Physical Activity and Cardiovascular Risk Factors among Elderly Men in Finland, Italy, and The Netherlands


Physical activity pattern and its relation with cardiovascular risk factors was investigated in 1,402 men aged 69–90 years who participated in the 30-year follow-up survey of the Finnish (Eastern and Western Finland), Italian (Montegiorgio and Crevalcore), and Dutch (Zutphen) cohorts of the Seven Countries Study. Physical activity was assessed with a validated self-administered questionnaire designed for retired men. Total physical activity varied largely within cohorts. Median total reported physical activity ranged from 50 minutes/day in Montegiorgio to 89 minutes/day in Crevalcore. Walking, gardening, and bicycling together contributed more than 70% of total physical activity in all cohorts. Depending on the definition of physical inactivity, the estimated prevalence of inactivity varied between 5% and 33% in Zutphen and between 18% and 68% in Montegiorgio. Total physical activity was inversely associated with resting heart rate (r = -0.11, p < 0.001) and was positively associated with high density lipoprotein (HDL) cholesterol (r = 0.08, p < 0.01) in pooled data. These associations remained statistically significant after adjustment for age, cohort, smoking, body mass index, and alcohol intake. Total activity was not associated with total cholesterol, non-HDL cholesterol, blood pressure, or body mass index. The authors conclude that physical activity may have a beneficial effect on HDL cholesterol levels in elderly men. Walking, gardening, and bicycling contribute substantially to their physical activity pattern. Am J Epidemiol 1996;143:553-61.

Increasing attention is being paid to preventing and delaying the onset of chronic diseases among the elderly in order to extend the duration of functional well-being and healthy life expectancy. Many physiologic structures and functions decline with age and disuse. Maintenance of regular physical activity by the elderly is therefore important (1).

Population-based data on the physical activity patterns of the elderly are scarce, and direct comparisons of data are hampered by the use of different survey methods. Although physical activity and physical fitness have been associated with prevention and treatment of chronic diseases and conditions such as coronary heart disease, colon cancer, non-insulin-dependent diabetes mellitus, osteoporosis, hypertension, and obesity in middle-aged populations (2–6), data for older populations are lacking or conflicting (1).

Data on physical activity patterns were collected from surviving members of the Finnish, Italian, and Dutch cohorts of the Seven Countries Study, which started in the 1960s. Originally, middle-aged men were examined for relations between cardiovascular risk factors and health (7, 8). The present study, conducted in men aged 69–90 years, describes and compares physical activity patterns in different European cultures and reports the relations between physical activity and classical biologic risk factors for coronary heart disease. When data from three cohorts are pooled, the range of variation in the parameters under study widens, and we expected this to increase the study’s sensitivity to detect associations among the elderly. In addition, several different classifications of

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physical inactivity were applied in the analyses, since they are all used in public health recommendations.

MATERIALS AND METHODS

Study populations

In Finland, the original cohorts in 1959 totaled 1,677 men, all born in 1900–1919, from two geographically defined flat, rural areas: Ilomantsi in eastern Finland, close to the Russian border, and Pöytä and Mellilä in southwestern Finland, near the city of Turku (7). Both areas have a continental climate. In the fall of 1989, 524 men were still alive. Ninety percent of these survivors (n = 470) were examined, and 464 completed the physical activity questionnaire.

In the Netherlands, the original cohort consisted of 878 men living in Zutphen, a commercial town in the eastern part of the country (7). The Netherlands is a flat, lowland country with a mild seaside climate. In 1985, the surviving original cohort (n = 555) was extended by 711 men drawn from a two-thirds random sample of men living in Zutphen. Like the original cohort, these additional men were born between 1900 and 1920. A total of 1,266 men were invited to participate in the 1985 survey, 939 of whom responded positively. Of these 939 men, 718 were still alive in the spring of 1990; 560 (78 percent) of them were examined, and 520 completed the physical activity questionnaire.

