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Cardiovascular Disease Mortality in Relation to Physical Activity during Adolescence and Adulthood in Japan: Does School-Based Sport Club Participation Matter?

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Abstract

We examined potential associations of sport club participation during adolescence and sports-related physical activity during adulthood with mortality from cardiovascular diseases (CVD) in a Japanese population. Between 1988 and 1990, 29 526 men and 41 043 women aged 40-79 years responded to a questionnaire including questions about the frequency of sports participation at baseline and sport club participation during junior/senior high school. Subjects were followed-up until the end of 2009, and 4230 cardiovascular deaths (870 CHD, 1859 stroke) were identified. Cox proportional-hazard regression models were used to estimate hazard ratios (HR). During the first-two thirds of the follow-up – where the proportional hazards assumption was met – the multivariate-adjusted HR (95% confidence interval) for total CVD mortality was 0.77 (0.61-0.98) among men and 0.82 (0.61-1.10) among women who were physically active at baseline (≥ 5 h/week versus 1-2h/week). The corresponding HRs for coronary heart disease (CHD) mortality were 0.65 (0.39-1.07) and 0.40 (0.17-0.91), respectively. The combined associations of sports participation during adulthood and adolescence were also examined. Among men who participated in sports for ≥ 5 h/week at baseline, the multivariate-adjusted HR for those who also engaged in sport club activities during adolescence was 0.89 (0.61-1.30) for total CVD mortality and 0.24 (0.08-0.71) for CHD mortality when compared to non-participants. Among women, no statistically significant differences were found between sport club participants and non-participants. In conclusion, participating in sport clubs during adolescence might lead to a more pronounced risk-reduction for CHD mortality among men who also participate in sport activities during adulthood.

Key Words: physical activity; cardiovascular diseases; coronary disease; primary prevention

Introduction

Taking part in cultural or sport club activities during junior/senior high school years is an integral part of Japanese culture. Previous studies reported that participating in school-based organized sport activities was associated with a favorable cardiovascular risk profile in Japanese adolescents, including elevated HDL-cholesterol and adiponectin levels, lower total cholesterol and triglyceride levels, decreased insulin resistance, lower blood pressure, lower body fat percentage, and was negatively associated with smoking and alcohol consumption.¹⁻⁴ Cardiovascular risk factors and risk factor clustering tracking from childhood to adulthood was found to affect the risk of CVD morbidity and mortality in later years.⁵⁻¹⁷ Moderate to vigorous physical activity during adulthood was inversely associated with CVD morbidity and mortality due to improved lipid profile and insulin sensitivity, lowered blood pressure, improved endothelial function, and reduced oxidative stress.¹⁸⁻³⁰ While associations of physical activity during adolescence and adulthood were extensively studied separately, there is very little information on the possible combined associations of the two. This study, therefore, examined the associations of participation in school-based sport clubs and physical activity during adulthood on CVD mortality in later years among Japanese in a large-scale population-based cohort study.

Methods

Study population and baseline questionnaire

The data was obtained through the Japan Collaborative Cohort (JACC) Study for Evaluation for Cancer Risk, sponsored by the Japanese Ministry of Education, Science, Sports, and Culture. As part of the JACC study, self-administered questionnaires containing information on medical history and lifestyle factors were collected between 1988 and 1990.³¹ Before filling out the questionnaire, informed individual consent was obtained from each participant in 36 of the 45 study areas (written consent in 35 areas and oral consent in 1 area). In the remaining 9 areas, group consent was obtained from each area leader.³¹ The investigation protocol was approved by the ethics committees of Nagoya University and Osaka University. The number of respondents was 110 585, including 46 395 men and 64 190 women aged 40-79 years. For evaluating sport activity at baseline, the following question was used: "What is the average amount of time you spend engaging in sports on a weekly basis?" The possible answers were "<1 hour", "1 to 2 hours", "3 to 4 hours", and "≥5 hours". The participants were also asked whether they engaged in sport club activities during junior and senior high school: "Did you participate in sport club activities during junior and senior high schools?" The possible answers were "no", "for a short time", and "yes". The reliability and validity of the questionnaire regarding physical activity were previously reported elsewhere.³² After excluding 36 019 participants who did not answer the questions of interest and 3997 participants with history of CVD or cancer at baseline, the remaining number of participants was 70 569, 29 526 men and 41 043 women.

Mortality surveillance

In each community, death certificates were forwarded to the local public health center, then mortality data were sent to the Ministry of Health, Labor and Welfare for centralization. The underlying causes of death were coded based on the 10th revision of the International Classification of Diseases (ICD-10). All deaths within the study cohort were confirmed, excluding participants (censored cases) who died after moving out of their original community. In 35 communities, the follow-up was conducted until the end of 2009. However, in 4 areas the study was terminated at the end of 1999, in 4 other areas at the end of 2003, and in 2 areas at the end of 2008. The average follow-up was 16.4 years. Out of all participants, 24.8% died and 5.8% moved away by the end of follow-up. Cause-specific mortality was defined using ICD-10 codes: codes I01-I99 for total CVD mortality, codes I20-I25 for coronary heart disease (CHD) mortality, and codes I60-I69 for total stroke mortality.

