Impact of cardiovascular risk factors on coronary heart disease and mortality among middle aged diabetic men: a general population study

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Abstract

Objective—To investigate the effect of cardiovascular risk factors on coronary heart disease and all cause mortality in middle aged diabetic men.

Design—Prospective population study based on data collected from second screening (from 1974 to 1977) in the multifactor primary prevention trial and follow up until March 1983.

Setting—Gothenburg, Sweden.

Subjects—6897 Men aged 51 to 59, of whom 232 were self reported diabetics and 6665 were non-diabetic; none had a history of myocardial infarction.

Main outcome measures—Incidences of coronary heart disease and mortality from all causes.

Results—Diabetic men with a serum cholesterol concentration >7·3 mmol/l had a significantly higher incidence of coronary heart disease during follow up than those with a concentration ≤5·5 mmol/l (28·3% *v* 5·4%; p=0·020); corresponding figures for non-diabetic men were 9·4% and 2·4% respectively. In multivariate logistic regression analyses serum cholesterol concentration and smoking habit were independent predictors of coronary heart disease (odds ratio serum cholesterol concentration 6·1 (95% confidence interval 2·1 to 17·6), current smoking 2·9 (1·1 to 7·5)) and of all cause mortality (3·2 (1·3 to 7·9), 3·0 (1·4 to 6·7) respectively) in diabetic men whereas systolic blood pressure, body mass index, family history, marital state, and alcohol abuse were not. Low occupational class was an independent predictor of mortality (2·4 (1·01 to 5·5)), but not of coronary heart disease, in diabetic men.

Conclusions—Middle aged diabetic men with hypercholesterolaemia are at very high risk of developing coronary heart disease and of dying prematurely. Lowering serum cholesterol concentration in such subjects seems to be warranted.

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Introduction

The role of diabetes as a risk factor for cardiovascular disease in the middle aged is well established.[1-8] In addition to their diabetic state, diabetics commonly have an unfavourable profile of cardiovascular risk factors in terms of hypertension[2 3 9] and blood lipids and obesity.[2 9 10] Few studies have been devoted to the importance of other cardiovascular risk factors in the development of cardiovascular disease in diabetics. In the Framingham study cardiovascular risk factors influenced outcome in diabetics and non-diabetics similarly.[11] In contrast, serum cholesterol concentration, obesity, and smoking were not related to coronary heart disease mortality in diabetics in the Whitehall study whereas increased blood pressure was associated with a substantial increase in risk.[4] We report data on risk factors in relation to self reported diabetes in middle aged men in whom the incidence of myocardial infarction and mortality were recorded over a mean of 7·1 years.

Subjects and methods

The multifactor primary prevention trial started in Gothenburg in 1970 and included all men in the city who had been born between 1915 and 1925, except those born in 1923.[12] The intervention group of 10 000 men comprised a random third of the men in the trial, with two control groups of 10 000 men each. A first screening examination took place between January 1970 and March 1973. In the present study data were used from the second screening, which started in 1974 and was completed in 1977. All surviving men from the intervention group who still lived in Gothenburg (9411) were invited for screening; the response rate was 76%. Men who had a history of myocardial infarction (225) were excluded, leaving a population of 6897 men, aged 51-59 at baseline. Diabetes was ascertained by a postal questionnaire; all men who answered positively to the question "Did a doctor tell you that you had diabetes?" were classified as diabetics, and in a subsequent question they were asked whether they were receiving pharmacological treatment for diabetes. Blood glucose concentrations were not determined. At screening 232 men without previous myocardial infarction were classified as diabetics. Data on physical leisure activities, smoking habits, psychological stress (rated from 1 to 6, with 6 representing continuous long term stress), pharmacological treatment of hypertension, and family history of myocardial infarction were also obtained from the questionnaire.

