

Occupational and leisure time physical activity: risk of all-cause mortality and myocardial infarction in the Copenhagen City Heart Study. A prospective cohort study

Andreas Holtermann,¹ Jacob Louis Marott,² Finn Gyntelberg,³ Karen Søgaard,⁴ Poul Suadicani,³ Ole S Mortensen,^{1,3} Eva Prescott,^{2,5} Peter Schnohr²

To cite: Holtermann A, Marott JL, Gyntelberg F, *et al.* Occupational and leisure time physical activity: risk of all-cause mortality and myocardial infarction in the Copenhagen City Heart Study. A prospective cohort study. *BMJ Open* 2012;2:e000556. doi:10.1136/bmjopen-2011-000556

► Prepublication history for this paper is available online. To view these files please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2011-000556>).

Original study protocol It does not exist.

Received 27 October 2011
Accepted 18 January 2012

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For numbered affiliations see end of article.

Correspondence to

Dr Andreas Holtermann; aho@nrcwe.dk

ABSTRACT

Objectives: Men with low physical fitness and high occupational physical activity are recently shown to have an increased risk of cardiovascular disease and all-cause mortality. The association between occupational physical activity with cardiovascular disease and all-cause mortality may also depend on leisure time physical activity.

Design: A prospective cohort study.

Setting: The Copenhagen City Heart Study.

Participants: 7819 men and women aged 25–66 years without a history of cardiovascular disease who attended an initial examination in the Copenhagen City Heart Study in 1976–1978.

Outcome measures: Myocardial infarction and all-cause mortality. Occupational physical activity was defined by combining information from baseline (1976–1978) with reassessment in 1981–1983. Conventional risk factors were controlled for in Cox analyses.

Results: During the follow-up from 1976 to 1978 until 2010, 2888 subjects died of all-cause mortality and 787 had a first event of myocardial infarction. Overall, occupational physical activity predicted all-cause mortality and myocardial infarction in men but not in women (test for interaction $p=0.02$). High occupational physical activity was associated with an increased risk of all-cause mortality among men with low (HR 1.56; 95% CI 1.11 to 2.18) and moderate (HR 1.31; 95% CI 1.05 to 1.63) leisure time physical activity but not among men with high leisure time physical activity (HR 1.00; 95% CI 0.78 to 1.26) (test for interaction $p=0.04$). Similar but weaker tendencies were found for myocardial infarction. Among women, occupational physical activity was not associated with subsequent all-cause mortality or myocardial infarction.

Conclusions: The findings suggest that high occupational physical activity imposes harmful effects particularly among men with low levels of leisure time physical activity.

ARTICLE SUMMARY

Article focus

- Men with low physical fitness and high occupational physical activity are recently shown to have an increased risk of cardiovascular disease and all-cause mortality.
- It is unknown if the association between occupational physical activity with cardiovascular disease and all-cause mortality also depends on leisure time physical activity.

Key messages

- This study shows that men with high occupational physical activity have an increased risk of all-cause mortality.
- Leisure time physical activity was found to modify the positive association between occupational physical activity and risk of all-cause mortality. High occupational physical activity imposes harmful effects particularly among men with low levels of leisure time physical activity.

Strengths and limitations of this study

- Study strengths include the long follow-up time, repeated assessment of the occupational physical activity, objective measures of several covariates from clinical examinations, information on outcomes obtained from valid registers, and participation of both sexes. Some limitations are the lack of control for psychosocial work factors and the self-reported exposures.

INTRODUCTION

A positive association has been demonstrated between occupational physical activity and risk of cardiovascular and all-cause mortality among men with low cardiorespiratory capacity, that is, physical fitness.¹ A physiological explanation may be prolonged intravascular turbulence and increased wall shear stress from occupational physical

activity several hours per day,² inducing inflammatory processes in the arterial walls eventually leading to atherosclerosis.³

Theoretically, these acute adverse effects of occupational physical activity may be modified by leisure time physical activity known to promote cardiorespiratory fitness⁴ and reduce heart rate and blood pressure during daily activities.⁵ A higher cardiorespiratory fitness and lower heart rate provides a longer period in the diastolic phase of the cardiac cycle, causing better myocardium perfusion and reduced intravascular turbulence and wall shear stress, lowering the risk of inflammation and atherosclerosis.^{2–3} Therefore, the increased cardiorespiratory fitness and reduced heart rate and blood pressure from leisure time physical activity may counteract the prolonged intravascular turbulence and increased wall shear stress from occupational physical activity. We have previously shown that high occupational physical activity confers an increased risk of cardiovascular and all-cause mortality among men with a low physical fitness but not among men with high physical fitness.¹ However, the role of leisure time physical activity on the risk for cardiovascular disease and mortality from high occupational physical activity remains unsettled.

