Socioeconomic factors and physical activity in relation to cardiovascular disease and death

A 12 year follow up of participants in a population study of women in Gothenburg, Sweden

LEIF LAPIDUS, CALLE BENGTSSON

From the Department of Medicine II, Sahlgrenska Hospital, and the Department of Primary Health Care, Gothenburg University, Gothenburg, Sweden

SUMMARY In a prospective population study of middle aged women socioeconomic factors and physical activity as initially reported were related to the 12 year incidence of ischaemic heart disease and to total mortality. There was a significant age specific correlation between low socioeconomic status according to the husband's occupation and myocardial infarction. No such association was seen between the socioeconomic status of the women themselves and myocardial infarction. Women with a low educational level had a significantly increased age specific incidence of angina pectoris. There was no significant correlation between marital status or number of children and incidence of ischaemic heart disease or overall mortality. Women who initially reported low physical activity at work during the last year had a significantly increased age specific 12 year incidence of stroke and death, as did those who reported low physical activity during leisure hours in whom the incidence of myocardial infarction and electrocardiographic changes indicating ischaemic heart disease were also increased. Multivariate analyses showed that the association between low educational level and incidence of angina pectoris was independent of socioeconomic group, smoking habits, systolic blood pressure, indices of obesity, serum triglycerides, and serum cholesterol. Similarly, low physical activity during leisure hours seemed to be an independent risk factor for stroke, and low physical activity at work was an independent risk factor for overall mortality.

Socioeconomic factors and lifestyle, with the exception of smoking habits, have not attracted the same degree of interest as traditionally accepted risk factors, such as arterial hypertension and hyperlipidaemia, in studies of risk factors for ischaemic heart disease. Education,^{1,2} marital status,^{2,3} number of children,^{2,4,5} socioeconomic status,^{5,6} and degree of physical activity^{4,7} have been reported to be related to cardiovascular disease in women. Some of the observations mentioned were made in a case control study carried out by our group.⁴ We considered it important to re-evaluate our cross sectional results in a prospective study.

Requests for reprints to Dr Leif Lapidus, Department of Medicine II, Sahlgrenska Hospital, S-413 45 Gothenburg, Sweden.

Accepted for publication 4 November 1985

Study population

A population study of 1462 women aged 38, 46, 50, 54, and 60 was carried out in Gothenburg, Sweden, in 1968-69.⁸ The systematic sampling method, based on date of birth, and a high participation rate (90.1%), ensured that the participants were a representative cross section of women from the community studied. Table 1 shows the number of participants in the initial examination.

The population sample was followed up in 1974-75 and in 1980-81. Of those participating in 1968-69, 1154 (78.9%) took part in the 1980-81 follow up. Most of the non-participants in these follow up studies were interviewed by telephone or letter about their history of angina pectoris, myocardial infarction, or stroke. Hence information was

Table 1 *Participants and participation rates in the population study of women in Gothenburg 1968–69*

Age (yr)	Participants (No)	Participation rate (%)
38	372	91.4
46	431	90.0
50	398	91.3
54	180	88.7
60	81	83.5
Total	1462	90.1

obtained from a total of 1351 women (97.4% of those participating in 1968–69 and still alive in 1980–81). Further details of the studies in 1968–69, 1974–75, and 1980–81 have been presented elsewhere.^{8–10}

Methods

COLLECTION OF SOCIAL DATA

Information on place of birth of the women participating in the population study was obtained from the Revenue Office Register.⁴ Information about education, marital status, number of children, and socioeconomic status was obtained by a questionnaire.⁴ The subjects were divided into five socioeconomic groups according to Carlsson.¹¹ Group 1 according to this classification is group I in the present paper (large-scale employers and officials of high or intermediate rank), groups 2 and 3 are group II (small-scale employers, officials of lower rank, foremen), and groups 4 and 5 are group III (skilled and unskilled workers). Housewives were classed as a separate group.

