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**Author(s):** von Bonsdorff, Mikaela; Rantanen, Taina; Leinonen, Raija; Kujala, Urho; Törmäkangas, Timo; Mänty, Minna; Heikkinen, Eino

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1                   **Physical activity history and end-of-life hospital and long-term care**

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4                   Mikaela B von Bonsdorff, MSc,<sup>1</sup> Taina Rantanen, PhD,<sup>1</sup> Raija Leinonen, PhD,<sup>2</sup>  
5                   Urho M Kujala, MD, PhD,<sup>3</sup> Timo Törmäkangas, MSc,<sup>1</sup>  
6                   Minna Mänty, MSc,<sup>1</sup> Eino Heikkinen, MD, PhD<sup>1</sup>

7  
8  
9                   <sup>1</sup>Finnish Centre for Interdisciplinary Gerontology, University of Jyväskylä, PO Box 35 (Viv),  
10                  40014 University of Jyväskylä, Finland

11                  <sup>2</sup>GeroCenter Foundation for Research and Development, Kinkomaan sairaala, 40930 Kinkomaa,  
12                  Finland

13                  <sup>3</sup>Department of Health Sciences, University of Jyväskylä, PO Box 35, 40014 University of  
14                  Jyväskylä, Finland

15  
16  
17                  **Corresponding author and reprint requests:**

18                  Mikaela von Bonsdorff  
19                  Finnish Centre for Interdisciplinary Gerontology  
20                  University of Jyväskylä  
21                  PO Box 35 (Viveca)  
22                  FIN-40014 University of Jyväskylä  
23                  Tel. +358 14 260 4596, Fax +358 14 260 4600, e-mail [mikaela.bonsdorff@sport.jyu.fi](mailto:mikaela.bonsdorff@sport.jyu.fi)

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34 **ABSTRACT**

35

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

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

43 **Results.** Men needed on average 96 days (SD 7.0) and women 138 days (SD 6.2) of in-patient  
44 care in the last year of life. Among men, the risk for all-cause hospital care in the last year of life  
45 was higher for those who had been sedentary since midlife (adjusted risk ratio [IRR] 1.98, 95%  
46 confidence interval [CI] 1.14-3.42) compared to those who had been consistently physically active  
47 while use of long-term care did not correlate with physical activity history. Among women, the  
48 risk for long-term care was higher for those who had been sedentary (IRR 2.03, 95% CI 1.28-3.21)  
49 or only occasionally physically active (IRR 1.60, 95% CI 1.06-2.43), than for those who had been  
50 consistently active from midlife onwards, while use of hospital care did not correlate with physical  
51 activity history.

52 **Conclusion.** People who had been physically active since midlife needed less end-of-life in-  
53 patient care, but patterns differed between men and women.

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60 **INTRODUCTION**

61

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

65

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

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85 **METHODS**

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87 **Participants and data collection**

88 In the year 1988, a random sample of 1600 community-dwelling residents of the City of Jyväskylä  
89 in central Finland aged 65-84 years was drawn from the national Population Register as part of the  
90 prospective cohort study called Evergreen study (described in detail elsewhere) (19). Participants  
91 were interviewed face-to-face in 1988 and in 1996. 1224 people (77%) of the target group took  
92 part in the first interview in 1988. From that population, we conducted a nested case study. Cases  
93 consisted of 846 persons who had died during 1989-2004. Those who had died in 1988 and those  
94 who were alive at the end of the follow-up in January 2005 were excluded, to allow for a one-year  
95 follow-up of service use before death (Figure 1).

96

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

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110 **Outcome data**

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

121

122 **Measures**

123 Present physical activity level and intensity was determined on a seven point scale: moving about  
124 only minimally to carry out everyday chores; light physical activity 1-2 times/week; light physical  
125 activity several times/week; exercise causing breathlessness and sweating 1-2 times/week;  
126 exercise causing breathlessness and sweating several times/week; exercise causing breathlessness  
127 and heavy sweating several times/week; and engaging in competitive sports several times/week  
128 (20,21). Physical activity earlier in life was determined by asking retrospectively about  
129 participation in recreational or competitive sports at the ages of 10-19, 20-39, 40-64, 65-74 years,  
130 and 75 years and over (22). The disciplines typically included e.g. skiing, track and field sports,  
131 and gymnastics.

