Physical Activity History and End-of-Life Hospital and Long-Term Care

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Background. Little is known about the early predictors of need for care in late life. The purpose of this study was to investigate whether physical activity from midlife onward was associated with hospital and long-term care in the last year of life.

Methods. We studied a decedent population of 846 persons aged 66–98 years at death, who, on average 5.8 years prior to death, had participated in an interview about their current and earlier physical activity. Data on the use of care in the last year of life are register-based data and complete.

Results. Men needed on average 96 days (SD 7.0) and women 138 days (SD 6.2) of inpatient care in the last year of life. Among men, the risk for all-cause hospital care in the last year of life was higher for those who had been sedentary since midlife (adjusted incidence rate ratio [IRR] 1.98, 95% confidence interval [CI] 1.14–3.42) compared with those who had been consistently physically active, whereas use of long-term care did not correlate with physical activity history. Among women, the risk for long-term care was higher for those who had been sedentary (IRR 2.03, 95% CI 1.28–3.21) or only occasionally physically active (IRR 1.60, 95% CI 1.06–2.43), than for those who had been consistently active from midlife onward, whereas use of hospital care did not correlate with physical activity history.

Conclusion. People who had been physically active since midlife needed less end-of-life inpatient care but patterns differed between men and women.

Key Words: Aging—Physical activity—Health care—Chronic diseases—Decedent population—Disability.

The need for health care increases with age and closeness to death (1,2) mainly because of increased need for nursing home care among very old frail persons (3,4). However, little is known about the early predictors of need for care in late life (5).

Compression of morbidity theory suggests that healthy lifestyles may delay onset of morbidity and thus help compressing the period of disability and high health care costs to near the end of life (6). Regular physical activity reduces the risk for chronic disabling diseases such as coronary heart disease (7–9) and diabetes (10). Physical activity may be an important factor in preventing disability in old age among people with chronic disease (11–15). Recent long-term studies have found that midlife and old-age physical activity lowered the risk for late life disability and dementia (16,17) and that former elite athletes had less need for hospital care during later life than age-matched controls (18). However, little is known about the association of physical activity earlier in life and need for inpatient care prior to death among people who die in old age. The longer life span of physically active people may predispose them to more rather than less need for care at the end of life. In contrast, persons who exercise regularly may suffer less from chronic diseases and disability in old age and thus need less health and social care services at the end of life than more sedentary people. We studied the association of self-reported physical activity participation from midlife to old age and all-cause hospital and long-term care in the last year of life. Analyses were stratified according to gender and age at death.

Methods

Participants and Data Collection

In the year 1988, a random sample of 1,600 community-dwelling residents of the City of Jyväskylä in central Finland aged 65–84 years was drawn from the National Population Register as part of the prospective cohort study called Evergreen study (described in detail elsewhere; 19). Participants were interviewed face-to-face in 1988 and in 1996. A total of 1,224 people (77%) of the target group took part in the first interview in 1988. From that population, we conducted a nested case study. Cases consisted of 846 persons who had died during 1989–2004. Those who had died in 1988 and those who were alive at the end of the follow-up in January 2005 were excluded, to allow for a 1-year follow-up of service use before death (Figure 1).

Data were collected in face-to-face interviews conducted at the participants’ homes by trained university undergraduates...
in 1988 and 1996. To shorten the distance from interview to last year of life, the data collection wave more proximal to the last year of life was used. Thus, data collected in 1988 were used for persons who died during 1989–1997 and data collected in 1996 for those who died during 1998–2004, except for persons who had died during 1998–2004 but not participated in the 1996 interview (6%) or were institutionalized by 1996 (3%). For these persons, the 1988 interview data were used. The length of time from interview to death ranged between 1 and 9 years for 91% and 10 and 16 years for 9% of the participants, average time from interview to death being 5.8 years. The study was approved by the Ethical Committee of the Central Finland Health Care District.

Outcome Data
In Finland, university, central, and district hospitals offer specialized care. Health center inpatient wards and nursing homes (long-term care) provide mainly rehabilitation and palliative care. Data on university hospital, central and district hospital, and health center ward care were drawn from the National Research and Development Centre for Welfare and Health (Stakes) register. The information consisted of dates on all-cause admissions and discharges and the exact public or private institution in which care took place. Data on nursing home care were collected from the local registers of nursing homes in the area. On the basis of the register data, we calculated the exact number of inpatient days of hospital and long-term care in the last year of life. These data were linked to the Evergreen study interview data. The number of hospital and long-term care days in the last year of life were analyzed separately in the negative binomial regression models.

