be due to structural changes in work life and society. Low social status [33] and various negative life events, those of loss in particular, are important factors in depression [48]. Physically active people may also have a higher education, and they also may have acquired the habit of physical exercise as a consequence of good psychological health.

Former studies suggest that anxiety and depression may also result from stressful life episodes that threaten one's safety [12,48]. Our study also shows a connection between negative life events and depression, in agreement with earlier studies that have shown the association of negative life events with illnesses [12,48]. Finlay-Jones and Brown [12] claim that people are more vulnerable to anxiety if they face stressful events in their lives which make them generally insecure. In addition, anxiety sufferers may also generally suffer from various depressive conditions [20]. As far as family relations are concerned, our results agree with earlier results where depression was shown to occur more frequently with divorced or widowed people [33]. According to our study, marital status had no connection with anxiety, but according to Lehtinen et al. [34] anxiety disturbances are more common with men living in common-law marriages.

Regarding lifestyle, our study shows that moderate use of alcoholic beverages appears to slightly protect against depression, while none of the life style factors associated with anxiety. In general, those with alcohol abuse or dependence in particular frequently show depression [15] and also anxiety sufferers often show signs of alcoholism as well [16]. Prior adjustment for personality and interaction effects might account for the results, but also because of between-study differences in cultures, sample definitions, study design and measures. It is possible that those with the most severe alcohol problems did not participate in both surveys of our longitudinal study, or that use of alcohol was not stable over the 10-year follow-up period.

When examining the results of this study, certain limitations should be observed. In generalising from the results of this study, one should be careful because the study sample includes former male athletes who ended their sports career before answering the questionnaires. In addition, our data is based on only self-reported measures, and misclassification may have influenced the results, too. In this study, the questions on mood were used as a scale of mood in general, i.e. as an assessment of symptoms of anxiety and depressiveness; therefore our results may not be directly relevant to patients with clinical depression. Further, one should keep in mind that this model is only a weak predictor of depression and anxiety at the level of the individual.

In general, epidemiological studies suggest that the prevalence of depressive symptoms increases somewhat with age [9,24]. Ageing makes sport and physical activity on the whole more important, because the studies of the connections between physical activity and depression have corroborated the view that reduction in physical activity increases depressive inclination [39,46,53]. Physically active middle-aged and aged people suffer less from depression than their passive age-mates [6,40,59]. People who have been physically active during most of their adult life or at least for several years have been noted to have a better psychological health than is the case with physically inactive people, but no reliable causal relations can be shown. The possible improvement of psychological health as a consequence of physical health seems to be related to the habit of physical exercise itself rather than to improved physical fitness.

Our study shows that increasing physical activity in general is protective against depression, but it appears to have no effect on anxiety. These results can be used e.g. in planning health-preserving physical exercise programs. In any case, determining the effect of prevention needs further studies of the connections between physical activity, personality traits and illnesses.

Acknowledgement

The present study was supported by grants from the Juho Vainio Foundation, Helsinki (to HB), Finland and the Academy of Finland (# 42044 to JK).

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論文名	Influence of physical activity on depression and anxiety of former elite athletes
著 者	Bäckmand H, Kaprio J, Kujala U, Sarna S.
雑誌名	Int J Sports Med.
巻・号・頁	24(8) 609-19
発行年	2003
PubMedリンク	http://www.ncbi.nlm.nih.gov/pubmed/14598199

対象の内訳		ヒト	動物	地 域	欧米	研究の種類	縦断研究
	対象	一般健常者	空白		( )		コホート研究
	性別	男性	( )		( )		( )
	年齢	63.3	[redacted]		( )		前向き研究
	対象数	1000～5000			( )		( )
調査の方法	質問紙	( )					
アウトカム	予 防	な し	な し	な し	な し	(うつ・神経不安症)	( )
	維持・改善	な し	な し	な し	な し	( )	( )

図 表

Table3 Logistic regression results for subjects with depressiveness in the upper decile in 1995 versus other deciles

Dependent variables		*Odds ratio (with 95% confidence intervals)*	*p-value**	*Cumulative R2*
Depression				
Age -95,				0.041
physical activity	Age -95	1.00 (0.98 – 1.03)	0.832	
	MET -85, quintile 1^	3.77 (1.52 – 9.37)	0.004	
	MET -85, quintile 2^	2.60 (1.04 – 6.54)	0.042	
	MET -85, quintile 3^	1.54 (0.56 – 4.22)	0.404	
	MET -85, quintile 4^	2.83 (1.15 – 6.94)	0.023	
	(MET -85, quintile 5^ ref.)	1.00		
Personality				0.218
characteristics	Extroversion SD	0.75 (0.59 – 0.96)	0.021	
	Neuroticism SD	2.02 (1.54 – 2.65)	0.000	
	Life satisfaction SD	1.32 (1.03 – 1.70)	0.029	
	Hostility SD	1.17 (0.92 – 1.48)	0.198	
Life style				0.272
	Change in MET 95 – 85	0.92 (0.86 – 0.99)	0.024	
	Alcohol -85,occasional users	0.99 (0.41 – 2.41)	0.989	
	Alcohol -85,moderate users	0.83 (0.32 – 2.19)	0.709	
	Alcohol -85,heavy users	0.67 (0.23 – 2.01)	0.478	
	(Alcohol -85,abstainers ref.)	1.00		
	Change in alcohol consumption 95 – 85	0.98 (0.97 – 1.00)	0.009	
	Smoke -85,ex-smoker	1.33 (0.77 – 2.32)	0.308	
	Smoke -85,current smoker	1.72 (0.86 – 3.43)	0.124	
	(Smoke -85,never smoker ref.)	1.00		
	Smoke status changed; ex-smoker in 1995	1.14 (0.48 – 2.68)	0.771	
	Smoke status changed; current smoker in 1995	0.54 (0.19 – 1.53)	0.247	
	Marital status -85, married, remarried or cohabiting	0.69 (0.31 – 1.54)	0.367	
	(Marital status -85,unmarried, divorced or widow ref.)	1.00		
	Marital status changed; married, remarried or cohabiting in 1995	1.27 (0.38 – 4.25)	0.702	
	Marital status changed; unmarried, divorced or widow in 1995	3.46 (1.75 – 6.85)	0.000	
Life events				0.283
	Life events	1.07 (1.03 – 1.12)	0.002	
Sosioeconomic				0.305
Status	Executive	0.64 (0.29 – 1.45)	0.286	
	Skilled workers	1.92 (1.13 – 3.28)	0.017	
	Unskilled workers	0.53 (0.10 – 2.71)	0.446	
	Farmers	1.63 (0.67 – 3.94)	0.279	
	(Sosioeconomic status,clerical workers ref.)	1.00		

* Wald's test.
^ Quintile described in detail Table 1.

図表掲載箇所	P614, Table 3
概 要（800字まで）	以前にアスリートであった男性664名とコントロール500名において、余暇身体活動中の運動が、その後の追跡期間平均10年におけるうつ病や不安神経症に影響を与えるかを検討した論文である。うつ病や不安神経症に関しては、BSI-53（質問票）をもとに得点化している。運動に関しては、それぞれの活動の強度、期間、頻度から計算された。ウォーキングについては4メッツ、ウォーキングからジョギングは6メッツ、ジョギングは10メッツ、ランニングは13メッツを用いている。運動をもっとも行っている群（57.72メッツ・時/週）と比較して、32.2、14.4、6.0、1.4メッツ・時/週行っている群では、うつ病のリスク（RR）が、それぞれ、2.83（95%CI: 1.15-6.94）、1.54（0.56-4.22）、2.60（1.04-6.54）、3.77（1.52-9.37）であり、また神経不安症のリスクが1.91（0.81-4.51）、1.68（0.68-4015）、1.64（0.69-3.90）、1.57（0.65-3.79）であった。うつ病に関しては、運動との関係が認めらたが、神経不安症とは関連が認められなかった。
結 論（200字まで）	過去にアスリートであった者と一般健常人において、運動がその後のうつ病や不安神経症に関連する心理的状況に及ぼす影響を検討した。運動を行っているものでは、その後のうつ病に関連する心理的状況の悪化を予防可能なことが示された。
エキスパートによるコメント（200字まで）	運動や身体活動の心理的要因に対する有効な影響はいくつか報告されてきている。本研究では、過去アスリートであったものを対象者に含んでいたため、その影響が大きく示唆されたが、一般的な範囲内での身体活動量においてもより検討を進めていくことも必要である。

担当者　村上晴香

International Journal of Obesity (2004) 28, 99–104
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www.nature.com/ijo

PAPER

Physical activity in relation to development and maintenance of obesity in men with and without juvenile onset obesity

