PUBLIC HEALTH POLICY AND PRACTICE

Improved functional status in 16 years of follow up of middle aged and elderly men and women in north eastern Finland

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Study objective: To investigate age, period, and cohort effects on functional status.
Design: A prospective cohort study with measurements in 1981, 1990, and 1996.
Setting: Three municipalities in north east Finland.
Participants: A regionally representative sample of 19 to 63 year old men and women was drawn from the census data in 1979, of which 758 men and 1033 women initially aged 39–63 years entered the study in 1980 and completed the follow up in 1996 (90.9% of the alive cohort).
Measurements and main results: Functional status was determined based on self estimated disabilities (difficulties or not able) to walk 2 km, climb several flights of stairs, and run 100 m. The age adjusted odds of disability in stair climbing and running were lower among the men and the women in 1990 and 1996 than among the men and the women in 1981. There was a declining trend in the odds of disability with succeeding birth cohorts among both the men (odds ratios (OR) 0.79 and 95% confidence intervals (CI) 0.70 to 0.88 for stair climbing and OR 0.88 and 95% CI 0.78 to 0.98 for running) and the women (OR 0.85 and 95% CI 0.77 to 0.93 for stair climbing and OR 0.85 and 95% CI 0.76 to 0.94 for running). No statistically significant differences in walking disability were found between the study periods or the study cohorts.
Conclusions: The findings depict an improved time trend in functional status in the study population, with implications for future health and social care planning.

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Functional status decline represented by inability to perform the usual activities of daily life is a growing health problem among elderly persons. The magnitude of this problem is likely to become substantially greater with the continuing increase in longevity and in the size of the older population age groups in the developed countries.[1] In Finland, life expectancy at birth increased between 1966 and 1999 by eight years among the men and by seven years among the women. In addition, the population projection for 2000–2030 suggests that the proportion of people 65 years and older increases from 15% to 26%.[2]

There is conflicting evidence regarding what gains longevity has meant in health and functioning of the aging populations. Fries[3] suggests that because of healthier lifestyle behaviours, morbidity is compressed into a shorter period before death. In contrast, Schneider and Guralnik[4] argue that the age of onset of morbidity is unchanged, and older persons therefore remain functionally disabled and in poor health for a longer period of time. An important concern for future health and social care planning is whether more recent cohorts of older people are in better or worse health and functioning than previous cohorts.

Longitudinal studies provide the only method for directly studying age related changes in functional status. Several studies among older persons have examined functional status as a predictor of various health outcomes,[5–8] or related it to previously measured risk factors for functional status decline.[9–16] Other studies have estimated transition probabilities or average changes in functional status between two time points.[17–19] Relatively few studies have compared the functional status of similar age groups at two time points,[20–24] and even fewer studies have analysed age related changes in functional status at two or more time points, taking into account the age, period, and cohort effects.[25 26]

The purpose of this study was therefore to analyse 16 year changes in functional status of middle aged and elderly men and women, taking into account the age, period, and cohort effects.

METHODS

Study population

A systematic and representative sample of community based residents aged 19–63 years was drawn from the 1979 census data of a medium size industrial town and two rural municipalities in north east Finland. The result was a sample of 6787 men and women, of whom 5259 (77.5%) answered the baseline survey and formed a study cohort in 1980. According to national census data from the Central Statistical Office of Finland, a total of 340 men and 150 women (9.3% of the study cohort) died between the baseline survey on 1 March 1980 and the follow up survey on 30 September 1996.

The study population consisted of all the men and women who were both alive and between the ages of 55 and 79 years in 1996 (n=1969).

Procedure

A self administered, postal survey provided data on sociodemographic status, perceived health, chronic conditions, functional status, physical activity, smoking, and alcohol consumption. The questionnaire items have proved to be valid in terms of their relations to the existence of chronic diseases,[27] prediction of coronary heart disease risk,[28] use of physician and hospital services,[29 30] and decreased risk of all cause[29 31 32] and cardiovascular disease[31 32] mortality among middle aged and elderly persons.