Relatively few studies have investigated the effects of occupational physical activity on cardiovascular disease and mortality among women.⁶ Because type of occupational physical activity differs between male and female occupations,⁷ the effects of occupational physical activity on cardiovascular health may depend on sex. A recent editorial on occupational physical activity and cardiovascular health highlights the need for future investigations in additional cohorts among both sexes.⁸

Accordingly, we hypothesised that high occupational physical activity is an independent risk factor for myocardial infarction and all-cause mortality in both men and women. Finally, we hypothesised that the level of leisure time physical activity in both sexes modifies the association between occupational physical activity and risk of myocardial infarction and all-cause mortality.

MATERIALS AND METHODS

Study population

The Copenhagen City Heart Study is a prospective cardiovascular population study comprising a random sample of 19 698 men and women aged 20–101 years, drawn from the Copenhagen Population Register as of 1 January 1976. The first survey lasted from 1976 to 1978 (response rate 74%) and the second from 1981 to 1983 (response rate 70%). A total of 11 135 persons participated in both examinations.

Participants with previous myocardial infarction or stroke by self-report or according to the Danish National Patient Register established in 1977 were excluded (n=644). Moreover, all persons above the age of retirement in Denmark at the time of the second examination (ie, 67 years) were excluded, leaving 8496 persons

eligible. Finally, we excluded the 677 persons with missing values in occupational physical activity in one of the surveys, leaving 7819 eligible for analyses.

Established cardiovascular risk factors were assessed at both examinations using a self-administered questionnaire and a physical examination. The ethics committee for the Copenhagen area approved the study (KF 100.2039/91).

Occupational physical activity (the main predictor variable)

A single question with four categories was applied for measuring occupational physical activity:

‘Which description most precisely covers your pattern of physical activity at work?’⁹

1. You are mainly sedentary and do not walk much around at your workplace, for example, desk work, work including assembling of minor parts. [Score 1]
2. You walk around quite a bit at your workplace but do not have to carry heavy items, for example, light industrial work, non-sedentary office work, inspection and the like. [Score 2]
3. Most of the time you walk, and you often have to walk up stairs and lift various items. Examples include mail delivery and construction work. [Score 3]
4. You have heavy physical work. You carry heavy burdens and carry out physically strenuous work, for example, work including digging and shoveling. [Score 4]

To reduce risk of misclassification, the main predictor variable was based on combined information from assessment in 1976–1978 and 1981–1983, summarising the total sum of scores. Then, the scores were categorised into: ‘low’ = score 2–3, ‘moderate’ = score 4–5 and ‘high’ = score 6–8.

Leisure time physical activity (the potential effect modifier)

A single question with four categories was applied for measuring leisure time physical activity:

‘Which description most precisely covers your pattern of physical activity during leisure time?’¹⁰

1. Being almost entirely sedentary (eg, reading, watching television or movies, engaging in light physical activity such as walking or biking for less than 2 h/week). [Score 1]
2. Engaging in light physical activity for 2–4 h/week. [Score 2]
3. Engaging in light physical activity for more than 4 h/week or more vigorous activity for 2–4 h/week (eg, brisk walking, fast biking, heavy gardening, sports that cause perspiration or exhaustion). [Score 3]
4. Engaging in highly vigorous physical activity for more than 4 h/week or regular heavy exercise or competitive sports several times per week. [Score 4]

Because of very few women (n=52) and men (n=140) in the highest category of leisure time physical activity, the variable was categorised into: score 1 = ‘low’, score 2 = ‘moderate’ and score 3–4 = ‘high’.