INTERVIEW ABOUT PHYSICAL ACTIVITY

The subjects were interviewed about their physical activity at work and during leisure hours. On the basis of the level of physical activity we assigned women to groups I–IV, using a classification which had previously been used for men in Gothenburg¹² and modified for women.⁴ For example, women with light office work and no domestic work were assigned to group I for physical activity at work; women with shop work, light industrial work, or domestic work including the care of one child to group II; women with hospital work or domestic work including the care of two or three children to group III; and those with heavy work together with domestic work, or just domestic work including the care of four or more children to group IV. As regards activity during leisure hours, examples of group I activities are reading or looking at television, group II walking or cycling for half an hour a day, group III regular exercise such as running, tennis, or swimming, and group IV heavy exercise or competitive sports.

CLINICAL EXAMINATION

In the initial study of 1968–69, blood samples were taken after an overnight fast.⁴ Body weight was measured to the nearest 0.1 kg with a balance scale. Body height without shoes was measured to the nearest 0.5 cm. Body mass index was calculated as weight/height² (kg/m²). Waist and hip circumferences were measured and the waist : hip circumference ratio was calculated.¹³ Blood pressure was measured with a mercury manometer in the seated position after about 5 minutes' rest.⁴ Information about smoking habits was obtained by means of a standardised interview.⁴

END POINTS DURING THE FOLLOW UP PERIOD

Myocardial infarction—Each participant was asked whether she had any history of chest pain, as were most of the non-participants in the follow up studies. Records of all women who were admitted to hospital because of chest pain were studied, and acute myocardial infarction was defined as the presence of at least two of the following symptoms: (a) central chest pain, (b) transient rise of transaminase activities, and (c) typical electrocardiographic changes of recent onset. These criteria have been described in detail elsewhere.¹⁴ Fatal myocardial infarction was determined from the diagnosis on the death certificate. "Silent" myocardial infarction was defined as electrocardiographic changes interpreted as Minnesota code 1.1^{15 16} without a history of myocardial infarction. In our analysis, we used the combined incidences of fatal and non-fatal myocardial infarction. The incidence of "silent" myocardial infarction was added only when indicated in the text.

Angina pectoris—During an interview, patients were asked whether they had a history of chest pain. A diagnosis of angina pectoris was accepted when the criteria proposed by Rose were fulfilled.¹⁷

Electrocardiographic changes indicating ischaemic heart disease.—Electrocardiography was performed on all participants during rest in 1968–69 and in 1980–81. Minnesota codes^{15 16} 1.1–2, 4.1, 5.1–2 (in the absence of 3.1), 6.1, or 7.1 were taken to indicate ischaemic heart disease.

Stroke was defined as described by Harmsen and Tibblin.¹⁸ If non-fatal, a hospital diagnosis was required. Stroke was also recorded for subjects who at necropsy showed signs consistent with a recent cerebrovascular accident and for subjects in whom stroke was recorded as the main cause of death on their death certificates.

Death.—At the end of 12 years we were able to establish the vital status of 1458 (99.7%) of the initial participants. Death certificates were obtained for

all participants who died. Necropsies were performed in five patients dying of myocardial infarction and in 27 (40%) of 67 women in whom myocardial infarction had not been recorded on the death certificate. Patients with findings positive for myocardial infarction at the initial examination were excluded when the risk of myocardial infarction as

an end point was assessed. Similarly, patients with findings positive for other end points at the initial examination were excluded in the final calculation for the corresponding end points.

STATISTICAL METHODS

We used an extension of the χ^2 procedure according

Table 2 Observed and expected frequencies of end points in women born in the County of Gothenburg, women who had been living in Gothenburg for > 25 years, women born outside Scandinavia, and women who had grown up in a big city. 95% confidence interval for the age adjusted relative risk compared with other women is given in parentheses