132

133 Physical activity was categorized according to self-report data from midlife to old age, because  
134 physical activity from age 40 years and over has been found to predict activity in old age (22), and

135 because midlife physical activity has been observed to be related more closely to health and  
136 functional capacity in old age than more distal physical activity behavior (16,17). Three exclusive  
137 groups according to physical activity at 40-64 years, 65-74 years, 75 years and over, and present  
138 physical activity were formed. The groups were 1) consistently physically active from midlife  
139 onwards (consistent participation in recreational or competitive sports from 40 years onwards and  
140 at the time of the interview at least light physical activity several times/week), 2) occasionally  
141 physically active from midlife onwards (participation in sports at some point, but not consistently,  
142 from 40 years onwards and at the time of the interview either active or sedentary), and 3)  
143 consistently sedentary from midlife onwards (no engagement in sports from 40 years onwards and  
144 at the time of the interview light physical activity 1-2 times/week at most).

145

146 Potential confounders included age at death (range 66-98), gender, full-time education (6 years or  
147 less vs. more than 6 years), marital status (married or cohabiting/single, widowed, divorced),  
148 current smoking (yes/no) and receiving formal home care during the previous year (yes/no).  
149 Cognitive functioning was measured with Mini-D test (23), developed from the  
150 neuropsychological test of Luria (24). Scores ranged from 0-43, with a higher score indicating  
151 better cognitive functioning. Morbidity was assessed according to self-reported physician-  
152 diagnosed chronic diseases lasting over three months and primary causes of death obtained from  
153 the national Population Register. Causes of death were classified as diseases of the heart and  
154 circulatory, nervous, respiratory, digestive, and genitourinary system, and cancer at any site, acute  
155 infections, accidents and all other causes of death according to the International Classification of  
156 Diseases, ninth version (ICD-9) (25). The time from interview to death was calculated (range 1-16  
157 years) and used as a variable in the models. In addition, self-reported information on instrumental  
158 activities of daily living (IADL) disability was collected with regard to ten IADL tasks: preparing

159 meals, washing clothes, shopping, coping with light and heavy housework, administering and  
160 taking medications, using the telephone, using public transport, and handling finances (26,27).

161

## 162 **Statistical analyses**

163 Comparisons of discrete baseline characteristics were performed using chi-square tests. For  
164 continuous variables, independent sample t-test and ANOVA were used. All tests were performed  
165 as two-tailed in SPSS 14.0 with significance level  $p < 0.05$ .

166

167 We studied the association between physical activity from midlife onwards and hospital and long-  
168 term care using negative binomial regression models, where the strength of an association is  
169 measured as an Incidence Rate Ratio (IRR). IRRs are interpreted as relative risk estimates and  
170 represent the risk for persons in the predictor variable groups relative to those in the reference  
171 group. Hospital and long-term care outcomes were continuous variables with one day as a unit.

172 We estimated risk values (IRR) and their 95% confidence intervals (CI) by comparing those who  
173 had been sedentary from midlife onwards and those who had been occasionally physically active  
174 from midlife onwards with those who had been consistently physically active from midlife  
175 onwards (reference group). The likelihood ratio test was used to assess the interaction effect  
176 between gender and physical activity behavior. IRRs were calculated for men and women  
177 separately for risk for hospital and long-term care in the last year of life. Modeling was performed  
178 with STATA 9 software (29), with significance level set at  $p < 0.05$  for all effects.

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184 **RESULTS**

185

186 Of the 846 deaths, 26% occurred at the ages of 66-79, 53% at 80-88, and 21% at the ages of 89-98.

187 The mean age of death was 82 (SD 6.2) years for men and 84 (SD 6.1) years for women. 67% of

188 the participants were women. The most common causes of death were diseases of the heart and

189 circulatory system (54%), cancer at any site (19%), diseases of the nervous system e.g. dementia

190 (8%), and acute infections e.g. septicemia (4%). We observed a statistically significant gender

191 interaction for hospital ( $p=0.027$ ) and long-term care ( $p=0.001$ ), and thus analyzed care separately

192 for men and women.

193

194 Thirty-eight percent of men and 23 percent of women were categorized as physically active from

195 midlife onwards. They suffered less from IADL disability, used less formal home care, and more

196 frequently had higher education than those categorized into sedentary or occasionally physically

197 active groups (Table 1).