The baseline questionnaire was sent to the study cohort at the beginning of 1980. Follow up questionnaires requesting similar information, but with a narrower scope and additional

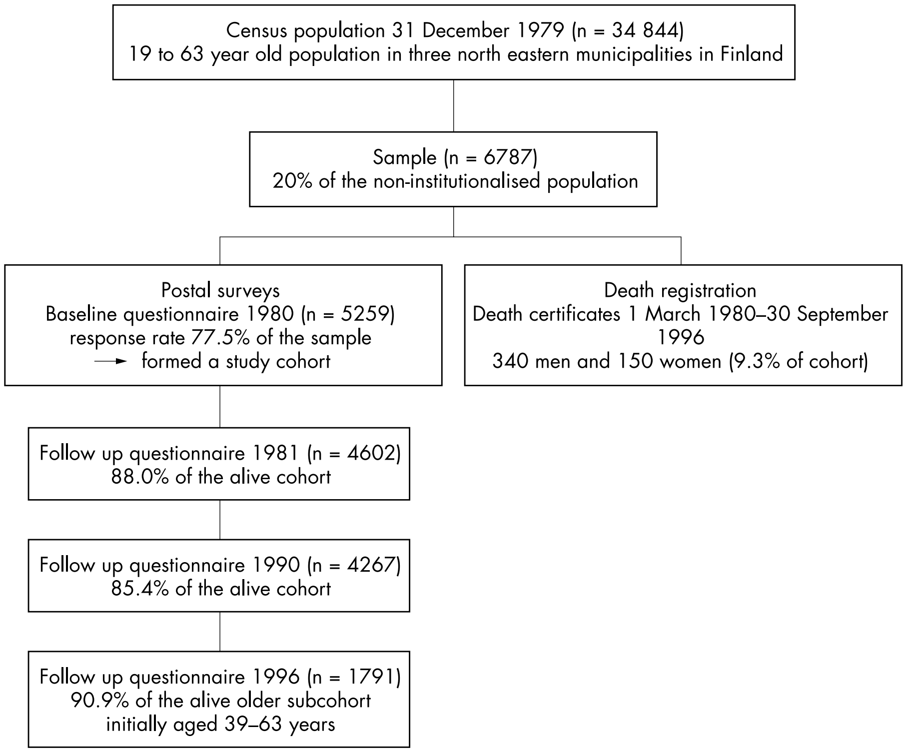

Figure 1 Study design of the 16 year prospective follow up study carried out in north east Finland during 1980–1996.

questions on functional status, were sent to all members of the cohort, irrespective of their places of residence in Finland, in 1981, 1990, and to the older members of the cohort in 1996. The response rates for these surveys, after two requests, were 88.0%, 85.4%, and 90.9% of the alive cohort, respectively. A total of 1791 (758 men and 1033 women) responded to the follow up questionnaire in 1996. Of the 178 non-respondents, 133 (6.7% of the alive cohort in 1996) failed to return the questionnaire after two requests, 29 (1.5%) refused to respond, seven (0.3%) did not respond because of a severe health restriction, and nine (0.5%) could not be contacted because of unknown address. The study design of the 16 year prospective follow up study carried out in north east Finland during 1980–1996 is shown in figure 1.

The ethics committee of the Urho Kaleva Kekkonen Institute for Health Promotion Research approved the study.

Measurements

Functional status was determined from a self estimate on ability to walk 2 km without rest, climb several flights of stairs

Table 1 Number of respondents in the 1981, 1990, and 1996 surveys by birth cohort and gender (n=1791)

		Age (y)			Respondents (% of the alive cohort)		
Cohort	Birth year	1981	1990	1996	Men	Women	Total
V	1937–1941	39–43	48–52	54–58	218 (92)	266 (92)	484
IV	1932–1936	44–48	53–57	59–63	166 (89)	232 (92)	398
III	1927–1931	49–53	58–62	64–68	172 (94)	233 (94)	405
II	1922–1926	54–58	63–67	69–73	132 (92)	174 (86)	306
I	1917–1921	59–63	68–72	74–78	70 (91)	128 (86)	198
Total					758 (92)	1033 (90)	1791

Table 2 Proportion (%) of disability in walking by gender, birth cohort, and survey period (n=758 men, n=1033 women)

	Men			Women		
Cohort (age in 1981)	1981	1990	1996	1981	1990	1996
V (39–43)	3	13	**21***	9	18	**26***
IV (44–48)	7	**30***	**29†**	12	**37***	**35†**
III (49–53)	15	**28†**	39	18	**35†**	42
II (54–58)	**22***	33	55	**28***	45	60
I (59–63)	**28†**	42	62	**32†**	57	78
Total number of respondents	566	687	743	745	923	990

*Persons aged 54 to 58 years in 1981 and 1996 (and persons aged 53 to 57 years in 1990). †Persons aged 59 to 63 years in 1981 and 1996 (and persons aged 58 to 62 years in 1990).