End points	Observed	Expected	Relative risk
<i>Born in Gothenburg or its environs (n = 763)</i>			
Myocardial infarction	15	12.8	1.5 (0.6-3.5)
Angina pectoris	30	25.3	1.0 (0.6-1.7)
Electrocardiographic changes	39	39.6	1.0 (0.6-1.6)
Stroke	8	7.2	1.3 (0.4-4.1)
Death	44	40.8	1.2 (0.7-2.0)
<i>Living in Gothenburg for > 25 years (n = 854)</i>			
Myocardial infarction	18	15.8	1.8 (0.6-5.3)
Angina pectoris	36	34.3	1.2 (0.6-2.1)
Electrocardiographic changes	43	44.0	0.9 (0.6-1.6)
Stroke	12	9.1	5.2 (0.9-29.8)
Death	56	51.0	1.5 (0.9-2.6)
<i>Born outside Scandinavia (n = 44)</i>			
Myocardial infarction	0	0.5	—
Angina pectoris	3	1.7	2.0 (0.6-6.8)
Electrocardiographic changes	3	2.3	1.4 (0.4-4.6)
Stroke	0	0.3	—
Death	0	1.6	—
<i>Grown up in a big city (n = 689)</i>			
Myocardial infarction	11	11.4	0.9 (0.4-2.2)
Angina pectoris	28	26.6	1.1 (0.6-1.9)
Electrocardiographic changes	31	34.1	0.8 (0.5-1.3)
Stroke	9	6.4	2.4 (0.7-8.2)
Death	42	36.2	1.4 (0.9-2.3)

Table 3 Observed and expected frequencies of end points in women who had low educational level (elementary school only), women who were divorced, women who were widowed, and women who had four children or more at the beginning of the follow up period. 95% confidence interval for the age adjusted relative risk compared with other women is given in parentheses

End points	Observed	Expected	Relative risk
<i>Elementary school only (n = 1013)</i>			
Myocardial infarction	20	16.7	2.6 (0.8-8.7)
Angina pectoris	48*	39.3	2.6 (1.3-5.5)
Electrocardiographic changes	52	50.6	1.1 (0.6-1.9)
Stroke	11	9.5	2.0 (0.5-9.0)
Death	55	53.3	1.1 (0.6-1.9)
<i>Divorced (n = 117)</i>			
Myocardial infarction	0	1.8	—
Angina pectoris	5	4.4	1.3† (0.5-3.3)
Electrocardiographic changes	4	5.7	0.6† (0.2-1.8)
Stroke	1	1.0	1.6† (0.2-12.2)
Death	9	6.0	1.7† (0.8-3.6)
<i>Widowed (n = 62)</i>			
Myocardial infarction	3	1.6	1.8† (0.6-5.5)
Angina pectoris	3	2.6	1.2† (0.4-3.9)
Electrocardiographic changes	2	3.2	0.6† (0.1-2.4)
Stroke	2	0.9	3.0† (0.6-13.5)
Death	5	5.1	1.1† (0.4-2.8)
<i>Four children or more (n = 142)</i>			
Myocardial infarction	4	2.2	2.1 (0.7-6.2)
Angina pectoris	8	5.1	1.7 (0.8-3.6)
Electrocardiographic changes	6	6.9	0.8 (0.4-2.0)
Stroke	2	1.2	1.8 (0.4-7.9)
Death	7	7.3	1.0 (0.4-2.1)

*p < 0.01 compared with other women in the population sample.

†Compared with married women.

to Mantel-Haenszel with one degree of freedom for analysis of frequencies in morbidity and mortality.¹⁹ This minimises the effect of age as a confounding factor. Relative risk (risk ratio) and confidence limits of relative risk were calculated according to the Mantel-Haenszel estimation.^{19 20} Associations between graded or continuous variables were tested by means of Pitman's non-parametric permutation test.²¹ When adjusting for confounding variables, we used an extension of Mantel-Haenszel's procedure for permutation testing.¹⁹ Two-tailed tests were used and *p* values < 0.05 were considered to be significant.

Results

INCIDENCE OF MYOCARDIAL INFARCTION, ANGINA PECTORIS, ELECTROCARDIOGRAPHIC CHANGES INDICATING ISCHAEMIC HEART DISEASE, STROKE, AND MORTALITY

Of all women initially free from signs of myocardial infarction from whom we obtained valid follow up data (*n* = 1424), 23 (1.6%) developed myocardial infarction during the follow up period (8 fatal myocardial infarction and 15 non-fatal myocardial infarction). Another five women developed "silent" myocardial infarction during follow up. New symptoms of angina pectoris were recorded in 56 (4.0%) of 1416 women, new electrocardiographic changes indicating ischaemic heart disease in 73 (6.0%) of 1218 women, and new signs of stroke in 13 (0.9%) of 1426 women. Altogether 75 women (5.1%) died during the follow up period.

