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Cohort differences in maximal physical performance: a comparison of 75- and 80-year-old men and women born 28 years apart

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Abstract

Background: Whether increased life expectancy is accompanied by increased functional capacity in older people at specific ages is unclear. We compared similar validated measures of maximal physical performance in two population-based older cohorts born and assessed 28 years apart.

Methods: Participants in the first cohort were born in 1910 and 1914 and were assessed at age 75 and 80 years, respectively (N=500, participation rate 77%). Participants in the second cohort were born in 1938 or 1939 and 1942 or 1943 and were assessed at age 75 and 80 years, respectively (N=726, participation rate 40%). Participants were recruited using a population register and all community-dwelling persons in the target area were eligible. Both cohorts were interviewed at home and examined at the research center with identical protocols. Maximal walking speed, maximal isometric grip and knee extension strength, lung function measurements; forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) were assessed. Data on non-participation were systematically collected.

Results: Walking speed was on average 0.2-0.4 m/s faster in the later than earlier cohort. In grip strength, the improvements were 5-25%, and in knee extension strength 20-47%. In FVC, the improvements were 14-21% and in FEV1 0-14%.

Conclusions: The later cohort showed markedly and meaningfully higher results in the maximal functional capacity tests, suggesting that currently 75- and 80-year old people in Finland are living to older ages nowadays with better physical functioning.

Key words: Secular trends, Birth cohorts, Functional capacity

Introduction

The life expectancy of older people is increasing. In Finland, for example, a person aged 75 in 1989 could expect to live a further 9.7 years whereas a same-age individual in 2017 could expect a further 12.6 years[1]. However, it is not clear whether a longer life accompanies improvements in functioning at specific ages. If functioning at specific ages is better than in the past, this could lead to a more positive outlook towards aging and contribute to projections on the needs of the work force and health and social care.

The earlier studies assessing cohort differences in the health and functioning of older people give an inconsistent picture. The prevalence of chronic conditions have been found to be stable or to increase among more recent than earlier cohorts of older people[2-4]. The results obtained from self-rated health and disability show improved[2,5], worsened[6] and stable[7,8] trends, depending on the study. These differences may stem from differences in the age groups studied, intervals between cohorts, indicators of disability and functioning, different trends between countries, and possibly from problems of comparability between recent and earlier cohorts. Moreover, the earlier studies were often based on self-report data. Apart from an individual's intrinsic capacity, self-assessments may be influenced by environmental circumstances, which may underlie the results[5].

Compared to self-assessments, performance-based measures requiring maximum effort provide more explicit and standardized information on cohort differences in physical functioning. Muscle strength, walking speed and respiratory function tests are informative and widely used performance-based tests of functional capacity, that capture current and preceding lifetime influences on functioning and predict disability and mortality risk[9,10]. Only a few studies have assessed cohort effects in performance-based maximum measures of physical performance, and the results have been mixed. For example, two studies reported an improved trend in hand grip strength[11,12] whereas other studies noted no improvement[5,13] or decline[14] among the more recent cohorts. In addition, a large population-based study assessing older adults from Germany, Sweden and Spain found contrasting trends in grip strength for different age groups. The results showed strong improvement for older adults aged 80 years and older, while younger older adults stagnated or even decreased[15]. In other studies, the later-born cohorts performed better in chair stand, walking speed and peak expiratory flow (PEF) tests[13,16,17]. When interpreting these results, it is important to bear in mind that timing and the rate of age-related changes between organs or biological systems within and between individuals differ[18,19]. For example, muscle strength declines earlier than walking speed and possibly precedes the decline in lung function[20,21]. Incorporating multiple measures will build a more comprehensive picture of the changes accompanying aging.

The challenges in assessing cohort effects include ensuring the comparability of the assessment methods and populations studied. Researchers in Finland are in an exceptionally good position to meet these challenges. First, a population-based study conducted in our center 28 years ago with standardized maximum performance-based assessment methods provides us with a valid point of reference on the functioning of people born approximately one generation ago[22,23]. Second, we can base recruitment on population registers, which reduces selection bias [11].

This study examined whether older adults born 28 years later have better physical performance compared to an earlier cohort measured at the same age. The factors underlying potential cohort differences are also investigated.

Methods

Study population

This study forms part of two projects conducted at the University of Jyväskylä, Finland. The dataset comprises the Evergreen cohort data collected in 1989-1990[24] and the Evergreen II cohort data collected in 2017-2018 as part of the *Active Ageing – Resilience and external support as modifiers of disablement outcome* (AGNES) project[25]. For both projects, samples were drawn from the Finnish Population Register based on birth year and place of residence. All community-living 75- and 80-year-old residents of the city of Jyväskylä formed the target group. Members of the earlier cohort examined in 1989-1990 were born in 1910 and 1914 and members of the later cohort examined in 2017-2018 were born in 1938-1939 and 1942-1943.

Recruitment, participation and non-participation

The Evergreen and Evergreen II recruitment procedures are comparable. Recruitment was as inclusive as possible. All persons in the targeted age groups, who were living in the community in a non-institutional setting in the recruitment area and able to respond, and who consented to take part, were included.

