Table 2 Multivariate relative risk (RR) and 95% confidence intervals (CIs) of colorectal, colon, and rectal cancer incidence according to time spent

	Time spent walking per day (h)					Time spent walking per day (h)			
	<0.5	0.5–1	1<	*P* for trend		<0.5	0.5–1	1≤	*P* for trend
Men					Women				
Colorectal cancer					Colorectal cancer				
Person-years	45 671	34 946	67 970		Person-years	46 261	38 843	72 107	
No. of cases	55	51	60		No. of cases	23	29	42	
(*n*=166)					(*n*=94)				
Age-adjusted RR	1.00	1.09 (0.74–1.60)	0.61 (0.42–0.88)	0.004	Age-adjusted RR	1.00	1.32 (0.77–2.29)	1.01 (0.61–1.69)	0.89
Multivariate RRI[a]	1.00	1.06 (0.72–1.57)	0.57 (0.38–0.83)	0.003	Multivariate RRI[a]	1.00	1.32 (0.76–2.30)	1.02 (0.60–1.75)	0.91
Multivariate RR2[b]	1.00	1.02 (0.67–1.56)	0.56 (0.37–0.85)	0.005	Multivariate RR2[b]	1.00	1.47 (0.80–2.75)	1.04 (0.56–1.95)	0.88
Colon cancer					Colon cancer				
No. of cases	40	30	31		No. of cases	10	15	25	
(*n*=101)					(*n*=50)				
Age-adjusted RR	1.00	0.87 (0.54–1.40)	0.42 (0.26–0.68)	<0.001	Age-adjusted RR	1.00	1.53 (0.69–3.41)	1.35 (0.65–2.81)	0.52
Multivariate RRI[a]	1.00	0.81 (0.50–1.32)	0.38 (0.23–0.64)	<0.001	Multivariate RRI[a]	1.00	1.78 (0.77–4.10)	1.33 (0.60–2.94)	0.63
Multivariate RR2[b]	1.00	0.72 (0.43–1.21)	0.38 (0.22–0.64)	<0.001	Multivariate RR2[b]	1.00	2.68 (0.94–7.68)	1.79 (0.64–4.96)	0.42
Rectal cancer					Rectal cancer				
No. of cases	15	21	29		No. of cases	13	14	17	
(*n*=65)					(*n*=44)				
Age-adjusted RR	1.00	1.68 (0.86–3.26)	1.11 (0.59–2.08)	0.94	Age-adjusted RR	1.00	1.17 (0.55–2.49)	0.75 (0.36–1.55)	0.38
Multivariate RRI[a]	1.00	1.75 (0.88–3.50)	1.07 (0.55–2.06)	0.94	Multivariate RRI[a]	1.00	1.18 (0.54–2.58)	0.82 (0.39–1.71)	0.55
Multivariate RR2[b]	1.00	2.12 (0.96–4.66)	1.21 (0.56–2.61)	0.86	Multivariate RR2[b]	1.00	1.28 (0.93–2.73)	0.71 (0.31–1.61)	0.35

[a]Multivariate RRI has been adjusted for age (in years), cigarettes smoking (never, past, and currently smoking 1–19 cigarettes per day, or currently smoking 20 or more cigarettes per day), alcohol consumption (never, past, or current), body mass index in kg/m^2 (18.4 or lower, 18.5 to 24.9, or 25.0 or more), family history of colorectal cancer (presence or absence), education (in school less than 15, or 16 years or older), sports or exercise (almost never, 1–2 h/week, 3–4 h/week, 5 h or more per week), and consumption frequencies of meat, green or yellow vegetables and oranges (1–2 times per month or less often, 1–2 times per week, 3–4 times per week, almost daily). For women, we also included menopausal status (before menopause, after menopause).
[b]Multivariate RR2 are from a multivariable model that excluded colorectal cancer cases diagnosed with the first 2 years of follow-up. Values in parentheses are 95% confidence intervals.

analyses according to covariates included in the multivariate model.

Discussion

In the present study with a population-based, prospective cohort in a rural northern area of Japan, we found a significant, inverse, dose–response association between time spent walking per day and the risk of colon cancer in men. No such association was observed in women. The comprehensive review by the World Cancer Research Fund in 1997 suggested an association between the physical activity and the risk of colorectal cancer (World Cancer Research Fund/American Institute for Cancer Research, 1997). These associations are demonstrated for both men and women, with a somewhat stronger dose–response relationship for men than for women (Macfarlane and Lowenfels, 1994; Thune and Furberg, 2001). The relationship between physical activity and rectal cancer is unclear. Our result is consistent with the results of these previous studies involving vigorous physical activity except the result of women.

In the present study, we found a significant inverse association between time spent walking and risk of colorectal cancer incidence in men but not in women. This sex difference might be attributed to the difference in incidence rate of colorectal cancer (166 cases in men, 94 cases in women). We might have limited statistical power to examine colorectal cancer risk in relation to time spent walking in women. In addition, the lack of reduction of risk in women may be partly explained by our inability to assess the pace of walking. As it is well known that walking pace is higher among middle-aged men than among middle-aged women (Himann *et al.*, 1988), the impact of time spent walking on the incidence rate of colorectal cancer in women might be weaker than in men.

While the mechanisms by which physical activity may affect colon cancer risk are not clear, several hypotheses have been proposed (Quadrilatero and Hoffman-Goetz, 2003). Physical activity may shorten the fecal transit time and thereby reduce the period of contact between carcinogens and mucosal cells. A second possible mechanism is that low physical activity and central adiposity are both associated with insulin resistance and the hyperinsulinemic state and may affect colon cancer risk through growth factors (Giovannucci, 1995; Colditz *et al.*, 1997). It is possible that activity exerts its protective effect through reduced insulin levels. Another possible mechanism is the effect of prostaglandins on colon cell proliferation. Physical activity produces an increase in prostaglandin F2α, which inhibits colonic cell proliferation, and increases intestinal motility. In contrast, prostaglandin E2 increases the rate of colonic cell proliferation and decreases colonic motility. Physical activity may increase prostaglandin F2α, but not prostaglandin E2 (Colditz *et al.*, 1997). A reduction in bowel transit time because of physical activity may account for the observed effect on colon cancer and the absence of a relationship between physical activity and rectal cancer.

The present study had several methodological advantages over previous studies on the relationship between physical activity and the risk of colorectal cancer. First, the present study was based upon the prospective observation of a large sample size, which included 20 519 men and 21 469 women, of whom 166 men and 94 women were diagnosed with colorectal cancer. Second, the identification of incident cases of colorectal cancer by computerized record linkage with the Miyagi Prefectural Cancer Registry resulted in very high case ascertainment. Third, we used a self-administered questionnaire on walking, with a high validity and reproducibility (Tsubono *et al.*, 2002).

To date, most studies of the risk in colorectal cancer in relation to physical activity have measured physical activity in two ways: by occupation and by leisure-time activities (Vainio *et al.*, 2002). In Japan, daily walking is recommended as one way of maintaining physical activity, and guidelines that include the number of steps per day have been proposed by policy-makers (Ministry of Health, Labour and Welfare, Japan, 2000). Walking is a physical activity that is part of national and local culture in Japan. Using a validated, single-item, self-administered questionnaire on walking (Tsubono *et al.*, 2002), we showed that longer time spent walking was associated with lower risk of the colon cancer in Japanese men. Our findings differ from those of the previous two studies (Wannamethee *et al.*, 2001; Chao *et al.*, 2004). Chao *et al.* (2004) reported no clear decrease in the risk of colon cancer with increasing hours per week of walking, but their participants reported engaging in recreational physical activities more intense than walking, which might have made it difficult to assess the effect of walking alone. Wannamethee *et al.* (2001) reported a non-significant, 25% lower risk of colorectal cancer associated with walking for more than 40 min/day, but their study was relatively small for a prospective design; it included 7588 men, of whom 135 were diagnosed as colorectal cancer. Thus, too few men engaged in walking for any firm conclusion to be drawn.

Our study has some potential limitations. First, the self-administered questionnaire used in our prospective studies included only the average duration of walking per day. We did not ask about other variables related to walking such as walking pace and various ways of walking (e.g. inside or outside, at work or at leisure time). This is because we did not originally intend to calculate total energy expenditure, or quantify the levels of walking according to different ways of walking, on the basis of our questionnaire (Fukao *et al.*, 1995). When we examined the relationship between the duration of the walk and the risk of colon cancer, we adjusted the data for leisure-time physical activity in addition to other confounders. Therefore, the relationship between the duration of the walk and the risk of colon cancer was independent of leisure-time physical activity. Second, we could not examine any changes in the walking time of the participants after the baseline survey. While more work to ascertain any changes in the walking time of the participants during follow-up would be needed, non-differential misclassification in our assessment of time spent walking could distort risk estimates toward the null. Third, the one-time assessment of physical activity as indicated by walking may not be equivalent to the quantitative measurement of physical activity. It is encouraging to see, however, these associations apparent even with one-time recording of time spent walking. Fourth, in our study, during the 7 years of follow-up, there were 109 cases of rectal cancer. Therefore, our study may not have had sufficient statistical power to detect small changes in the risk of rectal cancer by sex.

In Japan, the mortality and incidence rates of colorectal cancers have been increasing rapidly. In addition, the incidence of colon cancer also appears to be on the rise in Asian countries (Parkin *et al.*, 2002). Most prospective cohort studies of physical activity and colorectal cancer risk have been conducted in western populations, and little information has been available on the association in Asian countries (Haenszel *et al.*, 1973; Whittemore *et al.*, 1990; Kato *et al.*, 1990a; Kato *et al.*, 1990b; Chow *et al.*, 1993; Inoue *et al.*, 1995; Kotake *et al.*, 1995; Tang *et al.*, 1999). Our study provides important new evidence to redress this imbalance.