INITIAL SOCIOECONOMIC FACTORS IN RELATION TO END POINTS

Myocardial infarction.—Age specific 12 year incidence of myocardial infarction was significantly higher in the group of women who were initially assigned to socioeconomic group III according to their husbands' occupations than in other women (*p* < 0.01). There were no significant differences with respect to myocardial infarction when women who were born in Gothenburg or its environs, who had been living in Gothenburg for > 25 years, who were born outside Scandinavia, who had grown up in a big city, who had a low educational level, who were divorced or widowed, who had four children or more, who were housewives or who were assigned to socioeconomic group III according to their own occupations were compared with other women (Tables 2, 3, and 4). Similar results were obtained when women with "silent" myocardial infarction were included.

Angina pectoris.—Women with a low educational level had a significantly increased age specific incidence of angina pectoris compared with other women (*p* < 0.01), but no other significant differences were seen when we studied the same socioeconomic factors as we did for myocardial infarction (Tables 2, 3, and 4).

Electrocardiographic changes indicating ischaemic heart disease.—No significant differences were observed (Tables 2, 3, and 4).

Stroke.—No significant differences were observed (Tables 2, 3, and 4).

Mortality.—No significant differences were found for variables included in Tables 2, 3, and 4.

Table 4 Observed and expected frequencies of end points in women classified as housewives, women assigned to socioeconomic group III according to their occupation, and women whose husbands were assigned to socioeconomic group III. 95% confidence interval for the age adjusted relative risk compared with other women is given in parentheses

End points	Observed	Expected	Relative risk
<i>Housewives (n = 498)</i>			
Myocardial infarction	6	8.3	0.8 (0.3-2.3)
Angina pectoris	19	20.4	0.9 (0.5-1.6)
Electrocardiographic changes	24	25.7	0.9 (0.6-1.5)
Stroke	2	4.9	0.5 (0.1-2.5)
Death	17	26.3	0.7 (0.4-1.3)
<i>Socioeconomic group III according to the woman's occupation (n = 400)</i>			
Myocardial infarction	7	6.0	1.7 (0.5-5.6)
Angina pectoris	15	15.4	0.9 (0.5-1.8)
Electrocardiographic changes	19	20.2	0.8 (0.5-1.5)
Stroke	5	3.6	5.4 (0.8-38.4)
Death	21	20.3	1.3 (0.7-2.4)
<i>Socioeconomic group III according to the husband's occupation (n = 487)</i>			
Myocardial infarction	14*	7.9	4.6 (1.7-12.8)
Angina pectoris	18	16.5	1.2 (0.6-2.2)
Electrocardiographic changes	26	24.7	1.3 (0.7-2.2)
Stroke	3	2.7	0.9 (0.2-4.0)
Death	22	23.6	0.8 (0.5-1.5)

**p* < 0.01 compared with other women in the population sample.

Table 5 *P* values for age specific correlations between the end point and educational level, number of children, socioeconomic group according to the woman's occupation and according to the husband's occupation, and physical activity at work and during leisure hours

Attributes	MI	AP	Electrocardiographic changes	Stroke	Mortality
Educational level	NS	<0.01*	NS	NS	NS
Number of children	NS	NS	NS	NS	NS
Socioeconomic group according to the woman's occupation	NS	NS	NS	NS	NS
Socioeconomic group according to the husband's occupation	<0.05†	NS	NS	NS	NS
Physical activity at work:					
For ages 20-38	NS	NS	NS	NS	NS
After age 38	NS	NS	NS	NS	NS
In past year	NS	NS	NS	<0.05*	<0.05*
Physical activity during leisure hours:					
For ages 20-38	NS	NS	NS	NS	NS
After age 38	NS	NS	NS	NS	NS
In past year	NS	NS	NS	<0.01*	<0.05*

*Negative correlation.

†Low socioeconomic group correlated with myocardial infarction (MI).

AP, angina pectoris.