In Italy, the original rural cohorts from Montegiorgio (Ascoli Piceno) and Crevalcore (Bologna) comprised a total of 1,712 men in 1960 (7). Montegiorgio is a village located in the hills near the Adriatic Sea. It has a mild and temperate climate. Crevalcore is a village located in the flat Po Valley. The climate there is humid, with large temperature differences between summer and winter. In the fall of 1991, 641 men from these cohorts were still alive. All survivors were invited to participate in the study, except for seven men who lived too far from the screening center. Sixty-seven percent (n = 427) of the invited men were examined, and 418 completed the physical activity questionnaire.

Thus, a total of 1,457 elderly men were examined in Finland, Italy, and the Netherlands between 1989 and 1991. Ninety-six percent of these men (n = 1,402) completed the physical activity questionnaire.

Examinations

All relevant data were collected according to the international protocol used in previous surveys of the Seven Countries Study (7). Trained physicians and nurses conducted the clinical investigations at local survey sites. Questionnaires filled in by the participants were checked for missing values and inconsistencies by the staff.

Physical activity

Physical activity was assessed with a self-administered questionnaire originally designed for retired men, made available by Professor J. N. Morris (London School of Hygiene and Tropical Medicine) and described by Caspersen et al. (9). This questionnaire is considered reliable and valid for measuring physical activity in elderly men, having demonstrated a substantial 4-month test-retest correlation (r = 0.93, p < 0.001) and having been validated by the doubly labeled water method (r = 0.61, p < 0.01) in a subsample of Zutphen study participants (10). The core questionnaire consisted of six questions about the frequency and duration of walking and bicycling during the previous week; the average amount of time spent weekly on hobbies and gardening in both summer and winter; and the average amount of time spent monthly on odd jobs and sports. Questions on the average amount of time spent weekly on farming or forestry in both summer and winter were added to the questionnaire in Finland and Italy. Monthly cross-country skiing (frequency and duration) during the previous winter was included in the calculation of total activity in Finland.

Estimated times were converted to minutes per week for each type of activity and summed to obtain total weekly physical activity. The contribution of each type of activity to total activity was calculated for each individual. When a man did not report engaging in a particular activity, it was coded as zero. Hobbies and sports were only included when they demanded a certain amount of physical effort. For example, playing an instrument, playing billiards, and sculpturing were included, but not reading, playing chess, or doing puzzles. Billiards, fishing, bowling, and dancing were classified as hobbies. Activities were also grouped by level of intensity using the intensity codes and categories proposed by Caspersen et al. (9): light (e.g., tending animals), moderate (e.g., walking, low-speed bicycling, odd jobs, billiards, fishing, hunting), and heavy (e.g., brisk walking, bicycling at normal or high speed, gardening, farming, sports, dancing).

Physical inactivity was calculated in three ways. First, the most extreme definition of physical inactivity is none at all. In the context of public health, definitions based on the generally accepted assumption that regular vigorous activity using large muscle groups is beneficial for maintaining health and fitness are used (11). When these guidelines are not met,
people can be considered physically inactive. The second cutoff point for physical inactivity therefore refers to whether or not someone is regularly active while using large muscle groups. This was operationally defined as walking or bicycling for 20 minutes at least three times per week ("appropriate" activity). Third, the intensity requirement was added to the criteria. The cutoff point was then operationally defined as engaging in "appropriate" activity at an intensity of ≥60 percent of age-adjusted maximal capacity. This was calculated by comparing intensity codes for walking and bicycling (12) with an equation predicting age-adjusted maximal capacity ((60 — 0.55 × age)/3.5), expressed in metabolic equivalents as proposed by Caspersen et al. (13) ("vigorous" activity).

Cardiovascular risk factors

Height and weight were measured while the participant stood in light clothing without shoes. Body mass index was calculated by dividing weight (kg) by the square of height (m²). Blood pressure was measured twice on the right arm after 5 minutes' rest, with the man lying in a supine position. In Finland and Italy, a standard sphygmomanometer was used, while a random-zero sphygmomanometer was used in the Netherlands. Diastolic blood pressure was recorded at the fifth Korotkoff sound. The mean value of two measurements was recorded. Hypertension was defined according to World Health Organization criteria: use of antihypertensive medication, a systolic blood pressure of ≥160 mmHg, or a diastolic blood pressure of ≥95 mmHg (14). Resting heart rate was calculated from the electrocardiogram in Italy and the Netherlands. In Finland, it was derived by counting the radial arterial pulse over a 30-second interval between the two blood pressure measurements.