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OBJECTIVE: To examine long-term effects of leisure time physical activity (ltpa) and occupational physical activity (opa) on later obesity, and to examine the effect of body weight on later physical inactivity in men with and without juvenile onset obesity.
DESIGN: Population-based longitudinal study of obese and nonobese men, who were identified as draftees of median age of 19 y in 1943–77 and later examined at general health surveys in 1982–84, and in 1991–93.
SETTING: Copenhagen and adjacent regions, Denmark.
PARTICIPANTS: In all, 1143 juvenile obese men with a BMI $\geq 31\,kg/m^2$ (corresponding to 35% overweight by an originally used national standard) at draft board examination, and, as a nonobese control group, 1278 men selected as a 0.5% random sample of the approximately 255 600 men examined at the draft board and thus representing the study population.
MAIN OUTCOME MEASURES: Obesity, defined as BMI $\geq 30\,kg/m^2$, and physical inactivity at the last survey.
RESULTS: In the cross-sectional analyses, there were strong concurrent inverse associations between ltpa and prevalence of obesity in both groups, whereas there was no relation to opa. In logistic regression analyses of obesity at the last survey, including both ltpa and opa as well as age, BMI at draft board examination, BMI at first follow-up, length of education, smoking and drinking habits, there were no significant effects of ltpa and opa on the risk of development of obesity in the nonobese group or maintenance of obesity in the obese group. Similar analyses of physical inactivity at the last follow-up as outcome showed a significant direct effect of BMI at first follow-up, with a significant trend in the nonobese group, but not in the obese group and no effects on opa.
CONCLUSION: There is no long-term influence of physical activity on development and maintenance of obesity in men, whereas greater body weight increases risk of later physical inactivity during leisure time.
International Journal of Obesity (2004) **28**, 99–104. doi:10.1038/sj.ijo.0802525
Published online 11 November 2003

Keywords: physical activity; obesity; juvenile obesity; BMI; prevention; longitudinal

Introduction

A sedentary life style is assumed to play an important role in development and maintenance of obesity.[1–4] Physical activity as assessed in one point in time has a long-lasting effect on obesity-related factors such as blood lipids, insulin sensitivity, and on incidence of and the risk of dying from cardiovascular disease.[5,6] Numerous studies have shown in inverse relationship between body weight and physical activity, but prospective studies of the effect of physical activity on weight changes and obesity have given inconsistent results.[3]

When the relationship between physical activity and obesity is investigated, it is essential to achieve an appropriate temporal sequence. Most prospective studies have used data on physical activity and body weight both at baseline and at follow-up, which confounds the possible effects of physical activity on obesity with the possible effects of obesity on physical activity. From such analyses of concurrent changes, it is impossible to determine which change occurred first, and therefore they give no information on the possible causal direction. Moreover, the weight history until baseline assessment may confound the prospective relationship. Thus, obese subjects who had lost weight and increased physical activity and who thereafter

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Received 18 November 2002; revised 16 April 2003 and 28 July 2003; accepted 24 September 2003

regain body weight, would create a spurious association of high physical activity and later obesity.

The purpose of this study was to examine the long-term, possibly bidirectional, relation between leisure time physical activity (ltpa) and occupational physical activity (opa) and maintenance and development of obesity in men with and without juvenile onset obesity.

Subjects and methods

Study population

The study population comprised 362 200 young Danish males, who had been examined by the draft boards of the metropolitan area of Copenhagen and the surrounding counties from 1943 to 1977. The study sample consisted of two groups selected at draft board examination: a group of men with juvenile onset obesity and a nonobese control group. The obese group included 1143 men with at least 35% overweight according to an originally used national standard, which corresponds to a body mass index (BMI, weight in kg divided by height in meters squared, kg/m^2) of at least $31.0\,kg/m^2$. Being obese as young men at the draft board examination, they have developed the obesity in childhood or adolescence, wherefore they are denoted *'juvenile obese'*. As a control group, a 0.5% random sample was selected from among all men at draft board examination in the same region and time period. After exclusion from the control group, the men for whom height and weight measurements were unavailable and exclusion of the obese control subjects who were already included in the obese group, the nonobese control group comprised 1278 men. All men in the study sample were invited to participate in two general health surveys conducted by the Copenhagen City Heart Study in 1982–84 and in 1991–93, follow-ups 1 and 2, respectively.

Draft board examination

In Denmark, the draft board examination was obligatory during the study period, and the men were usually examined between the ages of 18 and 26y. At the draft board examination, all men underwent systematic examination including measurement of standing height (without shoes) and weight (in underwear only), and obesity was not an acceptable reason for exemption from examination.[7]

Follow-up studies

At the first follow-up survey (follow-up 1) performed from 1981 to 1983, 964 participated from the juvenile obese group, and 1134 from the control group. In the second follow-up survey (follow-up 2) performed from 1991 to 1994, 792 juvenile obese and 918 controls participated. At the surveys, height and weight measurements were performed, and information was collected about physical activity, length of education, smoking habits, and alcohol consumption from a self-administered questionnaire. Details of the study design and methods have been published previously.[8]

Physical activity

Ltpa was graded into four levels: (1) inactivity: none, or less than 2 h/week; (2) medium activity: 2–4 h of light exercise per week; (3) high activity: 2–4 h of moderate exercise per week, and (4) very high activity: more than 4 h of exercise per week. In this study, the group at level 4 was too small to be kept separate, and it was therefore included in the group of those at level 3. Opa was classified into four levels: (1) sitting; (2) standing; (3) walking; and (4) lifting or heavy work.

Statistical analyses

The strategy of the analyses was based on the research questions raised. For the first series of analyses, the questions were: What is the relation between physical activity and the risk of maintaining obesity among obese subjects, and what is the relation between physical activity and risk of later development of obesity among nonobese subjects? Thus, the population at the risk of the outcome had to be defined as subjects in whom the outcome had not yet occurred at baseline, that is, follow-up 1. The juvenile obese men and nonobese controls had to be analysed separately due to the differences in the questions addressed. In the second analysis, the question addressed was whether BMI at one point in time affected later risk of being physically inactive. The population at risk was, not restricted to those being physically active at baseline and the two groups of men was analysed together although separate estimates of the relations were obtained.

Logistic regression was used in all analyses. In the group of juvenile obese the effect of ltpa and opa on subsequent odds of maintenance of obesity was analysed (having BMI $\geq 30\,kg/m^2$ at second follow-up among those with BMI above $30\,kg/m^2$ at first follow-up). In the control group the effect of ltpa and opa on subsequent odds of development of obesity was analysed (having BMI $\geq 30\,kg/m^2$ at second follow-up among those with BMI below 30 at first follow-up). Similar analyses were conducted with physical inactivity at follow-up 2 as outcome, although in these analyses, the physically inactive subjects at follow-up 1 were included and a common model for the juvenile obese and nonobese controls were made.

Analyses of ltpa were adjusted for opa and *vice versa*. In order to adjust for potential confounding, the models included age (continuous variable), BMI at draft board and at the first follow-up study (continuous variables), length of education (years in school: ≤ 7; 8–11; and ≥ 12 y), smoking habits (never, ex-smoker, 1–14, 15–24, and >25 g tobacco/day), and alcohol consumption (<1, 1–7, 8–21, 22–35, and >35 unit/week). Confounders included in the cross-sectional analysis are mentioned in the table footnote, and are used as described above. In all the analyses, the linearity of age effects were tested and confirmed (likelihood ratio test).

In all the analyses, a 5% significance level was used, and the estimated odds ratios are given with 95% confidence limits (CI). Data analyses were performed using statistical analysis system (SAS, version 8).

Results

Tables 1 and 2 show the distribution of age, BMI, and proportion of obese for the juvenile obese and control groups at the draft board examination, and at the first and second follow-up surveys. The greatest increase in median BMI was seen in the control group (Table 1). Most of the control and juvenile obese men were physically active in leisure time at both surveys, but there was a tendency to a decrease in the level of ltpa from follow-ups 1 to 2 in both groups (Table 2). At both surveys, there were more inactive juvenile obese men than controls. The opposite was seen regarding opa, where the juvenile obese group was more physically active in general than the controls. There was a decreasing activity level in opa from the first to the second follow-up survey in both groups.

Table 2 shows the cross-sectional analyses of the data from the follow-up studies. There was a distinct inverse association between ltpa and obesity in both groups, which was significant as a trend in all analyses except at follow-up 2 in the juvenile obese group. There was no clear association between opa and obesity in either group. At the first follow-up, there was a tendency to increased odds ratios with higher level of opa, but the opposite was seen at the second follow-up.

Table 3 shows the changes in BMI from follow-ups 1 to 2 by ltpa and opa at follow-up 1 for the control and juvenile obese groups. There was no consistent trends across the levels of physical activity. The greatest increase in median BMI was found at the high level of ltpa in both groups.

As shown in Table 4, there were no significant effects of previous ltpa and opa (at follow-up 1) on development or maintenance of obesity at the second follow-up for control and juvenile obese subjects, respectively. Adjustment for the confounders did not change the crude estimates. There were no clear associations between opa and presence of obesity at the last follow-up in either group.

The proportion of the subjects who were physically inactive in leisure time at follow-up 2 increased by increasing BMI at follow-up 1 in the control group and showed generally higher proportions in the juvenile obese group (Table 5). The odds ratios for physical inactivity were estimated in a common model for the juvenile obese and the controls and including BMI at draft board and first follow-up, and opa, age, length of education, smoking and

Table 1 Number, age and BMI at draft board examination, and prevalence of obesity (BMI $\geq 30\,kg/m^2$), follow-ups 1 and 2

		Age (y)[a]		*BMI (kg/m²)*		
	Number	*Median*	*Range*	*Median*	*Range*	*Obese %*
Draft board examination						
Controls	1278	19	18–31	21.4	15.7–30.9	
Juvenile obese	1143	19	18–31	32.6	31.0–51.8	
Follow-up 1 (1981–83)						
Controls	1134	36	22–62	24.4	15.9–40.4	5.6
Juvenile obese	964	32	22–64	33.6	18.4–74.4	79.4
Follow-up 2 (1991–94)						
Controls	918	46	34–74	25.7	16.2–45.1	13.1
Juvenile obese	792	42	34–75	34.9	19.9–63.7	85.4

[a]At the follow-up examinations, the control group was older than the juvenile obese group, because there had been an increase in prevalence of obesity during the study period of draft board examinations, resulting in a relative increase in the younger part of the juvenile obese group.