Statistical analysis

Person-years were calculated from the date of study enrollment until the date of death, the date of moving out of the original community, or until the end of the study, whichever happened first. Cox proportional hazards regression models were used to estimate sex-stratified age- and multivariate-adjusted hazard ratios (HRs) with 95% confidence intervals (CIs) for total CVD, CHD, and total stroke mortality. All models were adjusted for age, then multivariate models were further adjusted for other potential confounding factors including history of hypertension (no or yes), history of diabetes (no or yes), body mass index (sex-specific quintiles), alcohol consumption (never, ex-drinker, and current drinker of 1-22, 23-45, 46-68, and ≥ 69 grams of ethanol/day), smoking status (never, ex-smoker, and current smoker of 1-19 or ≥ 20 cigarettes/day), hours of sleep (< 6.0 , 6.0-6.9, 7.0-7.9, 8.0-8.9, and ≥ 9 hours/day), employment status (unemployed or employed, including housewives and retirement), age of completed education (< 13 , 13-15, 16-18, and ≥ 19 years old), perceived level of mental stress (low, normal, high), fish intake (0, < 1 , 1-2, 3-4, and ≥ 5 times/week), and time spent walking indoors or outside (< 0.5 , 0.5, 0.6-0.9, and ≥ 1.0 hours/day). Since our aim was to study the associations of physical activity in healthy individuals, and those who engage in sport activities for less than an hour per week were more likely to have pre-existing health problems, the reference for sport participation at baseline was set for 1 to 2 hours per week (second lowest category). To examine the combined associations of sport participation at baseline and sport club participation during adolescence, a new variable was created where participants were categorized into four groups.: Group 1 included participants who engaged in < 5 hours of sports per week at baseline and did not participate in sport club activities during their school years. Group 2 also spent less than 5 hours per week doing sports when interviewed, but they participated in sports clubs for at least a “short time” during their adolescence. Both Group 3 and Group 4 participated in ≥ 5 hours of sports per week, but while participants in Group 3 – the reference group – did not engage in any sport club activities during their school years, participants in Group 4 joined junior/senior high school sport clubs for at least a “short time”. Since the information on physical activity during adulthood was collected only at baseline, we further hypothesized that the predictive power of baseline covariates might change during the long follow-up period, especially in older age-groups. After confirming the violation of the proportional-hazards assumption using tests based on cumulative sums of martingale residuals and interaction terms between sport participation at baseline and follow-up time, separate analyses were performed first for the first two thirds (until the end of 2003), then for the last third of the follow-up period (until the

end of 2009). In order to avoid the potential confounding resulting from any existing but unreported health disorders, additional analyses were performed after excluding deaths within the first two years of the follow-up period (437 men, 232 women). All analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary, NC).

Results

For this research, 70 569 participants of the JACC study (29 526 men and 41 043 women) were followed up between 1988 and 2009. During a median of 16.4 follow-up years, 2430 CVD deaths were identified, including 870 CHD and 1859 stroke cases.

Table 1 shows the sex-specific age-standardized characteristics of the participants according to four categories of sport participation at baseline and sport club participation during adolescence. Compared to participants reporting 1-2 hours/week of sport participation at baseline, men and women who did sports for at least 5 hours/week had a higher mean age and were more likely to walk at least 1 hour/day, regardless of sport club participation status. Among men and women who did not participate in school-based sport club activities, participants who reported ≥ 5 hours/week of sport activity at baseline had higher ethanol intake and were less likely to have collage or higher education compared to those who reported 1-2 hours of weekly sport participation at baseline. Compared to non-participants, men and women participating in sport clubs during adolescence were less likely to be physically inactive (< 1 hours/week) and were more likely to do sports for ≥ 3 hours/week, to have college or higher education, and to be current smokers.

Table 2 indicates the results of the assessment of the proportional hazards assumption for sport-related physical activity at baseline. The violation of the proportional hazards assumption was confirmed among participants who reported engaging in sport activities for < 1 hour or ≥ 5 hours per week when interviewed. To deal with the problem of nonproportionality, all further analyses were performed stratified by time. There was no violation of the proportional hazards assumption for the first two thirds of the follow-up period, that is, until the end of 2003.

Table 3 shows sex-specific age- and multivariate-adjusted HRs (95% confidence interval) for CVD mortality according to sport participation at baseline, stratified by follow-up time. During the first two thirds of the follow-up period, men reporting ≥ 5 hours/week of sport activity had a multivariate-adjusted HR of 0.77 (0.61-0.98) for total CVD mortality when compared to those who participated in sports for only 1-2 hours/week. The results for CHD and total stroke mortality showed a similar trend with multivariate-adjusted HRs of 0.65 (0.39-1.07) and 0.92 (0.65-1.30), respectively, but these associations did not reach statistical significance. The trend for physically active women (≥ 5 hours/week versus 1-2 hours/week) was similar with a multivariate-adjusted HR of 0.82 (0.61-1.10) for total CVD, 0.40 (0.17-0.91) for CHD, and 0.65 (0.42-1.01) for stroke mortality. During the last third of

the follow-up period, the results were not statistically significant. Sport club participation during adolescence in itself (adjusted for sport participation at baseline) was not statistically significantly associated with cardiovascular mortality in later years (data not shown).

