

Physical activity at work and job responsibility as risk factors for fatal coronary heart disease and other causes of death

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SUMMARY Altogether 99 029 men aged 40–59, employed on the Italian railroad system, were classified in three levels of physical activity at work and three levels of job responsibility and then followed up for five years in terms of mortality and cause of death. Physical activity and job responsibility have been investigated in different ways as possible risk factors of lethal events. When considering together the findings of univariate and bivariate analyses it appears that low physical activity and high job responsibility are attributes favouring myocardial infarction, and that high physical activity and low job responsibility are attributes favouring lethal chronic bronchitis and violent death. Overall, mortality from all causes is not significantly different in different classes of physical activity and job responsibility, and within total mortality these two characteristics play a role in the distribution of the various causes of death as a consequence of possible competing risks. A number of other non-measured factors, however, may have had a confounding effect.

The relation between habitual physical activity of working or leisure type and the development of coronary heart disease has been studied in a number of epidemiological investigations during the past 25 to 30 years.^{1–11} Although it is not considered to be a major risk factor, habitual physical activity is at present recognised as a protective factor against the development of atherosclerosis, and coronary events in particular, although in some instances it is partly confounded by other factors.

A long review of the available literature and statements on present knowledge was produced in 1978,^{12,13} and some contributions have also been provided by this group.^{5,6,14}

The question of responsibility at work is more controversial since such a characteristic is sometimes difficult to define, as are many others of a psychological type which have probably never been studied independently.

At present coronary heart disease seems no longer to be considered the executive's disease, at least in those countries where it was so considered two or three decades ago; the lower social classes are now hit harder by this disease.^{15,16}

The problem is obviously confounded by a number of other factors of a similar nature directly or indirectly related to the psychosocial characteristics.

Among these are unfavourable childhood and youth experience,^{17,18} urban lifestyle and residence, excessive employment mobility,^{16–19} hypochondria and emotional instability,²⁰ stressful jobs such as taxi and bus driving, etc,^{21–23} high hostility scale levels²⁴ and, of course, the classical type A of Jenkins, although at present this is known to be made up of at least four different components.^{25–29}

In terms of job responsibility beyond exposure to an excess of external stimuli, it can be assumed that type A individuals are more likely to seek and accept positions of high level responsibility.

Unfortunately, most such factors are ill defined, and a final conclusion cannot be reached by a review of the recent literature; the interpretation is always complicated by the presence of confounding factors. Part of a study, originally designed to investigate the relation of physical activity at work to coronary heart disease, could recently be exploited by this group for a joint evaluation of both physical activity and job responsibility at work.

Material and method

Altogether 99 029 men aged 40–59, employed on the Italian railroad system, were classified according to age (quinquennia), physical activity at work (three

levels: heavy, moderate, and sedentary), and job responsibility (three levels: high, medium, and low).

In particular, ergonomic studies were carried out in order to attribute average energy expenditure to the several types of work on the railroad. On the basis of such measurements, heavy workers have been defined as those characterised by more than 3000 calories per day; moderate workers 2400 to 3000 calories per day; and sedentary workers less than 2400 calories per day.

Responsibility at work has been evaluated by occupational psychologists who have characterised the several types of job using a score which takes into account the economic and financial implications of decisions taken at work as well as the relevance of possible damage and hazards both economic and for human life as a consequence of possible mistakes made at work.

The classification was made only once at the beginning of the study. For most individuals it reflected the characteristics of jobs undertaken some years before and after that point in time owing to the slow speed and the predefined tracks of careers on the railroad.

A systematic registration of all deaths has been performed on all men including those who had retired in the meanwhile. The coverage has been substantially complete for a period of five years.

Information on deaths and their causes has been obtained from the Central Medical Service of the Railroad, the Board of Pensions, and the Register Offices of the municipalities where the dead persons had their residences. Most of the causes of death have been validated by comparing the official causes with those elicited from hospital and other medical records. The causes of death have been classified according to the 8th Revision of the World Health Organization *International classification of diseases*, the study having been conducted during the period when this Revision was officially adopted in Italy.³⁰

The term coronary heart disease implies a fatal case of myocardial infarction or its early or late complications or sudden death of probable coronary origin.

Results

Table 1 gives the number of men at risk classified according to five-year age groups. Table 2 shows the same men classified according to three levels of physical activity and three levels of job responsibility. The class corresponding to high job responsibility and high physical activity is empty, and therefore only eight classes will be considered for analysis.

Age standardised death rates (against the whole population as reference) for five years as a function of the three levels of physical activity are shown in table 3.