The recruitment area, the City of Jyväskylä, had expanded since the first Evergreen project due to mergers with neighboring municipalities. However, we targeted people, whose addresses were within the previous city area or in similar adjacent areas, including urban areas and suburbs with apartment buildings and detached houses.

During the Evergreen study, in 1989-1990, participants were sent a letter informing them about the study and suggesting a time for a home interview. Those who declined were asked to give their reasons for non-attendance and the reasons were documented. Evergreen II participants in 2017-2018 were sent a letter informing them about the study after which we enquired about their willingness to take part by phone. For those willing to take part, the home interview was scheduled. During the phone call, those declining to take part were questioned on their reasons for non-participation. The study flow charts are shown in Figure 1. In Evergreen, 500 (77%) and in Evergreen II, 726 (40%) of those eligible participated in the home interviews and research center assessments. In both studies, self-rated health was examined with the question: "How would you yourself describe your health during the last year?" using a five-option response scale ranging from very poor to very good. For statistical analysis, we recoded the responses as good, moderate and poor. In the Evergreen study, the question was asked during the home interview while in the Evergreen II it was posed during the initial phone call.

Figure 1

<u>Assessment procedure</u>

The implementation and assessment methods in both projects were identical for all practical purposes. The interviews were conducted in the participants' homes and the physical tests in the Sport and Health Laboratory of the University of Jyväskylä. The measurement equipment and laboratory environment were similar for both cohorts.

Physical performance measurements

Ten-meter maximal walking speed was assessed in the laboratory corridor using a hand-held stopwatch. Five meters was allowed for acceleration and the participant was encouraged to continue a few meters past the finish line. Participants wore walking shoes or sneakers[25].

Maximal isometric hand grip strength and maximal isometric knee extension strength were measured in the Evergreen II cohort using an adjustable dynamometer chair (Good Strength; Metitur Oy, Palokka, Finland) and the result expressed in Newtons (N)[26]. For the Evergreen cohort, we used the prototype of the Good Strength device, including similar strain gauge technology. In both cohorts, the measurements were performed identically with similar joint angles and instructions to the participant. The measurements were done on the side of the dominant hand in a sitting position with the lower back supported. Hand grip strength was measured using a dynamometer fixed to the arm of the chair. Knee extension strength was measured at an angle of 60 degrees from the fully extended leg towards flexion. After a practice trial, the test was performed at least three times with a one-minute inter-trial rest period until no further improvement occurred, and the highest value was recorded[25]. The test-retest reliability of both tests is excellent. In the 80-year-olds, the Pearson correlation coefficients between measurements conducted one to two weeks apart were $r = 0.967$ for hand grip strength and $r = 0.965$ for knee extension strength[23].

Respiratory function in the Evergreen II cohort was assessed using spirometry (Medikro Pro spirometer, Medikro Oy, Kuopio, Finland) in a standing position with a nose clip. The forced vital capacity (FVC) maneuver was performed at least two times. Participants were instructed to inhale maximally and exhale as hard and as fast as possible and continue until there was no air left. The manoeuver was continued until the criterion of the ATS/ERS Taskforce[27] was met or a maximum of eight exhalations was performed. With the Evergreen cohort, respiratory function was assessed using comparable electronic spirometry (Medikro 202;

Medikro, Kuopio, Finland) in a standing position and three trials were allowed. In both studies, the highest volume of FVC and the forced expiratory volume in one second (FEV1) were recorded in liters. PEF was recorded in liters/second.

Covariates

Our analyses were not adjusted for any confounders. The age and gender groups were similar, and we concluded that differences in covariates between the cohorts were more likely to be factors underlying the cohort differences than confounders. To study these factors, we chose correlates of physical performance that differed between the cohorts, and that theoretically can be part of the mechanism leading to secular change. Years of full-time education is known to be associated with health and functional status[28], and was used to describe socio-economic position. Body size, especially height, affects muscle strength, walking speed and respiratory function[29,30]. We measured height with a stadiometer in cm and body mass with a beam scale in kg. Health behavior was described with physical activity and smoking. Physical activity was assessed with a single validated self-report question with six response options ranging from mostly sitting and resting to regular strenuous exercise[26]. For the statistical analysis, the responses were recoded as low, moderate and high. Smoking was classified as never vs. current/ former smoker.

Statistical analysis

To compare the current and earlier same-age cohorts, we used t-tests for continuous and chi-square test for categorical variables. We tested whether the cohort differences varied according to age and sex by adding birth cohort-by-sex and birth cohort-by-age interaction terms into the linear regression analyses comprising all the participants. Factors underlying the potential cohort differences were studied in a set of linear regression models. First, the models were fitted with each physical test as a dependent variable and birth cohort as an independent variable. Subsequently, we run several models adding covariates one at a time to analyze which of them attenuates the cohort differences in physical performance. Self-rated health was not included in the models explaining cohort differences, as we believe that improved self-rated health is likely to be a result of better physical functioning and not an explanatory factor. To clarify the potential clinical significance of the cohort differences, hand grip strength cut points for increased risk for mobility limitation were determined separately for men and women based on the Finnish reference data (37kg for men and 21kg for women)[31]. According to our knowledge, cut-points for knee extension strength and gait speed that predict mobility limitations have not been analyzed based on nationally representative samples in Finland, and therefore are not available for our use. Finally, we did sensitivity analyses to assess the comparability of our cohorts based on the data available for non-participants. If the non-participants were comparable, this would suggest that the cohorts were also comparable and that the differences observed between the cohorts were less likely attributable to selection bias.