Potential confounders

Potentially confounding factors for the association between occupational physical activity and cardiovascular health and mortality were measured as follows: smoking habits were categorised into never-smokers, ex-smokers and current smokers of <15, ≥15 g of tobacco per day. Current tobacco consumption was calculated by equating a cigarette to 1 g of tobacco, a cheroot to 3 g of tobacco and a cigar to 5 g of tobacco. Systolic blood pressure was measured in a sitting position after 5 min of rest. Diabetes and use of antihypertensive medication were self-reported. Those reporting to use antihypertensive medication were defined as hypertensive. Body mass index (BMI) was calculated as measured weight (kg) divided by height squared (m²). Alcohol consumption was categorised as abstinence, monthly, weekly or daily intake of at least 1 unit of alcohol. Household income was self-reported based on average income per month within the last year and stratified into low, medium and high. Cholesterol was measured non-fasting in millimoles per litre. Details of the potential confounders are previously published.¹¹

Follow-up

Subjects were followed in national registers from the second examination (1981–1983) until December 2008 for myocardial infarction and May 2010 for all-cause mortality. The endpoint myocardial infarction was defined as the first incidence of fatal or non-fatal myocardial infarction according to the International Classification of Diseases: eighth revision code 410 and 10th revision codes I21–I22. Episodes of non-fatal myocardial infarction were retrieved from the National Hospital Discharge Register. Deaths were obtained from the Civil Registration System and causes of death from the National Register of Causes of Death. To reduce the maximum follow-up time without exposure to occupational physical activity to 10 years (the pension age is 67 years in Denmark), persons were censored from follow-up analyses at 77 years of age. Subjects were thus followed until outcome, age 77 or end of follow-up in 2010, whatever came first. The median duration of follow-up was 17.8 years (range 0–27.7) for myocardial infarction and 18.4 years (range 0–29.4) for all-cause mortality.

Analyses

For demographics, Pearson's χ^2 test was used for categorical covariates and one-way analysis of variance for continuous covariates.

The associations between occupational physical activity and fatal and non-fatal myocardial infarction, and all-cause mortality were studied using sex-specific Cox proportional hazards regression models. Associations were investigated both overall and stratified according to level of leisure time physical activity. The Cox models were performed with age as underlying time scale and age at baseline as entry time. All adjusted models included the covariates smoking, alcohol consumption,

BMI, leisure time physical activity, systolic blood pressure, diabetes, blood pressure medication, cholesterol and household income. We tested for interaction between sex, occupational physical activity and the outcomes all-cause mortality and myocardial infarction. Deviation from the proportional hazards assumption was evaluated by Schoenfeld residuals and by inspection of log-log plots. p Values below 0.05 were considered statistically significant. Statistical analyses were performed with R V.2.13.1.

Moreover, we tested for interaction between occupational physical activity, leisure time physical activity and the outcomes all-cause mortality and myocardial infarction.

Two additional analyses were performed. In the first analysis, the risk of all-cause mortality and myocardial infarction was investigated including exclusively men and women who had not changed their level of occupational physical activity from the first (1976–1978) to the second examination (1981–1983). Due to the low number of women in the highest category of occupational physical activity (n=2), the variable was categorised as: 'low' = score 1, 'moderate' = score 2 and 'high' = scores 3 and 4 pooled. Because of the strong association between occupational physical activity and years of education, we found that it is necessary to carry out a second additional analysis including only those with a maximum school length of 10 years.

RESULTS

A total of 1493 (41.4%) men and 1395 (28.5%) women died; 511 (14.2%) men and 276 (5.6%) women experienced a first myocardial infarction episode during the follow-up period.

Table 1 shows lifestyle and other characteristics according to level of occupational physical activity among men and women. Several significant differences were found, but differences were generally small with no clear positive or negative trends. However, men with high occupational physical activity were more frequently smokers, had higher BMI, fewer with hypertension and fewer with long (>10 years) school education. Women with high occupational physical activity had lower alcohol consumption, a lower leisure time physical activity level, lower systolic blood pressure and fewer had a long school education.

Table 2 shows the distribution of participants in the four groups of occupational physical activity among men and women without a history of cardiovascular disease at the first examination (1976–1978) and the second examination (1981–1983) in the Copenhagen City Heart Study. Level of occupational physical activity remained constant between the two examinations for 61.0%, decreased for 22.6% and increased for 16.4% of the participants.