Table 2 Percentage distribution and odds ratios (OR)[a] with 95% confidence intervals for obesity (BMI $\geq 30\,kg/m^2$) from the cross-sectional analysis of leisure time (ltpa) and occupational (opa) physical activity at the first and second follow-up surveys for the control and juvenile obese subjects

	Controls				*Juvenile obese*			
	Follow-up 1		*Follow-up 2*		*Follow-up 1*		*Follow-up 2*	
	%	*OR*	*%*	*OR*	*%*	*OR*	*%*	*OR*
Ltpa								
Inactive	7.1	1	9.5	1	15.1	1	16.4	1
Medium	41.0	1.21 (0.47–3.10)	44.6	0.73 (0.38–1.39)	43.7	0.48 (0.26–0.88)	48.6	0.59 (0.28–1.26)
High	51.9	0.49 (0.18–1.35)	45.9	0.39 (0.20–0.78)	41.1	0.32 (0.17–0.58)	35.0	0.48 (0.22–1.04)
Opa								
Sitting	29.7	1	34.5	1	21.4	1	25.0	1
Standing	28.3	2.21 (1.00–4.90)	29.4	1.31 (0.77–2.25)	20.2	1.18 (0.72–1.93)	23.3	0.77 (0.39–1.52)
Walking	26.6	2.17 (0.95–4.97)	24.0	0.90 (0.49–1.66)	30.6	1.70 (1.05–2.76)	28.6	0.65 (0.33–1.26)
Lifting	15.4	3.33 (1.36–8.11)	12.2	0.85 (0.40–1.80)	27.8	1.03 (0.63–1.68)	23.1	0.58 (0.29–1.19)

[a]Adjusted for opa or ltpa, age, length of education, smoking and alcohol habits.

alcohol drinking reported at follow-up 1 (Table 6). It showed a significantly increasing trend in odds ratios for physical inactivity by increasing BMI at first follow-up in the control group ($P<0.02$), no trend in the juvenile obese group, which generally had higher odds ratios. A corresponding analysis of low opa showed no significant trends (Table 6).

Discussion

In this study, we found no support to a long-term effect of ltpa on development or maintenance of obesity. We did find a concurrent inverse association between ltpa and obesity for both juvenile obese and nonobese men, which is in agreement with previous cross-sectional studies.[9–13] The results indicate that body weight is a strong predictor of later physical inactivity in leisure time, possibly explaining the cross-sectional relationships. There were no significant relations in either direction between opa and obesity or body weight in the two groups.

The advantage of our study is that the study design is prospective, with an objective measure of height and weight (BMI) at three points in time, and that the analysis of the relationships respects this design. The study is without recall bias in the assessment of physical activity, and misclassification in BMI due to possible differential errors in reporting is therefore beforehand avoided. Despite being a relatively rough measure of physical activity, our results confirmed the expected concurrent inverse association for ltpa, and demonstrated that BMI could predict later physical inactivity. Moreover, earlier studies using the same measure have shown strong predictive values of ltpa in relation to total mortality and incidence of cardiovascular disease.[14,15] Therefore, we would expect that the physical activity measure would be able to pick up a relationship to later obesity, had it existed.

Table 3 Change in BMI units (median and 95% percentiles) from the first to the second follow-up surveys by leisure time (ltpa) and occupational physical activity (opa) at follow-up 1 for control and juvenile obese subjects

	Control			*Juvenile obese*		
	n	*Median*	*95% PC*[a]	n	*Median*	*95% PC*
Ltpa						
Inactive	43	1.17	−0.73–4.56	81	1.41	−6.10–7.83
Medium	292	1.30	−1.37–4.45	213	0.56	−5.91–7.26
High	402	1.36	−0.94–4.92	185	2.05	−3.32–10.0
Total	737	1.31	−1.27–4.61	479	1.37	−4.95–8.58
Opa						
Sitting	231	1.37	−1.05–4.48	92	2.08	−5.28–8.05
Standing	219	1.46	−0.84–5.48	96	0.77	−6.68–7.26
Walking	187	1.35	−1.31–4.38	163	1.40	−3.48–9.23
Lifting	95	1.12	−1.59–5.13	128	1.37	−4.33–9.44
Total	732	1.33	−1.27–4.61	479	1.37	−4.95–8.58

[a]PC: percentiles.

Table 5 Number of subjects and percentages being inactive during leisure time or occupationally at second follow-up survey by BMI level at follow-up 1 for control and juvenile obese subjects

	Control		*Juvenile obese*	
	n	*Inactivity (%)*	n	*Inactivity (%)*
Ltpa				
BMI				
15–21	143	7.0	0	—
22–24	273	7.3	0	—
25–29	287	11.9	131	16.0
30–34	38	21.1	254	13.8
35–	0	—	215	19.5
Total	741	9.7	600	12.7
Opa				
BMI				
15–21	135	38.5	0	—
22–24	252	39.3	0	—
25–29	258	31.8	117	29.1
30–34	31	25.8	242	23.1
35–	0	—	193	22.8
Total	676	35.7	552	24.3

Table 4 Prospective analysis of odds ratios (OR) with 95% confidence intervals for obesity (BMI $\geq 30\,kg/m^2$) at follow-up 2 as determined by physical activity in leisure time (ltpa) and occupational physical activity (opa) at follow-up 1 for control and juvenile obese

	Control		*Juvenile obese*	
	Crude OR	*Adjusted OR*[a]	*Crude OR*	*Adjusted OR*[a]
Ltpa				
Inactive	1	1	1	1
Medium	1.24 (0.36–4.25)	1.17 (0.31–4.49)	0.74 (0.23–2.35)	0.75 (0.22–2.58)
High	1.12 (0.32–3.86)	1.10 (0.28–4.34)	1.90 (0.54–6.72)	1.72 (0.46–6.39)
Opa				
Sitting	1	1	1	1
Standing	1.87 (0.83–4.21)	2.16 (0.92–5.11)	0.75 (0.25–2.25)	1.00 (0.29–3.39)
Walking	1.19 (0.52–2.72)	0.99 (0.38–2.53)	1.38 (0.48–3.96)	1.75 (0.54–5.62)
Lifting	0.75 (0.25–2.26)	0.67 (0.21–2.16)	1.06 (0.36–3.12)	1.09 (0.32–3.67)

[a]Adjusted for opa or ltpa, respectively, age, length of education, smoking and alcohol habits, BMI at draft board and the first follow-up.

Table 6 Prospective analysis of odds ratios (OR) with 95% confidence intervals for inactivity at follow-up 2 during leisure time and occupationally as determined by BMI level at follow-up 1 for control and juvenile obese

	Control		*Juvenile obese*	
	Crude OR	*Adjusted OR*[a]	*Crude OR*	*Adjusted OR*[a]
Ltpa				
BMI				
15–21	1	1	—	—
22–24	1.22 (0.54, 2.75)	1.14 (0.50, 2.61)	—	—
25–29	2.16 (0.97, 4.82)	1.97 (0.87, 4.49)	3.43 (0.91, 12.9)	3.21 (0.84, 12.3)
30–35	3.63 (1.16, 11.3)	3.07 (0.96, 9.88)	2.42 (0.66, 8.77)	2.20 (0.60, 8.08)
35–	—	—	3.13 (0.81, 12.1)	2.79 (0.70, 11.0)
Opa				
BMI				
15–21	1	1	—	—
22–24	1.31 (0.76, 2.23)	1.36 (0.78, 2.38)	—	—
25–29	0.96 (0.54, 1.73)	1.11 (0.60, 2.05)	1.11 (0.35, 3.55)	1.41 (0.42, 4.71)
30–35	1.78 (0.60, 5.31)	2.04 (0.65, 6.42)	0.86 (0.28, 2.60)	1.15 (0.36, 3.68)
35–	—	—	0.91 (0.28, 3.01)	1.34 (0.38, 4.64)

[a]Adjusted also for opa or ltpa, age, BMI at draft board, length of education, smoking and alcohol habits.

Earlier studies respecting the temporal sequence of possible causes and effects have given inconsistent results.[3] Williamson *et al*[9] found no relationship between baseline physical activity and subsequent weight gained over a 10 y period in 3515 men and 5810 women. In a prospective 10-y follow-up study of 2564 men and 2695 women, Haapanen *et al*[16] found an inverse relation between baseline physical activity level and body mass gain over 5 kg and BMI >26 kg/m^2 at the follow-up for men, but no relation for women, but in this study there were no adjustment for baseline BMI. Parker *et al*[17] found no association between ltpa and weight gain over 4 y period among 465 individuals, but did not show the results. A 3-y follow-up study performed by Klesges *et al*,[18] showed no relation between baseline sports activity and weight gain over a 2 y period for 142 men and no relation with ltpa for women. In a 2-y longitudinal study, Bild *et al*[19] found no relation between baseline physical activity and prediction of weight gain among 979 black men, and a direct relation between physical activity and weight gain among 1100 white men.