Results

In men and women and in both age groups, the number of years of education had doubled in the later- compared to earlier-born cohort (Table 1). In addition, the later-born cohort reported higher daily physical activity and better self-rated health compared to the earlier-born cohort. Among men, the proportion of ever smokers was lower in the later than earlier cohort. Among the 75-year-old women, the proportion of ever smokers was higher in the later than earlier cohort.

Mean grip strength, knee extension strength and walking speed were higher in the later- than earlier-born cohort (Table 2). In the respiratory function measures, the later-born cohort performed better in FVC and, among the 80-old men and women, in the FEV1 measures. The cohorts did not differ in PEF.

Grip strength below the validated cut-point for increased risk for mobility limitation (37 kg for men and 21 kg for women,[31]) was more evident in the earlier-born cohort. Among 75-year-old men, percentage of participants below the cut-point was 48% and 27% in the earlier and later-born cohort, respectively (between cohorts $p<0.001$). Among 75-year-old women the proportions were 35% vs. 28% ($p=0.052$). In 80-years-olds, 71% vs. 52% in men ($p=0.012$) and 75% vs. 44% in women ($p<0.001$), respectively, had values below the cut-points for increased risk for mobility limitation.

Table 2 shows the relative differences between the cohorts. The regression analyses comprising all participants showed significant cohort-by-sex interactions for grip strength ($p=0.041$), FVC ($p=0.015$) and FEV1 ($p=0.008$), suggesting larger increases in the absolute values among men compared to women in these assessments. However, the relative improvements in walking speed, grip strength and knee extension strength were greater in the 80-year-old women than in men in either age group or the 75-year-old women.

Cohort-by-age interactions were significant for walking speed ($p=0.035$) and grip strength ($p=0.001$), suggesting larger increases in the absolute values among the 80-year-olds than 75-year-olds. The interaction was also significant for FEV1 ($p=0.004$) in which only the 80-year-olds improved. Moreover, the relative percentile differences were larger among the 80-year-olds than 75-year-olds.

The linear regression models showed that the selected covariates did not fully explain the cohort differences in walking speed and muscle strength (Table 3 and 4). Better walking speed in the later cohort was partially explained by higher physical activity and longer education. The muscle strength differences in the later-born cohort were partially explained by their increased height, weight and physical activity level.

In general, the associations between birth cohort and respiratory functions attenuated after adjusting for body height and education (Table 3 and 4). The results suggest that increased body height in the later-born cohort explained a large part of the differences between the birth cohorts.

The participation rate in the later study was lower (see Figure 1). For this reason, we compared all knowledge available on non-participants. The most common reason for non-participation at both times was lack of interest or not having time to take part (eTable 1 in the Supplement). Poor health was slightly more common in the earlier cohort. In both studies, the proportions with unknown or other reasons for participation were practically identical. Information on self-rated health was available for 47% of the non-participants in the earlier cohort and for 73% of the non-participants in the later cohort. Self-rated health did not differ between the non-participants of the Evergreen and Evergreen II cohorts (p=0.539). The result did not change when the comparisons were made separately for age groups and sex. Overall, we observed no explicit differences between the non-participants of the earlier and later cohorts, suggesting the absence of systematic selection bias between the studies.

Discussion

We observed that the maximal physical performance of men and women aged 75 or 80 years assessed 28 years apart was markedly and meaningfully better in the later-born cohort. For grip strength, the improvements varied between 11 and 55 Newtons depending on age and sex. Inferring from a meta-analysis[18] (10 Newton or 1 kg higher grip strength corresponds to 3% decline in mortality), the mortality risk of the 80-year-old men in the later cohort will be 12% lower and in the same-age women 15% lower than in the earlier cohort. The walking speed improvements ranged between 0.2 and 0.4 m/s; a 0.1 m/s improvement in walking speed corresponds to substantially better mobility[32]. In addition, the risk for mobility limitations due to low muscle strength is meaningfully lower in the later-born cohorts. The present results are unique in that they derive from multiple highly relevant maximal physical performance tests assessed with identical highly standardized measures in two comparable cohorts examined approximately one generation apart. These results provide us with novel information about differences in functional aging in people growing old during different historical periods.