Table 3 shows the association between occupational physical activity and risk of all-cause mortality and myocardial infarction stratified by sex. The occupational

Sex	Men			Women		
	Low (n = 1114)	Moderate (n = 1152)	High (n = 1015) p Value	Low (n = 1506)	Moderate (n = 2303)	High (n = 729) p Value
Occupational physical activity						
Age, mean (SD)	52.1 (10.2)	53.0 (9.4)	51.5 (8.6)	54.1 (9.1)	54.4 (9.0)	49.7 (9.1)
Body mass index, mean (SD)	25.6 (3.9)	26.0 (3.7)	26.6 (3.7)	24.5 (4.3)	24.9 (4.6)	24.8 (4.3)
Current smokers, %	62.9	65.7	69.1	55.6	54.0	59.8
Consuming ≥1 unit alcohol a day, %	34.8	32.9	41.5	13.4	10.8	7.1
Low leisure time physical activity, %	14.9	11.8	14.3	16.5	13.4	11.0
Systolic blood pressure, mean (SD)	140.4 (19.4)	140.9 (19.5)	139.1 (18.8)	135.2 (20.9)	136.8 (20.6)	131.1 (19.6)
Blood pressure medication, %	8.7	7.6	5.4	9.6	9.2	7.1
Diabetes, %	4.0	3.7	3.7	1.5	1.7	1.0
Low income, %	9.3	12.2	9.0	18.5	27.7	17.2
High school education (>10 years), %	37.3	17.1	3.8	20.6	12.8	10.8
Cholesterol, mmol/l	5.7 (1.1)	5.8 (1.1)	5.8 (1.1)	6.0 (1.2)	6.0 (1.2)	5.8 (1.2)
Values of differences between the groups of occupational physical activity are provided.						

In the additional analysis including only those with a maximum school length of 10 years, the multi-adjusted analyses among men showed a significant increased risk of all-cause mortality from moderate (HR 1.17; 95% CI 1.00 to 1.37) and high (HR 1.21; 95% CI 1.03 to 1.42) occupational physical activity, but no significantly increased risk for myocardial infarction from moderate (HR 1.27; 95% CI 0.98 to 1.65) and high (HR 1.11; 95% CI 0.85 to 1.46) occupational physical activity. Among women with a maximum school length of 10 years, occupational physical activity was not significantly associated with all-cause mortality or myocardial infarction.

Table 2 Distribution of participants in the four levels of occupational physical activity among men and women between 20 and 67 years of age without a history of cardiovascular disorders at the first examination (1976–1978) and the second examination (1981–1983) in the Copenhagen City Heart Study (n=7819)

Sex	Men				Women			
	Low (1981–1983)	Moderate (1981–1983)	High (1981–1983)	Very high (1981–1983)	Low (1981–1983)	Moderate (1981–1983)	High (1981–1983)	Very high (1981–1983)
Occupational physical activity								
Low (1976–1978)	698	188	51	7	797	347	62	0
Moderate (1976–1978)	228	536	191	13	362	1304	352	2
High (1976–1978)	108	201	513	64	117	468	704	5
Very high (1976–1978)	58	67	146	212	0	5	11	2
Numbers in bold are those men and women who did not change their level of occupational physical activity from the first examination (1976–1978) to the second examination (1981–1983).								

COMMENTS

The primary finding of this study was the observation that leisure time physical activity modifies the positive association between occupational physical activity and risk of all-cause mortality. The second observation relating to the aim of the present study was the clear difference between men and women regarding occupational physical activity as a predictor of all-cause mortality and myocardial infarction. Overall, occupational physical activity did not predict risk among women. The third finding was that, overall, among men with a high occupational physical activity, a statistically significant increased risk of all-cause mortality was seen, also when controlling for relevant confounders. Regarding myocardial infarction risk, the results were less clear but with similar tendencies.

The observations of the present study are in agreement with a number of previous studies addressing the association between high occupational physical activity and increased risk of all-cause mortality and cardiovascular disease.^{3 6 12–14} The observation of a modifying effect of leisure time physical activity is in agreement with our previous observation that a high physical fitness seemed to completely counteract the positive association between occupational physical activity and risk of all-cause mortality and even ischaemic heart disease mortality.¹

Physical activity is regarded as beneficial for cardiovascular health, but a distinction should be made between leisure time and occupational physical activity.¹⁴ In contrast to leisure time physical activity, most occupational physical activity in modern industrialised societies does not include activities with high enough intensity to increase the maximal oxygen uptake capacity (physical fitness).¹ Such activities encompass regular dynamic use of large muscle groups with high intensity and sufficient time for recovery.^{15 16} An explanation for the increased risk of mortality attributed to high occupational physical activity may include haemodynamic effects on the cardiovascular system promoting the development of atherosclerosis.² Several hours per day of high levels of occupational physical activity will inevitably cause prolonged elevated heart rate, eliciting a higher fraction of the cardiac cycle in the systolic phase with unfavourable intravascular turbulence and wall shear stress, leading to inflammatory processes in the arterial walls, which may result in atherosclerosis, cardiovascular disease and death.³ Because of the distinctive effect of leisure time and occupational physical activity, non-specified (total) measurements of physical activity are likely to provide attenuated cardiovascular risk estimates. Therefore, measurements of physical activity ought to be domain specific.