Table 4 shows sex-specific HRs for the combined associations of sport club participation during adolescence and sports-related physical activity at baseline, stratified by follow-up time. During the first two thirds of the follow-up period, among men who reported ≥ 5 hours of sport activity at baseline the risk of CHD mortality for junior/senior high school club participants was lower compared to non-participants. Among physically active (≥ 5 h/week of sports at baseline) men, the multivariate-adjusted HRs (95% CI) for school-based sport club participants were 0.89 (0.61-1.30) for total CVD, 0.24 (0.08-0.71) for CHD, and 1.26 (0.73-2.17) for total stroke mortality when compared to non-participants. The corresponding results among physically active women were 1.01 (0.61-1.66) for total CVD and 0.86 (0.39-1.89) for total stroke mortality. For women in Groups 3 and 4 the number of CHD mortality cases were too few to provide stable hazard ratio estimates. The results for the last third of the follow-up period were not statistically significant.

When excluding study participants who died within two years after baseline inquiry, results did not change considerably (Tables A.1 and A.2).

Discussion

The present large cohort study showed that sport club participation during adolescence in itself – without being physically active later in life as well – was not associated with reduced cardiovascular mortality of participants aged 40 years or older. This is in line with previous findings stating that being physically active only during young adulthood do not prevent premature cardiovascular mortality in later years.³³ However, the multivariate-adjusted risk of CHD mortality among physically active men (≥ 5 hours/week of sports at baseline) was lower for those who participated in school-based sport clubs during their adolescence compared to non-participants. This association was confined to observations in the first two-thirds of the follow-up period, but did not change considerably after excluding deaths within the first two years of follow up.

One possible explanation for the lower CHD mortality risk among long-term physically active men might be a potential long-lasting influence of sport club participation in Japanese schools on physical activity, diet, or other lifestyles in later years. In Japan, extracurricular club activities are considered to be an important part of education.³⁴⁻³⁶ By 1926, around when study participants in the highest age-group reached junior/senior high school age, a wide range of sports were practiced by students. The list of available sports in schools included baseball, tennis, rowing, swimming, gymnastics, sumo, judo, kendo (Japanese fencing), kyudo (Japanese archery), track and field, basketball, football, soccer, handball and volleyball; all of which incorporated vigorous aerobic exercise and resistance training.³⁴ In the Japanese society, since the establishment of sport clubs participating students thoroughly devote themselves to sports, practicing at least 6 times per week – mainly after or before school – for at least 3 - 3.5 hours/day in both private and public schools, even during school vacations and holidays. Though more male students join sport clubs than female students (around 60% versus 40%), the intensity of the practice is similar for both sexes.³⁵⁻³⁶ Once they have joined, the majority of the students remain members of their chosen clubs throughout their middle school or high school years.³⁵ Therefore, participating in high-school-based sport clubs is associated with regular high levels of intensive physical activity including both aerobic and resistance exercises, which meets the requirements of physical activity recommendations and guidelines for this age group.³⁷⁻³⁸

In the published literature, participating in school-based sport clubs was linked to better lipid profiles, decreased insulin resistance, lower blood pressure, and lower body fat percentage compared to non-participants in Japanese adolescents.¹⁻³ Similar findings were

reported based on other – non-Japanese – populations, where physical activity was also positively related in youth to cardiorespiratory fitness, muscular strength, reduction in overall and visceral adiposity, increased bone mineral content and density, and better mental health.³⁷⁻³⁸ It was also shown that CVD risk factors and risk factor clusters might track from adolescence to adulthood increasing the risk of CVD mortality in later years.⁵⁻¹⁷ In our study population, there were no significant differences in mean BMI or in the prevalence of hypertension and diabetes by current or past physical activity status. Also, the evidence for confounding or mediation by these risk factors was very weak in our analyses. However, we did not examine more subtle factors such as detailed lipid profile, body fat percentage, insulin sensitivity, endothelial function, or inflammatory markers; therefore, we cannot evaluate potential differences in cardiovascular risk profiles among groups with different physical activity history.

The level of physical activity during adolescence and participation in organized youth sports were also positively associated with physical activity during young adulthood, attributing to longer years of sustained physical activity, and more beneficial CVD risk profiles.³⁹⁻⁴¹ Furthermore, sport club participation and sustained physically active lifestyle were associated with healthier lifestyle choices such as non-smoking and lower alcohol consumption, and a healthier diet with lower saturated fatty acid consumption and higher polyunsaturated to saturated fatty acid ratio.^{4,39} The baseline characteristics of our study subjects showed that school-based sport club participants were indeed more likely to be physically active during adulthood compared to non-participants, however, they were also more likely to be current smokers. In schools, the supervision and mentoring received from adults might lead to better behaviors, but outside of school and during adulthood participating in sport groups might lead to different lifestyle choices, including the habit of smoking.^{4,42}

Similarly to a previous study³⁶, our findings also showed that students participating in sports clubs during high school are more likely to pursue higher education compared to those who do not participate in sport club activities, which might lead to better socioeconomic status during adulthood, indirectly affecting CVD mortality in later years.