Table 3 Proportion (%) of disability in stair climbing by gender, birth cohort, and survey period (n=758 men, n=1033 women)

	Men			Women		
Cohort (age in 1981)	1981	1990	1996	1981	1990	1996
V (39–43)	8	16	**24***	23	30	**41***
IV (44–48)	18	**30***	**35†**	34	**47***	**53†**
III (49–53)	28	**37†**	39	43	**50†**	60
II (54–58)	**47***	44	60	**53***	53	70
I (59–63)	**45†**	53	68	**65†**	70	82
Total number of respondents	590	681	727	806	913	970

*Persons aged 54 to 58 years in 1981 and 1996 (and persons aged 53 to 57 years in 1990). †Persons aged 59 to 63 years in 1981 and 1996 (and persons aged 58 to 62 years in 1990).

Table 4 Proportion (%) of disability in running by gender, birth cohort, and survey period (n=758 men, n=1033 women)

	Men			Women		
Cohort (age in 1981)	1981	1990	1996	1981	1990	1996
V (39–43)	13	29	**45***	34	47	**60***
IV (44–48)	34	**51***	**60†**	46	**62***	**73†**
III (49–53)	40	**55†**	72	61	**69†**	83
II (54–58)	**64***	63	85	**77***	78	89
I (59–63)	**58†**	81	90	**81†**	81	94
Total number of respondents	524	682	737	688	915	978

*Persons aged 54 to 58 years in 1981 and 1996 (and persons aged 53 to 57 years in 1990). †Persons aged 59 to 63 years in 1981 and 1996 (and persons aged 58 to 62 years in 1990).

without rest, and run a distance of 100 m. The response alternatives were "no difficulties", "some difficulties", "severe difficulties", and "not at all able". The respondents were classified disabled if they reported difficulties or inability to perform the specified task. The mobility tasks were chosen because of their less gender specific and environment specific nature and their linkage to lower extremity functioning, which has been shown to have a substantial effect on the ability of elderly persons to remain independent.[5 6] The mobility self ratings on walking (π=0.80) and transferring (π=0.58) have been shown to correlate with their objective measures,[33 34] and their reproducibility have been shown to range between fair and good (weighted κ 0.57–0.70) in a representative population sample of middle aged and elderly persons.[35] Mobility self ratings, including running, have also been shown to correlate with their objective measures (Pearson's r=0.69) and with their retest values (Pearson's r=0.70–0.92) in different clinical populations.[36] In both Finland and Sweden, the self rating on ability to run 100 m has been found to discriminate well between different overweight[37], age, and gender[37 38] categories in nationally representative populations of middle aged and elderly adults.

Data analysis

All the analyses were conducted separately for the men and women. The respondents were divided into five year birth cohorts with their corresponding age groups for each survey period. Five birth cohorts were identified with birth years 1917–1921, 1922–1926, 1927–1931, 1932–1936, and 1937–1941. The task specific disability rates in the birth cohorts were compared within and between the survey periods (1981, 1990, and 1996) by means of cross tabulation. The task-specific disability rates of similar age groups were also compared between the survey periods. The disability rates were conditional on survival and on inclusion in the 1996 survey.

Generalised estimating equations (GEE) were used to model longitudinal correlated data on the differences in disability rates for the effects of age, period, and cohort. The Oswald software library (version 3.2) in S-PLUS program (version 4.0, release 2) was used for the analysis. The GEE procedure has the advantage of estimating regression coefficients of complete as well as incomplete data without making assumptions of the variance. The models were fitted by means of marginal models, with a logit link function and a compound symmetry covariance structure. It was recognised in fitting the models that the independent effects of age, period, and cohort can not be estimated simultaneously.[39] The approach adopted here was to investigate the age period and age cohort models for the data separately. In the age cohort models, tests for trends in disability status were performed to determine whether more recent cohorts are in better or worse health and functioning than previous cohorts. The odds ratios (OR) with 95% confidence intervals were calculated to determine the effect of the factors on disability status.

RESULTS

The number and proportion of respondents in the surveys of the study is presented by birth cohort and gender in table 1. The female to male ratio was somewhat higher in the oldest birth cohort (I) compared with the younger birth cohorts (II-V): 1.9 versus 1.3, 1.3, 1.4, and 1.2. In addition, the proportion of female respondents who completed the follow up was somewhat lower in the two oldest birth cohorts (I and II) compared with the younger birth cohorts (III-V): 86% versus 92%–94%. In 1981, the age adjusted prevalence of disability in stair climbing among the respondents to the 1990 and the 1996 surveys, respectively, was 32%, whereas the corresponding rate among the non-respondents was 42%.