Screening examinations were performed in the afternoon. Blood pressure was measured after five minutes' rest with the subject seated. Body mass index was calculated as weight/(height^2). Serum cholesterol concentration (from a blood sample taken after fasting for at least two hours) was determined according to standard laboratory procedures.[13]

Occupational class was determined from data on occupation collected at the first screening, according to a new socioeconomic classification system (SEI) produced by the Central Bureau of Statistics in Sweden,[14 15] and 6000 men in the present study could be classified. Data on alcohol abuse[16] and marital state were collected, with special permission, from official registers.

All men were followed up until March 1983 (mean follow up 7·1 years). All cases of non-fatal myocardial infarction and stroke in Gothenburg are recorded according to specific criteria.[17 18] Death certificates for men in the study were continuously collected, and the Swedish national cause specific death register was

matched against the computer file for all men in the study. Cause specific mortality was coded according to the 8th revision of the International Classification of Diseases. Total coronary heart disease was defined as all men with either non-fatal myocardial infarction or death attributed to coronary heart disease, or both, during follow up.

The primary prevention trial was designed as an intervention study, with special measures for smokers as well as for men with hypertension or hypercholesterolaemia. There were no significant differences in pattern of risk factors or outcome between the intervention group and the two equally large control groups[12]; consequently any changes that had occurred in the intervention group must also have taken place among the general population.

Statistical analysis—Fisher's exact test was used to test differences between two groups in a fourfold table. Possible associations between continuous variables and outcome in diabetics and non-diabetics separately were tested with logistic regression whereas a gradient test in proportions was used for graded variables.[19] Adjusted odds ratios were calculated by logistic regression.[20] The isotonic regression technique was used for constructing the regression surfaces.

TABLE I—*Baseline values of variables in men with and without self reported diabetes*

	Without diabetes (n=6665)	With diabetes (n=232)	p Value
Mean (SD) age (years)	55·3 (2·2)	55·5 (2·1)	0·047
Mean (SD) blood pressure (mm Hg):			
Systolic	145·7 (19·7)	154·5 (21·2)	<0·001
Diastolic	92·6 (11·6)	94·5 (12·1)	0·012
Mean (SD) heart rate (beats/min)	75·3 (12·5)	80·5 (14·3)	<0·001
Mean (SD) serum cholesterol (mmol/l)	6·40 (1·06)	6·49 (1·31)	0·22
Mean (SD) body mass index (kg/m²)	25·6 (3·3)	26·8 (4·5)	<0·001
No (%) receiving treatment for hypertension	970 (14·6)	67 (28·9)	<0·001
No (%) receiving insulin or oral antidiabetic agents		138 (59·5)	
No (%) smokers	2718 (40·8)	94 (40·5)	0·89
No (%) inactive during leisure time	1039 (15·6)	52 (22·4)	0·0096
No (%) registered alcohol abusers	452 (6·8)	28 (12·1)	0·0057
No (%) unskilled workers*	1334 (20·0)	54 (23·3)	0·091
No (%) receiving disability pension	401 (6·0)	37 (15·9)	<0·0001
No (%) with high stress score†	575 (8·6)	35 (15·1)	0·0025
No (%) married	5129 (77·0)	174 (75·0)	0·53
No (%) with history of coronary heart disease in at least one parent	1293 (19·4)	52 (22·4)	0·29

*Occupational class I.
†Feeling of permanent stress during past five years.