We found no support for the hypothesis that ltpa prevents obesity in the long run, which seems in conflict with the results from our cross-sectional analysis as well as with the theory of energy balance. According to this theory, changes in energy stores are equal to energy intake minus energy expenditure. Therefore, it was expected that higher levels of ltpa could prevent obesity. This would require that the increased expenditure is fully compensating for an increased energy intake, which according to studies in free-living women may not be the case, at least in the short term.[20] In the present setting of large groups of free-living individuals, assessed at long time intervals, it is not relevant to apply the energy balance equation in the interpretation, since valid assumptions about the changes of the components of the equation, including possible primary changes in the fat-storing process, cannot be made.

It is reassuring that a concomitant analysis of the long-term relation between physical activity, assessed by the same measures, and obesity in a different study population followed over many years essentially gave the same results.[21] In that study, it was moreover possible to take into account the possible effects of changes in physical activity in the period before the time period in which the changes in body weight were observed. This analysis showed no effect of such changes on the risk of later obesity, especially no increased risk of obesity followed among those with a decrease in physical activity. That study also discusses the various types of selection bias that may come from the unavoidable attrition during the very long time of follow-up of the population. In principle, the arguments presented in that study are valid in the present study.

Our results do not exclude a short-term link between physical activity and fat accumulation, in agreement with the expectation based on the energy balance equation. On the other hand, in a public health perspective, it is essential to demonstrate the long-term relationships in the free-living population. Even though there may be fundamental biological differences between weight gain in nonobese subjects and weight loss in obese subjects, it should be emphasized that our results may be relevant to strategies for prevention of obesity as well as strategies for management of already developed obesity.

The study clearly demonstrated that the greater the BMI, the greater the likelihood of being physically inactive in leisure time later in life, but not during work, even when taking into account original level of physical activity, preceding weight history as well as other pertinent behaviours. The tendency to reduced physical activity may be due to increasing discomfort by increasing body weight caused by for example musculoskeletal problems and breathlessness.

In conclusion, these findings suggest there are no long-term effects of ltpa and opa on development or maintenance of obesity in men who as young adults were either nonobese or had developed juvenile obesity. Irrespective of body weight changes and obesity, there are several well-documented short- and long-term health benefits from a lifestyle that includes regular physical activity, for example a reduction in the risk of cardiovascular disease mortality, and a reduced risk of type II diabetes mellitus, also in the obese.

Acknowledgements

The study was supported by the Danish Medical Research Council, The Danish Heart Foundation and the Danish National Research Foundation. We thank the staff at the Copenhagen City Heart Study for the skilful examination of the subjects.

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論文名	Physical activity in relation to development and maintenance of obesity in men with and without juvenile						
著　者	Bak H, Petersen L, Sorensen TI						
雑誌名	Int J Obes Relat Metab Disord						
巻・号・頁	28(1)　　99-104						
発行年	2004						
PubMedリンク	http://www.ncbi.nlm.nih.gov/pubmed/14610530						
対象の内訳		ヒト	動物	地　域	欧米	研究の種類	縦断研究
	対象	一般健常者	空白		(　　)		コホート研究
	性別	男性	(　　)		(　　)		(　　)
	年齢	34－75歳	[redacted]		(　　)		前向き研究
	対象数	1000～5000	空白		(　　)		(　　)
調査の方法	質問紙	(　　)					
アウトカム	予　防	な　し	肥満予防	な　し	な　し	(　　)	(　　)
	維持・改善	な　し	な　し	な　し	な　し	(　　)	(　　)
図　表							
図表掲載箇所							
概　要 (800字まで)	目的:肥満に対する余暇時間の身体活動(ltpa)と職業上の身体活動(opa)の長期間にわたる影響を調べること、および、小児期からの肥満のある男性とない男性の、その後の身体不活動への体重の影響を検討する。 デザイン:1943-77年で19歳(中央値)である肥満と非肥満の男性を対象にして1982-84年、および1991-93年に健康全般の調査を行った長期研究. 設定:コペンハーゲンかその近郊に住む、小児期からの肥満者と、無作為に抽出された非肥満者。 対象者:1回目の追跡調査時の小児期からの肥満群のBMIは32(22-64)で、非肥満群は36(22-62)である。2回目の追跡調査時の小児期からの肥満群は34.9(19.9-63.7)で非肥満群は25.7(16.2-45.1)である。 小児期からの肥満群:1143人→943人→792人、非肥満群:1278人→1134人→918人 アウトカムの評価:肥満はBMIが30kg/m2以上と定義された。 結果:非肥満群において、不活動群と比較して余暇活動の中強度群のオッズ比は1.17(0.31-4.49)、高強度群のオッズ比は1.10(0.28-4.34)、仕事の立位群は2.16(0.92-5.11)、歩行群は0.99(0.38-2.53)、高強度群は0.67(0.21-2.16)で、いずれも有意ではなかった。小児期からの肥満群における肥満の維持についても、活動による差はみられなかった。一方、BMIと余暇における身体活動には、有意な関係がみられた。						
結　論 (200字まで)	男性での肥満の進行や維持に対して身体活動の長期の影響はないが, 体重が大きいと余暇時間の不活動のリスクを増加させる.						
エキスパートによるコメント (200字まで)	身体活動が肥満の発現と関連しているのではなく、肥満が不活動をもたらすことが示唆され、興味深い。						

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Relationship between Subdomains of Total Physical Activity and Mortality

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ABSTRACT

BESSON, H., U. EKELUND, S. BRAGE, R. LUBEN, S. BINGHAM, K. KHAW, and N. J. WAREHAM. Relationship between Subdomains of Total Physical Activity and Mortality. *Med. Sci. Sports Exerc.*, Vol. 40, No. 11, pp. 1909–1915, 2008. **Purpose:** The purpose of this study was to describe the association of the overall and domain-specific physical activity on all-cause and cardiovascular mortality. A large body of epidemiological evidence suggests a strong and consistent inverse association between physical activity and mortality risk. However, it is unclear how this association varies according to the domain of life in which the activity takes place. **Methods:** In an English population-based cohort of 14,903 participants (mean age = 63 yr), total and domain-specific physical activity was assessed using a validated questionnaire (EPAQ2). After a median follow-up of 7 yr, there were 1128 deaths, with 370 from cardiovascular disease. **Results:** The relative risks (95% confidence interval) for all-cause mortality due to physical activity undertaken at home, during exercise, at work, for transport, and in total were 0.81 (0.66–0.99), 0.66 (0.54–0.80), 0.84 (0.55–1.30), 0.82 (0.67–1.00), and 0.77 (0.61–0.98), respectively, after adjustment for baseline age, sex, social class, alcohol consumption, smoking status, history of diabetes, history of cancer, and history of cardiovascular disease and stroke. Cardiovascular mortality was inversely associated with physical activity undertaken at home (*P* for trend = 0.03), during exercise (*P* for trend = 0.001), and in total (*P* for trend = 0.007). The results were unchanged after excluding individuals with a history of heart disease, stroke, and cancer at baseline and those who died within the first 2 yr of follow-up. **Conclusions:** In this study, physical activities at home and during exercise are associated with lower risk of mortality, whereas occupational and transportation-related activities are not. Promoting the potential benefits of physical activity undertaken at home and during exercise may be an important public health message for aging populations. **Key Words:** HOME, SPORT, EXERCISE, CARDIOVASCULAR, EPIC-NORFOLK

Physical activity is undertaken in different contexts or domains: at home, during work, for transportation, and for sport or exercise. Although a large body of evidence suggests an independent dose–response association between measures of physical activity and mortality (7,13,33), there is considerable heterogeneity in how physical activity was assessed in these studies and in the nature of the populations studied, with some being defined by occupation, thus limiting variation in that specific domain. Two previous European studies (4,5) have investigated the domain-specific associations of physical activity with mortality. However, none of these studies provided data on associations between physical activity undertaken at home and mortality. This information may be important because activities performed in different domains of life are likely to differ between men and women, which may affect the physical activity disease associations. A recent study from China suggested an independent association between domestic physical activity and mortality (23) but only in women.

Recently, we reported a 32% lower all-cause mortality risk among the active compared with the inactive participants in the EPIC-Norfolk study using a simple overall index of physical activity that was calculated from a questionnaire administered at baseline (19). In a later phase of the EPIC-Norfolk project, we collected more detailed information on domain-specific activity (34), which has now allowed us to extend our previous observations by examining the separate associations of each domain of physical activity with all-cause and cardiovascular mortality.

METHODS

Participants and methods. The European Prospective Investigation into Cancer (EPIC) study is a prospective cohort study designed to investigate the

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Submitted for publication February 2008.
Accepted for publication May 2008.

0195-9131/08/4011-1909/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0b013e318180bcad

etiology of major chronic diseases. From 1993 to 1997, EPIC-Norfolk (UK) recruited a population-based cohort of 25,639 men and women aged 45–79 yr, identified from participating general practice lists. Between January 1998 and October 2000, 14,905 of these attended the second health check and completed the EPIC Physical Activity Questionnaire (EPAQ2) (31). Written informed consents were obtained from the participants, and The Norwich Local Research Ethics Committee approved the study. Detailed descriptions of the recruitment and study methodology have been reported elsewhere (10).