198

199 For men and women, hospital care decreased and long-term care increased in the last year of life

200 with older age at death (Figure 2 A and B). For men, hospital care decreased with higher level of

201 physical activity from midlife onwards ( $p$  for trend 0.026), but there were no differences in long-

202 term care use according to physical activity behavior. For women, we detected an increase in long-

203 term care with lower physical activity level ( $p$  for trend 0.021), but there were no differences in

204 hospital care use according to physical activity behavior from midlife onwards (Figure 2 C and D).

205

206 For men, with the active group as the reference, the adjusted risk for all-cause hospital care in the

207 last year of life was higher for those who had been sedentary (risk ratio [IRR] 1.98, 95%

208 confidence interval [CI] 1.14-3.42). The long-term care risk did not differ according to physical

209 activity (Table 2). For women, the risk for hospital care did not differ according to physical  
210 activity. The risk for long-term care in the last year of life was higher for those women who had  
211 been sedentary (IRR 2.03, 95% CI 1.28-3.21) or occasionally physically active (IRR 1.60, 95% CI  
212 1.06-2.43) from midlife onwards, with the consistently physically active as the reference (Table 3).  
213 The results remained the same when we used data solely on earlier physical activity as a predictor  
214 of need for care.

215

216 We stratified the study group according to age at death (66-79, 80-88, and 89-98 years). For men,  
217 the results were similar for all age strata for the risk of hospital and long-term care. For women  
218 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  
219 was lower among the consistently active women compared to others. However, for women who  
220 died at the age of 89-98 years, the statistical significance of physical activity behavior on need for  
221 long-term care was diminished (data not shown).

222

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

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235 **DISCUSSION**

236

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

243

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

249

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

260  
261 A plausible explanation for the preventive effect of physical activity on the need for care is in line  
262 with the disablement process described by Nagi (33). Consistent physical activity from midlife  
263 onwards can reduce the risk of disease (6,8,34) and development of functional limitations (14,35).  
264 This further postpones or prevents the development of disability (36-38) which is often reflected in  
265 increased need for assistance and care in activities of daily living (39). We were able to confirm  
266 the relation between physical activity from midlife onwards and disability in old age by further  
267 analysis (data not shown). The risk for disability in old age was higher for those who had been  
268 sedentary or occasionally active from midlife onwards compared to the consistently active. Thus,  
269 consistent physical activity from midlife onwards might help decrease the development and  
270 progression of disability, which in turn could contribute to an increase in active life expectancy  
271 and a reduced need for end-of-life care.

272  
273 The strengths of the study are the decedent study population, the ante-mortem interviews used  
274 with register-based data for hospital and long-term, long follow-up, wide range of ages at death  
275 and the prospective design. Limitation in the study was that physical activity data were collected  
276 with retrospective interview and were based on self-report. Potential recall bias and possible  
277 subclinical cognitive impairments the participants might have had at the time of the interview may  
278 have influenced the results (5,40,41). Persons who were physically active at the time of the  
279 interview may recall their earlier physical activity more accurately. To be categorized as  
280 physically active, a person had to report engagement in recreational or competitive sports over all  
281 three periods in time, which consistently sedentary persons would probably not report by mistake.  
282 Furthermore, we cannot rule out the possibility, that some participants were sedentary in their  
283 midlife due chronic diseases. However, we performed subgroup analyses for those who had a  
284 disease of the heart and circulatory system. The association of physical activity with need for

285 hospital and long-term care did not differ from the results for the whole study population (data not  
286 shown). It has been reported earlier that a higher level of physical activity in midlife correlates  
287 with higher function in old age, regardless of adjustment for chronic diseases at baseline (39). Data  
288 were not available for us to take into account in our analyses care that took place outside  
289 institutions. However, we did adjust the models for marital status, as the spouse is the most likely  
290 provider of care outside the institutions. More detailed information on onset of chronic conditions  
291 and physical activity behavior throughout the life-span should be included in future studies. It  
292 should also be emphasized that our study is based on observational data and therefore definite  
293 conclusions about cause and effect can not be drawn.

294

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

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314 **CONFLICT OF INTEREST**

315

316 None disclosed.

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320

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322

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501 **Legends for figures:**

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503 Figure 1. Formation of the study population, deaths and data collection wave used

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505 Figure 2. All-cause hospital, long-term and total care in the last year of life according to age at

506 death (A and B) and physical activity behavior (C and D) for men and women