TABLE II—*Death and disease in men with and without diabetes during follow up*

End point	No (%) of men: Without diabetes (n=6665)	With diabetes (n=232)	Odds ratio* (95% confidence interval)	Odds ratio† (95% confidence interval)
Non-fatal myocardial infarction	216 (3·2)	18 (7·8)	2·4 (1·4 to 3·9)	2·1 (1·2 to 3·7)
Coronary death	150 (2·3)	21 (9·1)	4·1 (2·5 to 6·6)	3·4 (1·9 to 6·1)
Total coronary heart disease	330 (5·0)	31 (13·4)	2·8 (1·9 to 4·2)	2·3 (1·4 to 3·8)
Total (fatal and non-fatal) stroke	72 (1·1)	8 (3·4)	2·7 (1·2 to 5·9)	2·0 (0·8 to 5·1)
Total cardiovascular deaths	177 (2·7)	27 (11·6)	4·6 (3·0 to 7·1)	4·1 (2·5 to 6·9)
Death from:				
Cancer	143 (2·1)	8 (3·4)	1·5 (0·7 to 3·2)	1·1 (0·5 to 2·9)
Other causes	127 (1·9)	13 (5·6)	2·9 (1·6 to 5·3)	2·7 (1·3 to 5·6)
All causes	447 (6·7)	48 (20·7)	3·5 (2·5 to 4·9)	3·2 (2·1 to 4·8)

*Diabetes versus no diabetes, adjusted for age.
†Diabetes versus no diabetes, adjusted for age, serum cholesterol concentration, systolic blood pressure, smoking, body mass index, occupational class, family history, physical activity, stress score, marital state, and alcohol abuse.

TABLE III—*Percentage (number) of men developing coronary heart disease or dying during follow up by quintiles of serum cholesterol concentration, systolic blood pressure, body mass index, and diabetic state*

	Coronary heart disease			All cause mortality		
	Non-diabetics	Diabetics	Total	Non-diabetics	Diabetics	Total
Serum cholesterol (mmol/l):						
≤5·5	2·4 (31)	5·4 (3)	2·5 (34)	6·3 (81)	12·5 (7)	6·5 (88)
5·6-6·1	3·5 (50)	5·6 (2)	3·5 (52)	5·3 (77)	16·7 (6)	5·6 (83)
6·2-6·6	4·2 (52)	15·4 (6)	4·5 (58)	6·2 (77)	23·1 (9)	6·7 (86)
6·7-7·3	5·2 (66)	10·4 (5)	5·4 (71)	6·5 (83)	16·7 (8)	6·9 (91)
>7·3	9·4 (130)	28·3 (15)	10·1 (145)	9·3 (128)	34·0 (18)	10·2 (146)
p Value for trend*	<0·0001	0·020	<0·0001	0·0002	0·025	<0·0001
Systolic blood pressure (mm Hg):						
≤129	3·0 (39)	7·4 (2)	3·0 (41)	5·2 (69)	33·3 (9)	5·6 (78)
130-139	3·4 (43)	5·6 (1)	3·5 (44)	5·3 (67)	16·7 (3)	5·5 (70)
140-149	4·5 (59)	18·9 (10)	5·0 (69)	6·1 (80)	24·5 (13)	6·8 (93)
150-161	6·1 (85)	16·1 (10)	6·5 (95)	7·5 (105)	16·1 (10)	7·9 (115)
>161	7·5 (103)	11·1 (8)	7·7 (111)	9·1 (125)	18·1 (13)	9·6 (138)
p Value for trend*	<0·0001	0·64	<0·0001	<0·0001	0·26	<0·0001
Body mass index (kg/m²):						
≤22·9	4·9 (61)	5·0 (2)	4·9 (63)	7·2 (90)	17·5 (7)	7·5 (97)
23·0-24·6	3·9 (53)	20·6 (7)	4·3 (60)	5·4 (73)	23·5 (8)	5·9 (81)
24·7-26·1	3·4 (44)	7·3 (3)	3·5 (47)	6·0 (78)	31·7 (13)	6·8 (91)
26·2-28·0	5·6 (75)	19·5 (8)	6·0 (83)	7·4 (99)	17·1 (7)	7·6 (106)
>28·0	6·9 (97)	14·5 (11)	7·3 (108)	7·5 (105)	17·1 (13)	7·9 (118)
p Value for trend*	0·0076	0·50	0·0065	0·43	0·48	0·65

*Tested as a continuous variable.