Physical activity assessment. Physical activity was assessed using the self-completed EPAQ2 questionnaire that collects data on past year's physical activity behaviors in a disaggregated way so that the information may be reaggregated according to the dimension of physical activity of interest (34). The questionnaire consists of four sections: activity in and around the home, during work, commuting to work, and recreational physical activity. All commuting and some domestic questions were designed specifically for the study, whereas the questions on occupational activity were derived from the validated Modified Tecumseh Occupational Activity Questionnaire (2). The recreational section of the EPAQ2 was derived from the Minnesota Leisure Time Activity Questionnaire (30), with 30 predetermined sports selected according to their frequency and duration in a UK population (The Sports Council and The Health Education Authority, 1992) and six nonsportive activities, such as mowing the lawn, watering the lawn, digging, weeding, DIY (do it yourself), and playing music, which are considered activities undertaken in or around the home. The frame of reference for EPAQ2 is the past year. EPAQ2 was validated against repeated measures of free-living energy expenditure estimated from a 4-d individually calibrated minute-by-minute heart rate monitoring throughout a year suggesting that the questionnaire is valid for ranking individuals (34).

A score for physical activity at home was calculated by summing energy expenditure ($MET \cdot h \cdot wk^{-1}$) derived from questions on the number of flights of stairs climbed at home and the frequency and duration of participation in activities undertaken in or around the home, together with the energy costs of these activities (1). The energy costs of sport and exercise activities and a total sport physical activity score ($MET \cdot h \cdot wk^{-1}$) were similarly calculated from the sum of these individual activities. A score for transportation physical activity was calculated by summing energy expenditure ($MET \cdot h \cdot wk^{-1}$) derived from questions on how people commute from home to work and how they usually get about excluding work-related commuting. On the basis of the same principle, an occupational physical activity score ($MET \cdot h \cdot wk^{-1}$) was calculated using the reported duration of work and self-categorization of activity level at work. The different subdomains of physical activity being mutually exclusive, a total physical activity score was calculated by summing energy expenditure at home, work, transportation, and sport or exercise. The participants were then divided into four categories (inactive: <60 $MET \cdot h \cdot wk^{-1}$; moderately inactive: between 60 and 90 $MET \cdot h \cdot wk^{-1}$; moderately active: between 90 and 120 $MET \cdot h \cdot wk^{-1}$; active: >125 $MET \cdot h \cdot wk^{-1}$) on the basis of the quartiles of the total physical activity scores. Similarly, within each domain but with the exception of transportation, quartiles of physical activity were computed. For the transportation domain, activity categories were based on tertiles of scores among participants reporting some form of active commuting, and the lowest category was composed of participants reporting no such activity. In addition, we examined cycling and walking for transportation separately; the lowest category was composed of participants not reporting any cycling or walking activity, respectively, and the remaining participants were divided on the basis of the median of weekly duration of the given activity.

Other exposure assessments. Trained nurses carried out a health examination during a clinic visit. Height and weight were measured in light clothes and without shoes following standard clinical procedures. Body mass index (BMI) was calculated as weight in kilograms divided by meters squared ($kg \cdot m^{-2}$). Blood pressure was measured using a sphygmomanometer (Accutorr) after 3 min of seated rest. Two measurements of blood pressure were taken, and the mean of the readings was used in analysis. Serum levels of total cholesterol were measured on fresh samples with RA 100 (Bayer Diagnostics, Basingstoke, United Kingdom). Information on history of heart attack, stroke, cancer, and diabetes was obtained by self-report. Smoking status was classified into three categories (current smoker, former smoker, or never smoker); alcohol consumption was quantified in grams per day ($g \cdot d^{-1}$); and social classes were categorized into four categories on the basis of the last reported occupation (1 = professional occupations, 2 = managerial and technical jobs, 3 = skilled and partly skilled labor, and 4 = unskilled labor) as previously described (19).

Follow-up. Individuals were flagged for death certification at the UK Office of National Statistics (ONS), with vital status ascertained for the whole cohort. The ONS reports deaths in the cohort via a regular record linkage system. Causes of deaths were classified as follows: (i) death due to all causes; (ii) death due to underlying cardiovascular disease; (iii) death due to cancer; and (iv) death due to all other causes (i.e., deaths not related to cardiovascular disease or cancer). For our analyses, each participant contributed person-time from the date of their second health check until the date of death or the end of follow-up at March 31, 2006. Of 14,905 participants who completed the EPAQ2, two participants were lost to follow-up, reducing the cohort of the present analysis to 14,903 participants and a total of 102,964 person-years.

Statistical analysis. The analysis of the association between occupational physical activity and mortality being restricted to the subsample of working participants, the main variables of interest have been described by working status. The associations between the different levels of physical activity and mortality were analyzed using Cox regression analyses in which exit time was the earlier of date of death or the end of follow-up. All regression models were adjusted for baseline values of age, sex, smoking status, alcohol consumption, social class, history of cancer (yes or no), history of cardiovascular disease or stroke (yes or no), and history of diabetes (yes or no). When examining the domain-specific association of physical activity with mortality, all analyses were additionally adjusted for the other domains of activity. The inactive category was coded as the reference category for all analysis. Linear trend tests across levels of physical activity were performed using the continuous variables in nonparametric multivariate Cox models. Risk modification by sex, age, and BMI as well as the interaction between the different domains of physical activity were tested by adding the respective interaction terms to the Cox model, and their significance was tested by the likelihood ratio statistic.

Finally, we examined the effect of further adjustment for BMI, systolic blood pressure, and total cholesterol on the association between physical activity and mortality. All analyses were repeated after excluding 187 participants who died within 2 yr of follow-up and 1458 participants who had a history of heart disease, stroke, or cancer. Departure from the proportional hazards assumption was evaluated by Schoenfeld residuals. Analyses were conducted using Statistical Analysis System software version 9.1 (26).

RESULTS

The correlation coefficients between the scores from different subdomains of activity are depicted in Table 1. Physical activity at home was inversely correlated with physical activity undertaken at work, and physical activity during exercise was positively correlated with the physical activity performed for transportation. None of the other domains of activity were correlated to each other.

The characteristics of the participants stratified by working status are shown in Table 2. Nonworking participants were 11 yr older, and 77% of the deaths occurred in this group. The history of known cancer, cardiovascular disease, and type 2 diabetes at baseline was twice as high in the nonworking group compared with the working participants. Among the nonworking participants, 26.4% were categorized as being active or moderately active compared with 71.8% in the working group. Differences in total physical activity between the two groups were largely explained by differences in occupational activity because the levels of sport- and transport-related activity were similar. The level of activity undertaken at home was higher in the nonworking participants. A higher proportion of the working participants were male (46.1%) compared with the nonworking group (41.4%). There were no significant differences between the two groups for all other variables.

Total physical activity was significantly inversely related to all-cause and cardiovascular mortality (Table 3). The home and sport domains of physical activity were significantly associated with lower all-cause and cardiovascular mortality, independently of each other and of the activity undertaken in the other domains. After excluding the more intense activities undertaken at home (MET ≥ 5), namely, mowing the lawn, digging, and stair climbing, all-cause mortality was no longer associated with duration of physical activity undertaken at home (P for trend = 0.93; data not shown). The duration of the most intense physical activity

TABLE 1. Pearson correlation coefficients between the different subdomains of physical activity.

Physical Activity	Total	At Home	For Sport or Exercise	For Transportation	At Work[a]
Total	1	0.36**	0.34**	0.27**	0.79**
At home		1	−0.01	−0.01	−0.25**
For sport or exercise			1	0.16**	−0.03*
For transportation				1	0.00
At work[a]					1

[a] Correlation coefficients calculated based solely on working participants.
* $P < 0.05$.
** $P < 0.0001$.

TABLE 2. Description of the variables among participants of EPIC Norfolk 1998–2006 who completed the EPAQ2 questionnaire (n = 14,903) by working status.