Table 1 *Men at risk classified by five year age groups*

Age (yr)	N
40-44	33 122
45-49	25 918
50-54	30 132
55-59	9 857
Total	99 029

Table 2 *Men at risk classified by three levels of physical activity and three levels of job responsibility*

	Job responsibility			Totals
	Low	Medium	High	
Physical activity at work				
Sedentary	2 201	23 728	2 202	28 131
Moderate	1 517	36 046	3 757	41 320
Heavy	25 740	3 838	—	29 578
Totals	29 458	63 612	5 959	99 029

Table 3 *Age standardised death rates per 1000 in five years for all causes and some specific causes of death in men classified by physical activity: Absolute frequencies in parentheses*

Physical activity		Cause of death							
		All causes	Violence	Myocardial infarction	Stroke	Other CV diseases	Chronic bronchitis	Cancer	All other causes
Sedentary	(S)	26.20 (727)	1.83 (51)	7.70 (210)	2.20 (61)	1.52 (42)	0.18 (5)	7.83 (217)	4.94 (141)
Moderate	(M)	27.05 (1136)	2.86 (120)	7.50 (292)	1.44 (61)	1.52 (64)	0.40 (17)	8.50 (358)	4.83 (224)
Heavy	(H)	27.35 (798)	4.40 (129)	4.90 (112)	2.21 (65)	2.29 (67)	0.72 (21)	7.57 (220)	5.56 (184)
p of test on proportion									
S v M		ns	<0.01	ns	<0.05	ns	ns	ns	ns
S v H		ns	<0.001	<0.001	<0.05	<0.05	<0.01	ns	ns
M v H		ns	<0.001	<0.001	<0.05	<0.05	ns	ns	ns

Overall mortality from all causes is not substantially different between the three groups; on the other hand, people with sedentary or moderately active jobs show an excess of deaths from myocardial infarction, which is largely compensated by an excess of violent deaths in very active people. Moreover, heavy workers have an excess of deaths from other heart disease and from chronic bronchitis and allied conditions.

A similar tabulation (table 4) shows death rates as a function of job responsibility. In particular, violent deaths are more common among people with low than with high responsibility, whereas the opposite is the case for myocardial infarction.

In table 5 death rates for the same causes are reported for men classified in combined classes of physical activity and job responsibility. The variability among classes is greater than in the previous two tables. The high and low levels are as follows:

All causes—high in heavy workers with medium responsibility;

All causes—low in sedentary people with medium responsibility;

Violence—high in heavy workers with low responsibility;

Violence—low in sedentary people with high responsibility;

Myocardial infarction—high in sedentary people with high responsibility;

Myocardial infarction—low in physically moderate workers with low responsibility;

Stroke—high in heavy workers with medium responsibility;

Stroke—low in physically moderate workers with medium responsibility;

Other cardiovascular—high in physically moderate workers with medium responsibility;

Other cardiovascular—low in sedentary people with high responsibility;

Chronic bronchitis—high in heavy workers with medium responsibility;

Chronic bronchitis—low in sedentary people with low and high responsibility (zero) and in physically moderate people with low responsibility;

Cancer—high in physically moderate people with high responsibility;

Table 4 Age standardised death rates per 1000 in five years for all causes and some specific causes of death in men classified by job responsibility: Absolute frequencies in parentheses

		Cause of death							
Job responsibility		All causes	Violence	Myocardial infarction	Stroke	Other CV diseases	Chronic bronchitis	Cancer	All other causes
Low	(L)	27.28 (798)	4.08 (120)	5.00 (125)	2.01 (59)	2.52 (74)	0.62 (18)	7.55 (220)	5.50 (182)
Medium	(M)	26.78 (1712)	2.67 (171)	7.30 (427)	1.85 (118)	1.41 (90)	0.38 (24)	8.35 (536)	4.68 (346)
High	(H)	26.45 (151)	1.57 (9)	11.30 (62)	1.91 (10)	1.61 (9)	0.22 (1)	6.80 (39)	4.65 (21)
p of test on proportion									
L v M		ns	<0.001	<0.001	<0.001	ns	ns	ns	ns
L v H		ns	<0.01	<0.001	ns	ns	ns	ns	ns
M v H		ns	ns	<0.001	ns	ns	ns	ns	ns

Table 5 Age standardised death rates per 1000 in five years for all causes and some specific causes of death in men classified in eight combined classes of physical activity and job responsibility

		Cause of death							
Physical activity	Job responsibility	All causes	Violence	Myocardial infarction	Stroke	Other CV diseases	Chronic bronchitis	Cancer	All other causes
Sedentary	Low	30.00	1.21	9.70	2.84	3.03	—	6.77	6.45
Sedentary	Medium	25.20	1.93	7.20	2.17	1.44	0.21	8.59	3.66
Sedentary	High	25.80	1.13	11.60	1.51	0.47	—	2.00	9.09
Moderate	Low	26.30	2.07	3.80	2.64	3.08	—	8.79	5.92
Moderate	Medium	28.50	3.04	7.50	1.34	1.35	0.41	8.40	6.46
Moderate	High	25.80	1.93	10.20	2.16	2.46	0.43	10.64	2.02
Heavy	Low	26.90	4.53	4.80	1.85	2.38	0.73	7.50	5.11
Heavy	Medium	30.80	3.45	5.00	5.29	1.92	1.04	7.51	6.59

Cancer—low in sedentary people with high responsibility;
All other causes—high in sedentary people with high responsibility;
All other causes—low in physically moderate people with high responsibility.