A limitation of this study is that sport club participation was measured with only one close-ended question, the type of sport club and the exact amount of participation time is unknown. However, the unique social, cultural, and historical background ensured strong intensity and commitment involved in these activities. Once students joined a sport club, they tended to devote themselves to the same club for at least 3 years.³⁵ Information on sport participation during adulthood was also only assessed at baseline, which affected the

predictive power of the Cox regression models most likely due to changes in exercise habits of the study participants during the long follow-up. However, after confirming the violation of the proportional hazards assumption, the analyses were performed stratified by follow-up time. Presenting separate analyses for different periods of time is a well-known and widely accepted method for dealing with nonproportionality.⁴³ In the present study, the year 2003 was carefully chosen as the end of the first presented follow-up period for the following reasons: By the end of 2003, follow-up for subjects in 8 participating areas was terminated. Also, the end of 2003 concluded approximately two thirds of a 20-year follow-up period from the baseline. In a previous study of Finish men aged 45-64 years where physical activity was also only assessed at the baseline, high physical activity was associated with lower mortality risk compared to low physical activity during the first two thirds of a 20-year follow-up period, but this association did not hold during the last third of the follow-up time.⁴⁴ Apart from possible changes in exercise habits during follow-up, we also cannot exclude the possibility of the presence of one or more time-dependent confounders or mediators, which might also contributed to the observed differences between the first two thirds and the last third of the follow-up time. It is also possible that as the age of the observed population increased, physical activity was no longer protective against CVD mortality.

Another limitation is the sex-specific small number of subjects in the study (n=1097 for men and 795 for women) who were physically active both during adolescence and at baseline (≥ 5 hours/week). In men, the small number of CHD cases in Group 4 resulted in inflated hazard ratio estimates with wide 95% confidence intervals, therefore the obtained results have to be interpreted with caution; we would expect “more probable/more appropriate” HR estimates closer to the upper limit of the 95% confidence interval. In women, there were too few CHD mortality cases in both Groups 3 and 4 to obtain stable hazard ratio estimates, therefore we could not draw valid conclusions regarding the combined associations of sports participation during adolescence and adulthood with CHD mortality.

Conclusion

Participating in school-based sport clubs might attribute to lower CHD mortality risks in later years among physically active men. Implementing organized youth sport programs as an extracurricular activity in schools might be an important step towards establishing healthier lifestyle habits, leading to lower risks of adult morbidity and mortality. In addition, since the possible favorable influence of school-based sport club participation – in men – depended on physical activity during adulthood, it is crucial to promote a physically active lifestyle throughout the life-course.

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Conflicts of interest: none.

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Table 1. Sex-specific age-standardized characteristics of participants by sport participation at baseline and sport club participation during adolescence

	Not sport club participants				Sport club participants			
	Sport participation at baseline (hours/week)							
	<1	1-2	3-4	≥5	<1	1-2	3-4	≥5
Men								
No. at risk	11 680	1827	808	844	8772	3177	1321	1097
Percentage at risk	77	12	5	6	61	22	9	8
Age, years ^a	57.8(9.4)	58.7(10.4)	61.8(10.2)	64.1(8.8)	53.1(9.3)	52.7(10.0)	56.0(11.1)	58.0(10.5)
Body mass index, kg/m ²	22.5(2.8)	22.6(2.6)	22.9(2.7)	22.9(2.9)	22.9(2.8)	22.9(2.7)	23.0(2.7)	22.9(2.7)
History of hypertension, %	15	17	16	17	15	16	15	19
History of diabetes, %	4	7	7	6	5	6	5	6
Ethanol intake, grams/day	34.8(22.9)	32.3(21.6)	33.3(24.1)	38.9(26.1)	34.8(22.6)	32.6(21.7)	32.4(21.0)	33.8(22.0)
Hours of sleep, hours/day	7.5(1.1)	7.4(1.0)	7.4(1.0)	7.6(1.1)	7.4(1.1)	7.4(1.0)	7.4(1.0)	7.5(1.0)
Current smoker, %	50	44	46	47	55	51	50	50
Fish intake ≥1 time/week, %	80	81	81	80	82	82	83	83
College or higher education, %	10	15	13	10	19	26	25	23
Unemployed, %	13	17	17	16	12	16	15	16
High perceived mental stress, %	19	18	21	21	22	21	19	19
Walking 1h/day or more, %	45	42	40	76	42	41	42	68
Women								
No. at risk	21 196	2854	1135	948	10 406	2705	1004	795
Percentage at risk	81	11	4	4	70	18	7	5
Age, years ^a	57.7(9.7)	58.4(9.8)	61.7(9.5)	63.1(8.9)	52.8(9.1)	53.3(9.62)	55.1(10.2)	58.8(10.2)
Body mass index, kg/m ²	22.9(3.2)	22.8(3.0)	22.9(3.1)	22.9(3.2)	23.0(3.1)	23.0(2.8)	22.9(3.0)	22.8(3.0)
History of hypertension, %	17	19	16	21	18	18	16	16
History of diabetes, %	3	4	5	4	3	3	2	4
Ethanol intake, grams/day	10.4(13.7)	9.7(13.8)	9.5(11.0)	12.4(13.3)	10.7(13.6)	9.5(10.6)	10.1(15.1)	10.0(15.68)
Hours of sleep, hours/day	7.1(1.1)	7.1(1.1)	7.1(1.0)	7.2(1.1)	7.0(1.0)	7.0(1.0)	7.0(1.0)	7.0(1.0)
Current smoker, %	4	3	4	3	5	4	5	5
Fish intake ≥1 time/week, %	83	83	83	82	85	83	84	83