Various explanations can be offered for the current results. The first is that the later cohort had more propitious life course exposures that positively affected their health and functioning. The earlier cohorts were born in 1910-1915, when Finland was largely agricultural, undeveloped and still part of the Russian empire until 1917. Children worked from an early age, experienced the turmoil following the Civil War in 1918, and as young adults, they took part in the Second World War. The later cohort was born in 1938-1942. During the 1940s, many reforms were implemented, including the provision of school meals for all children free of charge and longer obligatory education. This improved the nutritional situation, especially for children from lower income homes, and delayed their entry into the labor market. These societal reforms may underlie our findings of increased height and weight in the latter cohort, which is mostly a result of better nutrition[33]. With the rapid development of the country in the 1950s, access to secondary and tertiary education improved and the female disadvantage in education decreased[34]. This is in line with the doubling of length of education between the earlier and later cohorts. Higher education is associated with better jobs, and better economic conditions and psychosocial resources and with more beneficial health behavior, all of which contribute to better health and functioning. Heavy manual work in earlier life is associated with increased risk for problems in health and functioning in older age[35]. The regression analyses indicated that positive secular trends in the covariates were important aspects underlying improved muscle strength and walking speed in the later cohort. Longer education in men and increased leisure-time physical activity levels in both sexes were associated with better walking speed whereas increased body size and physical activity level were associated with better muscle strength. However, the association of physical activity with cohort differences in physical performance can be interpreted in two ways: high physical activity may result from better physical performance, or vice versa[36].

Many of the birth cohort effects remained unexplained by the variables available in our data. Other potential explanations include improved medical care and better access to health care. In addition, working conditions has improved through legislation protecting employees and improved technological solutions. However, we can probably rule out genetic differences between the cohorts as an explanation: since the resettlement of the Karelian population in Finland during the Second World War, there has been very little immigration. In addition, we do not believe that selective mortality explains the results. Mortality prior to the age 75 or 80 years was lower in the latter cohort than the earlier cohort, making the later cohort less rather than more selected.

In the lung function tests, the results were somewhat inconsistent. The later-born cohort performed better in the FVC test, which measures the total amount of air that can be forcibly exhaled. However, cohort differences in exhaled airflow were small or non-existent. In contrast to an earlier finding among 75-year-olds, we noted a positive change only among the 80-year-olds in the FEV1 test and no improvement in PEF[17]. In our study, cohort differences in lung function were partly explained by the greater body size in the later-born cohort. Increased education, potentially indicating better working conditions and health habits also explained better lung function in the younger cohort. Smoking is the main reason for decreased pulmonary function and chronic airway obstruction. In our study, the proportion of ever smokers in the later cohort was lower among men and higher among women, a finding in line with previous reports[37]. However, it had only a minor impact on the cohort differences. Environmental factors pertaining to pulmonary health have possibly worsened during the past few decades due to urbanization, exposures to emissions of biomass fuels and other causes of environmental pollution. Long-term exposure to ambient air pollutants have been shown to result in impaired lung function and an increasing prevalence of obstructive lung diseases, which may explain why the improvement in FEV1 was smaller than that in FVC and not evident in the 75-year-old cohort[38].

The better physical performance in the later-born cohort can be explained by their slower rate-of-change with increasing age, a higher lifetime maximum in physical performance, or a combination of the two. Between the years 1989 and 2017, the remaining life expectancy in Finland has increased by around three years among 75-year-olds and two years among 80-year-olds[1] Having more years to death at these ages, together with the current results, suggests that today's older people are functionally younger than people of the same age one generation earlier. Our findings support the hypothesis of the postponement of disability to older ages[39], although our data cannot be used to support or reject the compression of morbidity hypothesis, which continues to be debated[40]. Nevertheless, the results point toward more years spent with higher functional capacity at least among current 75- and 80-year-old adults in Finland. However, it is unclear whether this positive trend applies to younger cohorts. Beller et al.[12] showed an opposing trend in grip strength among younger cohorts, which may stem from changes in health-related lifestyles, such as increased sedentary lifestyle and obesity. In addition, differences in historical and economic developments and cultural factors may also result in mixed trends in physical performance in different countries.

The main strength of this study is the use of standardized maximal performance assessments of multiple functions conducted with identical methods 28 years apart. Muscle strength, walking speed and respiratory functions describe the intrinsic physiological capacity of older adults. Another strength of the study is that we compared men and women of exactly the same ages. Participant recruitment was also comparable in both studies. We found that non-participants did not differ between the studies in terms of self-rated health or reasons to decline participation, a finding that supports the comparability of the cohorts. However, we cannot rule out the possibility that some unmeasured influences underlying the participation rates may have affected the results. In addition, our study is unique in the length of the interval between the studies being almost three decades.

The study has also its limitations. First, the participation rate in the later study was lower than in the earlier, which could mean that the participants in the later study represent a healthier section of the target population than those in the earlier study. Because non-participants did not differ between the studies, we may assume that the cohorts were comparable. However, it is still possible that because of the smaller participation rate, the later cohort is more selected and potentially healthier group, and we cannot completely rule out the possibility of selection bias explaining partly the results. The measurement equipment for assessing grip strength and knee extension strength was identical in both times, and methodological differences probably do not explain the observed differences between the cohorts. However, we cannot rule out the possibility that for lung function test, some systematic measurement difference may have affected the results. Another possible limitation is that the cohort differences in comorbidity could not be included in the analyses due to changes in the diagnostics, treatment and recording of chronic conditions over the past three decades. The results may be unique to Finland; however, it is likely that they can be generalized to other countries that have undergone similar societal changes during the last 100 years. We do not have data on life-course exposures earlier in the participants' lives, information which would have strengthened our conclusions on the possible reasons for the cohort differences.