MULTIVARIATE ANALYSIS

Table 5 shows the *p* values for the non-parametric correlations between educational level, number of children, socioeconomic group according to the women's own occupations and according to their husbands' occupations on the one hand and the end points myocardial infarction, angina pectoris, electrocardiographic changes indicating ischaemic heart disease, stroke, and mortality on the other, when age is taken into account as a background variable. Educational level was inversely correlated with angina pectoris ($p < 0.01$). In extended multivariate analyses the relation was independent of socioeconomic group and also independent of traditional risk factors for cardiovascular disease such as smoking habits, systolic blood pressure, indices of obesity, serum triglycerides, and serum cholesterol. When serum triglyceride concentration and waist : hip circumference ratio were included as potential confounding variables, the significance level changed from $p < 0.01$ to $p < 0.05$. The correlation between low socioeconomic group according to the husband's occupation and myocardial infarction was statistically significant ($p < 0.05$), but when the same background variables were included the correlation disappeared when serum triglyceride concentration, waist : hip circumference ratio, and body mass index were taken into account as background variables in multivariate analyses. No other significant correlations were observed (Table 5).

INITIAL PHYSICAL ACTIVITY IN RELATION TO END POINTS

Myocardial infarction.—There was a significant age specific difference in the 12 year incidence of myocardial infarction in the group of women who

had initially reported a low level of physical activity during leisure hours (group I) during the last year compared with other women ($p < 0.05$). No significant differences were observed when women who reported a low level of physical activity at work (group I) during the last year were compared with other women (Table 6). Similar results were obtained when women with "silent" myocardial infarction were included.

Angina pectoris, electrocardiographic changes indicating ischaemic heart disease, and stroke.—Increased age specific incidences of electrocardiographic changes indicating ischaemic heart disease ($p < 0.01$) and of stroke ($p < 0.001$) were seen in women who at the beginning of the follow up period reported a low level of physical activity during leisure hours (group I) in the past year. The incidence of stroke was also increased in the group of women who reported low physical activity at work (group I) in the past year ($p < 0.001$). There were no significant differences in the incidence of angina pectoris. Table 6 shows the results of the statistical analyses.

Mortality.—Women who initially reported low physical activity at work (group I) in the past year had an increased age specific mortality compared with other women ($p < 0.001$). Women who reported low physical activity during leisure hours (group I) in the past year also had an increased mortality when compared with other women ($p < 0.05$) (Table 6).

MULTIVARIATE ANALYSIS

Table 5 shows the *p* values for the non-parametric correlations between initial physical activity at work and during leisure hours during the three life periods studied and the end points of myocardial

Table 6 Observed and expected frequencies of end points in women initially assigned to activity group I for physical activity at work and during leisure hours in the past year. 95% confidence interval for the age adjusted relative risk compared with other women is given in parentheses

End points	Observed	Expected	Relative risk
<i>Physical activity at work group I (n = 66)</i>			
Myocardial infarction	2	0.8	1.4 (0.3-6.7)
Angina pectoris	2	2.4	0.8 (0.2-3.2)
Electrocardiographic changes	1	3.0	0.3 (2.7-23.0)
Stroke	4***	0.8	7.8 (2.7-23.0)
Death	15***	4.8	5.2 (2.8-9.7)
<i>Physical activity during leisure hours group I (n = 264)</i>			
Myocardial infarction	9*	4.6	2.8 (1.2-6.5)
Angina pectoris	10	10.1	1.0 (0.5-1.9)
Electrocardiographic changes	22**	13.5	2.0 (1.2-3.3)
Stroke	9***	2.6	10.1 (3.8-27.1)
Death	23*	15.2	1.9 (1.1-3.2)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ compared with other women in the population sample.