College or higher education, %	7	11	11	7	12	14	15	16
Unemployed, %	17	18	18	19	14	16	15	16
High perceived mental stress, %	18	18	17	18	19	16	16	14
Walking 1h/day or more, %	44	46	50	73	45	46	52	77

Values are means(SD) or percentages and are standardized to the sex-specific age distribution of the study population.

^aValue is not age adjusted.

Table 2. Assessment of the proportional hazards assumption with time interactions for sports participation at baseline^a

	Follow-up from baseline until the end of 2009				Follow-up from baseline until the end of 2003			
	Sport participation at baseline (hours/week) ^x time							
	<1 ^x time	1-2 ^x time	3-4 ^x time	≥5 ^x time	<1 ^x time	1-2 ^x time	3-4 ^x time	≥5 ^x time
Total CVD	0.98 (0.97-1.00) ^b	1.0	1.00 (0.98-1.03)	1.01 (0.99-1.04)	0.99 (0.96-1.02)	1.0	0.99 (0.94-1.03)	1.04 (0.99-1.09)
CHD	1.01 (0.97-1.04)	1.0	1.02 (0.96-1.07)	1.06 (1.00-1.13) ^c	1.03 (0.97-1.09)	1.0	1.00 (0.91-1.10)	1.03 (0.92-1.15)
Total stroke	0.98 (0.95-1.00)	1.0	1.01 (0.97-1.04)	1.02 (0.98-1.06)	0.98 (0.94-1.02)	1.0	0.98 (0.91-1.04)	1.07 (0.99-1.15)

^aModels were adjusted for age and sex.

^bp=0.03

^cp<0.05

Table 3. Sex-specific HRs (95% CI) for CVD mortality according to sport participation at baseline, stratified by follow-up time

		Follow-up from baseline until the end of 2003				Follow-up from 2004 until the end of 2009			
		Sport participation at baseline (hours/week)							
		<1	1-2	3-4	≥5	<1	1-2	3-4	≥5
Men									
Person-years		263 435	64 787	26 836	24 613	74 331	18 802	7005	6137
N		20 452	5004	2129	1941	13 548	3380	1282	1150
Total CVD	n	1007	220	128	110	498	123	70	63
Age-adjusted HR		1.17 (1.01-1.35)	1.0	0.99 (0.80-1.23)	0.76 (0.61-0.96)	0.99 (0.81-1.20)	1.0	1.13 (0.84-1.51)	0.87 (0.64-1.18)
Multivariate HR ^a		1.10 (0.95-1.28)	1.0	0.98 (0.79-1.22)	0.77 (0.61-0.98)	0.93 (0.76-1.14)	1.0	1.08 (0.81-1.46)	0.87 (0.64-1.18)
CHD	n	215	55	29	22	130	29	14	22
Age-adjusted HR		0.98 (0.73-1.32)	1.0	0.93 (0.59-1.46)	0.64 (0.39-1.05)	1.08 (0.72-1.61)	1.0	1.00 (0.53-1.90)	1.40 (0.80-2.45)
Multivariate HR ^a		0.94 (0.69-1.28)	1.0	0.93 (0.59-1.46)	0.65 (0.39-1.07)	1.01 (0.67-1.52)	1.0	0.95 (0.50-1.81)	1.55 (0.87-2.73)
Total stroke	n	457	87	65	53	191	49	32	23
Age-adjusted HR		1.35 (1.07-1.70)	1.0	1.26 (0.91-1.74)	0.91 (0.65-1.28)	0.95 (0.69-1.30)	1.0	1.29 (0.82-2.01)	0.79 (0.48-1.31)
Multivariate HR ^a		1.25 (0.99-1.58)	1.0	1.24 (0.89-1.71)	0.92 (0.65-1.30)	0.88 (0.64-1.22)	1.0	1.26 (0.80-1.98)	0.76 (0.46-1.26)
Women									
Person-years		419 971	74 017	28 187	22 849	123 019	21 814	7971	6238
N		31 602	5559	2139	1743	21 712	3838	1429	1133
Total CVD	n	928	143	71	68	587	112	53	49
Age-adjusted HR		1.21 (1.01-1.44)	1.0	0.94 (0.71-1.25)	0.87 (0.65-1.16)	1.02 (0.84-1.25)	1.0	0.98 (0.71-1.36)	0.87 (0.62-1.21)
Multivariate HR ^a		1.03 (0.86-1.23)	1.0	0.88 (0.66-1.18)	0.82 (0.61-1.10)	0.97 (0.79-1.19)	1.0	0.93 (0.67-1.29)	0.84 (0.60-1.18)
CHD	n	168	28	14	7	101	18	12	6
Age-adjusted HR		1.13 (0.76-1.68)	1.0	0.95 (0.50-1.80)	0.45 (0.20-1.04)	1.09 (0.66-1.80)	1.0	1.39 (0.67-2.90)	0.67 (0.27-1.70)
Multivariate HR ^a		0.94 (0.62-1.41)	1.0	0.86 (0.45-1.64)	0.40 (0.17-0.91)	0.99 (0.59-1.64)	1.0	1.36 (0.65-2.84)	0.75 (0.29-1.92)
Total stroke	n	444	75	33	29	233	42	25	21
Age-adjusted HR		1.10 (0.86-1.40)	1.0	0.84 (0.56-1.27)	0.72 (0.47-1.11)	1.07 (0.77-1.49)	1.0	1.25 (0.76-2.05)	1.02 (0.60-1.72)
Multivariate HR ^a		0.92 (0.72-1.18)	1.0	0.79 (0.52-1.19)	0.65 (0.42-1.01)	1.01 (0.72-1.41)	1.0	1.14 (0.69-1.88)	0.99 (0.58-1.69)