In conclusion, this population-based, prospective cohort study in rural Japan showed that time spent walking per day was associated with a lower risk of colon, but not rectal cancer, in men. No apparent association with colon or rectal cancer was observed in women.

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対象の内訳

	ヒト	動物	地 域	国内	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	40-64歳			( )		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	なし	なし	ガン予防	なし	( )	( )
維持・改善	なし	なし	なし	なし	( )	( )

図 表

Table 2 Multivariate relative risk (RR) and 95% confidence intervals (CIs) of colorectal, colon, and rectal cancer incidence according to time spent

	Time spent walking per day (h)					Time spent walking per day (h)			
	<0.5	0.5–1	1<	*P* for trend		<0.5	0.5–1	1 ≤	*P* for trend
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Colorectal cancer					Colorectal cancer				
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No. of cases (*n*=166)	55	51	60		No. of cases (*n*=94)	23	29	42	
Age-adjusted RR	1.00	1.09 (0.74–1.60)	0.61 (0.42–0.88)	0.004	Age-adjusted RR	1.00	1.32 (0.77–2.29)	1.01 (0.61–1.69)	0.89
Multivariate RR1[a]	1.00	1.06 (0.72–1.57)	0.57 (0.38–0.83)	0.003	Multivariate RR1[a]	1.00	1.32 (0.76–2.30)	1.02 (0.60–1.75)	0.91
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No. of cases (*n*=101)	40	30	31		No. of cases (*n*=50)	10	15	25	
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Rectal cancer					Rectal cancer				
No. of cases (*n*=65)	15	21	29		No. of cases (*n*=44)	13	14	17	
Age-adjusted RR	1.00	1.68 (0.86–3.26)	1.11 (0.59–2.08)	0.94	Age-adjusted RR	1.00	1.17 (0.55–2.49)	0.75 (0.36–1.55)	0.38
Multivariate RR1[a]	1.00	1.75 (0.88–3.50)	1.07 (0.55–2.06)	0.94	Multivariate RR1[a]	1.00	1.18 (0.54–2.58)	0.82 (0.39–1.71)	0.55
Multivariate RR2[b]	1.00	2.12 (0.96–4.66)	1.21 (0.56–2.61)	0.86	Multivariate RR2[b]	1.00	1.28 (0.93–2.73)	0.71 (0.31–1.61)	0.35

[a]Multivariate RR1 has been adjusted for age (in years), cigarettes smoking (never, past, and currently smoking 1–19 cigarettes per day, or currently smoking 20 or more cigarettes per day), alcohol consumption (never, past, or current), body mass index in kg/m^2 (18.4 or lower, 18.5 to 24.9, or 25.0 or more), family history of colorectal cancer (presence or absence), education (in school less than 15, or 16 years or older), sports or exercise (almost never, 1–2 h/week, 3–4 h/week, 5 h or more per week), and consumption frequencies of meat, green or yellow vegetables and oranges (1–2 times per month or less often, 1–2 times per week, 3–4 times per week, almost daily). For women, we also included menopausal status (before menopause, after menopause).

[b]Multivariate RR2 are from a multivariable model that excluded colorectal cancer cases diagnosed with the first 2 years of follow-up. Values in parentheses are 95% confidence intervals.

図表掲載箇所	P406, Table2
概 要 (800字まで)	本研究は、日本のThe Miyagi Cohort Studyに参加した男女41,988名を対象に7年間の追跡調査を行い、歩行に費やす時間と結腸直腸がん発症リスクとの関連を検討したものである。質問紙により、過去1年間で1日当たり平均何時間歩行に費やしたかを尋ね、0.5時間/日未満、0.5-1時間/日、1時間/日以上の3群に分類した。1日当たり0.5時間未満の集団と比較すると、男性で1時間/日以上の集団で結腸直腸がん発症リスクが0.56(95%信頼区間:0.37-0.85)と有意に減少し、結腸がん発症リスクも、1時間/日以上の集団で0.38(0.22-0.64)と減少した。女性ではいずれも有意な減少はみられなかった。直腸がん発症リスクに関しては、男女共に有意な関連はみられなかった。
結 論 (200字まで)	今回の日本人コホートにおいては、男性でのみ、1日の歩行時間と結腸直腸がん発症リスクに負の相関がみられたが、女性ではそれらの関連はみられなかった。
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使用された研究である。男性において1日1時間の歩行時間と結腸直腸がん発症リスクに負の相関がみられたが、女性では見られなかった。我が国のコホートで得られた知見で意義深い。

担当者 久保絵里子・村上晴香・宮地元彦

PAPERS

Physical activity and stroke in British middle aged men

Goya Wannamethee, A G Shaper

Abstract

***Objectives*—To assess the relation between physical activity and stroke and to determine the overall benefit of physical activity for all major cardiovascular events.**

***Design*—Prospective study of a cohort of men followed up for 9·5 years.**

***Setting*—General practices in 24 towns in England, Wales, and Scotland (British regional heart study).**

***Subjects*—7735 men aged 40-59 at screening, selected at random from one general practice in each of 24 towns.**

***Main outcome measures*—Fatal and non-fatal strokes and heart attacks.**

***Results*—128 major strokes (fatal and non-fatal) occurred. Physical activity was inversely associated with risk of stroke independent of coronary risk factors, heavy drinking, and pre-existing ischaemic heart disease or stroke (relative risk 1·0 for inactivity, 0·6 moderate activity, and 0·3 vigorous activity; test for trend p=0·008). The association remained after excluding men reporting regular sporting (vigorous) activity. However, vigorous physical activity was associated with a marginally significant increased risk of heart attack compared with moderate or moderately vigorous activity in men with no pre-existing ischaemic heart disease or stroke (relative risk 1·6; 95% confidence interval 0·96 to 2·8). In men with symptomatic ischaemic heart disease or stroke those doing moderately vigorous or vigorous activity had a risk of heart attack slightly higher than that in inactive men (relative risk=1·6; 0·8 to 3·3).**

***Conclusions*—Moderate physical activity significantly reduces the risk of stroke and heart attacks in men both with and without pre-existing ischaemic heart disease. More vigorous activity did not confer any further protection. Moderate activity, such as frequent walking and recreational activity or weekly sporting activity, should be encouraged without restriction.**

Introduction

Physical activity is recognised to be beneficial for ischaemic heart disease and for mortality from cardiovascular disease in general.[1] We recently showed that moderate and moderately vigorous physical activity, even in the absence of sporting (vigorous) activity, is sufficient to produce a beneficial effect on ischaemic heart disease in middle aged British men.[2] The benefits of physical activity with respect to stroke are far less certain. The few studies that have examined this relationship specifically have mainly shown physical inactivity to be associated with an increased risk of stroke.[3-7] But how much physical activity is required to obtain benefit for stroke is unclear.

This paper examines the relation between physical activity and the risk of stroke in 7735 middle aged British men drawn from general practices in 24 British towns and representative of the socioeconomic distribution of middle aged men in Great Britain. We assessed the relation in men with and without evidence of ischaemic heart disease at initial screening. In addition we examined the relation between physical activity and total cardiovascular events (stroke and heart attack) to determine the levels of physical activity associated with maximum benefit and minimum risk.

Subjects and methods

The British regional heart study is a large prospective study of cardiovascular disease comprising 7735 men aged 40-59 selected from the age-sex registers of one group general practice in each of 24 towns in England, Wales, and Scotland. The criteria for selecting the town, the general practice, and the subjects as well as the methods of data collection have been reported.[8] Research nurses administered to each man a standard questionnaire that included questions on smoking habits, alcohol intake, physical activity, and medical history. Several physical measurements were made, and blood samples were taken for measuring biochemical and haematological variables. Details of smoking habits, alcohol intake, social class, blood pressure, and physical measurements have been reported.[2]

PRE-EXISTING ISCHAEMIC HEART DISEASE OR STROKE

The men were asked whether a doctor had ever told them that they had had angina or a myocardial infarction (heart attack, coronary thrombosis), a stroke, or several other disorders. The World Health Organisation (Rose) chest pain questionnaire for angina or possible myocardial infarction was administered to all men at the initial examination,[9] and a three-orthogonal lead electrocardiogram was recorded at rest and analysed by computer in the department of medical cardiology, Glasgow Royal Infirmary.

The men were separated into three groups according to the degree of evidence of ischaemic heart disease present at screening. (1) No evidence of ischaemic heart disease on WHO (Rose) chest pain questionnaire or electrocardiogram and no recall of a doctor diagnosing ischaemic heart disease (n=5767). (2) Asymptomatic ischaemic heart disease: those with electrocardiographic evidence of definite or possible myocardial ischaemia or myocardial infarction and who did not report any chest pain on WHO questionnaire or have recall of a doctor diagnosing ischaemic heart disease (n=777). (3) Symptomatic ischaemic heart disease: those with angina or a possible myocardial infarction on WHO chest pain questionnaire or who remembered a doctor diagnosing angina or heart attack (n=1165).