Measures
Present physical activity level and intensity was determined on a 7-point scale: moving about only minimally to carry out everyday chores, light physical activity one to two times a week, light physical activity several times a week, exercise causing breathlessness and sweating one to two times a week, exercise causing breathlessness and sweating several times a week, exercise causing breathlessness and heavy sweating several times a week, and engaging in competitive sports several times a week (20, 21).

Physical activity earlier in life was determined by asking retrospectively about participation in recreational or competitive sports at the ages of 10–19, 20–39, 40–64, 65–74 years, and 75 years and older (22). The disciplines typically included, for example, skiing, track and field sports, and gymnastics.

Physical activity was categorized according to self-report data from midlife to old age because physical activity from 40 years and older has been found to predict activity in old age (22) and because midlife physical activity has been observed to be related more closely to health and functional capacity in old age than more distal physical activity behavior (16, 17). Three exclusive groups according to physical activity at 40–64 years, 65–74 years, and 75 years and older, and present physical activity were formed. The groups were as follows: (a) consistently physically active from midlife onward (consistent participation in recreational or competitive sports from 40 years onward and at the time of the interview at least light physical activity several times per week), (b) occasionally physically active from midlife onward (participation in sports at some

![Figure 1. Formation of the study population, deaths, and data collection wave used.](https://academic.oup.com/biomedgerontology/article-abstract/64A/7/778/549416/15228846)
point, but not consistently, from 40 years onward and at the time of the interview either active or sedentary), and (c) consistently sedentary from midlife onward (no engagement in sports from 40 years onward and at the time of the interview light physical activity one to two times a week at most).

Potential confounders included age at death (range 66–98 years), gender, full-time education (6 years or less vs more than 6 years), marital status (married or cohabiting/single, widowed, divorced), current smoking (yes/no), and receiving formal home care during the previous year (yes/no). Cognitive functioning was measured with Mini-D test (23), developed from the neuropsychological test of Luria (24). Scores ranged from 0 to 43, with a higher score indicating better cognitive functioning. Morbidity was assessed according to self-reported physician-diagnosed chronic diseases lasting more than 3 months and primary causes of death obtained from the National Population Register. Causes of death were classified as diseases of the heart and circulatory, nervous, respiratory, digestive, and genitourinary system, and cancer at any site, acute infections, accidents, and all other causes of death according to the International Classification of Diseases, ninth version (25). The time from interview to death was calculated (range 1–16 years) and used as a variable in the models. In addition, self-reported information on instrumental activities of daily living (IADL) disability was collected with regard to 10 IADL tasks: preparing meals, washing clothes, shopping, coping with light and heavy housework, administering and taking medications, using the telephone, using public transport, and handling finances (26,27).

Statistical Analyses

Comparisons of discrete baseline characteristics were performed using chi-square tests. For continuous variables, independent sample t test and analysis of variance were used. All tests were performed as two tailed in SPSS 14.0, with significance level at \( p < .05 \).

We studied the association between physical activity from midlife onward and hospital and long-term care using negative binomial regression models, where the strength of an association is measured as an incidence rate ratio (IRR). IRRs are interpreted as relative risk estimates and represent the risk for persons in the predictor variable groups relative to those in the reference group. Hospital and long-term care outcomes were continuous variables with 1 day as a unit. We estimated risk values (IRR) and their 95% confidence intervals (CIs) by comparing those who had been sedentary from midlife onward and those who had been occasionally physically active from midlife onward with those who had been consistently physically active from midlife onward (reference group). The likelihood ratio test was used to assess the interaction effect between gender and physical activity behavior. IRRs were calculated for men and women separately for risk for hospital and long-term care in the last year of life. Modeling was performed with STATA 9 software (28), with significance level set at \( p < .05 \) for all effects.

RESULTS

Of the 846 deaths, 26% occurred at the ages of 66–79, 53% at 80–88, and 21% at 89–98 years. The mean age of death was 82 (SD 6.2) years for men and 84 (SD 6.1) years for women. About 67% of the participants were women. The most common causes of death were diseases of the heart and circulatory system (54%); cancer at any site (19%); diseases of the nervous system, for example, dementia (8%); and acute infections, for example, septicemia (4%). We observed a statistically significant gender interaction for hospital (\( p = .027 \)) and long-term care (\( p = .001 \)) and thus analyzed care separately for men and women.