Results

Table I shows the baseline values of variables of men in the study. Those with diabetes had significantly higher mean systolic and diastolic blood pressures, heart rates, and body mass index whereas total serum cholesterol concentration was not significantly different from that in the non-diabetics. There were no differences in smoking habits or occupational class; diabetic men, however, more commonly had disability pensions. They were more commonly physically inactive, registered for alcohol abuse, and with high stress scores than the non-diabetics.

The incidence of all cardiovascular diseases was significantly increased among the men with diabetes (table II), but for stroke the association with diabetes no longer remained significant when other risk factors were considered. Death from causes other than cardiovascular disease or cancer were more common among men with diabetes; six of 13 deaths in this category were diagnosed as due to diabetes: three to uraemia and three to other diabetic complications. The odds ratio for all cause mortality in the diabetics compared with the non-diabetics was only slightly reduced when other factors were controlled for.

Serum cholesterol concentration was associated with the incidence of coronary heart disease as well as with all cause mortality in the diabetics and non-diabetics (table III). Diabetics with cholesterol concentrations >7·3 mmol/l had a high rate of coronary heart disease and also high mortality. No significant association between systolic blood pressure and coronary heart disease could be detected among them; however, only three cases of coronary heart disease occurred in diabetic men with systolic blood pressure <139 mm Hg. As the blood pressure distribution was skewed to the right in the diabetic population, with comparatively few diabetics in the lowest two quintiles the difference was not significant. There was no association between systolic blood pressure and mortality among the diabetics, and the findings for diastolic blood pressure were similar (data not shown). Body mass index was not related to either coronary heart disease or mortality in the diabetics.

The incidence of coronary heart disease among the non-diabetic smokers was essentially double that of the non-smokers, with no increase in risk among the ex-smokers (table IV). Among the diabetics even ex-smokers had an increased risk for coronary heart disease as well as for mortality, and the rates among the smokers were substantially increased compared with the non-smokers. There were significant inverse trends for coronary heart disease and mortality in relation to occupational class among the non-diabetics. No such association could be detected for coronary heart disease among the diabetic men, but for total mortality the trend was of borderline significance (p=0·054).

Table V shows odds ratios adjusted by logistic

regression for all variables in relation to fatal and non-fatal coronary heart disease and to all cause mortality for diabetics and for non-diabetics. All variables except age were dichotomised. Only serum cholesterol concentration and smoking were independently related to the incidence of coronary heart disease among the diabetics. The odds ratio for systolic blood pressure >139 mm Hg was 3·7, but the confidence interval was wide owing to the small number of cases and included unity. Serum cholesterol concentration, current smoking, and low occupational class were independent predictors of all cause mortality in diabetics. Statistical testing for a possible interaction effect between serum cholesterol concentration and diabetes for coronary heart disease and all cause mortality was non-significant. The odds ratio for smoking in relation to coronary heart disease was similar among the diabetics and non-diabetics whereas smoking seemed to confer a higher mortality risk in the diabetics than the non-diabetics; the result of a formal test for an interaction effect was, however, not significant.

The figure shows the combined effect of smoking and cholesterol concentration on the incidence of coronary heart disease in the diabetics and in the non-diabetics as depicted by the isotonic regression technique; non-smoking diabetic men with low or moderate serum cholesterol concentrations seemed to be at low risk for coronary heart disease.

TABLE IV—*Percentage (number) of men developing coronary heart disease or dying during follow up by smoking habit, occupational class, and diabetic state*