^aMultivariate models were further adjusted for cardiovascular risk factors such as BMI, history of diabetes, history of hypertension, smoking status, alcohol consumption, sleeping hours, education, employment status, perceived mental stress, fish intake, and walking time.

Table 4. Sex-specific HRs (95% CI) for CVD mortality according to sport participation at baseline and sport club participation during adolescence

		Follow-up from baseline until the end of 2003				Follow-up from 2004 until the end of 2009			
		Sport participation at baseline (hours/week) / Sport club participation during high school years (Yes or No)							
		Group1 (<5/No)	Group2 (<5/Yes)	Group3 (≥5/No)	Group4 (≥5/Yes)	Group1 (<5/No)	Group2 (<5/Yes)	Group3 (≥5/No)	Group4 (≥5/Yes)
Men									
Person-years		181 226	173 833	10 450	14 163	48 140	51 998	2280	3857
N		14 315	13 270	844	1097	8902	9308	439	711
Total CVD	n	833	522	64	46	416	275	28	35
Age-adjusted HR		1.36 (1.05-1.76)	1.37 (1.06-1.78)	1.0	0.85 (0.58-1.24)	1.34 (0.91-1.96)	1.25 (0.84-1.85)	1.0	1.26 (0.76-2.06)
Multivariate HR ^a		1.29 (1.00-1.68)	1.33 (1.02-1.74)	1.0	0.89 (0.61-1.30)	1.26 (0.85-1.85)	1.24 (0.83-1.85)	1.0	1.26 (0.76-2.08)
CHD	n	180	119	18	4	99	74	8	14
Age-adjusted HR		0.99 (0.61-1.61)	1.02 (0.62-1.68)	1.0	0.25 (0.09-0.75)	1.02 (0.49-2.10)	1.02 (0.49-2.14)	1.0	1.66 (0.70-3.97)
Multivariate HR ^a		0.92 (0.56-1.52)	0.92 (0.55-1.54)	1.0	0.24 (0.08-0.71)	0.82 (0.39-1.73)	0.85 (0.40-1.81)	1.0	1.53 (0.63-3.70)
Total stroke	n	393	216	27	26	172	100	8	15
Age-adjusted HR		1.55 (1.05-2.30)	1.39 (0.93-2.08)	1.0	1.16 (0.67-1.98)	1.94 (0.95-3.96)	1.60 (0.77-3.31)	1.0	1.89 (0.80-4.45)
Multivariate HR ^a		1.49 (1.00-2.21)	1.41 (0.93-2.13)	1.0	1.26 (0.73-2.17)	1.96 (0.95-4.03)	1.76 (0.84-3.70)	1.0	2.09 (0.88-4.98)
Women									
Person-years		331 792	190 383	12 297	10 552	92 990	59 814	3126	3113
N		25 185	14 115	948	795	16 572	10 407	576	557
Total CVD	n	893	249	44	24	547	205	31	18
Age-adjusted HR		1.34 (0.99-1.81)	1.14 (0.83-1.58)	1.0	0.93 (0.56-1.53)	1.10 (0.76-1.58)	1.05 (0.72-1.53)	1.0	0.82 (0.46-1.47)
Multivariate HR ^a		1.26 (0.93-1.71)	1.18 (0.85-1.63)	1.0	1.01 (0.61-1.66)	1.10 (0.76-1.60)	1.13 (0.76-1.66)	1.0	0.90 (0.50-1.61)
CHD	n	160	50	3	4	97	34	5	1
Age-adjusted HR		3.57 (1.14-11.2)	3.47 (1.08-11.1)	1.0	2.28 (0.51-10.2)	1.18 (0.48-2.91)	1.03 (0.40-2.66)	1.0	0.28 (0.03-2.41)
Multivariate HR ^a		3.46 (1.10-10.9)	3.62 (1.12-11.8)	1.0	2.29 (0.51-10.3)	1.00 (0.40-2.51)	0.83 (0.32-2.18)	1.0	0.28 (0.03-2.45)
Total stroke	n	429	123	20	9	225	75	14	7
Age-adjusted HR		1.39 (0.89-2.18)	1.20 (0.75-1.93)	1.0	0.76 (0.35-1.67)	0.97 (0.56-1.66)	0.80 (0.45-1.42)	1.0	0.70 (0.28-1.74)
Multivariate HR ^a		1.35 (0.86-2.13)	1.29 (0.80-2.10)	1.0	0.86 (0.39-1.89)	0.96 (0.55-1.66)	0.86 (0.48-1.56)	1.0	0.76 (0.30-1.89)