In some of the analyses those with recall of stroke (n=40) have also been included in the symptomatic group (see figure). In the subsequent analyses men in

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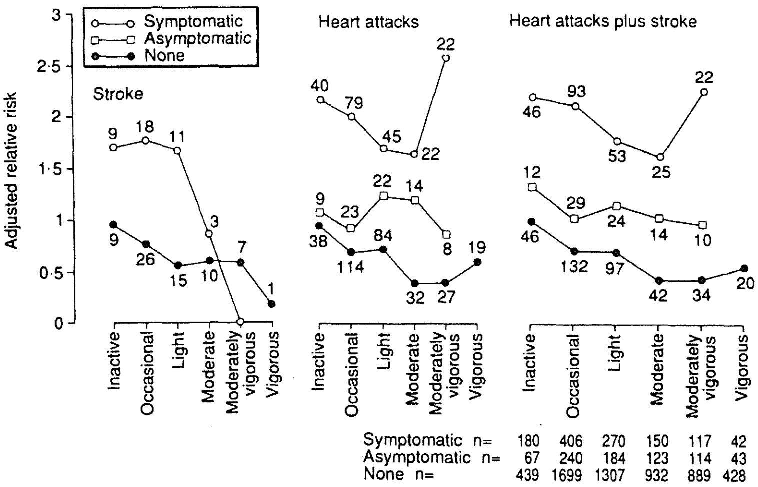

Adjusted relative risk of stroke and heart attack separately and both events combined in men with symptomatic ischaemic heart disease, asymptomatic ischaemic heart disease, and no evidence of heart disease according to physical activity. Relative risk is adjusted for age, social class, smoking, body mass index, and heavy drinking. Numbers of events are indicated on the figure

groups 2 and 3 were regarded as having pre-existing ischaemic heart disease or stroke.

PHYSICAL ACTIVITY

At screening the men were asked to indicate their usual pattern of physical activity under the headings of regular walking or cycling, recreational activity, and sporting (vigorous) activity. Regular walking and cycling related to weekday journeys, which included those to and from work. Recreational activity included gardening, walking for pleasure, and do it yourself jobs. Sporting activity included running, golf, swimming, tennis, sailing, and digging. A physical activity (exercise) score was derived for each man based on frequency and type (intensity) of the physical activity. Scores were assigned for each type of activity and duration based on the intensity and energy demands of the activities reported. This was based on the recommendations of a National Heart, Lung, and Blood Institute workshop[10] and the Minnesota intensity codes.[11] Full details of the derivation of the score have been described.[2] The total score is a measure of how much physical activity has been carried out or energy expended.

The men were grouped into six broad categories based on their total score. The categories were inactive (score 0-2; n=686); occasional activity (score 3-5; n=2345)—regular walking or recreational activity only; light activity (score 6-8; n=1761)—more frequent recreational activities or sporting exercise less than once a week; moderate activity (score 9-12; n=1205)—cycling or very frequent recreational activities or sporting activity once a week; moderately vigorous activity (score 13-20; n=1120)—sporting activity at least once a week or frequent cycling plus frequent recreational activities or walking or frequent sporting activity only; vigorous activity (score ≥21; n=513)—very frequent sporting exercise or frequent sporting exercise plus other recreational activities. The physical activity score has been validated by using heart rate and lung function in men with no evidence of ischaemic heart disease.[2]

FOLLOW UP

All men, whether or not they had evidence of ischaemic heart disease or stroke at initial examination, were followed up for mortality from all causes and morbidity from cardiovascular causes for 9·5 years.[12] Information on death was collected through the established "tagging" procedures provided by the NHS registers in Southport (England and Wales) and Edinburgh (Scotland). Non-fatal strokes were those which produced a neurological deficit that was present for more than 24 hours. Fatal episodes were those coded on the death certificate as ICD (ninth revision) 430-438. A non-fatal myocardial infarction was diagnosed according to WHO criteria.[13] Fatal events were defined as deaths in which ischaemic heart disease (ICD 410-414) was the underlying cause. The ascertainment of non-fatal events (heart attack, stroke) was based on continuous reporting by general practitioners, reinforced by a regular series of reviews of all patient records at one and a half, three, five, six and a half, eight, and nine and a half years.

STATISTICAL METHODS

Multiple logistic regression was used to obtain the rates adjusted for age and the relative risks adjusted for age, smoking, body mass index, social class, heavy drinking, and systolic blood pressure. Age, body mass index, and systolic blood pressure were fitted as continuous variables, physical activity as five dummy variables, smoking as four dummy variables (never smoked, former smoker, light smoker, moderate smoker, and heavy smoker), social class as two dummy variables (manual, non-manual, and armed forces). Tests for trend were assessed by assigning quantitative values 1-6 for the six groups of physical activity and fitting physical activity as a continuous variable rather than as five dummy variables. The physical activity index was consistently used on a group basis and not as a continuous score for individuals.

Results

Within the 9·5 year follow up there were 128 major stroke events, of which 33 were fatal and 95 non-fatal, and 612 major heart attacks, of which 293 were fatal and 319 non-fatal. The physical activity score was available for 7630 men. Data on physical activity were not provided by 10 men who had a heart attack.

PHYSICAL ACTIVITY AND STROKE

Table I shows the age adjusted rates/1000 men/year for stroke in all men. Relative risks adjusted for age are also shown. There was a strong inverse association between physical activity and risk of stroke even after adjusting for age ($p<0·0001$). In a recent report from

TABLE I—*Age adjusted rates of stroke according to physical activity*

	All men			Men with no ischaemic heart disease or stroke			Men with ischaemic heart disease or stroke		
Physical activity	No of men	No of strokes	Rate/1000/year (relative risk)	No of men	No of strokes	Rate/1000/year	No of men	No of strokes	Rate/1000/year
Inactive	686	21	3·1 (1·0)	439	9	2·2	247	12	4·7
Occasional	2345	52	2·3 (0·7)	1699	26	1·6	646	26	4·2
Light	1761	29	1·7 (0·5)	1307	15	1·2	454	14	3·3
Moderate	1205	15	1·4 (0·4)	932	10	1·2	273	5	2·1
Moderately vigorous	1120	9	1·0 (0·3)	889	7	0·9	231	2	1·2
Vigorous	513	2	0·5 (0·2)	428	1	0·3	85	1	1·4

the British regional heart study, physical activity was shown to be strongly (inversely) associated with social class, smoking, heavy drinking, body weight, and blood pressure,[2] factors known to be associated with the risk of stroke. Since blood pressure may be a mediating factor we examined the relation between physical activity and stroke adjusting first for age, social class, smoking, heavy drinking, and body mass index (table II). Even after adjustment for these factors there was a significant inverse association between physical activity and risk of stroke (p=0·001). Further adjustment for systolic blood pressure reduced the trend only slightly, and the association remained significant (p=0·003). Moderate and moderately vigorous levels of activity were associated with a 50% reduction in the risk of stroke, and the benefit from vigorous activity was even greater. Since the presence and severity of ischaemic heart disease is strongly associated with physical activity, we also adjusted for prevalence of pre-existing ischaemic heart disease or stroke. This further adjustment made little difference to the strong association seen and the trend remained significant (p=0·008) (table II).

PHYSICAL ACTIVITY AND PRE-EXISTING ISCHAEMIC HEART DISEASE OR STROKE

Table I shows the age adjusted rates for men with and without evidence of ischaemic heart disease or stroke. There was a significant inverse relation between physical activity and stroke in men with and without evidence of ischaemic heart disease or stroke (p=0·01 and p=0·007 respectively). Table II shows the relative risk of stroke in these two groups adjusted for age, social class, smoking, heavy drinking, and body mass index and then in addition for systolic blood pressure. After the initial adjustment the relation was similar in the two groups, although the trend was more consistent in those with ischaemic heart disease or stroke. The most vigorously active men in both groups showed more than a 60% reduction in risk of stroke. Moderate levels of physical activity were associated with a 40% reduction in those without evidence of ischaemic heart disease and a 50% reduction in those with evidence. A test for trend gave significant results in those with ischaemic heart disease or stroke (b=−0·26, p=0·02) and marginally significant results in those without ischaemic heart disease or stroke (b=−0·17, p=0·06), where b is the logistic regression coefficient fitting the six physical activity index groups continuously (that is, magnitude of the trend). Further adjustment for systolic blood pressure reduced the trend slightly (b=−0·25 and b=−0·16, respectively).

TABLE II—*Relative risk (95% confidence interval) of stroke in all men and in men with and without evidence of ischaemic heart disease*

	All men (n=7630 (128 strokes))			Men with no evidence of ischaemic heart disease (n=5694 (68 strokes))		Men with evidence of ischaemic heart disease (n=1936 (60 strokes))	
Physical activity	A	B	C	A	B	A	B
Inactive	1·0	1·0	1·0	1·0	1·0	1·0	1·0
Occasional	0·8 (0·5 to 1·4)	0·8	0·8	0·8 (0·4 to 1·7)	0·8	1·0 (0·4 to 1·8)	0·9
Light	0·6 (0·3 to 1·1)	0·6	0·6	0·6 (0·2 to 1·3)	0·6	0·7 (0·3 to 1·7)	0·7
Moderate	0·5 (0·3 to 1·0)	0·5	0·6	0·6 (0·2 to 1·5)	0·7	0·5 (0·2 to 1·4)	0·5
Moderately vigorous	0·4 (0·2 to 1·0)	0·5	0·5	0·6 (0·2 to 1·6)	0·7	0·3 (0·1 to 1·5)	0·3
Vigorous	0·2 (0·1 to 0·9)	0·2	0·3	0·2 (0·0 to 1·5)	0·2	0·3 (0·1 to 3·0)	0·4
Test for trend	p=0·001	p=0·003	p=0·008	p=0·06	p=0·1	p=0·02	p=0·04

A=Adjusted for age, social class, smoking, heavy drinking, and body mass index.
B=Adjusted for the factors in A plus systolic blood pressure.
C=Adjusted for the factors in A and B plus prevalence of ischaemic heart disease or stroke.