Venous blood samples (fasting in Finland and non-fasting in Italy and the Netherlands) were taken. In each country, cholesterol determinations were made in lipid laboratories using procedures standardized according to the criteria of the World Health Organization's Lipid Reference Laboratories in Prague, Czechoslovakia, or Atlanta, Georgia. In all laboratories, serum total cholesterol was determined enzymatically with the CHOD-PAP Mono-Test kit of Boehringer Mannheim (Mannheim, Germany). High density lipoprotein (HDL) cholesterol was determined after precipitation of apolipoprotein B-containing lipoproteins with dextran-magnesium chloride in Finland, dextran-magnesium sulfate in the Netherlands, and magnesium phosphotungstate in Italy. Non-HDL cholesterol was used as a proxy measure for low density lipoprotein cholesterol.

Information on cigarette smoking status (never, ever, or current) was collected by the standardized Seven Countries questionnaire in Finland and Italy and by a locally developed questionnaire in the Netherlands. Information on alcohol consumption (g/day) was obtained by trained dieticians using the cross-check dietary history method (15). In Finland, this information was available only from a random sample of the study population that participated in the dietary survey (16).

History of coronary heart disease

Information on history of myocardial infarction was obtained using the London School of Hygiene and Tropical Medicine questionnaire (17).

Statistical methods

The SAS computer package (version 6.07) was used for all statistical analyses (SAS Institute, Inc., Cary, North Carolina). Analysis of variance and multiple linear regression analyses were used. Because the distribution of physical activity values was highly skewed to the right, testing for statistical significance was based on rank-ordered data when activity was the dependent variable. Spearman correlations between physical activity and cardiovascular risk factors were calculated. The associations between physical (in)activity and high risk factor levels were investigated by logistic regression analysis. Two-sided p values less than 0.05 were considered statistically significant.

Although each cohort was also analyzed separately, only pooled data are presented here, because analyses of the interaction between total physical activity and the cohorts did not point to any effect modification by cohort. Dummy variables for cohort were included in all analyses of pooled data to account for differences in culture and measurement methods, etc. Additional adjustments were made for age, smoking, body mass index, and alcohol intake.

Complete information on physical activity and cardiovascular risk factors was available for 1,271 men. However, the sample size was reduced to 1,060 when associations were adjusted for alcohol consumption.

RESULTS

The cohorts from Zutphen and Eastern Finland were younger than the other cohorts (table 1). Hypertension was most common in Italy, with antihypertensive medication being widely prescribed in the Italian cohorts in comparison with the other cohorts. The highest mean total cholesterol level and the highest prevalence of current cigarette smoking were found in
Zutphen. The lowest mean HDL cholesterol level and the highest mean body mass index were observed in Western Finland. The prevalence of a history of myocardial infarction was highest in Eastern Finland.

Physical activity patterns

The reported amount of time spent on physical activity differed between cohorts (table 2). The largest difference was observed between Crevalcore and Montegiorgio, with Crevalcore having the highest level of total reported physical activity (median, 625 minutes/week) and Montegiorgio the lowest (median, 333 minutes/week) (p < 0.05). Differences between other cohorts were not statistically significant. Total physical activity decreased with increasing age in the entire study population (β = −24.4 minutes/week per year of age; figure 1). This trend was statistically significant (p < 0.01) in all cohorts except Montegiorgio (p = 0.20). The differences between cohorts increased with increasing age. In the youngest age group (69–74 years), median total weekly activity ranged from 375 minutes in Montegiorgio to 825 minutes in Crevalcore. In the oldest age group (80–90 years), median total weekly activity ranged from 230 minutes in Montegiorgio to 343 minutes in Crevalcore.