To conclude, the present study suggests improved physical performance, especially in walking speed and muscle strength, in the more recent birth cohorts of 75- and 80-year-old Finnish adults. These functional traits underlie mobility, activities of daily living and participation in social life. The results may help to identify potentially unrecognized resources of older adults and encourage their continued engagement in valued activities in later life.

Contributors

K. Koivunen: Conception and design of the study, drafting the manuscript, data preparation, analysis and interpretation. E. Sillanpää: Contribution to the design of the study, data analysis and interpretation, drafting the manuscript. M. Munukka: Data preparation, analysis and interpretation, critical revision for important intellectual content. E. Portegijs: Data collection, critical revision for important intellectual content. T. Rantanen: Conception and design of the study, acquiring the funding for conducting the research, conducting the study and acquiring data, data analysis and interpretation, drafting the manuscript.

Conflicts of interest

T.R. serves on the Journal of Gerontology: Medical Sciences editorial board. Otherwise, the authors declare no conflicts of interest.

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Captions for Tables and Illustrations

Figure 1. Flow Chart for Evergreen and Evergreen II.

Table 1. Descriptive statistics and cohort differences of 75- and 80-year-old men and women born in 1910 and 1914 (Evergreen cohort) and born in 1938-1939 and 1942-1943 (Evergreen II cohort).

Table 2. Cohort differences in physical performance of 75- and 80-year-old men and women born in 1910 and 1914 (Evergreen cohort) and born in 1938-1939 and 1942-1943 (Evergreen II cohort).

Table 3. Linear regression of the association between the birth cohort and physical performance measures in men.

Table 4. Linear regression of the association between the birth cohort and physical performance measures in women.

Table 1. Descriptive statistics and cohort differences of 75- and 80-year-old men and women born in 1910 and 1914 (Evergreen cohort) and born in 1938-1939 and 1942-1943 (Evergreen II cohort).

	75 years		Cohort	**80 years**		Cohort
	Evergreen	Evergreen II	difference p-value[a]	Evergreen	Evergreen II	difference p-value[a]
Men, n	104	183		60	132	
Age, mean (SD)	75.3 (0.3)	75.4 (0.4)	0.171	79.6 (0.3)	79.6 (0.4)	0.626
Years of education, mean (SD)	6.2 (3.5)	12.2 (4.4)	<0.001	5.9 (4.1)	11.9 (4.4)	<0.001
Height, cm, mean (SD)	169.5 (6.2)	172.7 (6.0)	<0.001	169.1 (6.5)	172.3 (6.1)	0.001
Weight, kg, mean (SD)	74.1 (10.7)	80.4 (13.0)	<0.001	75.3 (12.8)	80.1 (12.6)	0.017
Self-rated health, n (%)			<0.001			<0.001
Very good / Good	13 (13)	106 (58)		10 (17)	60 (46)	
Average	79 (76)	72 (39)		35 (59)	69 (52)	
Poor / Very poor	12 (12)	5 (3)		14 (24)	3 (2)	

Physical activity, n (%)			<0.001			<0.001
Low	30 (29)	10 (6)		24 (40)	15 (12)	
Moderate	62 (60)	127 (70)		33 (55)	94 (72)	
High	12 (12)	44 (24)		3 (5)	21 (16)	
Smoking, n (%)						
Never	33 (34)	87 (48)	0.027	19 (33)	72 (56)	0.004
Current / Former	64 (66)	95 (52)		38 (67)	56 (44)	
Women, n	191	251		145	160	
Age, mean (SD)	75.3 (0.3)	75.4 (0.4)	0.557	79.6 (0.3)	79.7 (0.4)	0.517
Years of education, mean (SD)	6.1 (3.2)	12.0 (4.1)	<0.001	5.7 (3.1)	11.8 (6.2)	<0.001
Height, cm, mean (SD)	155.8 (5.6)	159.4 (5.1)	<0.001	155.5 (5.4)	158.2 (5.5)	<0.001
Weight, kg, mean (SD)	67.5 (11.6)	71.1 (12.4)	0.002	64.5 (10.2)	69.7 (12.0)	<0.001
Self-rated health, n (%)			<0.001			<0.001
Very good / Good	27 (14)	137 (55)		18 (13)	67 (42)	
Average	139 (73)	108 (43)		93 (65)	85 (53)	
Poor / Very poor	25 (13)	6 (2)		33 (23)	8 (5)	
Physical activity, n (%)			<0.001			<0.001
Low	42 (22)	29 (12)		48 (34)	21 (13)	
Moderate	139 (74)	190 (76)		92 (65)	120 (76)	

High	7 (4)	30 (12)		2 (1)	18 (11)	
Smoking, n (%)			0.005			0.051
Never	167 (90)	201 (80)		133 (93)	136 (86)	
Current / Former	18 (10)	49 (20)		10 (7)	22 (14)	

Note: [a] t-test for continuous variables and chi-square test for categorical variables.