infarction, angina pectoris, electrocardiographic changes indicating ischaemic heart disease, stroke, and mortality when age is taken into account as a background variable. Physical activity at work as well as physical activity during leisure hours during the past year and the incidence of stroke were negatively correlated ($p < 0.05$ and $p < 0.01$ respectively). When socioeconomic group, educational level, smoking habits, systolic blood pressure, indices of obesity, serum triglyceride concentration, and serum cholesterol concentration were included as potential confounding factors, physical inactivity during leisure hours during the last year was found to be independently correlated with stroke. The correlation between physical inactivity at work during the last year and the 12 year incidence of stroke was independent of all these background variables except for one of the indices of obesity (waist : hip circumference ratio). There was also a significant negative correlation between physical activity at work and physical activity during leisure hours during the past year and the 12 year mortality ($p < 0.05$). Multivariate analyses of the total mortality showed that low physical activity at work during the last year was an independent risk factor when all the potential confounding variables mentioned above were taken into account, but the inverse correlation between initial physical activity during leisure hours during the last year and total mortality disappeared when the waist : hip circumference ratio was included in the multivariate analyses. No other significant correlations were seen.

Discussion

The information from previous prospective studies on socioeconomic factors and physical activity as risk factors for cardiovascular disease in women is limited. In a previous clinical study we compared all

women who had myocardial infarction in the community during a three year period with women in our population sample of women who had been examined during the same period.⁴ No significant differences in place of birth, educational level, marital status, or socioeconomic status were found between women with myocardial infarction and women in the general population. Physical inactivity, both at work and during leisure hours, was found to have been significantly more common during different periods of life in women who later had an acute myocardial infarction than in other women in the general population.

In the present prospective study, we found an independent correlation between low educational level and incidence of angina pectoris. As far as we know, such a correlation has not previously been reported. In two retrospective studies Szklo *et al* and Talbott *et al* found that women who had myocardial infarction or who had died suddenly showed more educational incongruity with their spouses than did those in a control population.^{1 2}

Talbott *et al* found that women who died suddenly were less often married.² We did not find a significantly increased risk of cardiovascular disease or death among widows or any other civil status group either in our previous cross sectional study⁴ or in this prospective study. In a prospective study of 2828 women Helsing and Szklo also found no increase in mortality risk for widows compared with married women.²²

In our previous cross sectional study, we found that women with four or more children were over-represented in the myocardial infarction group; similar results were reported from the Framingham study,⁵ in which women working outside the home with three children or more had an increased risk of ischaemic heart disease. In a retrospective study, however, Talbott *et al* found that women who died

suddenly had fewer children than those in the control population.² In our prospective study, we could not verify the increased risk found in our cross sectional study, but in our prospective study the risk ratio was doubled in women with four or more children.

In our prospective study socioeconomic status correlated with myocardial infarction only when classified according to the husband's occupation. The correlation with myocardial infarction disappeared when serum triglyceride concentration and indices of obesity were included as potential confounding variables in the multivariate analysis. Heller *et al* also studied the risk of ischaemic heart disease in women in relation to the occupation of their men and found that "women married to professional men are at a lower risk compared with other women."⁶

Physical inactivity was related to cardiovascular disease and death in the Framingham study.⁷ The investigators found an inverse correlation between physical activity and mortality due to cardiovascular disease but the statistical significance was lost when adjustment was made for age, probably because "the more sedentary women are older than the active ones." There was no significant correlation between physical activity and overall mortality in that study. We found an increased incidence of stroke and death in women who initially reported low physical activity at work and during leisure hours during the last year and, in addition, an increased incidence of myocardial infarction and electrocardiographic changes indicating ischaemic heart disease in women who reported low physical activity during leisure hours during the past year, even when age was considered as a background variable. When several potential confounding variables were included, physical inactivity at work was still a risk factor for mortality from all causes, and physical inactivity during leisure hours was an independent risk factor for stroke. These findings from our prospective study accord with those from our previous cross sectional study.⁴ Low physical activity may be a causative factor. Another possibility might be that persons already disabled with latent ischaemic heart disease have a lower level of physical activity as well as an increased morbidity and mortality.

The causes of cardiovascular disease are still not explained. Traditionally accepted risk factors such as raised blood pressure, raised serum lipids, smoking habits, indices of obesity, and diabetes seem to explain only part of cardiovascular disease. Socioeconomic factors also seem to feature in the pathogenesis of cardiovascular disease.

The analyses and presentation of data were supported by grants from the Swedish Medical Research Council and the Faculty of Medicine of Gothenburg University.