	Coronary heart disease			All cause mortality		
	Non-diabetics	Diabetics	Total	Non-diabetics	Diabetics	Total
Smoking habit:						
Non-smoker	3·1 (58)	5·6 (4)	3·2 (62)	4·8 (91)	11·3 (8)	5·0 (99)
Ex-smoker	3·4 (67)	13·9 (9)	3·7 (76)	4·7 (93)	16·9 (11)	5·1 (104)
Current smoker	7·5 (203)	19·1 (18)	7·9 (221)	9·3 (253)	30·9 (29)	10·0 (282)
p Value for trend	<0·0001	0·015	<0·0001	<0·0001	0·0021	<0·0001
Occupational class*:						
5	2·7 (18)	12·5 (2)	2·9 (20)	3·9 (26)	6·3 (1)	3·9 (27)
4	4·2 (45)	12·5 (4)	4·4 (49)	5·3 (57)	18·8 (6)	5·7 (63)
3	4·8 (55)	15·2 (7)	5·2 (62)	6·4 (73)	15·2 (7)	6·7 (80)
2	5·1 (81)	4·9 (2)	5·1 (83)	5·8 (92)	14·6 (6)	6·0 (98)
1	5·8 (77)	18·5 (10)	6·3 (87)	8·1 (108)	29·6 (16)	8·9 (124)
p Value for trend	0·0018	0·71	0·0017	0·0003	0·054	<0·0001

*Class 5=professionals, higher civil servants, executives, and managing directors; class 4=intermediate non-manual employees; class 3=assistant non-manual employees and foremen in industrial production; class 2=skilled workers; and class 1=unskilled and semiskilled workers.

TABLE V—*Odds ratios* (95% confidence intervals) for major risk factors for non-diabetics and diabetics in relation to coronary heart disease and all cause mortality*

	Coronary heart disease		All cause mortality	
Risk factor	Non-diabetics	Diabetics	Non-diabetics	Diabetics
Serum cholesterol (>7·3 or ≤7·3 mmol/l)	2·4 (1·8 to 3·1)	6·1 (2·1 to 17·6)	1·4 (1·1 to 1·7)	3·2 (1·3 to 7·9)
Systolic blood pressure (>139 or ≤139 mm Hg)	1·9 (1·4 to 2·5)	3·7 (0·7 to 20·1)	1·3 (1·03 to 1·7)	1·1 (0·4 to 3·2)
Current smoking (present or absent)	2·5 (1·9 to 3·2)	2·9 (1·1 to 7·5)	1·9 (1·5 to 2·4)	3·0 (1·4 to 6·7)
Body mass index (>28 or ≤28 kg/m²)	1·6 (1·2 to 2·1)	1·0 (0·4 to 2·8)	1·1 (0·8 to 1·4)	0·5 (0·2 to 1·3)
Family history of coronary heart disease (present or absent)	1·5 (1·1 to 2·0)	0·8 (0·2 to 2·3)	1·4 (1·1 to 1·9)	0·9 (0·4 to 2·3)
Married or unmarried	0·8 (0·6 to 1·2)	0·4 (0·1 to 1·4)	1·3 (1·01 to 1·7)	0·9 (0·3 to 2·5)
Low socioeconomic state (occupational class 1/2-5)	1·2 (0·9 to 1·6)	1·6 (0·6 to 4·4)	1·3 (1·03 to 1·7)	2·4 (1·01 to 5·5)
Registered for alcohol abuse (yes or no)	1·5 (0·9 to 2·3)	1·6 (0·4 to 7·1)	2·6 (1·9 to 3·7)	0·8 (0·2 to 3·3)

*Obtained by entering age and all variables in table (dichotomised and with cut off points as above) into logistic regression analyses.