^aMultivariate models were further adjusted for cardiovascular risk factors such as BMI, history of diabetes, history of hypertension, smoking status, alcohol consumption, sleeping hours, education, employment status, perceived mental stress, fish intake, and walking time.

Table A.1. Sex-specific HRs (95% CI) for CVD mortality according to sport participation at baseline, stratified by follow-up time^a

		Follow-up from baseline until the end of 2003				Follow-up from 2004 until the end of 2009			
		Sport participation at baseline (hours/week)							
		<1	1-2	3-4	≥5	<1	1-2	3-4	≥5
Men									
Person-years		263 071	64 715	26 806	24 586	74 331	18 802	7005	6137
N		20 130	4940	2102	1917	13 548	3380	1282	1150
Total CVD	n	919	201	122	104	498	123	70	63
Age-adjusted HR		1.17 (1.00-1.36)	1.0	1.04 (0.83-1.30)	0.79 (0.62-1.00) ^c	0.99 (0.81-1.20)	1.0	1.13 (0.84-1.51)	0.87 (0.64-1.18)
Multivariate HR ^b		1.10 (0.94-1.28)	1.0	1.02 (0.81-1.28)	0.79 (0.62-1.00) ^c	0.93 (0.76-1.14)	1.0	1.08 (0.81-1.46)	0.87 (0.64-1.18)
CHD	n	198	50	28	19	130	29	14	22
Age-adjusted HR		0.99 (0.73-1.35)	1.0	1.00 (0.63-1.58)	0.61 (0.36-1.03)	1.08 (0.72-1.61)	1.0	1.00 (0.53-1.90)	1.40 (0.80-2.45)
Multivariate HR ^b		0.94 (0.69-1.30)	1.0	0.98 (0.62-1.57)	0.60 (0.35-1.03)	1.01 (0.67-1.52)	1.0	0.95 (0.50-1.81)	1.55 (0.87-2.73)
Total stroke	n	421	81	61	52	191	49	32	23
Age-adjusted HR		1.34 (1.05-1.70)	1.0	1.27 (0.91-1.77)	0.96 (0.67-1.36)	0.95 (0.69-1.30)	1.0	1.29 (0.82-2.01)	0.79 (0.48-1.31)
Multivariate HR ^b		1.25 (0.98-1.59)	1.0	1.25 (0.89-1.75)	0.95 (0.67-1.35)	0.88 (0.64-1.22)	1.0	1.26 (0.80-1.98)	0.76 (0.46-1.26)
Women									
Person-years		419 764	73 983	28 169	22 829	123 019	21 814	7971	6238
N		31 425	5532	2125	1729	21 712	3838	1429	1133
Total CVD	n	873	135	63	68	587	112	53	49
Age-adjusted HR		1.21 (1.01-1.45)	1.0	0.89 (0.66-1.20)	0.92 (0.69-1.24)	1.02 (0.84-1.25)	1.0	0.98 (0.71-1.36)	0.87 (0.62-1.21)
Multivariate HR ^b		1.03 (0.86-1.24)	1.0	0.83 (0.61-1.12)	0.87 (0.65-1.17)	0.97 (0.79-1.19)	1.0	0.93 (0.67-1.29)	0.84 (0.60-1.18)
CHD	n	158	27	13	7	101	18	12	6
Age-adjusted HR		1.10 (0.73-1.66)	1.0	0.91 (0.47-1.76)	0.47 (0.21-1.08)	1.09 (0.66-1.80)	1.0	1.39 (0.67-2.90)	0.67 (0.27-1.70)
Multivariate HR ^b		0.91 (0.60-1.38)	1.0	0.81 (0.42-1.58)	0.40 (0.17-0.93)	0.99 (0.59-1.64)	1.0	1.36 (0.65-2.84)	0.75 (0.29-1.92)
Total stroke	n	421	71	28	29	233	42	25	21
Age-adjusted HR		1.10 (0.86-1.42)	1.0	0.76 (0.49-1.17)	0.76 (0.49-1.17)	1.07 (0.77-1.49)	1.0	1.25 (0.76-2.05)	1.02 (0.60-1.72)
Multivariate HR ^b		0.93 (0.72-1.20)	1.0	0.71 (0.46-1.11)	0.69 (0.45-1.08)	1.01 (0.72-1.41)	1.0	1.14 (0.69-1.88)	0.99 (0.58-1.69)

^aStudy participants who died within two years after baseline inquiry are excluded.