The age related prevalence of disability in walking, stair climbing, and running is presented by gender, birth cohort, and survey period in figures 2, 3, and 4. There was, with few exceptions, a linear increase in the prevalence of disability in walking, stair climbing, and running across the cohorts and the periods among the men and the women. The disability rates were lowest in walking and highest in running, and they were consistently lower among the men than among the

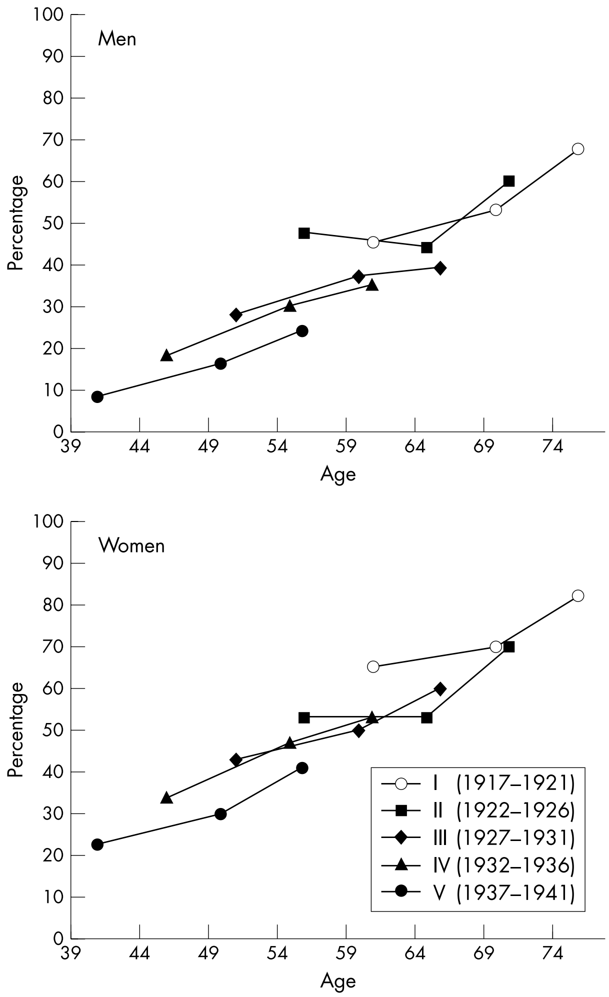

Figure 2 Prevalence of stair climbing disability under the age, period, and cohort model among men (n=758) and women (n=1033).

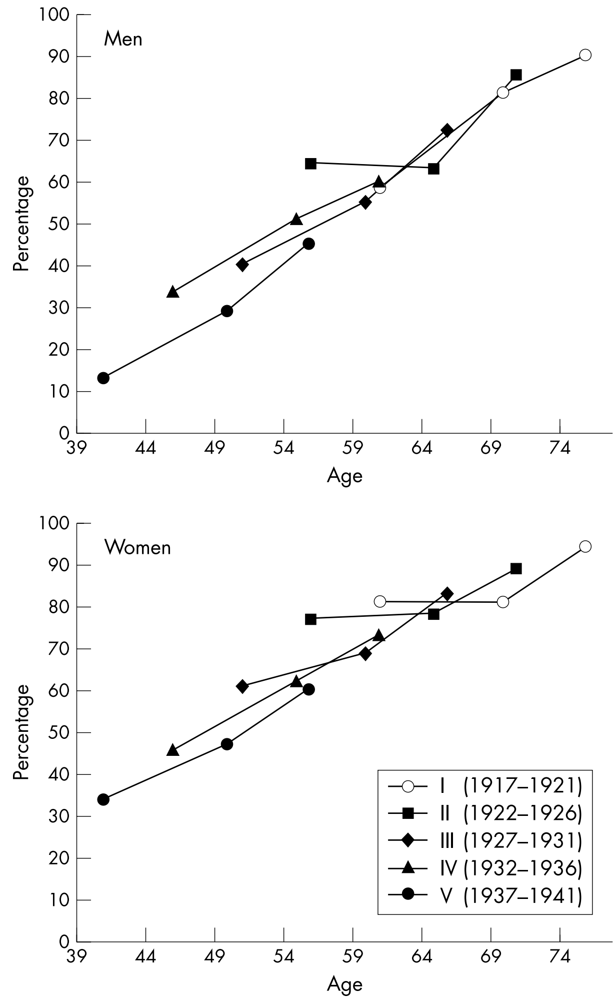

Figure 3 Prevalence of running disability under the age, period, and cohort model among men (n=758) and women (n=1033)