TABLE III—*Relative risk of stroke adjusted for age, social class, smoking, body mass index, and heavy drinking and excluding men reporting sporting activity at least once a month*

	Men with no ischaemic heart disease or stroke			Men with ischaemic heart disease or stroke		
Physical activity	No of men	No of strokes	Relative risk	No of men	No of strokes	Relative risk
Inactive	439	9	1·0	247	12	1·0
Occasional	1678	26	0·82	640	26	0·90
Light	1210	15	0·63	434	14	0·75
Moderate	587	5	0·47	189	5	0·67
Moderately vigorous	92	1	0·53			

IS SPORTING ACTIVITY ESSENTIAL FOR REDUCING STROKE?

We recently showed that sporting (vigorous) activity, although beneficial, was not essential to reduce the risk of heart attack.[2] We therefore examined the relation with stroke separately in men with and without ischaemic heart disease or stroke, excluding men reporting sporting activities at least once a month (n=2091). After this exclusion, the number of men with pre-existing disease in the moderately vigorous and vigorous groups was very small (n=25) and these men have not been included in table III. A clear inverse trend in those with no evidence of ischaemic heart disease or stroke was evident even after adjustment for age, social class, body weight, and heavy drinking. However, this trend was not significant at the 5% level, presumably because of small numbers (b=−0·23, p=0·15). In men with ischaemic heart disease or stroke the inverse trend was present but less clear (b=−0·16, p=0·30) than it was before exclusion of men reporting sporting activities.

STROKE OR HEART ATTACKS

Although our findings indicate a clear benefit for risk of stroke from increasing levels of physical activity in men with and without ischaemic heart disease or stroke, we recently showed that the relation between physical activity and the risk of heart attack differs in men with and without ischaemic heart disease.[2] The figure shows the relation between physical activity and heart attack, stroke, and both events combined in order to assess the overall benefit of physical activity for risk of a stroke or heart attack. Data for 9·5 years' follow up in all men are presented adjusted for age, social class, smoking, body mass index, and heavy drinking. Because of the small number of men with asymptomatic and symptomatic ischaemic heart disease in the vigorous activity group (n=43 and n=42 respectively) these men, seven of whom had a heart attack, have been omitted from the analysis. As there were only 19 cases of stroke in men with asymptomatic ischaemic heart disease these data have not been presented.

Heart attack—In men without pre-existing ischaemic heart attack or stroke, the risk of heart attacks decreased significantly with increasing activity up to moderate and moderately vigorous levels (p<0·001) but then increased for vigorous activity. The increased risk in the vigorously active group compared with the moderate and moderately vigorous groups (relative risk=1·6; 95% confidence interval 0·96 to 2·8) was marginally significant (p=0·07). Compared with inactive men, men doing moderate and moderately vigorous activity had about a 60% reduction in risk (0·42; 0·3 to 0·7 for moderate activity and 0·44; 0·3 to 0·7 for moderately vigorous activity). In men with symptomatic ischaemic heart disease or stroke, the risk decreased progressively, but not significantly, up to levels of moderate activity, but men engaged in moderately vigorous activity had an increased risk compared with moderately active men (1·6; 0·8 to 3·3 (p=0·1)). No clear pattern was seen in men with asymptomatic ischaemic heart disease.

Stroke—A progressive lowering of risk was seen with increasing levels of physical activity in men with and without pre-existing ischaemic heart disease or stroke.

Heart attack or stroke—When the overall risk of experiencing either a heart attack or a stroke was examined (figure) in men with no evidence of ischaemic heart disease or stroke, risk decreased significantly with increasing activity up to moderate and moderately vigorous levels ($p<0.001$) and thereafter showed a slight but non-significant increase. Men with moderate and moderately vigorous activity had over a 50% reduction in overall risk of a cardiovascular event compared with inactive men (0·44; 0·3 to 0·7 for moderate activity and 0·45; 0·3 to 0·7 for moderately vigorous activity). In men with asymptomatic ischaemic heart disease physical inactivity was associated with the highest risk but thereafter there was little difference in risk between physical activity groups. In men with symptomatic ischaemic heart disease or stroke the lowest risk of an event was seen in the moderate activity group. Compared with moderately active men those engaged in moderately vigorous activity had an increased risk of an event (1·3; 0·4 to 2·6 ($p=0.15$)).

Discussion

In this study of middle aged British men physical activity showed a strong inverse association with risk of stroke independent of age, social class, smoking, heavy drinking, systolic blood pressure, and pre-existing ischaemic heart disease or stroke. Although physical activity is associated with lowering of systolic blood pressure,[2] this accounted for little of the lower risk seen. The inverse relation was seen for men with and without evidence of ischaemic heart disease.

PREVIOUS STUDIES

In a study of former Harvard students (all male) participation in college sports was associated with a 60% reduction in risk of fatal stroke 10-50 years (average 30 years) later.[3] No adjustments were made for other risk factors and continued physical activity was not accounted for. In a later study of these students[5] men free of diagnosed coronary heart disease at age 35-74 years reported their regular physical activity and were then followed for an average of 14 years. A strong inverse association was found between reported exercise levels and death from stroke and coronary heart disease. The exercise benefit was twice as strong for stroke as for coronary heart disease. It was independent of other risk factors, and sporting participation in student days carried little or no benefit in later years.

In the Framingham study analysis based on a 14 year follow up showed an inverse relation between physical activity and risk of stroke, but the trend was not significant after adjustment for age.[14] The classification of physical activity was very broad and included leisure time and occupational activity. Annual assessment of job activity in 3886 San Francisco longshoremen for 22 years showed that those with lower energy expenditure had a 62% increase in risk of stroke compared with those with higher energy expenditure after adjusting for age, smoking, and blood pressure, but the difference was not significant. In a Dutch case-control study of survivors of stroke aged 40-74 admitted to hospital and hospital based controls, subjects were categorised according to their leisure time physical activity during the greatest portion of life as little, light, or heavy. Those engaged in heavy levels of physical activity showed a significant 60% reduction in risk of stroke compared with people engaged in little physical activity.[6] Other risk factors were not adjusted for. In a random sample of men and women aged 30-59 years from two counties in eastern Finland, men and women with low physical activity at work had, respectively, a 60% and 70% increase in risk of stroke compared with those with high activity after adjusting for cardiovascular risk factors.[7] Leisure time activity was not related to risk of stroke.

The size of the reduction in risk of stroke associated with physical activity seen in these studies is similar to that in our study when all men were included.

VIGOROUS SPORTING ACTIVITY

We have previously shown that regular sporting (vigorous) activity, though beneficial in its own right, is not essential to produce a beneficial effect on heart attacks.[2] This also seemed to be true for stroke, and an inverse association was still seen in men both with and without pre-existing ischaemic heart disease or stroke after excluding those reporting regular sporting activity.

OVERALL EFFECT ON STROKE AND HEART ATTACKS

We observed that compared with moderate activity vigorous physical activity in men with no evidence of ischaemic heart disease or stroke and moderately vigorous activity in those with symptomatic ischaemic heart disease or stroke were associated with an increased risk of heart attacks. We could not determine whether the reduction in the number of strokes at high levels of physical activity was a direct effect of physical activity or whether it was due to competing causes. If men who are vigorously active have higher rates of heart attack, and have attacks at a younger age than is seen for stroke, then there will be fewer susceptible men at risk of stroke. However, the consistent dose response relation for stroke in men with and without ischaemic heart disease or stroke suggests that the reduction in risk of stroke is directly associated with physical activity. In men with no evidence of ischaemic heart disease or stroke, since moderate and moderately vigorous levels of activity were associated with the lowest rates of stroke and heart attacks the lower rates of stroke seen in these men are unlikely to be due to competing causes.

Since heart attacks are over four times more common than strokes the benefits of reduction in stroke at vigorous levels of physical activity must be considered in the light of the overall risk of having either a heart attack or a stroke. In all men, irrespective of the nature of pre-existing ischaemic heart disease or stroke, physical inactivity was associated with the highest risk of having a stroke or heart attack, with risk falling with increasing activity up to moderate or moderately vigorous levels (figure). In men with no ischaemic heart disease or stroke, moderate and moderately vigorous levels of physical activity were associated with over a 50% reduction. Above this level risk increased slightly, but was still lower than that for inactivity, occasional activity, and even light activity because of the marked reduction in stroke attacks. In men with symptomatic ischaemic heart disease or stroke overall benefit was not apparent in those undertaking moderately vigorous activity despite the overwhelming reduction in stroke.

The high risk of heart attacks in the inactive men with symptomatic ischaemic heart disease or stroke may partly be attributed to the fact that these men have more severe symptoms and are therefore unable to undertake physical activity. Several prospective studies have examined the relation between physical activity and overall mortality from cardiovascular causes and have found a progressive decrease in risk of death from cardiovascular disease with increasing physical activity. However, the highest category of physical activity in these studies tends to be fairly broad in definition and vigorously active subjects have not always been clearly separated.[14,15] In addition, men with clinical evidence of ischaemic heart disease have been excluded—that is, the men in whom vigorous levels of activity seemed to have the most adverse effects. Slattery *et al* found that those who did intense (sporting) activity did not show any more benefit in overall mortality from cardiovascular causes than those who did frequent light or moderate activities but no intense activity.[15]

CONCLUSIONS

Moderate levels of physical activity, such as frequent regular walking plus recreational activity or sporting activity once a week, seem to be sufficient to produce a significant beneficial effect on cardiovascular risk in men both with and without evidence of ischaemic heart disease or stroke. More vigorous activity does not seem to confer any further protection and frequent sporting (vigorous) activity may be associated with an increased risk of heart attack, especially in those with symptomatic evidence of ischaemic heart disease or stroke. Such men who are contemplating or involved in regular vigorous activity should discuss their programme with an appropriate doctor. It seems reasonable, however, to recommend widespread and unrestricted participation in moderate levels of physical activity. Moderate activity is readily attainable by large sections of the population and requires no special facilities.