	Working Participants, n = 7252		Nonworking Participants, n = 7651	
Person-years	50,584		52,380	
Number of deaths				
All causes	256		872	
Cancer	143		373	
Cardiovascular	71		299	
Other	42		200	
	Mean	**SD**	**Mean**	**SD**
Age (yr)	57.1	7.2	68.0	7.2
Height (cm)	168.2	9.0	165.7	8.8
Weight (kg)	74.8	13.5	73.6	13.0
BMI ($kg \cdot m^{-2}$)	26.4	3.9	26.9	4.0
Alcohol consumption ($g \cdot d^{-1}$)	9.4	13.0	8.2	12.4
Physical activity ($MET \cdot h \cdot wk^{-1}$)				
All domains combined	122.1	53.7	72.3	37.3
At home	42.6	26.9	52.5	31.0
For sport or exercise	14.4	16.7	14.7	18.5
For transportation	6.6	10.1	5.0	7.4
At work	58.6	49.2		
	N	**%**	***N***	**%**
Men	3342	46.1	3171	41.4
Smoking status				
Never smoker	3698	50.1	3571	46.7
Ex-smoker	2872	39.6	3472	45.4
Current smoker	648	8.9	525	6.9
Social classes				
Professionals	552	7.6	542	7.1
Managerial and technical jobs	2866	39.5	2837	37.1
Skilled and partly skilled labor	3538	48.8	3857	50.4
Unskilled labor	208	2.9	242	3.2
History of diabetes	158	2.2	332	4.3
History of cancer	364	5.0	713	9.3
History of cardiovascular disease	125	1.7	364	4.8

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undertaken at home (i.e., climbing stairs, mowing the lawn, and digging) was associated with a reduced risk of all-cause mortality (*P* for trend = 0.03; data not shown). Neither cycling nor walking for transportation, analyzed separately and together, nor activity at work was significantly associated with all-cause and cardiovascular mortality. Total and domain-specific activity was not related to cancer mortality (data not shown). Domain-specific results were similar with and without adjusting for the other domains. The association between total activity and all-cause mortality was not modified by sex (*P* for interaction = 0.90) or BMI (*P* for interaction = 0.81). Domain-specific results observed among men were also similar to those observed among women. When comparing the most active to the least active participants, the relative risks of all-cause mortality (95% confidence interval) for physical activity at home and for sport or exercise were 0.84 (0.65–1.10) and 0.63 (0.49–0.81) among men and 0.70 (0.48–1.03) and 0.73 (0.53–1.02) among women, respectively. However, effect modification by age was observed (*P* = 0.02). In participants older than 63 yr (median), total activity was strongly and inversely related to all-cause mortality (*P* < 0.0001), whereas no relationship was observed in younger participants (*P* = 0.57). Effect modification by age was also observed for activity at home (*P* = 0.002) but not for the other domains of activity.

After excluding participants who died within 2 yr of follow-up and those who had a history of heart disease, stroke, or cancer, total activity (*P* for trend = 0.006), activity at home (*P* for trend = 0.01), and during sport or exercise (*P* for trend = 0.01) were inversely related to all-cause mortality, after additional adjustment for BMI, systolic blood pressure, and cholesterol, whereas no association was observed for transport- or work-related activity.

We observed a strong and highly significant interaction between activity at home and sport or exercise activity on all-cause mortality (*P* = 0.002). Physical activity at home was inversely related to all-cause mortality only when participants were categorized as being inactive or moderately inactive for sport or exercise (Fig. 1A). Reciprocally, activity for sport or exercise was inversely related to all-cause mortality only when the participants were inactive or moderately inactive at home (Fig. 1B).

TABLE 3. Association between physical activity (PA; total and by domains) and mortality (all causes and cardiovascular).

	All-Cause Mortality, 1128 Events				Cardiovascular Mortality, 370 Events			
	n	HR	95% CI	*P* for Linear Trend	*n*	HR	95% CI	*P* for Linear Trend
Total PA[a]								
Inactive (<60 MET·h·wk^{-1})	526	1.00		0.0002	188	1.00		0.0067
Moderately inactive (60–90 MET·h·wk^{-1})	312	0.87	0.73–1.03		102	0.88	0.65–1.18	
Moderately active (90–125 MET·h·wk^{-1})	161	0.67	0.54–0.83		47	0.61	0.41–0.91	
Active (≥125 MET·h·wk^{-1})	129	0.77	0.61–0.98		33	0.68	0.43–1.06	
PA at home[b]								
Inactive (<25 MET·h·wk^{-1})	325	1.00		0.0211	113	1.00		0.0298
Moderately inactive (25–40 MET·h·wk^{-1})	268	0.90	0.74–1.10		94	0.82	0.58–1.17	
Moderately active (40–60 MET·h·wk^{-1})	276	0.91	0.74–1.12		87	0.78	0.54–1.12	
Active (≥60 MET·h·wk^{-1})	259	0.81	0.66–0.99		76	0.75	0.52–1.06	
PA for sport or exercise[c]								
Inactive (<2 MET·h·wk^{-1})	386	1.00		<0.0001	139	1.00		0.001
Moderately inactive (2–9 MET·h·wk^{-1})	279	0.81	0.67–0.97		85	0.78	0.56–1.10	
Moderately active (9–20 MET·h·wk^{-1})	233	0.73	0.60–0.88		74	0.71	0.51–1.00	
Active (≥20 MET·h·wk^{-1})	230	0.66	0.54–0.80		72	0.60	0.42–0.85	
PA for transportation[d]								
Inactive (0 MET·h·wk^{-1})	356	1.00		0.1286	123	1.00		0.2961
Moderately inactive (0–3 MET·h·wk^{-1})	263	0.96	0.79–1.17		92	1.05	0.75–1.47	
Moderately active (3–8 MET·h·wk^{-1})	256	0.99	0.82–1.21		78	0.92	0.65–1.31	
Active (≥8 MET·h·wk^{-1})	253	0.82	0.67–1.00		77	0.79	0.55–1.13	
Cycling for transportation[e]								
Noncyclists	990	1.00		0.3908	333	1.00		0.7960
Cycling up to 30 min·wk^{-1}	77	1.02	0.77–1.35		23	0.81	0.47–1.40	
Cycling over 30 min·wk^{-1}	61	1.01	0.76–1.36		14	0.72	0.39–1.33	
Walking for transportation[f]								
Nonwalkers	376	1.00		0.3056	131	1.00		0.8051
Walking up to 90 min·wk^{-1}	399	0.96	0.80–1.15		126	1.00	0.72–1.38	
Walking >90 min·wk^{-1}	353	0.89	0.73–1.09		113	0.93	0.64–1.35	
PA at work[g,h]								
Inactive (<20 MET·h·wk^{-1})	98	1.00		0.6243	30	1.00		0.6841
Moderately inactive (20–50 MET·h·wk^{-1})	52	1.02	0.69–1.50		8	0.62	0.26–1.47	
Moderately active (50–80 MET·h·wk^{-1})	50	1.02	0.67–1.56		13	1.08	0.48–2.41	
Active (≥80 MET·h·wk^{-1})	56	0.84	0.55–1.30		20	0.98	0.44–2.15	

[a]Adjusted for baseline age, sex, social class, alcohol consumption, smoking status, history of diabetes, history of cancer, and history of cardiovascular disease and stroke.
[b] Additionally adjusted for activity for sport or exercise, at work, and for transportation.
[c] Additionally adjusted for activity at home, at work, and for transportation.
[d] Additionally adjusted for activity at home, for sport or exercise, and at work.
[e] Additionally adjusted for activity at home, for sport or exercise, at work, and walking.
[f] Additionally adjusted for activity at home, for sport or exercise, at work, and cycling.
[g] Additionally adjusted for activity at home, for sport or exercise, and for transportation.
[h] Analyses restricted to working participants.

DISCUSSION

The results from this population-based cohort study suggest that the inverse association between total physical activity and all-cause mortality is predominantly driven by sport, exercise, and the most intense activities carried out in and around the home. We found little evidence of an association between occupational or transport-related activity with mortality. Although the results for physical activity during sport or exercise are compatible with previous reports, few studies have been able to examine the association of the other domains of activity, particularly activity at home. Participants who reported being most active at home had a 19% lower risk of all-cause mortality compared with the least active group even after adjustment for potential confounders and physical activity in other domains. Our results also suggest that the reduced risk of mortality associated with the exercise and home domains of activity was not additive, indicating a possible ceiling effect of activity on all-cause mortality.

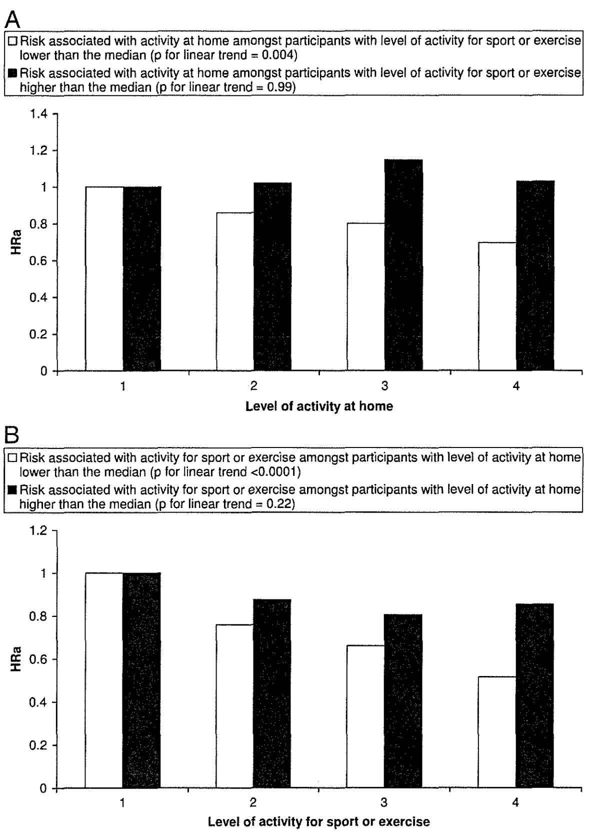

FIGURE 1—A. Interaction between physical activity at home and for sport or exercise on all-cause mortality. Risk associated with activity at home on all-cause mortality according to the level of physical activity for sport or exercise. B. Interaction between physical activity at home and for sport or exercise on all-cause mortality. Risk associated with physical activity for sport or exercise on all-cause mortality according to the level of activity at home. HR[a] indicates hazard ratio adjusted for baseline age, sex, social class, alcohol consumption, smoking status, history of diabetes, history of cancer, history of cardiovascular disease and stroke, physical activity at work, and for transportation.