As illustrated in table 2, most study participants did not change their level of occupational physical activity from the first examination (1976–1978) to the second examination (1981–1983). Among the 39% who did, changes were typically small and mostly to lower levels of

Table 3 Combined measure of occupational physical activity from 1976 to 1978 and from 1981 to 1983 as predictor for fatal and non-fatal myocardial infarction and all-cause mortality among men and women between 20 and 67 years of age without a history of cardiovascular disorders in the Copenhagen City Heart Study (n=7819)

	Person-years	No. of cases (%)	HR (95% CI) [†]	HR (95% CI) [‡]
Men				
Myocardial infarction				
Occupational physical activity				
Low (n=1114)	19 941	133 (12)	1 (reference)	1 (reference)
Moderate (n=1152)	19 828	183 (16)	1.34 (1.07 to 1.68)**	1.30 (1.03 to 1.64)*
High (n=1015)	18 424	145 (14)	1.18 (0.93 to 1.50)	1.20 (0.93 to 1.55)
All-cause mortality				
Occupational physical activity				
Low (n=1114)	21 108	395 (35)	1 (reference)	1 (reference)
Moderate (n=1152)	21 136	478 (41)	1.17 (1.02 to 1.33)*	1.15 (1.01 to 1.33)*
High (n=1015)	19 596	435 (43)	1.21 (1.05 to 1.38)**	1.22 (1.05 to 1.41)**
Women				
Myocardial infarction				
Occupational physical activity				
Low (n=1506)	27 403	87 (6)	1 (reference)	1 (reference)
Moderate (n=2303)	41 944	113 (5)	0.82 (0.62 to 1.09)	0.76 (0.56 to 1.02)
High (n=729)	15 257	45 (6)	1.10 (0.76 to 1.57)	0.98 (0.67 to 1.44)
All-cause mortality				
Occupational physical activity				
Low (n=1506)	28 326	439 (29)	1 (reference)	1 (reference)
Moderate (n=2303)	43 330	619 (27)	0.89 (0.79 to 1.01)	0.88 (0.78 to 1.00)
High (n=729)	15 901	194 (27)	0.96 (0.81 to 1.14)	0.95 (0.79 to 1.13)

*p≤0.05, **p≤0.01.

[†]Control made for age.[‡]Control made for age, smoking, alcohol, body mass index, leisure time physical activity, systolic blood pressure, diabetes, cholesterol, blood pressure medication and household income.

occupational physical activity. Additional analyses on the association between occupational physical activity and all-cause mortality and myocardial infarction, exclusively including participants who reported the same level of occupational physical activity at both examinations, showed results that were practically identical with the analyses based on the entire study population (data not shown). So, it seems unlikely that the observed positive association between occupational physical activity and all-cause mortality as well as myocardial infarction can be attributed to occupational physical activity changes due to health problems. Moreover, the significantly increased multi-adjusted risk of all-cause mortality from high occupational physical activity among men with a low educational level (<10 years) indicates that the observed association between occupational physical activity and all-cause mortality is not a result of socioeconomic confounding.

In contrast to the significant relationship among men, occupational physical activity was not a predictor of either all-cause mortality or myocardial infarction among women. The most likely reason for this difference is the fact that occupational physical activity qualitatively and quantitatively may reflect different physiological impacts from male and female work tasks, respectively. Lifting of heavy burdens, that is, isometric work is a much more frequent work task in male occupations, and more dynamic work tasks more frequently characterise manual

female work demands.⁷ It is well known that heavy isometric work induces an acute rise in blood pressure with a subsequent induction of arterial wall shear stress. Due to the more dynamic occupational work tasks for women, this physiological effect may not be nearly as pronounced as for men.