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Randomised clinical trial of manipulative therapy and physiotherapy for persistent back and neck complaints: results of one year follow up

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Abstract

***Objective*—To compare the effectiveness of manipulative therapy, physiotherapy, treatment by the general practitioner, and placebo therapy in patients with persistent non-specific back and neck complaints.**

***Design*—Randomised clinical trial.**

***Setting*—Primary health care in the Netherlands.**

***Patients*—256 patients with non-specific back and neck complaints of at least six weeks' duration who had not received physiotherapy or manipulative therapy in the past two years.**

***Interventions*—At the discretion of the manipulative therapists, physiotherapists, and general practitioners. Physiotherapy consisted of exercises, massage, and physical therapy (heat, electrotherapy, ultrasound, shortwave diathermy). Manipulative therapy consisted of manipulation and mobilisation of the spine. Treatment by general practitioners consisted of drugs (for example, analgesics), advice about posture, home exercises, and (bed)rest. Placebo treatment consisted of detuned shortwave diathermy (10 minutes) and detuned ultrasound (10 minutes).**

***Main outcome measures*—Changes in severity of the main complaint and limitation of physical functioning measured on 10 point scales by a blinded research assistant and global perceived effect measured on a 6 point scale by the patients.**

***Results*—Many patients in the general practitioner and placebo groups received other treatment during follow up. Improvement in the main complaint was larger with manipulative therapy (4·5) than with physiotherapy (3·8) after 12 months' follow up (difference 0·9; 95% confidence interval 0·1 to 1·7). Manipulative therapy also gave larger improvements in physical functioning (difference 0·6; −0·1 to 1·3). The global perceived effect after six and 12 months' follow up was similar for both treatments.**

***Conclusions*—Manipulative therapy and physiotherapy are better than general practitioner and placebo treatment. Furthermore, manipulative therapy is slightly better than physiotherapy after 12 months.**

Introduction

In most cases of back pain and neck pain no underlying disease can be established and the causes of the complaints remain unknown.[1,2] Fortunately, most patients with acute complaints recover within a few weeks, often with the help of (bed)rest, analgesics, and advice about posture and exercises.[3] The complaints disappear within a few months in about 90% of the cases,[2,4,5] although the recurrence rate is high.[1] When the complaints persist there are several options for treatment. General practitioners in the Netherlands often refer patients with persisting complaints for physiotherapy or, less commonly, for manipulative therapy.

Physiotherapists usually give exercise therapy, alone or in combination with other treatments—for example,

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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	40-59歳			( )		前向き研究
	対象数	5000～10000	空白		( )		( )
調査の方法	質問紙	( )					
アウトカム	予 防	脳血管障害予防	な し	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)	本調査の目的は身体的活動と脳卒中との関係と, すべての主要な心血管疾患に対する身体的活動の効果を検討することである。 男性を対象に9.5年間、追跡調査を行った。対象者はイングランド, ウェールズ、スコットランド(イギリス地域心臓研究)の24の町の住民である。24の町で1回一般診療を受けたことがある男性から無作為に抽出した7,735人(40-59歳)を対象とした。 128例の脳卒中(致命的、非致命的)が起こった。身体活動が多いことは、冠状動脈疾患危険因子である。多量の飲酒, 虚血性心疾患または脳卒中の既往と独立して脳卒中のリスクを減少した(不活動での相対危険度は 1. 0、中強度の活動での相対危険度は 0. 3, 強度な活動での相対危険度は1. 0; p=0.008)。この関係は定期的なスポーツ(強度)活動を行っている男性を除いた後にも変わらなかった。しかしながら, 強度の身体活動は虚血性心疾患や脳卒中の既往がなく、中強度またはやや強度な活動を行っている男性に比べて心臓発作発生のリスクがやや有意に認められた。不活発な男性の心臓発作のリスクより症候性虚血性心疾患、または脳卒中があって中強度または強度な活動をする男性では、わずかに高かった(相対危険度 1. 6;0.8—3.3)。
結 論 (200字まで)	虚血性心疾患の既往の有無にかかわらず、適度な運動は男性の脳卒中と心臓発作のリスクを有意に減少させる。より強度な活動はさらなる効果は与えなかった。頻繁な歩きや余暇活動、または毎週のスポーツ活動などの適度の活動は制限なく奨励されるべきである。
エキスパートによるコメント (200字まで)	身体活動の予防的効果を既往との関係で示し、又、過度の活動のリスクについても示した。

担当者 呉泰雄　髙田和子

2. 18 歳以上における運動量の
基準値策定に用いた文献

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Influence of Physical Activity on Depression and Anxiety of Former Elite Athletes

Abstract

The purpose of this study was to investigate the influence of physical activity and other factors on the mood of former elite male athletes and controls of middle and old age. The subjects were 664 former athletes and 500 controls who answered questionnaires in 1985 and 1995. The dependent variables depressive and anxiety symptoms were assessed by the shortened anxiety and depression scales of the BSI-53. Logistic regression was used for longitudinal as well as cross-sectional analyses to estimate odds ratios for symptoms of depression and anxiety in relation to leisure physical activity adjusted for age in 1995, sports group, personality characteristics, alcohol use, smoking, marital status, life events and socio-economic status. In the longitudinal analysis, low levels of physical activity as well as neuroticism, dissatisfaction, marital status, life events and social class in 1985 increased the risk of depression in 1995. Also physical activity has a protective effect against depressiveness; an increase of one MET-unit (hour/day) statistically significantly decreased the risk of depressiveness by 8%. In the longitudinal analysis, physical activity had no significant association with anxiety. Cross-sectional analysis for depressive symptoms in 1995, but not for anxiety found associations with sports group and physical activity as well as alcohol use and marital status. Very high physical activity has a significant protective effect against depression.

Key words
Anxiety · athlete · cohort study · depression · mood · physical activity

Introduction

Psychological well-being can turn into a state of dynamic instability if the individual cannot control changing conditions and prerequisites of external and internal stress and strain factors. Often it is loss of psychological equilibrium that introduces psychological symptoms e.g. in the form of depression and anxiety. Depression and anxiety are relatively common mental disorders. In most developed countries, the estimated prevalence of short-term anxiety disorders 2–9% [3,35,36,51] and clinically recognized depression affects 5–10% of the population [47,60].

The effects of physical exercise and activity on mood are mediated by physiological, psychological and social factors. These three factors constitute an indivisible entity that is subject to direct and indirect effects of physical exercise. In their critical review, Folkinsin and Simen [14] examine physiological, psychological and cognitive explanatory models, theories and viewpoints. One can make the general observation that physical exercise is largely a kind of psychologically regulated behaviour. The main psychologically stabilising effect of physical exercise is probably the capacity of physical exercise to introduce a largely pleasant emotional experience. Physical exercise also has many effects on e.g. the chemical functioning of the brain, and via mediating substances, also on psychological experiences, functions and social interplay. Therefore it is difficult to clearly categorise the

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effects of physical exercise. Physical exercise offers many kinds of feelings, experiences and identification objects for people. Irrespective of physical talent and activity, all people have an equal right to enjoy and feel successful about physical exercise. Feelings of success resulting from physical exercise contribute to our self-control and self-knowledge. Many feelings and experiences of success resulting from sports help us tolerate and cope with diverse failure-related feelings and situations. Physical exercise probably contributes to a feeling of life control. Feelings of success in sports and attaining self-imposed goals also advance psychological well-being. A person who feels well usually finds his life meaningful and his mood positive.

This study is based on a psychophysiological explanatory model. According to Pulkkinen [57], emotive regulation helps sustain internal stimulation within controllable and function-optimising limits. Pulkkinen's model should also help show the connection of poor self-control to the individual's inability to sufficiently control all variable external and internal stress factors. This may introduce or even increase psychological symptoms, e.g. as anxiety and depression. The model has been useful in explaining emotion regulation of people with physical symptoms [57]. Emotions also have a clear psychophysiological component because strong emotions always co-occur with an increase in physiological activation level.

In studies of physical exercise, activity and mood, more attention could be spent on the fact that in the background of depressiveness and anxiety, there may be factors related to physical activity, personality, life style, family relations, socioeconomic status and life events that influence the results of the study. For instance, several studies suggest that stressful, safety-threatening episodes contribute to anxiety and depression [12,20,48]. As far as athletes are concerned, one should note that also sports injuries and their severity can affect mood. Weise-Bjornstal [62] introduce the study by Smith et al. that reported less mood disturbance in the two groups of injured athletes with mild and moderately serious injuries than is apparent in non-injured college norms. These athletes had more positive mood state profiles even when injured than the average college aged young adults person. Only athletes with serious injuries experienced significant mood disturbance.

Many sports and mood related studies are generally based on a physiological or psychological explanatory model, with a wide range of study designs from experimental to quasi-experimental to nonexperimental. Many studies have analysed the associations between physical exercise and depression [11,47,55,61], and anxiety [41,42,49,55], and this research has indicated that physical exercise has generally positive effects on people's spirits. This is found both in the clinically and non-clinically depressive/anxiety groups [4,37,38]. Aerobic exercise, in particular seems to decreases depression and anxiety [19,32,49], but also non-aerobic exercise has been found to be effective [37,38]. The most positive effects of exercise on people's mental health have been seen among those who persist in their training programme for several months [45,55]. Most studies on physical exercise and mental health have examined the connections between physical exercise and mood in middle and old age [6,39,40,46,53]. It has thus become generally accepted that regular physical activity reduces feelings of depression and anxiety, and promotes physical well-being [50]. However, the duration of the positive effect on mood is not well-known, and there are few studies on the long-term effects on mood of vigorous physical activity in adolescence and as young adults. Furthermore, it is not known if the type of physical activity has any long-term influence. Previous descriptive studies of depression and anxiety among different forms of sport are rare [5,44].