women. As described in tables 2, 3, and 4, the prevalence of disability in similar age groups decreased across the survey periods, especially in terms of stair climbing and running disability. For example (bold figures in table 3), 47% of the men and 53% of the women in cohort II (aged 54–58 years in 1981) were disabled in stair climbing compared with 30% of the men and 47% of the women in cohort IV (aged 53–57 years in 1990) and 24% of the men and 41% of the women in cohort V (aged 54–58 years in 1996). The corresponding figures were 45% of the men and 65% of the women in cohort I (aged 59–63 years in 1981) compared with 37% of the men and 50% of the women in cohort III (aged 58–62 years in 1990) and 35% of the men and 53% of the women in cohort IV (aged 59–63 years in 1996).

An age-period model was applied to quantify the differences in age related prevalence of disability between the survey periods (table 5). Higher age predicted statistically significantly disability in walking, stair climbing, and running among the men (ORs 1.09 to 1.12) and the women (ORs 1.09 to 1.11). The higher odds of stair climbing and running (not walking) disability with age were countered by statistically significantly lower odds of disability between the survey periods, suggesting that the age related decline in the proportion of men and women with disability during follow up was strongly attributed to the time of the survey periods.

An age-cohort model was applied to quantify the differences in age related prevalence of disability between the birth cohorts (table 6). As in the age-period model, higher age predicted disability in walking, stair climbing, and running among the men (ORs 1.05 to 1.10) and the women (ORs 1.05 to 1.09). The higher odds of stair climbing and running (not walking) disability with age were countered by lower odds of disability between the birth cohorts. There was a consistent, declining trend in the odds of disability in stair climbing (OR 0.79 and 95% CI 0.70 to 0.88 for men and OR 0.85 and 95% CI 0.77 to 0.93 for women) and in running (OR 0.88 and 95% CI 0.78 to 0.98 for men and OR 0.85 and 95% CI 0.76 to 0.94 for women) with succeeding birth cohorts. For the women, the decline in the odds of stair climbing disability was notable in cohort II, III, and IV as compared with cohort I, but even more so in cohort V as compared with all other cohorts in terms of both the decline in stair climbing disability and running disability. For the men, the corresponding disability decline was notable in cohort III and IV as compared with cohorts I and II, and in cohort V as compared with all other cohorts.

DISCUSSION

This 16 year longitudinal investigation among middle aged and elderly men and women indicates that the age related prevalence of disability as assessed by difficulties in stair climbing and running declined in the 1980s and the early 1990s. The extent of the decline varied with time of birth, with smallest relative declines in the earliest birth cohort and largest declines in the latest birth cohort. Consistent findings in the disability rates between similar age groups across the survey periods and the age-period analysis pointed at a period

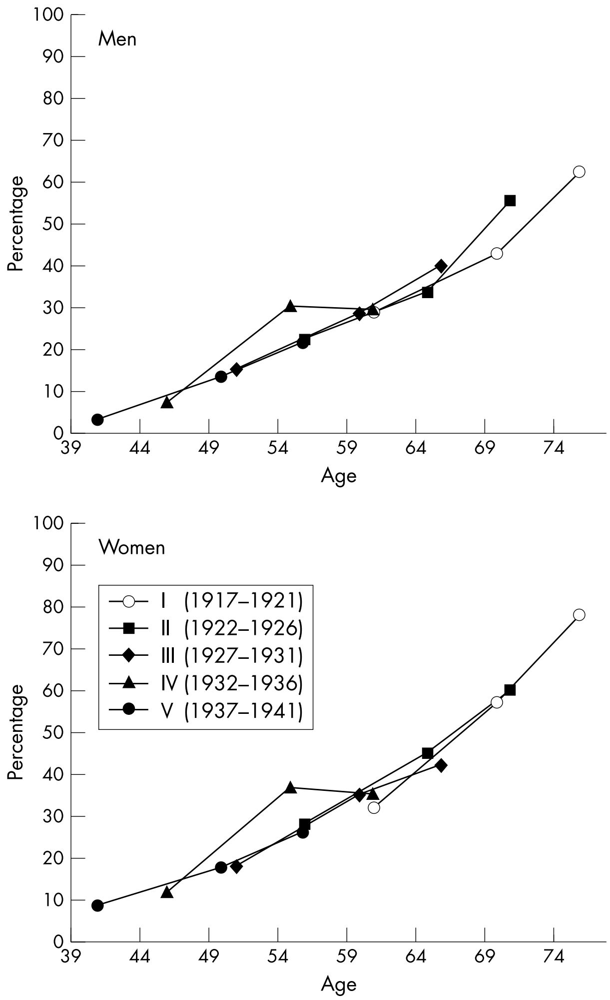

Figure 4 Prevalence of walking disability under the age, period, and cohort model among men (n=758) and women (n=1033).

