Hypertension	1.76	1.36-2.27	2.40	1.75
Total cholesterol	1.01	1.00-1.02	1.01	2.24
Triglycerides	1.00	0.99-1.06	1.00	1.67
HDL-cholesterol	0.97	0.94-1.03	0.96	1.28
LDL-cholesterol	0.99	0.96-1.02	0.99	1.11
Body mass index	1.03	1.00-1.07	1.1	1.29

Further attempts at using other forms of multivariate analysis like multiple linear regression as well as discriminant analysis to measure distance from the means, failed to provide definite criteria to differentiate between CAD and normals using the suspected risk factors.

Limitations of our report. It needs to be pointed out that the data represent patients who came voluntarily to our department at a tertiary-care level and therefore will not reflect the picture at the community level. The strength of our inferences and conclusions stems from the fact that it is fully prospectively collected data of all consecutive patients who attended the department with a definitive diagnosis. It will probably be true for all terti-

ary care centres where such data are available. Changes at primary and secondary level will need further detailed study.

The crux of our message is that the factors contributing to the development of CAD appear to have been with us for decades and will continue to be with us at nearly the same levels unless modified. The increasing awareness of the problem of CAD and its magnitude should help us to accept the facts pointed above and get on with preventive measures directed specifically at modifiable risk factors to reduce the clinical load and burden on the health care system of the country and more importantly, to reduce patient morbidity.

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