The purpose of this investigation was to study physical activity and mood in a cohort of former elite male athletes representing different sports and controls of middle and old age. Also, the purpose of this study was to determine the important factors modulating the relationship of physical activity with depression and anxiety.

Material and Methods

Subjects

A detailed description of the study subjects has been reported previously [5]. In brief, the subjects consisted of male athletes who represented Finland in selected sports at least once in the Olympic games, World or European championships or intercountry competitions between 1920–1965 [54]. Controls were selected from Finnish men who had been classified as completely healthy (military class A1, fully fit for ordinary military service) at 20 years of age at the medical examination preceding their conscription [54]. The controls were matched by birth cohort and area of residence with the athletes [54]. The original cohort comprised of 2448 athletes and 1712 controls. In 1985, the subjects responded to a questionnaire, which was repeated in 1995, with a fairly similar questionnaire. In 1985 the response rate was 80–90% for athletes and 77% for controls. In the 1995 study there were 1336 replies, with a response rate between 70% and 80% for the athletes and 71% for controls. In the present study we included those 1164 participants who answered both questionnaires.

Occupational data were collected partly from the Central Population Registry of Finland and partly from the questionnaires in 1985 and 1995. Classification into occupational group was based on the 4-digit code of occupation in official use in Finland since 1972 [7]. Occupational groups were classified into the following main categories: executives, clerical workers, skilled workers, unskilled workers and farmers [54]. The occupation of each person was classified according to the work he had been engaged longest during his lifetime.

Measurements

Mood in 1995

Depression and anxiety were the main outcome measures and were assessed using 12 items from the BSI-53 (Brief Symptom Inventory) [8,30]. We used two partial scales of the short stress symptom survey (37 different stress symptoms) as scale of anxiety and depressiveness. The response alternatives (never, seldom, sometimes, often, very often) were scored 0 to 4, with sum scores ranging from 0–24. The short stress symptom survey is based on the more extensive BSI-53 symptom survey. The BSI-53 is a shorter version of the widely used SCL-90 (Symptom

Check List) [8,30].The reliability of SCL-90 and BSI-53 is good and the correlation to the corresponding structures of the MMPI is 0.35 to 0.55 [8,30].

There are nine partial scales in the BSI-53 symptom survey; these are supposed to measure distinct symptom dimensions or structures. In the BSI-53, depression reflects a broad range of signs and symptoms of the clinical depression, but primarily a tendency towards depression. In our study anxiety was defined as symptoms that manifest themselves as restlessness, nervousness and stress. The shortened scales of the BSI-53 were used in Finland by Kronholm [30], too, who stated that the sum points of the short stress symptom survey and of Beck's depression survey correlate with each other. In his study, the correlation was 0.67. A detailed presentation on the scales, correlation coefficients of scale items and total score distributions have earlier been described in detail [5]. Cronbach's alpha was 0.84 for the six-item anxiety scale and 0.86 for the six-item depression scale.

Personality characteristics in 1985

Extroversion and neuroticism were measured using items from the abbreviated Eysenck's Personality Inventory (EPI) [13]. This short form has been frequently used [28,56,58]. Cronbach's alpha was 0.73 for both the nine-item extroversion scale and the ten-item neuroticism scale.

Life satisfaction was measured by a scale with four questions [27], which contains the items "interestingness of life", "life happiness", "life easiness" and "loneliness". A high value indicates a decrease in life satisfaction. The life satisfaction scale has been associated with health, health behaviour and personality features [25–27]. It has proved to be closely related to the 21-item Beck Depression Inventory [25]. The correlation between these two measurements has been found to range from 0.61 to 0.88 [25]. Cronbach's alpha was 0.74.

Hostility was measured by a scale with three questions [29], which contains the items "quarrelsomeness", "irritability" and "anger". This scale is predictive of CHD outcomes [29]. The reliability of hostility scale has been shown to be good with an alpha of 0.77.

Lifestyle variables in 1985 and 1995

Assessment of physical activity was based on computing MET values. We calculated an activity metabolic (MET) index by assigning a multiple of resting metabolic rate (MET score) to each activity and by calculating the product of intensity × duration × frequency of activity [63] using responses to three questions on the type of activity, the mean duration of each physical activity episode, and the frequency per month of such episodes. In this calculation we used the following MET values (metabolic equivalents calculated as the work metabolic rate divided by the resting metabolic rate): 4 for exercise intensity corresponding to walking, 6 for vigorous walking to jogging, 10 for jogging and 13 for running. The activity MET index was expressed as the score of MET hours per day. The subjects were classified into five quintiles.

Use of alcohol was recorded in beverage-type (beer, wine, spirits) specific items on frequency and quantity and then converted into grams of ethanol, to give the monthly consumption of pure alcohol [52]. The subjects were classified into abstainers (0 g/day), occasional users (1–10 g/day), moderate users (11–29 g/day) and heavy users (≥30 g/day).

The smoking status of the subjects was based on their detailed smoking history [22]: the respondents were classified as never smoked, ex-smokers or currently smokers ≥1 cigarettes/day.

Life events in 1985

Assessment of life events based on stressful life events [18] questionnaire in 1985. Social and interpersonal incidents involving different aspects of life were asked: death of a spouse, death of a friend, poor health of family member, sexual problems, divorce or legal separation, problems in other human relationships, considerable interpersonal conflicts at work, loss of a job, serious financial problems, personal health problems, substantial conflicts with their spouse, or any other serious problems. The response alternatives (never, during the last 6 months, during the last 5 years, or earlier) were scored 0, 3, 2, 1 to weight the most recent life events (during the last 6 months). As a scale of life events, 21 different propositions have been used. A sum score of life events was calculated. Cronbach's alpha was 0.66.

Statistical analysis

Two types of data analysis were done. The main aim of the first analysis was to assess the relationship between self-reported physical activity in 1985 and in 1995 and self-reported mood in 1995, to determine the importance of longitudinal changes in the physical activity on depression and anxiety among elite male athletes and non-athletes in their middle and old age. Secondly, we examined using a cross-sectional analysis the association between self-reported mood, physical activity and sport group in 1995. The statistical processing was done on version 11.0 of the SPSS for Windows (SPSS Inc., Chicago, IL, U.S.A.). The statistical significance in differences between categorical variables were tested by Chi-square tests, and differences in continuous variables were tested by the independent sample *t*-test (Table **1**).

The dependent variables in the logistic model of the study are depressiveness and anxiety. We included the following independent variables into the model: age and physical activity (baseline physical activity 1985), personality characteristics, life style (changes of physical activity 1995–1985), life events, and socioeconomic status. We introduced into the model five separate blocks of different parts, all forced in the model. The highest decile of the outcome variable was considered as "positive outcome" (depression score ≥8, or anxiety score ≥7), with the remaining 90% classified as not affected. The four personality scales were standardised in the model in order to make the comparison easier. All the variables, and their classifications used in the regression analysis have been described in Table **2**.

Table **1** Characteristics of former athletes and referents participating in questionnaire surveys in 1985 and 1995

	Athletes (N = 664)		*Controls (N = 500)*		*P for group difference*
Characteristic	1985	1995	1985	1995	
Age mean (SD), years		64.6 (9.2)		62.0 (8.2)	
Mood mean (SE)					1) p-value
Depression (Range 0–24)		2.69 (0.14)		3.57 (0.19)	< 0.001
Anxiety (0–24)		2.66 (0.11)		3.17 (0.16)	0.010
Personality characteristics mean (SE)					1) p-value
Extroversion (Range 0–9)	4.54 (0.10)		3.96 (0.11)		< 0.001
Neuroticism (0–10)	3.75 (0.09)		4.33 (0.11)		< 0.001
Life satisfaction (4–20)	7.94 (0.10)		8.59 (0.12)		< 0.001
Hostility (3–15)	7.13 (0.11)		7.36 (0.14)		0.192
Life style					2) p-value -85
*MET index quintile, MET h/day (%)					< 0.001
Quintile I (< 0.39, < 0.41 MET h/day)	12.1	15,8	30.1	29.6	2) p-value -95
Quintile II (0.40–1.32, 0.42–1.60)	19,5	18.3	29.3	20.8	< 0.001
Quintile III (1.33–2.78, 1.61–3.99)	17.7	26.5	15.8	29.4	
Quintile IV (2.79–6.42, 4.00–6.42)	24,3	12.7	12.9	7.0	
Quintile V (> 6.43, > 6.43)	26.4	26.8	11.9	13.2	
MET mean (SE)	4.50 (0.19)	4.20 (0.18)	2.24 (0.15)	2.43 (0.14)	1) p-value -85
					< 0.001
					1) p-value -95
					< 0.001
Use of alcohol, g/day (%)					2) p-value -85
Abstainers (0 g/day)	8.2	10.2	10.6	12.0	0.341
Occasional users (1–10 g/day)	56.7	52.8	58.5	52.6	2) p-value -95
Moderate users (11–29 g/day)	22.6	21.5	19.5	19.5	0.694
Heavy users (>30 g/day)	12.4	15.5	11.4	15.9	
Alcohol consumption mean (SE)	13.7 (0.68)	14.6 (0.72)	12.8 (0.79)	14.8 (0.89)	1) p-value -85
					0.377
					1) p-value -95
					0.891
Cigarette smoking (%)					2) p-value -85
Never smokers	49.7	50.9	30.6	31.0	< 0.001
Ex-smokers	31.5	34.7	40.6	45.0	2) p-value -95
Current smokers	18.8	14.4	28.8	24.0	< 0.001
Marital status					2) p-value -85
Unmarried (unmarried, divorced, widdow)	11.4	16.2	13.8	18.0	0.224
Married (married, remarried, cohabiting)	88.6	83.8	86.2	82.0	2) p-value -95
					0.400
Life events mean (SE)					1) p-value
Life events (Range 0–60)	8.91 (0.21)		8.86 (0.25)		0.892
Socioeconomic status (%)					2) p-value
Executives	21.9		12.8		< 0.001
Clerical workers	41.5		28.2		
Skilled workers	30.2		42.6		
Unskilled workers	2.0		3.8		
Farmers	4.4		12.6		

*Metabolic equivalent (MET) index was calculated by assigning a multiple of resting metabolic rate to each activity and calculating the product of intensity × duration × frequency.
1) p-value by t-test (2-tailed).
2) p-value by Chi-Square tests or Pearson Chi-Square Asymp. (2-sided).