Walking, gardening, and bicycling together contributed more than 70 percent of the mean total activity time in all cohorts (table 2). Walking contributed most to the total time in Finland and Zutphen, gardening in Montegiorgio, and bicycling in Crevalcore. Sporting activities contributed very little to the total time spent on physical activity (3 percent or less in all cohorts). The total amount of time spent on each type of activity decreased with increasing age, but the relative contribution remained relatively stable. For example, the oldest men spent an average of 57 minutes/week less time on walking than the youngest men, while the relative contribution of walking was similar for the two age groups.

Moderate intensity activities contributed most to total activity time in Finland and Zutphen (table 2). Heavy intensity activities were the predominant contributors in Italy. Total time spent on heavy and moderate intensity activities decreased with increasing age (heavy activity: β = −13.9 minutes/week per year of age (p < 0.001); moderate activity: β = −9.5 minutes/week per year of age (p < 0.001)). The contribution to total reported time showed modest increases of 0.6 percent per year for moderate intensity activities (p = 0.01) and decreased at −0.5 percent per year for heavy intensity activities (p = 0.02).

The prevalence of no reported physical activity at all varied between 5 percent in Zutphen and 18 percent in Montegiorgio (table 2). The prevalence of not enough “appropriate” physical activity ranged from 28 percent in Zutphen to 68 percent in Montegiorgio. The prevalence of inactivity based on not enough “appropriate” physical activity increased with age (31 percent in the young vs. 50
percent in the old; \( p < 0.001 \). As expected, the association with age disappeared when the age-related decline in an individual's maximum capacity was taken into account (41 percent in the young vs. 50 percent in the old; \( p = 0.50 \)).

Men with a history of myocardial infarction spent less time in physical activity than men without a previous myocardial infarction (age- and cohort-adjusted mean values: 675 minutes/week vs. 511 minutes/week; \( p = 0.02 \)).

Physical activity and cardiovascular risk factors

Total physical activity was inversely associated with resting heart rate after adjustment for age, cohort, body mass index, and cigarette smoking (table 3) (\( \beta = -0.0014 \) beats/minute per minute of activity per week). This inverse association was seen with all presented categories of physical activity, but was not significant for gardening.

Total activity was positively associated with HDL cholesterol and alcohol intake (table 3). The association with HDL cholesterol was the result of positive, albeit statistically nonsignificant, associations in all cohorts (range of age-adjusted \( r \)'s: 0.06–0.12; \( p \geq 0.12 \)). Time spent in heavy intensity activities especially contributed to this association, although this may have been due to a confounding effect of smoking status. However, after additional adjustment for smoking and body mass index, the correlation of total activity and cardiovascular risk factors remained positive, although not significant (age-adjusted correlation: \( r = 0.08; p = 0.12 \)).

![FIGURE 1. Median total physical activity according to age in Finland, Italy, and the Netherlands, 1989–1991. There were 566 men in the group aged 69–74 years (ranging from 56 in Crevalcore to 252 in Zutphen); 500 men in the group aged 75–79 years (ranging from 63 in Eastern Finland to 168 in Zutphen); and 336 men in the group aged 80–90 years (ranging from 39 in Eastern Finland to 100 in Zutphen). V, Crevalcore, Italy; O, Western Finland; D, Eastern Finland; O, Zutphen, The Netherlands; A, Montegiorgio, Italy.]

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activity with HDL cholesterol remained statistically significant in the pooled data ($r = 0.08, p < 0.01$) ($\beta = 0.00004 \text{ mmol/liter per minute of activity per week}$). This association remained similar after further adjustment for alcohol intake ($r = 0.07, p = 0.02$) or history of myocardial infarction ($r = 0.07, p = 0.01$).

The prevalence of low HDL cholesterol ($\leq 0.9 \text{ mmol/liter}$) decreased with increasing total physical activity after adjustment for age and cohort ($\beta = -0.00028, p = 0.04$). The odds ratio for low HDL cholesterol, comparing the highest physical activity quartile (median, 1,360 minutes/week) with the lowest (median, 70 minutes/week), was 0.70 (95 percent confidence interval (CI) 0.50–0.98). Neither additional adjustment for smoking and body mass index (odds ratio = 0.70, 95 percent CI 0.51–1.01) nor adjustment for alcohol intake (odds ratio = 0.72, 95 percent CI 0.48–1.09) influenced the strength of this association, although it became statistically nonsignificant.