Thirty-eight percent of men and 23% of women were categorized as physically active from midlife onward. They suffered less from IADL disability, used less formal home care, and more frequently had higher education than those categorized into sedentary or occasionally physically active groups (Table 1).

For men and women, hospital care decreased and long-term care increased in the last year of life with older age at death (Figure 2A and B). For men, hospital care decreased with higher level of physical activity from midlife onward (\( p \) for trend .026), but there were no differences in long-term care use according to physical activity behavior. For women, we detected an increase in long-term care with lower physical activity level (\( p \) for trend .021), but there were no differences in hospital care use according to physical activity behavior from midlife onward (Figure 2C and D).

For men, with the active group as the reference, the adjusted risk for all-cause hospital care in the last year of life was higher for those who had been sedentary (IRR 1.98, 95% CI 1.14–3.42). The long-term care risk did not differ according to physical activity (Table 2). For women, the risk for hospital care did not differ according to physical activity. The risk for long-term care in the last year of life was higher for those women who had been sedentary (IRR 2.03, 95% CI 1.28–3.21) or occasionally physically active (IRR 1.60, 95% CI 1.06–2.43) from midlife onward, with the consistently physically active as the reference (Table 3). The results remained the same when we used data solely on earlier physical activity as a predictor of need for care.

We stratified the study group according to age at death (66–79, 80–88, and 89–98 years). For men, the results were similar for all age strata for the risk for hospital and long-term care. For women who had died at the age of 66–79 or 80–88 years, the risk for long-term care in the last year of life was lower among the consistently active women compared to others. However, for women who
died at the age of 89–98 years, the statistical significance of physical activity behavior on need for long-term care was diminished (data not shown).

In addition, the proximity of the interview and death was investigated by excluding persons who had died 1–2 years after the interview, but it did not change the results.

**DISCUSSION**

Men who reported consistent physical activity from midlife onward needed fewer days of hospital care in their last year of life than those who reported less physical activity. For women who died before 90 years of age, the same was true for long-term care. All analyses were
performed for a decedent population who had taken part in an ante mortem interview about their physical activity participation. These data were linked with register-based data on hospital and long-term care during the year preceding death.

Our results are in agreement with earlier studies about the need for end-of-life inpatient care and age at death. Hospital care with aggressive forms of care decreases (29,30) and need for long-term care increases with older age at death (2,3). However, most of the earlier research has not included care given both in a hospital and in a nursing home, which underestimates the total care needed at the end of life (31).

To the best of our knowledge, this is the first study to report on the association of physical activity and the need for hospital and long-term care at the end of a long life. For sedentary men, the higher use of hospital care may be due to their higher incidence of conditions requiring specialized care or longer duration of care compared with more physically active men (32). In men, physical activity earlier in life and length of long-term care in the last year of life did not correlate. A potential explanation is that men needing care are often cared for at home by their spouses and they tend to die before their caregivers (32). Our analyses showed that sedentary women needed more days of long-term care in their last year of life than more active women. This could be due to the fact that sedentary women might have suffered from disability more frequently than their active counterparts and thus would have needed more long-term care at the end of life.

A plausible explanation for the preventive effect of physical activity on the need for care is in line with the disablement process described by Nagi (33). Consistent physical activity from midlife onward can reduce the risk for disease (6,8,34) and development of functional limitations (14,35). This further postpones or prevents the development of disability (36–38), which is often reflected in increased need for assistance and care in activities of daily living (39). We were able to confirm the relation between physical activity from midlife onward and disability in old age by further analysis (data not shown). The risk for disability in old age was higher for those who had been sedentary or occasionally active from midlife onward compared with the consistently active. Thus, consistent physical activity from midlife onward might help decrease the development and progression of disability, which in turn could contribute to an increase in active life expectancy and a reduced need for end-of-life care.