Strengths and limitations

The main strengths of the present study include the prospective design, the large size of a random sample of both men and women representative of the population of Copenhagen, long follow-up time, almost 100% follow-up on national registers, repeated assessment of the occupational physical activity, objective measures of several covariates from clinical examinations, information on outcomes obtained from valid registers and participation of both sex. Some limitations of the study should be addressed: (1) the lack of control for psychosocial work factors, (2) exposures are self-reported, (3) the leisure time physical activity was only measured at baseline. (Ad 1) Previous studies have shown that control for psychosocial work factors have minimal influence on the association between occupational physical activity and cardiovascular disease and mortality.^{3–6} It is unknown if a potential bias due to lack of control for psychosocial work factors would increase or attenuate the risk estimates. (Ad 2) Another limitation of the present study is that the occupational physical

Table 4 Combined measure of occupational physical activity from 1976 to 1978 and from 1981 to 1983 as predictor for fatal and non-fatal myocardial infarction and all-cause mortality among men and women between 20 and 67 years of age without a history of cardiovascular disorders stratified on leisure time physical activity in 1981–1983 in the Copenhagen City Heart Study (n=7816)

	Occupational physical activity	Person-years	No. of cases (%)	HR (95% CI) [†]	HR (95% CI) [‡]
Men					
Myocardial infarction					
Low leisure time physical activity (n=447)	Low (n=166)	2825	25 (15)	1 (reference)	1 (reference)
	Moderate (n=136)	2248	25 (18)	1.28 (0.74 to 2.23)	1.39 (0.76 to 2.53)
	High (n=145)	2382	23 (16)	1.15 (0.65 to 2.03)	1.15 (0.62 to 2.13)
Moderate leisure time physical activity (n=1468)	Low (n=531)	9544	59 (11)	1 (reference)	1 (reference)
	Moderate (n=532)	9131	82 (15)	1.39 (1.00 to 1.95)	1.27 (0.89 to 1.80)
	High (n=405)	7254	63 (16)	1.43 (1.00 to 2.04)*	1.41 (0.96 to 2.06)
High leisure time physical activity (n=1364)	Low (n=417)	7572	49 (12)	1 (reference)	1 (reference)
	Moderate (n=483)	8442	75 (16)	1.31 (0.92 to 1.88)	1.27 (0.87 to 1.86)
	High (n=464)	8761	59 (13)	1.00 (0.69 to 1.47)	1.04 (0.69 to 1.55)
All-cause mortality					
Low leisure time physical activity (n=447)	Low (n=166)	3012	74 (45)	1 (reference)	1 (reference)
	Moderate (n=136)	2422	73 (54)	1.27 (0.92 to 1.75)	1.15 (0.81 to 1.62)
	High (n=145)	2549	85 (59)	1.48 (1.08 to 2.02)*	1.56 (1.11 to 2.18)*
Moderate leisure time physical activity (n=1468)	Low (n=531)	10 049	185 (35)	1 (reference)	1 (reference)
	Moderate (n=532)	9702	230 (43)	1.24 (1.02 to 1.50)*	1.28 (1.05 to 1.57)*
	High (n=405)	7794	179 (44)	1.29 (1.05 to 1.59)*	1.31 (1.05 to 1.63)*
High leisure time physical activity (n=1364)	Low (n=417)	8048	136 (33)	1 (reference)	1 (reference)
	Moderate (n=483)	8997	174 (36)	1.08 (0.86 to 1.35)	0.96 (0.76 to 1.22)
	High (n=464)	9226	171 (37)	1.06 (0.85 to 1.33)	1.00 (0.78 to 1.26)
Women					
Myocardial infarction					
Low leisure time physical activity (n=637)	Low (n=248)	4085	17 (7)	1 (reference)	1 (reference)
	Moderate (n=309)	5335	18 (6)	0.82 (0.42 to 1.59)	1.03 (0.49 to 2.15)
	High (n=80)	1564	7 (9)	1.13 (0.47 to 2.73)	1.55 (0.55 to 4.35)
Moderate leisure time physical activity (n=2568)	Low (n=899)	16 632	58 (6)	1 (reference)	1 (reference)
	Moderate (n=1317)	24 387	63 (5)	0.72 (0.50 to 1.03)	0.65 (0.45 to 0.95)*
	High (n=352)	7427	22 (6)	1.01 (0.62 to 1.65)	0.78 (0.46 to 1.33)
High leisure time physical activity (n=1332)	Low (n=358)	6671	12 (3)	1 (reference)	1 (reference)
	Moderate (n=677)	12 222	32 (5)	1.38 (0.71 to 2.68)	1.00 (0.49 to 2.01)
	High (n=297)	6266	16 (5)	1.75 (0.82 to 3.70)	1.18 (0.54 to 2.60)
All-cause mortality					
Low leisure time physical activity (n=637)	Low (n=248)	4247	94 (38)	1 (reference)	1 (reference)
	Moderate (n=309)	5503	106 (34)	0.87 (0.66 to 1.14)	0.89 (0.66 to 1.20)
	High (n=80)	1612	30 (38)	0.91 (0.60 to 1.37)	0.99 (0.63 to 1.54)
Moderate leisure time physical activity (n=2568)	Low (n=899)	17 210	259 (29)	1 (reference)	1 (reference)
	Moderate (n=1317)	25 221	325 (25)	0.83 (0.70 to 0.98)*	0.80 (0.68 to 0.95)*
	High (n=352)	7726	90 (26)	0.93 (0.73 to 1.18)	0.92 (0.71 to 1.18)
High leisure time physical activity (n=1332)	Low (n=358)	6853	86 (24)	1 (reference)	1 (reference)
	Moderate (n=677)	12 607	188 (28)	1.12 (0.87 to 1.45)	1.06 (0.81 to 1.39)
	High (n=297)	6563	74 (25)	1.18 (0.86 to 1.61)	1.05 (0.76 to 1.45)