Table **2** Description of variables

Variable	*Description*
Age -95	Continuous from 46 to 92
Sports	Six groups: 1 = endurance sports, 2 = power sports/combat, 3 = power sports/individual, 4 = team sports, 5 = shooting, 6 = controls; reference group 6
Mood	
Depression	Two groups: 0 = no depressive, score* < 7.99, 1 = depressive, score* > 8
Anxiety	Two groups: 0 = no anxious, score* < 6.99, 1 = anxious, score* > 7
Personality characteristics	
Extroversion	Continuous from 0 to 9 – standardized mean and variance
Neuroticism	Continuous from 0 to 10 – standardized mean and variance
Life satisfaction	Continuous from 4 to 20 – standardized mean and variance
Hostility	*Continuous from 3 to 15 – standardized mean and variance*
Life style	
MET -85, -95	Quintile I – V: described in detail table 1.; referents quintile V
MET 95 – 85	Changes of MET value 95 – 85 (h/day)
Alcohol -85, -95	Four groups: 0 = abstainers, 1 = occassional users, 2 = moderate users, 3 = heavy users; reference group 0
Alcohol 95 – 85	Changes of alcohol concumption 95 – 85 (g/day)
Smoke -85, -95	Three groups: 0 = never, 1 = ex-smokers, 2 = current smokers; reference group 0
Smoke 95 – 85	Three groups: 0 = same status in 1995 and 1985, 1 = changed status (never or currents smokers in 1985 but ex-smokers in 1995), 2 = changed status (never or ex-smokers in 1985 but current smokers in 1995)
Marital status -85, -95	Two groups: 0 = unmarried, divorced or widow, 1 = married, remarried or cohabiting
Marital status 95 – 85	Three groups: 0 = same status in 1995 and 1985, 1 = changed status (unmarried, divorced or widow in 1985 but married, remarried or cohabiting in 1995), 2 = changed status (married, remarried or cohabiting in 1985 but unmarried, divorced or widow in 1995)
Life events	Continuous from 0 to 60
Sosioeconomic status	Five groups: 1 = executive, 2 = clerical workers, 3 = skilled workers, 4 = unskilled workers, 5 = farmers; reference group 2

*The shortened anxiety and depression scales of the BSI-53.

Results

Longitudinal analysis (Tables 3 and 4)

In a longitudinal analysis, our model was well fitting to the data (goodness of fit for depression ($p < 0.001$) and for anxiety ($p < 0.001$)). The logistic model classifies 90.6% of all observations of depression adequately, and 90.4% of anxiety. The explanatory power (Nagelkerke – R2) was 30.5% for depression, and 22.6% for anxiety.

In the model (all factors in model), both low (MET quintiles I, II) and relatively high (MET quintile IV) levels of physical activity indicated a higher risk of depression relative to extremely active physical activity (MET quintile V) in 1985. The intermediate levels (MET quintile III) were not statistically significant, but the point estimate for the odds ratio was 1.5 in 1985 compared to quintile V. When adjusted for baseline METs (and other variables in the model), change in physical activity had a protective effect against depressiveness; an increase of one MET-unit (hour/day) statistically significantly decreased the risk of depressiveness by 8% (95% CI 1 – 14%).

Introversion, neuroticism and life satisfaction were associated with risk of depression, but baseline alcohol and smoking were not associated with risk of depression. Change in the use of alcohol decreased risk of depression, the change of the one alcohol-unit (g/day) statistically significantly but modestly (by 2%) decreased the risk of depressiveness, when the model already contained the personality and other variables. The risk of depression was significantly higher following divorce or widowhood between 1985 – 1995; risk of depression was increased by 7% (95% CI 2.5 to 12%) per life event score point. As for socio-economic status, there was a nearly two-fold risk of depression among skilled workers compared to clerical workers.

In the logistic model, physical activity was not associated with anxiety. Of the personality characteristics, neuroticism and hostility were associated with high risk of anxiety. None of the life style or life events were associated with anxiety. As for socio-economic status, the risk of anxiety was two-fold for skilled workers compared to clerical workers.

Cross-sectional analysis (Table 5) of 1995 data

The cross-sectional analysis model fitted well to the depression (goodness of fit $p < 0.001$), and anxiety data (goodness of fit $p = 0.026$). In the cross-sectional analysis, the logistic model produces the right classification for depression in 89.1% of the cases, and for anxiety in 90.0% of all observations. The explanatory power was 12.5% for depression, and 5.3% for anxiety.

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Table **3** 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**.

The sports group showed a statistically significant lower risk of depression compared to controls. Both low (MET quintile I) and relatively high (MET quintile IV) levels of physical activity were associated with a higher risk of depression than the most physically active group. An association with low risk of depression was detected in occasional and moderate users of alcohol compared to teetotallers, but among users of alcohol no significant increase was observed. Likewise, married people had a very significantly lower risk of depression. As for anxiety, no significant associations were observed (Table **5**).

Discussion

In this study, we examined the effect of physical activity on mood in the case of former elite athletes and controls, and we tried to identify factors related to mood. Our data set is relatively large, with high response rates. The measures are of high reliability, and they have been used in several other studies. Unfortunately, the surveys did not use the same scale for anxiety and depressiveness. However, in our 1985 questionnaire we used the scale on life satisfaction as a personality parameter; several studies note that it is clearly correlated with e.g. depression, suicides, mortality and fatal injuries [25 – 27]. In the study, life satisfaction was charted with a scale commonly used in Nordic countries, including subjective interest in life, happiness in life, ease of life,

Table 4 Logistic regression results for subjects with anxiety symptoms in the upper decile versus other deciles

Dependent variables		*Odds ratio (with 95% confidence intervals)*	*p-value**	*Cumulative R2*
Anxiety				
Age -95,				0,018
physical activity	Age -95	1,00 (0.97 - 1.03)	0,995	
	MET -85, quintile 1^	1,57 (0.65 - 3.79)	0,314	
	MET -85, quintile 2^	1,64 (0.69 - 3.90)	0,266	
	MET -85, quintile 3^	1,68 (0.68 - 4.15)	0,259	
	MET -85, quintile 4^	1,91 (0.81 - 4.51)	0,138	
	(MET -85, quintile 5^ ref.)	1,00		
Personality				0,182
characteristics	Extroversion SD	0,90 (0.71 - 1.15)	0,398	
	Neuroticism SD	2,06 (1.57 - 2.69)	0,000	
	Life satisfaction SD	1,23 (0.96 - 1.58)	0,103	
	Hostility SD	1,36 (1.07 - 1.72)	0,011	
Life style				0,209
	Change in MET 95 - 85	0,99 (0.93 - 1.06)	0,770	
	Alcohol -85,occasional users	0,99 (0.41 - 2.43)	0,990	
	Alcohol -85,moderate users	0,70 (0.26 - 1.90)	0,486	
	Alcohol -85,heavy users	1,08 (0.37 - 3.15)	0,887	
	(Alcohol -85,abstainers ref.)	1,00		
	Change in alcohol consumption 95 - 85	0,99 (0.97 - 1.00)	0,075	
	Smoke -85,ex-smoker	1,16 (0.67 - 2.00)	0,606	
	Smoke -85,current smoker	1,65 (0.83 - 3.26)	0,153	
	(Smoke -85,never smoker ref.)	1,00		
	Smoke status changed; ex-smoker in 1995	0,83 (0.34 - 2.02)	0,683	
	Smoke status changed; current smoker in 1995	1,02 (0.42 - 2.47)	0,966	
	Marital status -85,married, remarried or cohabiting	1,09 (0.48 - 2.47)	0,830	
	(Marital status -85,unmarried, divorced or widow ref.)	1,00		
	Marital status changed; married, remarried or cohabiting in 1995	0,21 (0.02 - 1.81)	0,155	
	Marital status changed; unmarried, divorced or widow in 1995	0,91 (0.40 - 2.10)	0,831	
Life events				0,211
	Life events	1,03 (0.99 - 1.08)	0,177	
Sosioeconomic				0,226
Status	Executive	1,20 (0.57 - 2.54)	0,630	
	Skilled workers	2,11 (1.21 - 3.68)	0,008	
	Unskilled workers	1,51 (0.39 - 5.84)	0,548	
	Farmers	1,99 (0.80 - 4.97)	0,142	
	(Sosioeconomic status,clerical workers ref.)	1,00		

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

and loneliness. This scale is closely related to an established depression scale, the 21-item Beck Depression Inventory (BDI) [25]. In various studies, life satisfaction and BDI have a correlation of 0.61 - 0.88 [25].