Table 2. Cohort differences in physical performance of 75- and 80-year-old men and women born in 1910 and 1914 (Evergreen cohort) and born in 1938-1939 and 1942-1943 (Evergreen II cohort).

	75 years		Cohort difference		80 years		Cohort difference	
	Evergreen	Evergreen II			Evergreen	Evergreen II		
	Mean (SD)	Mean (SD)	% (95% CI)	p-value[a]	Mean (SD)	Mean (SD)	% (95% CI)	p-value[a]
Men								
Walking speed, m/s	1.8 (0.5)	2.0 (0.4)	11 (5, 18)	<0.001	1.5 (0.5)	1.8 (0.4)	20 (11, 33)	<0.001
Grip strength, N	374 (89)	406 (74)	9 (3, 14)	0.001	309 (80)	364 (74)	18 (10, 26)	<0.001
Knee extension strength, N	362 (99)	452 (102)	25 (18, 32)	<0.001	332 (73)	397 (101)	20 (12, 27)	<0.001

FVC, l	2.9 (0.7)	3.4 (0.8)	17 (12, 24)	<0.001	2.6 (0.7)	3.3 (0.6)	27 (15, 30)	<0.001
FEV1, l	2.5 (0.6)	2.6 (0.6)	4 (-0.7, 12)	0.081	2.2 (0.6)	2.5 (0.5)	14 (9, 25)	<0.001
PEF, l/s	7.4 (2.0)	7.4 (2.0)	0 (-7, 6)	0.841	6.9 (2.1)	7.4 (1.7)	7 (1, 17)	0.093
Increased risk for mobility limitation, n (%)	48 (47.5%)	48 (26.5%)		<0.001	39 (70.9%)	68 (51.9%)		0.012
Women								
Walking speed, m/s	1.5 (0.4)	1.7 (0.3)	18 (13, 22)	<0.001	1.2 (0.3)	1.6 (0.3)	33 (22, 34)	<0.001
Grip strength, N	227 (58)	238 (52)	5 (0.2, 9)	0.042	172 (55)	215 (44)	25 (19, 32)	<0.001
Knee extension strength, N	241 (73)	302 (81)	25 (19, 31)	<0.001	188 (63)	277 (82)	47 (38, 56)	<0.001
FVC, l	2.2 (0.5)	2.5 (0.5)	14 (12, 20)	<0.001	1.9 (0.5)	2.3 (0.4)	21 (18, 29)	<0.001
FEV1, l	1.9 (0.4)	1.9 (0.4)	0 (-4, 4)	0.825	1.6 (0.4)	1.8 (0.3)	12 (4, 14)	0.001

PEF, l/s	5.0 (1.2)	4.9 (1.1)	-2 (-6, 3)	0.544	4.8 (1.4)	5.0 (1.3)	4 (-3, 10)	0.318
Increased risk for mobility limitation, n (%)	67 (35.4%)	69 (27.7%)		0.052	104 (75.4%)	70 (44.3%)		<0.001

Note. CI, confidence interval; FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second; PEF, peak expiratory flow. [a] t-test

Table 3. Linear regression of the association between the birth cohort and physical performance measures in men.

	Men 75 years			Men 80 years		
	Birth cohort		Model	Birth cohort		Model
	β (SE)	p-value	Adjusted r^2	β (SE)	p-value	Adjusted r^2
Walking speed, m/s						
Birth cohort	0.211 (0.055)	<0.001	0.046	0.330 (0.075)	<0.001	0.089
+ education	0.029 (0.066)	0.663	0.105	0.226 (0.089)	0.012	0.106
+ height	0.189 (0.057)	0.001	0.051	0.294 (0.077)	<0.001	0.097
+ weight	0.256 (0.056)	<0.001	0.076	0.346 (0.076)	<0.001	0.093
+ PA	0.073 (0.054)	0.176	0.211	0.174 (0.072)	0.016	0.275
+ smoking	0.181 (0.057)	0.002	0.049	0.271 (0.077)	0.001	0.098
Grip strength, N						
Birth cohort	32.2 (9.9)	0.001	0.033	54.9 (12.2)	<0.001	0.094
+ education	19.1 (12.2)	0.118	0.036	51.4 (14.4)	<0.001	0.095
+ height	19.3 (9.9)	0.052	0.108	41.5 (11.8)	0.001	0.193
+ weight	23.8 (10.0)	0.018	0.069	46.4 (12.0)	<0.001	0.147
+ PA	16.7 (10.2)	0.104	0.091	50.0 (12.6)	<0.001	0.109
+ smoking	25.2 (10.1)	0.016	0.025	49.5 (12.7)	<0.001	0.092
Knee extension strength, N						