The strengths of the study are the decedent study population, the ante mortem interviews used with register-based data for hospital and long-term care, long follow-up, wide range of ages at death, and the prospective design. Limitation in the study was that physical activity data were collected with retrospective interview and were based on self-report. Potential recall bias and possible subclinical cognitive impairments the participants might have had at the time of the interview may have influenced the results (5,40,41). Persons who were physically active at the time of the interview may recall their earlier physical activity more

### Table 2. IRR and 95% CI From Negative Binomial Regression Models for the Risk for Hospital and Long-term Care in the Last Year of Life for Men, With Consistently Physically Active From Midlife Onward as the Reference Group

<table>
<thead>
<tr>
<th>Physical activity from midlife onward</th>
<th>Hospital Care, IRR (95% CI)</th>
<th>Long-term Care, IRR (95% CI)</th>
<th>Hospital Care, IRR (95% CI)</th>
<th>Long-term Care, IRR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistently physically active</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Occasionally physically active</td>
<td>1.46 (0.98–2.17)</td>
<td>0.84 (0.48–1.46)</td>
<td>1.35 (0.91–2.00)</td>
<td>1.29 (0.68–2.43)</td>
</tr>
<tr>
<td>Consistently sedentary</td>
<td>1.79 (1.03–3.12)</td>
<td>0.82 (0.37–1.82)</td>
<td>1.96 (1.14–3.42)</td>
<td>1.23 (0.52–2.94)</td>
</tr>
<tr>
<td>Age at death, IRR/y</td>
<td>0.95 (0.92–0.98)</td>
<td>1.09 (1.04–1.14)</td>
<td>0.97 (0.94–1.00)</td>
<td>1.07 (1.00–1.14)</td>
</tr>
</tbody>
</table>

Note: CI = confidence interval; IRR = incidence rate ratio. Model 1, adjusted for age at death; model 2, model 1 + adjusted for time from interview to death, marital status, education, smoking, formal home care, cognitive functioning, selected chronic diseases, and causes of death.

### Table 3. IRR and 95% CI From Negative Binomial Regression Models for the Risk for Hospital and Long-term Care in the Last Year of Life for Women, With Consistently Physically Active From Midlife Onward as the Reference Group

<table>
<thead>
<tr>
<th>Physical activity from midlife onward</th>
<th>Hospital Care, IRR (95% CI)</th>
<th>Long-term Care, IRR (95% CI)</th>
<th>Hospital Care, IRR (95% CI)</th>
<th>Long-term Care, IRR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistently physically active</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Occasionally physically active</td>
<td>0.90 (0.63–1.30)</td>
<td>1.78 (1.22–2.59)</td>
<td>0.70 (0.48–1.03)</td>
<td>1.60 (1.06–2.43)</td>
</tr>
<tr>
<td>Consistently sedentary</td>
<td>0.68 (0.45–1.02)</td>
<td>1.79 (1.18–2.71)</td>
<td>0.72 (0.47–1.10)</td>
<td>2.03 (1.28–3.21)</td>
</tr>
<tr>
<td>Age at death, IRR/y</td>
<td>0.93 (0.91–0.95)</td>
<td>1.08 (1.06–1.11)</td>
<td>0.97 (0.94–0.99)</td>
<td>1.04 (1.01–1.07)</td>
</tr>
</tbody>
</table>

Note: CI = confidence interval; IRR = incidence rate ratio. Model 1, adjusted for age at death; model 2, model 1 + adjusted for time from interview to death, marital status, education, smoking, formal home care, cognitive functioning, selected chronic diseases, and causes of death.
accurately. To be categorized as physically active, a person had to report engagement in recreational or competitive sports over all three periods in time, which consistently sedentary persons would probably not report by mistake. Furthermore, we cannot rule out the possibility that some participants were sedentary in their midlife due to chronic diseases. However, we performed subgroup analyses for those who had a disease of the heart and circulatory system. The association of physical activity with need for hospital and long-term care did not differ from the results for the whole study population (data not shown). It has been reported earlier that a higher level of physical activity in midlife correlates with higher function in old age, regardless of adjustment for chronic diseases at baseline (39). Data were not available for us to take into account in our analyses care that took place outside institutions. However, we did adjust the models for marital status as the spouse is the most likely provider of care outside the institutions. More detailed information on onset of chronic conditions and physical activity behavior throughout the life span should be included in future studies. It should also be emphasized that our study is based on observational data and therefore definite conclusions about cause and effect cannot be drawn.

Our findings among people who died after 66 years of age suggest that consistent long-term physical activity may decrease the need for end-of-life hospital care for men and long-term care for women regardless of the common chronic diseases people may have. However, physical activity may not reduce the need for long-term care at the end of life for women with extremely long lives, which is the group of people that will continue to grow within the next few decades in Western countries. Our results provide novel information, which need to be confirmed in further studies.

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