Others have reported an inverse association between total activity and all-cause mortality similar to the observations from this study, but most of the previous analyses were restricted to leisure time activity or did not combine all domains of activity (7,13,33). To our knowledge, only two previous studies, one from Puerto Rico (8) and one from China (23), have examined the associations between physical activity from all domains with mortality, both suggesting an inverse association between total physical activity with all-cause mortality.

We observed an effect modification by age on the association between activity and mortality, which is supported by others (4). However, in a recent review (18), an inverse association between vigorous activity or exercise and all-cause mortality was reported in all studies reviewed, regardless of the age of the participants. The absence of association between activity and mortality among young participants in this study may be explained by lack of power within this age group (n = 198 deaths).

Our findings of a reduced risk of all-cause mortality associated with activity for sport and exercise are consistent with recent reviews reporting an inverse association between exercise or vigorous leisure time activity and all-cause mortality (7,13,33). The inverse relation observed in our study between intense activities undertaken at home and all-cause and cardiovascular mortality independently of activity in other domains is consistent with the most recent recommendations emphasizing the importance of moderate- to vigorous-intensity physical activity performed as part of daily living (13). In our study, these intense domestic activities corresponded to heavy gardening and climbing stairs at home. One recent study in women suggested an inverse relationship between domestic physical activity and all-cause mortality independent of activity from other domains (23). Our results extend these observations to both men and women. Three previous studies included a few domestic activities in their leisure time activity categorization (4,5,22). In two of these studies (4,5), low or moderately intense leisure time activity was associated with a reduced risk of all-cause mortality. The study that failed to show an inverse relationship between nonvigorous leisure activity and all-cause mortality was restricted to men (22). The negative and significant interaction between activity at home and during sport and exercise suggests a ceiling effect of activity on mortality. The amount of activity during sport or exercise associated with an inverse relation in this study (i.e., moving from moderately inactive to moderately active) is equal to approximately 30 min of moderate-intensity activity five times per week, which is compatible with official recommendations (25). In contrast, 3 h of activity at home is associated with the same reduced risk. This difference in the magnitude of the association between activity at home and during sport might be due to a higher intensity during leisure time and/or different degree of measurement error from these two domains.

We found no evidence of an association between transport-related physical activity and all-cause mortality. This was also the case when analyzing cycling and walking separately. This is in accordance with two previous studies (5,6). In contrast, two studies from Denmark (4) and China (23) observed a reduced risk of all-cause mortality by increasing levels of transport-related activity. However, these results were mainly explained by cycling as a mode of transportation, an activity more prevalent in these countries than in the UK (4,23). Neither did we observe an association between activity at work and all-cause mortality. These findings are consistent with some (4,11,20,21) but not all (5,12,14,28) previous studies.

The inverse associations between activity and cardiovascular mortality are consistent with the literature (7,13,33). Apart from improving plasma lipid profile, reducing body weight, and lowering blood pressure for which our *post hoc* analyses were adjusted, activity may act through many other biological pathways such as reducing platelet aggregation, increasing fibrinolytic activity, improving insulin sensitivity and glucose tolerance, improving cardiac function, improving cardiorespiratory fitness, and lowering the resting heart rate (16). In contrast, we did not observe any association between activity and cancer mortality. As noticed in a recent review (33), physical activity is only associated with risk reduction of some specific cancers. Most of the studies investigating on overall cancer mortality reported little evidence of reduced risk due to activity, except some with follow-up longer than 10 yr and/or on the basis of leisure activity (3,9,15,17,24,27,29,32). It suggests that if an association exists between physical activity and overall cancer mortality, the magnitude of the association is low, or alternatively, the association occurs at least 10 yr after the activity has been undertaken.

Our study has several methodological strengths, including its prospective design and the high proportion of individuals followed up (99.99%). We assessed all domains of daily activity, including activity at home, at work, for transportation, and for sport or exercise. We mutually adjusted our analyses for activity in the various domains and controlled for a wide range of potential confounding factors collected at baseline. Analyses performed after exclusion of the participants with history of heart disease, stroke, and cancer at baseline as well as those deceased within 2 yr of follow-up showed similar results as analyses adjusting for these factors. Therefore, it is unlikely that our findings might be due to the underlying pathological process underlying the decreasing physical activity before mortality. In addition, the population-based sample of our study is heterogeneous in respect to several sociodemographic and anthropometric variables that make the results more generalizable compared with studies that have focused on defined groups (e.g., specific occupations).

Nonetheless, our results should be interpreted considering the following potential limitations. Physical activity was assessed by self-report. Although the questionnaire has been validated previously (34), the level of measurement error was considerable. In particular, reported housework was not correlated to energy expenditure assessed by the flex heart rate method, whereas occupational and recreational activities were. It should be noted, however, that the flex heart rate method may not be a perfect measure of the light-intensity activity that typically takes place in the home. In the context of this study, that measurement error is likely to be nondifferential because it would not be associated with the prognosis of the participants, and thus, its effect would be to attenuate the true association. Possibly, the different subdimensions of activity are recalled with different degrees of measurement error, a fact that would complicate judgment of their relative importance. In addition, physical activity was assessed at baseline, and possible changes in physical activity during follow-up have not been taken into account. Although the effect of confounding has been diminished by adjustment for potential confounders, residual confounding may still exist. Furthermore, our results may be explained by unmeasured or unknown confounding factors. Finally, the analyses of the effect of work related on mortality were based on a restricted sample of participants, who were younger and therefore presented fewer events that limit the power to detect an association.

SUMMARY

Engaging in sport or exercise and intense activities at home were independently associated with mortality risk reductions of 19% and 34%, respectively, compared with being physically inactive. The reduced risks of mortality associated with physical activity from these two domains were not additive, suggesting a ceiling effect. In contrast, physical activity at work and for transportation did not confer a risk reduction for all-cause mortality.

The authors thank the staff of EPIC for their invaluable contributions. The cohort of EPIC-Norfolk is funded by the Cancer Research Campaign; the Medical Research Council; the Stroke Association; the British Heart Foundation; the Department of Health; the Europe Against Cancer Programme Commission of the European Union and the Ministry of Agriculture; Fisheries and Food. The results of the present study do not constitute endorsement by ACSM.

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論文名	Relationship between subdomains of total physical activity and mortality
著 者	Besson H, Ekelund U, Brage S, Luben R, Bingham S, Khaw KT, Wareham NJ
雑誌名	Med Sci Sports Exerc
巻・号・頁	40(11)　　1909-1915
発行年	2008
PubMedリンク	http://www.ncbi.nlm.nih.gov/pubmed/?term=18845964

対象の内訳		ヒト	動物	地 域	欧米	研究の種類	縦断研究
	対象	一般健常者	空白		( )		コホート研究
	性別	男女混合	( )		( )		( )
	年齢	63歳	[redacted]		( )		前向き研究
	対象数	10000以上			( )		( )
調査の方法	質問紙	( )					
アウトカム	予 防	心疾患予防	なし	なし	なし	死亡	( )
	維持・改善	なし	なし	なし	なし	( )	( )

図 表

TABLE 3. Association between physical activity (PA: total and by domains) and mortality (all causes and cardiovascular).

	All-Cause Mortality, 1128 Events				Cardiovascular Mortality, 370 Events			
	n	HR	95% CI	*P* for Linear Trend	*n*	HR	95% CI	*P* for Linear Trend
Total PA[a]								
Inactive (<60 MET·h·wk^{-1})	525	1.00		0.0002	188	1.00		0.0067
Moderately inactive (60–90 MET·h·wk^{-1})	312	0.87	0.73–1.03		102	0.88	0.65–1.18	
Moderately active (90–125 MET·h·wk^{-1})	161	0.67	0.54–0.83		47	0.61	0.41–0.91	
Active (≥125 MET·h·wk^{-1})	129	0.77	0.61–0.98		33	0.68	0.43–1.06	
PA at home[b]								
Inactive (<25 MET·h·wk^{-1})	325	1.00		0.0211	113	1.00		0.0298
Moderately inactive (25–40 MET·h·wk^{-1})	268	0.90	0.74–1.10		94	0.82	0.58–1.17	
Moderately active (40–60 MET·h·wk^{-1})	275	0.91	0.74–1.12		87	0.78	0.54–1.12	
Active (≥60 MET·h·wk^{-1})	259	0.81	0.66–0.99		76	0.75	0.52–1.06	
PA for sport or exercise[c]								
Inactive (<2 MET·h·wk^{-1})	386	1.00		<0.0001	139	1.00		0.001
Moderately inactive (2–9 MET·h·wk^{-1})	279	0.81	0.67–0.97		85	0.78	0.56–1.10	
Moderately active (9–20 MET·h·wk^{-1})	233	0.73	0.60–0.88		74	0.71	0.51–1.00	
Active (≥20 MET·h·wk^{-1})	230	0.66	0.54–0.80		72	0.60	0.42–0.85	
PA for transportation[d]								
Inactive (0 MET·h·wk^{-1})	356	1.00		0.1266	123	1.00		0.2961
Moderately inactive (0–3 MET·h·wk^{-1})	263	0.96	0.79–1.17		92	1.05	0.75–1.47	
Moderately active (3–8 MET·h·wk^{-1})	256	0.99	0.82–1.21		78	0.92	0.65–1.31	
Active (≥8 MET·h·wk^{-1})	253	0.82	0.67–1.00		77	0.79	0.55–1.13	
Cycling for transportation[e]								
Noncyclists	990	1.00		0.3908	333	1.00		0.7960
Cycling up to 30 min·wk^{-1}	77	1.02	0.77–1.35		23	0.81	0.47–1.40	
Cycling over 30 min·wk^{-1}	61	1.01	0.76–1.35		14	0.72	0.39–1.33	
Walking for transportation[f]								
Nonwalkers	376	1.00		0.3056	131	1.00		0.8051
Walking up to 90 min·wk^{-1}	399	0.96	0.80–1.15		126	1.00	0.72–1.38	
Walking >90 min·wk^{-1}	353	0.89	0.73–1.09		113	0.93	0.64–1.35	
PA at work[g,h]								
Inactive (<20 MET·h·wk^{-1})	98	1.00		0.6243	30	1.00		0.6841
Moderately inactive (20–50 MET·h·wk^{-1})	52	1.02	0.69–1.50		8	0.62	0.26–1.47	
Moderately active (50–80 MET·h·wk^{-1})	50	1.02	0.67–1.56		13	1.08	0.48–2.41	
Active (≥80 MET·h·wk^{-1})	56	0.84	0.55–1.30		20	0.98	0.44–2.15	