Birth cohort	89.4 (12.6)	<0.001	0.151	65.0 (15.1)	<0.001	0.087
+ education	85.1 (15.4)	<0.001	0.142	58.4 (17.6)	0.001	0.093
+ height	81.9 (12.9)	<0.001	0.163	58.7 (15.4)	<0.001	0.101
+ weight	83.0 (12.9)	<0.001	0.161	58.3 (15.1)	<0.001	0.114
+ PA	68.7 (12.9)	<0.001	0.209	54.1 (15.2)	<0.001	0.133
+ smoking	85.0 (13.0)	<0.001	0.131	56.8 (15.3)	<0.001	0.100
FVC, l						
Birth cohort	0.521 (0.091)	<0.001	0.103	0.604 (0.103)	<0.001	0.158
+ education	0.378 (0.111)	0.047	0.108	0.584 (0.122)	<0.001	0.157
+ height	0.391 (0.089)	<0.001	0.199	0.451 (0.099)	<0.001	0.279
+ weight	0.562 (0.093)	<0.001	0.117	0.580 (0.105)	<0.001	0.165
+ PA	0.417 (0.096)	<0.001	0.133	0.510 (0.108)	<0.001	0.192
+ smoking	0.485 (0.095)	<0.001	0.097	0.548 (0.105)	<0.001	0.171
FEV1, l						
Birth cohort	0.135 (0.077)	0.081	0.007	0.364 (0.086)	<0.001	0.091
+ education	-0.011 (0.094)	0.905	0.025	0.356 (0.103)	<0.001	0.084
+ height	0.037 (0.076)	0.631	0.093	0.242 (0.084)	0.004	0.205
+ weight	0.161 (0.079)	0.044	0.010	0.334 (0.088)	<0.001	0.093
+ PA	0.048 (0.082)	0.556	0.032	0.282 (0.091)	0.002	0.117
+ smoking	0.097 (0.080)	0.223	0.022	0.282 (0.087)	0.001	0.128
PEF, l/s						

Birth cohort	-0.049 (0.244)	0.841	0.000	0.533 (0.292)	0.069	0.013
+ education	-0.483 (0.296)	0.104	0.011	0.515 (0.346)	0.138	0.009
+ height	-0.307 (0.244)	0.209	0.055	0.265 (0.295)	0.370	0.067
+ weight	-0.028 (0.251)	0.912	0.000	0.390 (0.294)	0.186	0.042
+ PA	-0.437 (0.254)	0.087	0.054	0.276 (0.310)	0.373	0.029
+ smoking	-0.158 (0.252)	0.531	0.004	0.397 (0.102)	0.188	0.014

Note. Each covariate was added in the model one at a time with birth cohort; β, unstandardized beta indicates mean cohort difference (reference group Evergreen cohort); SE, standard error; PA, Physical activity; FVC, forced vital capacity, FEV1, forced expiratory volume in 1 second; PEF, peak expiratory flow.

Table 4. Linear regression of the association between the birth cohort and physical performance measures in women.

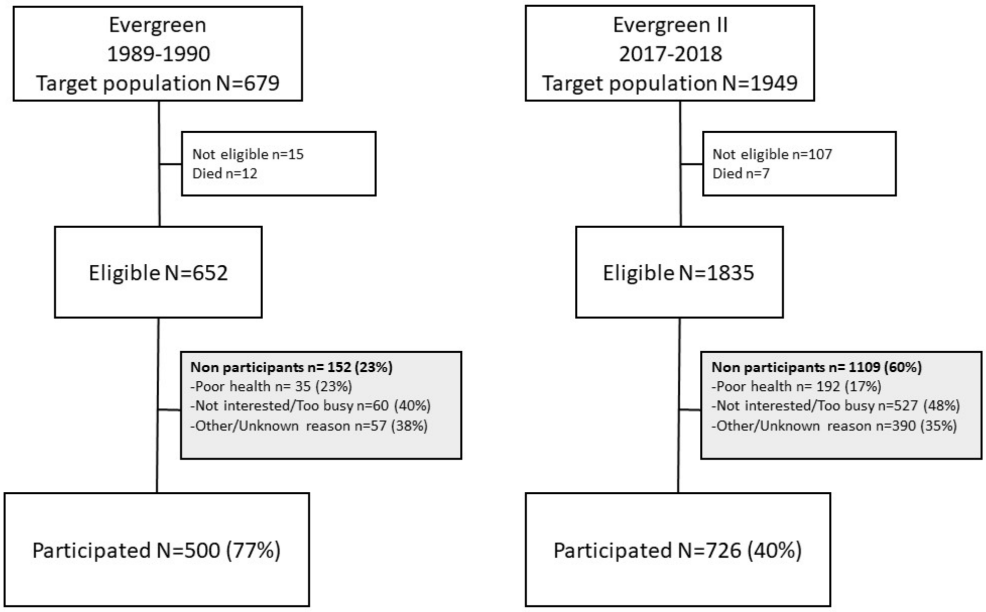
	Women 75 years			Women 80 years		
	Birth cohort		Model	Birth cohort		Model
	β (SE)	p-value	Adjusted r^2	β (SE)	p-value	Adjusted r^2
Walking speed, m/s						
Birth cohort	0.261 (0.033)	<0.001	0.122	0.349 (0.038)	<0.001	0.224
+ education	0.146 (0.041)	<0.001	0.151	0.318 (0.044)	<0.001	0.231
+ height	0.240 (0.035)	<0.001	0.127	0.329 (0.039)	<0.001	0.228
+ weight	0.274 (0.032)	<0.001	0.213	0.398 (0.037)	<0.001	0.287
+ PA	0.205 (0.031)	<0.001	0.275	0.274 (0.036)	<0.001	0.347
+ smoking	0.275 (0.034)	<0.001	0.138	0.354 (0.038)	<0.001	0.224
Grip strength, N						
Birth cohort	10.8 (5.31)	0.042	0.007	43.5 (5.8)	<0.001	0.158
+ education	9.09 (6.76)	0.181	0.003	41.9 (7.3)	<0.001	0.161
+ height	-0.09 (5.40)	0.987	0.084	35.8 (5.7)	<0.001	0.227
+ weight	8.71 (5.33)	0.103	0.022	37.0 (5.8)	<0.001	0.206
+ PA	6.18 (5.37)	0.251	0.036	38.4 (5.9)	<0.001	0.191
+ smoking	11.3 (5.4)	0.038	0.006	43.2 (5.9)	<0.001	0.153
Knee extension strength, N						
Birth cohort	60.4 (7.5)	<0.001	0.127	88.7 (8.6)	<0.001	0.264