*p≤0.05.

[†]Control made for age.[‡]Control made for age, smoking, alcohol, body mass index, systolic blood pressure, diabetes, cholesterol, blood pressure medication, and household income.

activity and leisure time physical activity information was based on self-assessment, which may entail some degree of misclassification.¹⁷ Such misclassification would, however, not explain the findings presented, as the potential bias would rather attenuate the risk estimates.

Moreover, the rather crude measure of alcohol consumption may have caused some misclassification of alcohol consumption. Because of the very few

participants responding in the highest category of leisure time physical activity, the highest category was merged with the second highest category of leisure time physical activity. However, merging of the responses to these categories could only have a minor impact on the risk estimates from the second highest category alone. Although the occupational physical activity was measured at different ages in this study population with

a large age range (25–66 years), the rather similar mean age in the groups with different levels of occupational physical activity (table 1) makes it unlikely that this would influence the results of the study.

In conclusion, occupational physical activity was a predictor of all-cause mortality as well as myocardial infarction in men but not in women. Occupational physical activity was positively associated with risk of all-cause mortality in men with low and moderate leisure time physical activity but not in men with high leisure time physical activity. The results suggest that high occupational physical activity imposes harmful effects particular among men with lower levels of leisure time physical activity. Sex differences in the relationship between occupational physical activity and risk of all-cause mortality and myocardial infarction may reflect qualitative as well as quantitative differences with respect to occupational physical exposures.

Author affiliations

¹National Research Centre for the Working Environment, Copenhagen, Denmark

²The Copenhagen City Heart Study, Bispebjerg University Hospital, Copenhagen, Denmark

³The Copenhagen Male Study, Epidemiological Research Unit, Department of Occupational and Environmental Medicine, Bispebjerg University Hospital, Copenhagen, Denmark

⁴Institute of Sport Science and Clinical Biomechanics, University of Southern Denmark, Odense M, Denmark

⁵Department of Cardiology, Bispebjerg University Hospital, Copenhagen, Denmark

Acknowledgements The Danish Working Environment Research Foundation.

Contributors All authors contributed to the conception, design, interpretation of data and writing or critically revising the manuscript. JLM made the statistical analyses. AH and JLM are guarantors. All authors approved the final version of the manuscript.

Funding The study is a part of the Physical work demands and fitness project, financed by the Danish Working Environment Research Foundation. The sponsor had no influence on the study design, data collection, analysis, interpretation of data, writing the article and decision to submit it for publication. We declare that all authors are independent of the funders.

Competing interests None.

Ethical approval The ethics committee for the Copenhagen area Denmark approved the study (KF 100.2039/91).

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Technical appendix and statistical code are available from the corresponding author at aho@nrcwe.dk. Consent was not obtained, but the presented data are anonymised and risk of identification is very low. No additional data available.

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

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