[a] *Adjusted for baseline age, sex, social class, alcohol consumption, smoking status, history of diabetes, history of cancer, and history of cardiovascular disease and stroke.*
[b] Additionally adjusted for activity for sport or exercise, at work, and for transportation.
[c] Additionally adjusted for activity at home, at work, and for transportation.
[d] Additionally adjusted for activity at home, for sport or exercise, and at work.
[e] Additionally adjusted for activity at home, for sport or exercise, at work, and walking.
[f] Additionally adjusted for activity at home, for sport or exercise, at work, and cycling.
[g] Additionally adjusted for activity at home, for sport or exercise, and for transportation.
[h] Analyses restricted to working participants.

図表掲載箇所	P1912, Table3
概 要 (800字まで)	本研究は、イギリスのThe European Prospective Investigation into Cancer(EPIC) Studyに参加した男女14,903名を対象に7年間の追跡調査を行い、領域別の身体活動量や総身体活動量と総死亡や心血管疾患死亡との関連を検討したものである。身体活動は3つの質問紙を用い、過去1年間の家の周りの活動、職場での活動、職場への通勤、余暇活動について尋ねた。各活動の強度をメッツ値に置き換え、時間積によって週当たりの身体活動量を算出した。総身体活動量を60メッツ時/週未満、60-90メッツ時/週、90-125メッツ時/週、125メッツ時/週以上の4群に分類した。各活動についても同様に4群に分類した。総身体活動が60メッツ時/週未満の集団と比較すると、90-125メッツ時/週、125メッツ時/週以上の集団でそれぞれ総死亡リスクが0.67(95%信頼区間:0.54-0.83)、0.77(0.61-0.98)と量反応的に減少した(Ptrend=0.0002)。心血管疾患死亡リスクについては、90-125メッツ時/週の集団で0.61(0.41-0.91)に減少した(Ptrend=0.0067)。また、運動スポーツを2メッツ時/週未満の集団と比較すると、2-9メッツ時/週、9-20メッツ時/週、20メッツ時/週以上の集団でそれぞれ総死亡リスクが、0.81(0.67-0.97)、0.73(0.60-0.88)、0.66(0.54-0.80)と量反応的に減少した(Ptrend<0.0001)。心血管疾患死亡リスクについては、20メッツ時/週以上の集団で0.60(0.42-0.85)と有意に減少した(Ptrend=0.001)。総死亡リスクに関して、家の周りの活動が25メッツ時/週未満の集団と比較すると、60メッツ時/週以上の集団でのみ0.81(0.66-0.99)と有意に減少した。
結 論 (200字まで)	全強度の身体活動量の合計が90メッツ時/週以上で、総死亡リスクおよび心血管疾患死亡リスクが有意に減少することが明らかとなった。また、中高強度の運動スポーツを2メッツ時/週以上実施することで、総死亡リスクが有意に減少することが明らかとなった。心血管疾患死亡リスクについては、20メッツ時/週で有意に減少する。総身体活動量のうち、高強度の運動や家事活動がリスク減少に関連していることが明らかとなった。
エキスパートによるコメント (200字まで)	身体活動基準の策定に用いられた研究の1つである。身体活動の領域別に総死亡や心血管疾患死亡のリスクとの関係を検討した論文である。総身体活動の増大は死亡のリスクを減少させ、特に高強度の運動や家事活動が関連していることが示されている。職業上の身体活動や移動における身体活動については、この研究では関連が認められていないが、関連すると報告する研究もあることから、今後は職業における身体活動の種類や職業上のストレスといった絞絡因子との関係についても詳細な検討が必要であろう。

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Cancer Epidemiology, Biomarkers & Prevention

Amount, Type, and Timing of Recreational Physical Activity in Relation to Colon and Rectal Cancer in Older Adults: the Cancer Prevention Study II Nutrition Cohort

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Cancer Epidemiol Biomarkers Prev 2004;13:2187-2195. Published online December 14, 2004.

Amount, Type, and Timing of Recreational Physical Activity in Relation to Colon and Rectal Cancer in Older Adults: the Cancer Prevention Study II Nutrition Cohort

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Abstract

Physical activity has consistently been associated with lower risk of colon cancer, but information is limited on the amount, type, and timing of activities. The relationship between physical activity and rectal cancer is unclear. We examined characteristics of recreational physical activity in relation to colon and rectal cancer in the Cancer Prevention Study II Nutrition Cohort of 70,403 men and 80,771 women (median age, 63 years); 940 colon and 390 rectal cancers were identified from enrollment in 1992 to 1993 through August 1999. The multivariate-adjusted rate ratios (95% confidence intervals) associated with any recreational physical activity compared with none were 0.87 (0.71-1.06) for colon cancer and 0.70 (0.53-0.93) for rectal cancer. Colon cancer risk decreased significantly with increasing total hours (*P* for trend without reference group = 0.007) and metabolic equivalent hours (*P* for trend = 0.006) per week of activities. No clear decrease in rectal cancer risk was seen with increasing hours per week of physical activity. Rate ratios (95% confidence intervals) were 0.72 (0.52-0.98) for <2 hours, 0.68 (0.47-0.97) for 2 to 3 hours, 0.59 (0.41-0.83) for 4 to 6 hours, and 0.83 (0.59-1.16) for ≥7 hours per week of physical activity compared with none. Past exercise, as reported in 1982, was not associated with risk of either colon or rectal cancer. We conclude that increasing amounts of time spent at recreational physical activity are associated with substantially lower risk of colon cancer and that recreational physical activity is associated with lower risk of rectal cancer in older men and women. (Cancer Epidemiol Biomarkers Prev 2004;3(12):2187–95)

Introduction

Physical activity is an attractive cancer preventive strategy because it potentially benefits many health end points in addition to reducing the risk of certain cancers. Comprehensive reviews have noted a consistent association between increased physical activity and lower risk of colon cancer (1-3) and colorectal adenomas (4-10). Prospective (11-26) and case-control (27-38) studies of men have typically found, with few exceptions (13, 20, 22, 26), a statistically significant 40% lower risk of colon or colorectal cancer among the most active compared with the least active. Studies of women have been less consistent, generally finding a statistically nonsignificant 10% to 20% lower risk of colon or colorectal cancer associated with increased physical activity (10, 11, 13, 15, 17, 18, 20, 21, 23, 24). The results of prospective (14, 16, 20, 25) and case-control (29-31, 34, 39) studies of rectal cancer and total or recreational physical activity in men or women have not been consistent; studies have reported an inverse association (14, 30, 34, 39), no association (25, 29, 31), or higher risk of rectal cancer associated with greater activity (16, 20).

More information is needed about the characteristics (amount, type, and timing) of physical activity necessary to affect colon and rectal cancer risk. The temporal relationship between physical activity and reduced risk of colon or rectal cancer is important both for biological understanding and for encouraging physical activity among older adults, yet few studies have determined physical activity at different time points in life. Whereas the association with colon cancer has been stronger with recent activity than with past activity (40), this may reflect the greater potential for measurement error when past activity is characterized only by recall.

We examined how the characteristics (amount, type, and timing) of recreational physical activity affect its association with colon or rectal cancer incidence among older adults in the Cancer Prevention Study II (CPS II) Nutrition Cohort. Because this cohort is a subset of the larger CPS II Mortality Cohort established in 1982, participants had prospectively reported data on physical activity and several other covariates on a questionnaire completed 10 years before enrollment in the Nutrition Cohort.

Materials and Methods

Study Population. The CPS II Nutrition Cohort of 86,404 men and 97,786 women was established in 1992 to

Received 2/25/04; revised 6/4/04; accepted 7/15/04.

Grant support: American Cancer Society (CPS II Nutrition Cohort); Public Health Service grant K07CA75062 (A. Chao) from the National Cancer Institute, NIH, Department of Health and Human Services.

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