+ education	55.0 (9.6)	<0.001	0.122	99.2 (10.1)	<0.001	0.271
+ height	49.7 (7.8)	<0.001	0.159	82.6 (8.8)	<0.001	0.276
+ weight	55.5 (7.4)	<0.001	0.165	83.5 (8.8)	<0.001	0.272
+ PA	54.4 (7.6)	<0.001	0.150	77.1 (8.7)	<0.001	0.308
+ smoking	61.1 (7.6)	<0.001	0.127	87.6 (8.7)	<0.001	0.256
FVC, l						
Birth cohort	0.342 (0.046)	<0.001	0.115	0.439 (0.052)	<0.001	0.195
+ education	0.280 (0.059)	<0.001	0.115	0.340 (0.066)	<0.001	0.201
+ height	0.199 (0.043)	<0.001	0.289	0.356 (0.050)	<0.001	0.307
+ weight	0.373 (0.046)	<0.001	0.113	0.441 (0.054)	<0.001	0.193
+ PA	0.304 (0.046)	<0.001	0.154	0.415 (0.054)	<0.001	0.189
+ smoking	0.341 (0.047)	<0.001	0.111	0.434 (0.053)	<0.001	0.189
FEV1, l						
Birth cohort	0.008 (0.038)	0.825	0.000	0.148 (0.043)	0.001	0.036
+ education	-0.024 (0.048)	0.618	0.000	0.086 (0.055)	0.123	0.044
+ height	-0.086 (0.037)	0.023	0.122	0.088 (0.042)	0.039	0.134
+ weight	0.008 (0.038)	0.835	0.000	0.142 (0.045)	0.002	0.033
+ PA	-0.023 (0.038)	<0.001	0.036	0.133 (0.045)	0.004	0.029
+ smoking	0.019 (0.039)	0.020	0.008	0.148 (0.044)	0.001	0.032
PEF, l/s						
Birth cohort	-0.076 (0.122)	0.535	0.000	0.156 (0.156)	0.318	0.000

+ education	-0.241 (0.156)	0.124	0.002	0.049 (0.201)	0.809	-0.001
+ height	-0.277 (0.125)	0.028	0.052	0.048 (0.160)	0.763	0.022
+ weight	-0.101 (0.123)	0.412	0.001	0.125 (0.162)	0.441	-0.002
+ PA	-0.145 (0.125)	0.246	0.009	0.031 (0.161)	0.849	0.015
+ smoking	-0.050 (0.124)	0.688	0.001	0.163 (0.160)	0.308	-0.003

Note. Each covariate was added in the model one at a time with birth cohort; β, unstandardized beta indicates mean cohort difference (reference group Evergreen cohort); SE, standard error; PA, Physical activity; FVC, forced vital capacity, FEV1, forced expiratory volume in 1 second; PEF, peak expiratory flow

Figure 1


Evergreen
1989-1990
Target population N=679
Not eligible n=15
Died n=12
Eligible N=652
Non participants n= 152 (23%)
-Poor health n= 35 (23%)
-Not interested/Too busy n=60 (40%)
-Other/Unknown reason n=57 (38%)
Participated N=500 (77%)
Evergreen II
2017-2018
Target population N=1949
Not eligible n=107
Died n=7
Eligible N=1835
Non participants n= 1109 (60%)
-Poor health n= 192 (17%)
-Not interested/Too busy n=527 (48%)
-Other/Unknown reason n=390 (35%)
Participated N=726 (40%)