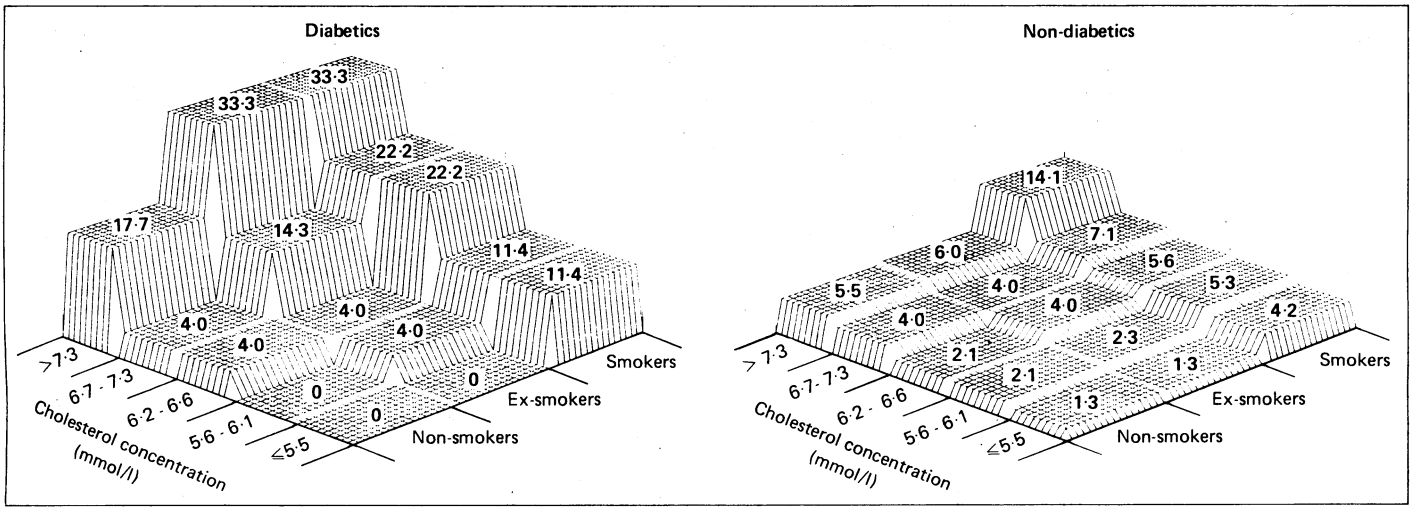
Discussion

The present study confirms the well known association between coronary heart disease and diabetes and establishes hypercholesterolaemia and smoking as important risk factors within a diabetic population. Even though no significant interaction between these two factors and diabetes in relation to coronary heart disease could be shown, the combination of either with diabetes confers a substantial increase in risk.

Blood glucose concentrations were not recorded nor glucose tolerance tests performed to establish the diagnosis of diabetes in our diabetic subjects. Forty per cent of the diabetics in the study did not use insulin or oral antidiabetic agents, which is comparable to the proportion of pharmacologically untreated diabetics in other studies,[7 21] but might indicate that some of them may have been false positives. In addition, diabetes may have been undiagnosed,[22 23] and even though undiagnosed diabetes may have a milder course and less risk of complications, misclassification of diabetics into the non-diabetic group would lead to underestimation of the real differences; but the non-diabetic group was very large, and any underestimation is probably minimal.

The data collected in this survey did not permit differentiation between insulin dependent and non-insulin dependent diabetes. In another study in Gothenburg, aimed at determining the prevalence of diabetes among men aged 50 and above, however, virtually all diabetics were not dependent on insulin.[21] As the present study was designed as an intervention study diabetes might have been diagnosed at a higher rate in subjects with high blood cholesterol concentrations, in the course of managing their hyperlipidaemia, than in those with normal concentrations. Even so, this might have occurred only in diabetics who were not diabetic at the first screening, and removing such subjects from the analyses made no difference to the results.

Most general population studies on diabetes in



Percentage probabilities of coronary heart disease in diabetics and non-diabetics by smoking and quintiles of serum cholesterol concentration

relation to long term sequelae have been hampered by small numbers, resulting in a lack of statistical power; this was true of the present study, but the fact that only men were studied and that their age span was fairly narrow suggests that the diabetic study population may be less heterogeneous than that of some other studies. The lack of any association between blood pressure and outcome in diabetics may, however, be due to chance. In the Whitehall study, which also examined only men, coronary heart disease mortality increased significantly with increasing systolic blood pressure[4]; in multiple logistic regression analyses, however, the association between hypertension and outcome in diabetics was significant only for all cause mortality and not for coronary heart disease mortality.[24] In view of the well known relation between high blood pressure and obesity it is somewhat surprising that no association between coronary heart disease and this factor was found, either in the Whitehall study or in our study.