The overall picture emerging from table 5 suggests that some combinations of physical activity and job responsibility tend to favour or to protect against some diseases, although the overall final differences in terms of diseases from all causes are relatively small. The interest in trying to estimate the combined effect of physical activity and job responsibility is clear, and several techniques can be employed.

The rates in tables 3 and 4 (univariate analysis for physical activity and job responsibility separately) have been recomputed (but not reported here) by adjusting for the other characteristics' distributions. The net result has been that the overall picture has not changed substantially.

Another attempt, presented in table 6, has been made by taking the eight combined activity-responsibility classes and solving a bivariate equation for each fatal endpoint, where y is the considered disease, x_1 is the "score" for physical activity and x_2 the "score" for job responsibility. Such scores have been arbitrarily given the levels of 1, 2, and 3 for sedentary, moderate, and heavy physical activity; and low, medium, and high job responsibility respectively.

The data suggest the following:

- (1) All coefficients of physical activity are positive except that concerning myocardial infarction.
- (2) All coefficients of job responsibility are negative except that concerning chronic bronchitis.
- (3) Only two coefficients yield statistical significance being different from zero with a chance of 99% or more.
- (4) Only three R^2 (the square of the multiple correlation coefficients) explain a substantial proportion (at least 50%) of the variance of death rates as a function of the two considered characteristics; they refer to violent deaths, myocardial infarction, and chronic bronchitis.

Comment

The available data and results suggest that both characteristics, physical activity and job responsibility, although somewhat inversely related, may play an independent role in the prediction of fatal events.

However, since the overall death rates for all causes are relatively homogeneous among the several

Table 6 Regression equations of mortality from various causes on physical activity and job responsibility

Cause of death	Equation	R^2
All causes	$y = 27.45 + 0.68 \text{ PA} - 0.70 \text{ JR}$	0.18
Violence	$y = 0.52 + 1.21^{**} \text{ PA} - 0.20 \text{ JR}$	0.82
Myocardial infarction	$y = 7.60 - 1.88 \text{ PA} - 1.82 \text{ JR}$	0.73
Stroke	$y = 1.52 + 0.61 \text{ PA} - 0.10 \text{ JR}$	0.18
Other CV diseases	$y = 3.10 + 0.12 \text{ PA} - 0.70 \text{ JR}$	0.47
Chronic bronchitis	$y = 0.63 + 0.42^{**} \text{ PA} + 0.11 \text{ JR}$	0.79
Cancer	$y = 6.38 + 0.98 \text{ PA} - 0.37 \text{ JR}$	0.14
All other causes	$y = 6.42 + 1.08 \text{ PA} - 1.43 \text{ JR}$	0.56

** $p < 0.05$.

classes, their impact seems to relate mainly in favouring (or protecting against) one instead of another cause of death.

There are several ways of interpreting such findings. Firstly, the possibility cannot be ruled out that the different social classes identified by different levels of physical activity and job responsibility may receive, for some reason, different types of diagnoses. However, it is difficult to argue that this would be so systematic as to distort all disease classification.

Another possibility is that dealing with a typical situation of competing risks, ie, being for some direct or indirect reason protected against a disease means, at the same time, being more prone or simply more exposed to others, and *vice versa*. Two peculiar situations are mentioned. It is known that the class "sedentary with low responsibility" includes a proportion of men who moved from other classes because of some already manifest disease. This may explain part of the excess mortality in this class, but the type of classification made once for all should limit the impact of this possibility. Heavy workers, on the other hand, with either low or medium job responsibility exhibit the highest death rate from violent causes. This means that, excluding the non-natural causes, their overall death rates would be closer to those of the sedentary people, that is, 22.95 per 1000 for heavy workers, 24.19 per 1000 for physically moderate workers, and 24.37 per 1000 for sedentary people. On the other hand, the excess mortality from violent causes is not fully explained by the specific occupational hazards of those having high physical activity, and this group shows a lower death rate for "natural causes".

Apart from the doubts and the uncertainties raised by these notes the impression remains that job characteristics are associated with fatal disease distribution, although a more thorough approach is needed in order to clarify several points, especially the possibility of effects due to competing risks.

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