Physical inactivity was associated with a higher prevalence of low HDL cholesterol, but this result was not statistically significant. When physical inactivity was defined as not being appropriately active (i.e., no regular physical activity while using large muscle groups), the odds ratio was 1.21 (95 percent CI 0.87–1.68) after adjustment for age, cohort, smoking, and body mass index. When physical inactivity was defined as not being vigorously active, the adjusted odds ratio was 1.24 (95 percent CI 0.90–1.70).

Total cholesterol, non-HDL cholesterol, body mass index, and arterial blood pressure were not consistently associated with total physical activity (table 3). Blood pressure levels were analyzed after exclusion of men using antihypertensive medication. However, when men using antihypertensive medication were included in the analyses and the prevalence of hypertension was studied, no association with total activity was observed ($p = 0.41$). Results were similar in all cohorts.

Except for the association between physical activity and body mass index ($p$ value for interaction $< 0.01$), the results did not vary by age. The association between physical activity and body mass index was nonsignificant in all age groups, but the association tended to be an inverse one in the youngest age groups after adjustment for cohort and cigarette smoking (ages 69–74 years: $r = -0.06, p = 0.19$; ages 75–79 years: $r = -0.02, p = 0.70$) and positive in the oldest age group (ages 80–90 years; $r = 0.03, p = 0.63$). This was consistently observed across physical activity categories.
DISCUSSION

The results of the present study show that physical activity patterns varied not only between our European cohorts but also within these cohorts. Despite cultural differences, the association of total physical activity with the selected cardiovascular risk factors was essentially the same in all cohorts and did not vary with age. Total activity was inversely associated with resting heart rate and was positively associated with HDL cholesterol. These associations remained statistically significant after adjustment for potentially confounding factors. No consistent associations were seen with total cholesterol, non-HDL cholesterol, body mass index, arterial blood pressure, or hypertension.

Our physical activity questionnaire has been shown to be reliable and valid for measuring physical activity in elderly Dutch men (10). The inverse association between total physical activity and resting heart rate in this study indicates that cross-cultural extrapolation is justified, because resting heart rate can be considered a surrogate measure for physical activity and fitness (18). However, the degree to which this questionnaire is accurate across populations is not known, and this question should be resolved empirically.

Discussion of topics related to intensity of physical activity is especially impeded by difficulties in interpreting standardized intensity codings, which are routinely used in epidemiologic research. Cultural and environmental differences are added to the generally recognized limitations of such coding schemes, such as individual variation in movement patterns, differences in reporting, and use of estimated energy expenditure instead of empirically derived energy expenditure (12). Furthermore, most of the available data are based on adults rather than elderly men. In the absence of cohort-specific intensity codings for 69- to 90-year-old men, we chose to use the intensity codings and classification system previously applied to elderly men in the 1985 Zutphen Study (9). The intensity codes proposed by Ainsworth et al. (12) were included for specific types of activity that were not classified in the Zutphen survey. These codings were also used to estimate the prevalence of physical inactivity when the individual's age-adjusted maximal capacity was taken into account.

However, it remains generally difficult to draw conclusions about the intensity of physical activities using questionnaires and intensity codes. Intensity codes operationally define intensity as the "level of imposed workload," implicitly assuming a similar maximal capacity for all subjects. In attempting to fully understand the relation between intensity of physical activity and health-related benefits, an individual's relative workload is also physiologically important. The classification of intensity into light, moderate, and heavy categories as proposed by Caspersen et al. (9) roughly allows for the decline in maximal capacity with increasing age in the total study population by lowering the boundaries between intensity categories used for adults. Thus, in our study, the total amounts of time spent on heavy intensity and moderate intensity activities declined with age. As expected, the age effect diminished when the intensity codes were related to individually estimated maximal capacity. This was demonstrated not only by Caspersen et al. (13, 19) but also by two of our different ways of estimating the prevalence of physical inactivity. When physical activity was absolutely defined (not meeting the criterion of walking or bicycling for 20 minutes at least three times per week), the prevalence increased with age, in contrast to the case when it was "relatively" defined (not walking or bicycling for 20 minutes three times per week at an intensity of ≥60 percent of maximal capacity).