Few studies have been devoted to the combined effects of diabetes and smoking. In our study, among non-diabetics ex-smokers had virtually the same incidence of coronary heart disease and the same mortality as those who had never smoked. In contrast, diabetic ex-smokers had an increased risk. Probably diabetics were more liable to give up smoking for health reasons. Smoking seemed to double the risk for coronary heart disease and for total mortality in diabetics as well as in non-diabetics.

The role of disturbances in lipid metabolism, particularly hypercholesterolaemia, is increasingly being confirmed as causing development of atherosclerosis. Serum cholesterol concentration in the general population is now recommended to be <5·2 mmol/l,[25] and diabetics are included as a risk group, demanding special attention, which seems reasonable given their very high risk of developing atherosclerotic disease. The role of hypercholesterolaemia in predicting the prognosis in diabetics, however, has not been particularly well studied. Whereas diabetics in the Framingham study contended with cardiovascular risk factors as well as non-diabetics[11] no relation between serum cholesterol concentration and coronary mortality was found in the subset of diabetics in the Whitehall study,[4] which is difficult to explain. As the diabetic population was no larger than that of the present study and only coronary deaths were studied this might be due to chance variations. In our study fatal and non-fatal coronary events were similarly related to serum cholesterol concentration.

Total serum cholesterol concentration was not different between diabetic and non-diabetic men. There might, however, have been other differences in blood lipids that were not measured. Low density lipoprotein concentration, which is strongly associated with coronary heart disease,[26] may be affected by diabetes.[27] In contrast, high density lipoprotein concentration, which is generally regarded as protective, is decreased in diabetics.[9 28] In addition, increased plasma concentrations of triglycerides are common in diabetes.[9 28 29] The altered lipid metabolism in diabetes has recently been reviewed[30]; the complexities of the alterations may not be reflected in a single measurement of total serum cholesterol concentration; even so, this single measurement was the strongest predictor of coronary heart disease in our diabetic population. Although statistical tests for interaction between serum cholesterol concentration and diabetes with respect to coronary heart disease and mortality were non-significant, the difference in odds ratios for serum cholesterol concentration between diabetics and non-diabetics suggests that the effect of increased serum cholesterol concentration might in fact be stronger among diabetics.

Studies of populations with a low prevalence of coronary heart disease, such as that of Japan,[31] have shown that this is comparatively low also among diabetics. Serum cholesterol concentrations in Sweden are high by international standards, with a concomitantly high incidence of coronary heart disease. To reduce cholesterol concentrations in the general population should be a major aim in preventive medicine; in addition, diabetic men with hypercholesterolaemia are at an extremely high risk of developing coronary heart disease. The benefits of lowering cholesterol concentration in general and selected populations have been illustrated.[32 33] Although pharmacological treatment reduces serum cholesterol concentration in diabetics,[34] its effects on long term prognosis have yet to be investigated. Special attention to hypercholesterolaemia in diabetics in addition to vigorous antismoking counselling certainly seems to be warranted.

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Incidence of peptic ulcer disease in Gothenburg, 1985

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Abstract

***Objective*—To determine the incidence and age distribution of peptic ulcer disease in adults in Gothenburg.**

***Design*—Retrospective study of patients with symptoms over one year.**

***Setting*—All gastroenterology and *x* ray departments.**

***Patients*—Any patient found to have an active ulcer crater during 1985.**

***Main outcome measures*—Sex, age, past history of gastrointestinal ulcers, and smoking habit.**

***Results*—In 1985, 1402 peptic ulcers were diagnosed in 1137 adults. Over half (403; 54%) of the ulcers in men and 393 (60%) ulcers in women were in patients aged over 60. All types of ulcer showed increasing incidence with age. The sex ratio of patients aged 40-50 with peptic ulcers was 1:1. Nearly half (109; 48%) of ulcers diagnosed for the first time in men and 129 (57%) of such ulcers in women were in patients aged over 60. Elderly men and women were also more likely to develop haemorrhage.**