^bMultivariate models were further adjusted for cardiovascular risk factors such as BMI, past history of diabetes, past history of hypertension, smoking status, alcohol consumption, sleeping hours, education, employment status, perceived mental stress, fish intake, and walking time.

^cp<0.05

Table A.2. Sex-specific HRs (95% CI) for CVD mortality according to sport participation at baseline and sport club participation during adolescence^a

		Follow-up from baseline until the end of 2003				Follow-up from 2004 until the end of 2009			
		Sport participation at baseline (hours/week) / Sport club participation during high school years (Yes or No)							
		Group1 (<5/No)	Group2 (<5/Yes)	Group3 (≥5/No)	Group4 (≥5/Yes)	Group1 (<5/No)	Group2 (<5/Yes)	Group3 (≥5/No)	Group4 (≥5/Yes)
Men									
Person-years		180 938	173 653	10 430	14 156	48 140	51 998	2280	3857
N		14 059	13 113	829	1088	8902	9308	439	711
Total CVD	n	766	476	60	44	416	275	28	35
Age-adjusted HR		1.34 (1.03-1.75)	1.34 (1.02-1.76)	1.0	0.87 (0.59-1.28)	1.34 (0.91-1.96)	1.25 (0.84-1.85)	1.0	1.26 (0.76-2.06)
Multivariate HR ^b		1.29 (0.99-1.69)	1.32 (1.00-1.74)	1.0	0.90 (0.61-1.34)	1.26 (0.85-1.85)	1.24 (0.83-1.85)	1.0	1.26 (0.76-2.08)
CHD	n	169	107	16	3	99	74	8	14
Age-adjusted HR		1.04 (0.62-1.75)	1.02 (0.60-1.74)	1.0	0.21 (0.06-0.73)	1.02 (0.49-2.10)	1.02 (0.49-2.14)	1.0	1.66 (0.70-3.97)
Multivariate HR ^b		0.98 (0.58-1.66)	0.94 (0.55-1.63)	1.0	0.20 (0.06-0.68)	0.82 (0.39-1.73)	0.85 (0.40-1.81)	1.0	1.53 (0.63-3.70)
Total stroke	n	361	202	26	26	172	100	8	15
Age-adjusted HR		1.49 (1.00-2.22)	1.36 (0.90-2.05)	1.0	1.20 (0.70-2.07)	1.94 (0.95-3.96)	1.60 (0.77-3.31)	1.0	1.89 (0.80-4.45)
Multivariate HR ^b		1.46 (0.97-2.18)	1.41 (0.92-2.15)	1.0	1.32 (0.76-2.29)	1.96 (0.95-4.03)	1.76 (0.84-3.70)	1.0	2.09 (0.88-4.98)
Women									
Person-years		331 584	190 333	12 284	10 545	92 990	59 814	3126	3113
N		25 012	14 070	938	791	16 572	10 407	576	557
Total CVD	n	835	236	44	24	547	205	31	18
Age-adjusted HR		1.25 (0.93-1.70)	1.08 (0.78-1.50)	1.0	0.93 (0.56-1.53)	1.10 (0.76-1.58)	1.05 (0.72-1.53)	1.0	0.82 (0.46-1.47)
Multivariate HR ^b		1.17 (0.86-1.60)	1.11 (0.80-1.54)	1.0	1.00 (0.61-1.65)	1.10 (0.76-1.60)	1.13 (0.76-1.66)	1.0	0.90 (0.50-1.61)
CHD	n	151	47	3	4	97	34	5	1
Age -adjusted HR		3.39 (1.08-10.6)	3.27 (1.02-10.5)	1.0	2.29 (0.51-10.2)	1.18 (0.48-2.91)	1.03 (0.40-2.66)	1.0	0.28 (0.03-2.41)
Multivariate HR ^b		3.31 (1.05-10.4)	3.51 (1.08-11.4)	1.0	2.29 (0.51-10.3)	1.00 (0.40-2.51)	0.83 (0.32-2.18)	1.0	0.28 (0.03-2.45)
Total stroke	n	404	116	20	9	225	75	14	7
Age-adjusted HR		1.32 (0.84-2.06)	1.14 (0.71-1.84)	1.0	0.76 (0.35-1.67)	0.97 (0.56-1.66)	0.80 (0.45-1.42)	1.0	0.70 (0.28-1.74)
Multivariate HR ^b		1.27 (0.81-2.01)	1.21 (0.75-1.97)	1.0	0.85 (0.39-1.88)	0.96 (0.55-1.66)	0.86 (0.48-1.56)	1.0	0.76 (0.30-1.89)

^aStudy participants who died within two years after baseline inquiry are excluded.^bMultivariate models were further adjusted for cardiovascular risk factors such as BMI, past history of diabetes, past history of hypertension, smoking status, alcohol consumption, sleeping hours, education, employment status, perceived mental stress, fish intake, and walking time.