References

- 1 Szklo M, Tonascia J, Gordis L. Psychosocial factors and the risk of myocardial infarction in white women. *Am J Epidemiol* 1976; 103: 312-20.
- 2 Talbot E, Kuller LH, Detre K, Perper J. Biologic and psychosocial risk factors of sudden death from coronary disease in white women. *Am J Cardiol* 1977; 39: 858-64.
- 3 Zalokar JB. Marital status and major causes of death in women. *J Chronic Dis* 1960; 11: 50-60.
- 4 Bengtsson C. Ischaemic heart disease in women. A study based on a randomized population sample of women and women with myocardial infarction in Göteborg, Sweden. *Acta Med Scand* 1973; suppl 549.
- 5 Haynes SG, Feinleib M. Women, work and coronary heart disease: prospective findings from the Framingham heart study. *Am J Public Health* 1980; 70: 133-41.
- 6 Heller RF, Williams H, Sittampalam Y. Social class and ischaemic heart disease: use of the male : female ratio to identify possible occupational hazards. *J Epidemiol Community Health* 1984; 38: 198-202.
- 7 Kannel WB, Sorlie P. Some health benefits of physical activity. *Arch Intern Med* 1979; 139: 857-61.
- 8 Bengtsson C, Blohmé G, Hallberg L, *et al*. The study of women in Gothenburg 1968-1969—a population study. General design, purpose and sampling results. *Acta Med Scand* 1973; 193: 311-8.
- 9 Bengtsson C, Hallberg L, Hällström T, *et al*. The population study of women in Göteborg 1974-1975—the second phase of a longitudinal study. General design, purpose and sampling results. *Scand J Soc Med* 1978; 6: 49-54.
- 10 Sigurdsson JA. High blood pressure in women. A cross-sectional and a longitudinal follow-up study. *Acta Med Scand* 1983; suppl 669.
- 11 Carlsson G. *Social mobility and class structure*. Lund, Sweden: GWK Gleerup, 1958.
- 12 Wilhelmsen L, Tibblin G. Physical inactivity and risk of myocardial infarction. The men born in 1913 study. In: Larsen OA, Malmberg RO, eds. *Coronary heart disease and physical fitness*. Copenhagen: Munksgaard, 1971.
- 13 Lapidus L, Bengtsson C, Larsson B, Pennert K, Rybo E, Sjöström L. Distribution of adipose tissue and risk of cardiovascular disease and death: a 12 year follow up of participants in the population study of women in Gothenburg, Sweden. *Br Med J* 1984; 289: 1257-61.
- 14 Elmfeldt D, Wilhelmsen L, Tibblin G, Vedin JA, Wilhelmsson C-E, Bengtsson C. Registration of myocardial infarction in the city of Göteborg, Sweden. A community study. *J Chronic Dis* 1975; 28: 173-86.
- 15 Blackburn H, Keys A, Simonson E, Rautaharju P, Punsar S. The electrocardiogram in population studies. A classification system. *Circulation* 1960; 21: 1160-75.
- 16 Åstrand I, Areskog N-H, Carlsten A, *et al*. The "Minnesota Code" for ECG classification. Adaptation to CR leads and modification of the code for ECGs recorded during and after exercise. *Acta Med Scand* 1967; suppl 481.
- 17 Rose GA. The diagnosis of ischaemic heart pain and intermittent claudication in field surveys. *Bull WHO* 1962; 27: 645-58.
- 18 Harmsen P, Tibblin G. A stroke register in Göteborg, Sweden. *Acta Med Scand* 1972; 191: 463-70.
- 19 Mantel N. Chi-square tests with one degree of freedom: extensions of the Mantel-Haenszel procedure. *J Am Stat Assoc* 1963; 58: 690-700.
- 20 Miettinen O. Estimability and estimation in case-referent studies. *Am J Epidemiol* 1976; 103: 226-35.
- 21 Bradley JV. *Distribution-free statistical tests*. Englewood Cliffs, NJ: Prentice Hall, 1968: 68-86.
- 22 Helsing KJ, Szklo M. Mortality after bereavement. *Am J Epidemiol* 1981; 114: 41-52.