Many of the age-related physiologic alterations in function may be attenuated by regular physical activity, and thus may preserve functional independence even in the very old (1). In this study, large variability in total activity was noted within cohorts, and mean activity levels differed substantially between cohorts. For public health purposes, the median amount of total activity is especially informative. The Montegiorgio cohort had the lowest median level of total activity (50 minutes/day). This cohort also had the highest estimated prevalence of physical inactivity. Montegiorgio is a hilly area; whenever one goes outdoors there, one must always go either uphill or downhill. In elderly men, many of whom have physical ailments, this probably influences their level of physical activity.

Seasonal variation between cohorts during the survey period might have influenced the comparison of physical activity patterns, although the surveys took place during the seasonal transition periods between the extremes of summer and winter. In Finland, total activity might have been underestimated because of shorter days and deteriorating weather in the fall. The pattern of physical activity described in our study is generally in accordance with previously reported results for elderly populations in the United Kingdom (20), the United States (21), and the Netherlands (9). Walking, gardening, and bicycling contributed substantially to the physical activity pattern of our study population. Except for the Montegiorgio cohort (9 percent), the prevalence of men reporting bicycling was remarkably high in all cohorts (ranging from 34 percent in Eastern Finland to 78 percent in Crevalcore). Despite a decrease in total amounts of
time spent on separate activities with increasing age, the pattern remained generally stable with age.

Total physical activity was independently associated with HDL cholesterol in our cohorts. The positive association in the pooled data resulted from a positive association in each individual cohort. Such a favorable association was also reported for the Zutphen cohort in 1985 after adjustment for age, cigarette smoking, body mass index, and alcohol consumption (9). These results are consistent with reported results from population-based studies of Japanese men aged 60–81 years in Hawaii (22) and 50- to 89-year-old men in a California retirement community (23). The effects of exercise on HDL cholesterol levels in elderly people have not been extensively investigated, but favorable effects are described in training studies and studies comparing active elderly people with their sedentary counterparts (24–26). Research designed to explain the potential relation between exercise and lipoproteins is sparse, and results have not been fully consistent. Several mechanisms have been postulated, including 1) increased activity of the enzyme lipoprotein lipase, 2) decreased activity of hepatic lipase, and 3) increased activity of lecithin cholesterol acyltransferase with exercise (27).

Total physical activity was not consistently associated with total cholesterol, non-HDL cholesterol, body mass index, or arterial blood pressure in our study. Except for the blood pressure results, our results are in line with previously published data (9, 22, 23, 28). Exclusion of a large number of men who were taking antihypertensive medication, especially in the Italian cohorts, could have influenced the results with regard to blood pressure. However, when all men were included in the analyses of the pooled data, no clear association was noted between total physical activity and the prevalence of hypertension. Inverse associations between physical activity and blood pressure in elderly men and women have been reported in other cross-sectional studies (29, 30) and in training studies (31–33). Like the pooled data in our study, the results of the 1985 Zutphen survey did not suggest a clear association between total physical activity and blood pressure (9). The previously reported inverse association between summer gardening and systolic blood pressure seen in the 1985 Zutphen survey (9) was not confirmed in the 1990 Zutphen survey (which was part of our internationally pooled data) or in our pooled data as a whole, either for summer gardening (data not shown) or for year-round gardening.

Despite cultural differences, the associations seen here between total physical activity and the selected cardiovascular risk factors were essentially the same in all five of our cohorts and across age groups. Total physical activity was inversely associated with resting heart rate and was positively associated with HDL cholesterol. We conclude that physical activity may have a beneficial effect on HDL cholesterol levels in elderly men.

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