One can observe that a less commonly known scale on mood is used in this study. We do not argue that the scale on anxiety and depressiveness is specific as a diagnostic instrument, but we consider that in this study it functions well as a scale at the level of symptoms that reflect mood. One can also argue that also in other scales on anxiety and depressiveness, questions largely similar to ours are used, such as those on thoughts on ending one's life, downheartedness, an almost general lack of interest, the feeling of hopelessness about future, timidity, feeling of worthlessness, excitedness and tenseness, fits of fear or panic.

The study sample for the logistic regression analysis was divided into two groups, which created a somewhat arbitrary dichotomy, though it corresponds quite well with estimates of prevalence of depression and anxiety disorders in the population, and as discussed below in more detail, expected relationships with other covariates were observed. Sensitivity analyses using the top two deciles as cases yielded weaker associations. Our main observation in the longitudinal study with consideration of covariates is that the sports group did not benefit from any statistically signi-

Table **5** Logistic regression results of cross-sectional analyses in 1995 data. Outcomes are depressiveness (upper part of table) and anxiety symptoms in 1995 (lower part)

Dependent variables		*Odds ratio (with 95% confidence intervals)*	*p-value**	*Cumulative R2*
Depression				
Age -95,				0,038
Sports	Age -95	0,99 (0.97–1.01)	0,358	
	Endurance sports	0,44 (0.18–1.11)	0,081	
	Power sports/Combat	1,25 (0.71–2.19)	0,447	
	Power sports/Individual	1,02 (0.50–2.07)	0,968	
	Team sports	0,48 (0.25–0.92)	0,026	
	Shooting	0,24 (0.06–1.07)	0,062	
	(Sports, controls ref.)	1,00		
Life style				0,125
	MET -95, quintile 1^	3,22 (1.62–6.39)	0,001	
	MET -95, quintile 2^	1,91 (0.91–4.01)	0,087	
	MET -95, quintile 3^	1,77 (0.88–3.54)	0,107	
	MET -95, quintile 4^	2,66 (1.18–6.02)	0,019	
	(MET -95, quintile 5^ ref.)	1,00		
	Alcohol -95,occasional users	0,48 (0.27–0.84)	0,010	
	Alcohol -95,moderate users	0,42 (0.21–0.83)	0,013	
	Alcohol -95,heavy users	0,57 (0.28–1.16)	0,123	
	(Alcohol -95,abstainers ref.)	1,00		
	Smoke -95,ex-smoker	1,57 (0.99–2.51)	0,058	
	Smoke -95,current smoker	1,65 (0.96–2.86)	0,072	
	(Smoke -95,never smoker ref.)	1,00		
	Marital status -95,married, remarried or cohabiting	0,34 (0.22–0.53)	0,000	
	(Marital status -95,unmarried, divorced or widow ref.)	1,00		
Anxiety				
Age -95,				0,016
Sports	Age -95	0,98 (0.96–1.01)	0,214	
	Endurance sports	0,61 (0.26–1.43)	0,256	
	Power sports/Combat	1,09 (0.59–1.98)	0,791	
	Power sports/Individual	0,79 (0.35–1.74)	0,551	
	Team sports	0,73 (0.40–1.31)	0,287	
	Shooting	0,51 (0.15–1.75)	0,285	
	(Sports, controls ref.)	1,00		
Life style				0,053
	MET -95, quintile 1^	1,59 (0.88–2.88)	0,124	
	MET -95, quintile 2^	0,92 (0.48–1.78)	0,802	
	MET -95, quintile 3^	0,91 (0.50–1.66)	0,768	
	MET -95, quintile 4^	0,43 (0.16–1.18)	0,103	
	(MET -95, quintile 5^ ref.)	1,00		
	Alcohol -95,occasional users	0,67 (0.36–1.22)	0,191	
	Alcohol -95,moderate users	0,55 (0.27–1.15)	0,113	
	Alcohol -95,heavy users	0,80 (0.38–1.68)	0,557	
	(Alcohol -95,abstainers ref.)	1,00		
	Smoke -95,ex-smoker	1,21 (0.75–1.95)	0,427	
	Smoke -95,current smoker	1,48 (0.86–2.56)	0,155	
	(Smoke -95,never smoker ref.)	1,00		
	Marital status -95,married, remarried or cohobiting	0,66 (0.40–1.08)	0,101	
	(Marital status -95,unmarried, divorced or widow ref.)	1,00		

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

ficant protective effect, but in the cross-section model, team sports athletes turned out to be significantly associated with low levels of depression. In both of these models, physical activity had no statistically significant associations with anxiety. The classification of physical activity used in our study is based on the items in the questionnaires concerning the frequency, intensity and time used for exercise. According to several studies, all these factors are somewhat related to improved maximal oxygen uptake and prevention of illnesses [1,31]. In the baseline situation of our study, we categorised the physical activity of former elite athletes in 1985. We used the physical activity of the baseline situation as a structural factor to enable analysis of sports activity changes between 1995 and 1985. So, in the analyses and results, the actual predicting factor is change in physical activity with adjustment for baseline levels.

Our result concerning low physical activity agrees with an earlier cross-section analysis where Camacho et al. [6] showed that the baseline prevalence of symptoms of depression was higher for persons reporting low levels of physical activity than for highly active persons and in the follow-up the incidence of depressive symptoms revealed a significant difference only between persons in the lowest and highest activity groups. Also cross-section analyses by both Farmer et al. [11] and Paffenbarger et al. [47] support our results. Paffenbarger et al. [47] indicated that the relative risk of depression was 27% lower for men who had reported playing 3 or more hours of sports each week than for men who had reported playing none. At an 8-year follow-up, little or no recreational physical activity was found to be a significant predictor of increased depressive symptoms among white men who had excessive depressive symptoms at baseline, low levels of recreational activity predicted continued depressive symptoms at the follow-up [12]. Generally persons with good psychological health may be more active overall.

Physical exercise has given former elite athletes many kinds of "top" moments, as well as feelings and experiences of success. Further, physical exercise has helped them face and cope with diverse failures and disappointments. Many sports-derived feelings and experiences should also increase their consciousness of various factors influencing their life control. Sports-induced experiences and the feeling of well-being resulting from a sports activity or event probably maintain and contribute to the psychological well-being of former elite athletes as well.

Most of the former elite athletes have continued engaging in physical exercise and activities after their active sports career, but generally at lower activity levels. Compared with their active career, even a minor decrease in the amount of sports activity may introduce quite a significant change in life of some former elite athletes, since so far sports has been a central part of their daily lives. For former elite athletes, even a minor decrease in physical activity means giving up a long-term life habit. This may result in depressive symptoms and anxiety. Decrease in sports activity may result from several factors. Some may have had to cut down the amount of their former activity e.g. due to age, illness, and restrictions and losses due to sports injuries. One should also note that depressed and anxious people generally are physically less active. Mood, depressiveness and anxiety are in part explained by sports, but in part by many other factors, as our results show.

Henriksson [17] suggests that depression is often associated with the presence of other simultaneous disorders. Also according to Kaplan et al. [21] and Keitner et al. [23], people suffering from physical complaints exhibit more depression than those who are healthy. Our study does not yet account for the effect of illnesses related to ageing on mood, though illnesses related to ageing may have an effect on physical competence, and thus influence physical activity and mood.

As far as athletes are concerned, one should note that also sports injuries and their severity can affect mood. Weise-Bjornstal [62] introduce the study by Smith et al. that reported less mood disturbance in the two groups of injured athletes with mild and moderately serious injuries than is apparent in non-injured college norms. These athletes had more positive mood state profiles even when injured than the average college aged young adults. Only athletes with serious injuries experienced significant mood disturbance. The effects of physical activity on mood are transmitted by physiological, psychological and social factors. These three factors constitute an indivisible whole that is subject to direct and indirect effects of physical exercise and activity. A large proportion of the effects of physical exercise on mood can be and often is explained by psychophysiological factors. One can state that healthy and physically active people are emotionally more stable than anxious or depressed people. When a healthy and physically active person experiences significant strain, he tends to recover from it faster psychophysiologically than a physically inactive person not feeling well. A healthy and physically active person may have a better control of variable external and internal stress factors, and this may decrease their symptoms, depression and anxiety.

There may be biological, psychological and social background factors of relevance. Earlier, observations have been made according to which people with regular physical exercise generally have low depressiveness as a trait of their personality [5,44]. In addition, Morgan et al. [44] found that former long-distance runners were less depressed than the average population, but that there were no differences in their anxiety levels. Our study shows that of personality traits, neuroticism had a high risk of depression, while extroversion had low risk of depression. Our study also shows that neuroticism and hostility had high risk of anxiety. Psychological qualities remain relatively stable in adults with age, except for neuroticism [43], which decreases steadily [10]. Some personality traits may contribute to better self-control. Some personality traits may also explain the fact that some people better control changeable external and internal stress factors, and therefore have fewer psychological symptoms in the form of depression. Our study shows that dissatisfaction with one's life correlates with several personality traits, or with a personality composed of certain traits [2,5]. There is a positive correlation between dissatisfaction with one's life and neuroticism, while in the case of extroversion the correlation is negative [2,5]. Our result about the high risk of depression due to dissatisfaction with one's life seems to agree with a Finnish study where dissatisfaction with one's life was observed to predict early death, especially suicide and fatal injury [25–27].

Our study also shows that the socio-economic status is important; skilled workers have a higher risk of depression. This may