***Conclusions*—In Gothenburg there is a surprisingly high incidence of peptic ulcer disease, which increases considerably with age, possibly explained by the availability of modern diagnostic techniques as 1121 (80%) ulcers had been diagnosed by gastroscopy. Compared with earlier studies there was no difference in the incidence between men and women aged 40-50.**

Introduction

During the past 20 years the death rate and rate of surgical intervention for duodenal and gastric ulcer have declined[1-3] and the number of hospital admissions for peptic ulcer disease has fallen.[4-6] These observations may suggest that the incidence of peptic ulcer disease is declining. The perforation rate, however, is increasing in older women in the United Kingdom,[7] and a rising predominance of gastric ulcer among women was reported in 1982.[8] In Norway an increase in prevalence of both gastric and duodenal ulcer in women took place between 1946 and 1982.[9] The increasing number of hospital admissions for both gastric ulcers and ulcers of unspecified sites in the United States in 1970-85 was shown to be caused by an over 100% increase in patients with gastric ulcer and haemorrhage registered in 1980-5.[10] During the same period admissions to hospital for uncomplicated duodenal ulcer continued to fall, with no fall in the number of cases of duodenal ulcer with complications.

The population based studies of Kiaer *et al*[11] and Permutt and Cello[12] and the specific study of Ihamäki *et al*[13] used gastroscopic findings; other investigations are based on *x* ray diagnosis or inpatient series, or both. In Sweden gastroscopy is the primary means of investigating suspected peptic ulcer, and in 1985, 80% (1121) of all diagnoses of ulcers made in Gothenburg were confirmed by gastroscopy. We investigated the incidence of peptic ulcer disease during a period when decreasing mortality, surgical intervention, and hospital admissions for this condition were reported.

Patients and methods

The figure of 360 042 for the adult population of Gothenburg—that is, people aged over 15—was estimated as the mean of the numbers registered on 31 December 1984 and 31 December 1985. The figures were derived from the local population register of all residents in one year age classes. The population was divided into age groups of five or 10 years for calculation of the age specific incidence. In Gothenburg 1·2% of people aged over 65 and 14% of men aged 40 are immigrants, most having come from Finland, usually at the age of about 20. In Sweden all residents belong to the social insurance system, which means that the consumption of medical care is uniformly distributed. Endoscopic methods are therefore widely used in both inpatients and outpatients.

Peptic ulcers diagnosed during 1985 were registered in collaboration with all gastroenterology departments performing gastroscopies and all *x* ray departments. In 1985 gastroscopy was performed at three major surgical centres, one major department of internal medicine, two smaller hospital departments, and three private practices. Data about all gastroscopies performed in Gothenburg were recorded during the year.

The *x* ray units equipped with organ specific computerised registers supplied results of all barium meals. Of the 1137 patients with active ulcer craters, 1013 were interviewed by telephone about earlier episodes of ulcers, other relevant disease, and smoking habits. The relations between smoking habits among the population as a whole and the patients with peptic ulcer of the present study will be presented in a separate paper.

Hospital records of patients with perforated or bleeding ulcers diagnosed at an emergency operation without previous gastroscopy were collected during the year from the two hospitals with casualty departments. Patients found to have no ulcer crater at the time of operation were excluded. Gastric ulcers were defined as ulcers near to or proximal to the gastric angulus; prepyloric ulcers as ulcers on the gastric side of the pylorus or within 3 cm proximal to the pylorus; and duodenal ulcers as ulcers located in the duodenal bulb or on the distal part of the pyloric valve.

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