effect, whereas consistent findings in disability rates between similar age groups across the birth cohorts and the age-cohort analysis pointed at a birth cohort effect. Although the age effect on the prevalence of walking disability in the age-period and the age-cohort analysis was of similar or greater magnitude than the age effect on stair climbing and running disability, there were no statistically significant differences in the age related prevalence of walking disability between the birth cohorts over the 16 year follow up.

The findings of this study differ in part from those of others. However, the comparison of time trends in disability between studies is complicated by differences in sampling strategies, methods of data collection and analyses, measures of disability, age of subjects, and length of intervals defining birth cohorts and follow up times. This study comprised a sample of middle aged and elderly men and women with a wide age range (39–63 years at baseline) and a long follow up time (16 years). In a similar study to this improved mobility status was observed between 1979 and 1989 by comparing two Finnish birth cohorts of men between the ages 65 and 69 years and women between the ages 60 and 64 years.[40] In the USA, the Framingham Health Study offspring cohort aged 55–70 years in 1994 reported also less need for help in mobility than did the similarly aged members of the original cohort in 1977,[20] a finding consistent with the US Bureau of the Census's Survey of Income and Program Participation among persons aged 50 years and older[41] and the National Long Term Care Survey among persons aged 65 years and older.[42] However, no differences in mobility status were found between two independent samples each of middle aged[43] and elderly Finnish men and women[44] between 1972 and 1992 and between 1988 and 1996, respectively. The minor differences in mobility status between the cohorts in the former study and between the cohorts in the present study may be explained by a ceiling effect: 70% of the 59–63-year-olds in 1981, 1990, and 1996 in this study (table 2) and 80% of the 66 year olds in 1972 and 1992 in the study by Pohjolainen *et al*[43] reported no difficulty with walking. In line with a Canadian study,[23] two other Finnish studies, using 10 year and 20 year data over the same time period than this study, found also no notable differences in disability status between two independent study populations aged 75 years and over.[22 24] However, all three studies differed methodologically from this study and they concerned older populations. In this study the age effect on functional status was disentangled from the period and the cohort effect. Accordingly, functional status improved in the study population both across the survey periods and birth cohorts. This finding is in line with the Melton Mowbray Study concerning British men and women 75 years and over.[26] However, in the Zutphen Elderly Study, only a strong age effect on functional status was found among Dutch men 70 years and over.[25] The lack of a period and a cohort effect may in part be explained by the comparatively short follow up time in the study.

Table 5 Estimated odds ratios (OR) and 95% confidence intervals (CI) of disability in walking, stair climbing, and running according to age and survey period* among men (n=758) and women (n=1033)

Task	Predictor	Men OR (95% CI)	Women OR (95% CI)
Walking	Age (y)†	1.09 (1.07 to 1.12)	1.10 (1.08 to 1.12)
	Period (age)‡		
	1981 (39–63)	1.00	1.00
	1990 (48–72)	1.21 (0.88 to 1.65)	1.15 (0.91 to 1.46)
	1996 (54–78)	1.17 (0.80 to 1.71)	0.94 (0.70 to 1.23)
Stair climbing	Age (y)†	1.10 (1.08 to 1.13)	1.09 (1.07 to 1.11)
	Period (age)‡		
	1981 (39–63)	1.00	1.00
	1990 (48–72)	0.58 (0.45 to 0.76)	0.63 (0.52 to 0.77)
	1996 (54–78)	0.47 (0.33 to 0.66)	0.60 (0.45 to 0.78)
Running	Age (y)†	1.12 (1.10 to 1.15)	1.11 (1.09 to 1.13)
	Period (age)‡		
	1981 (39–63)	1.00	1.00
	1990 (48–72)	0.63 (0.49 to 0.81)	0.60 (0.48 to 0.76)
	1996 (54–78)	0.63 (0.45 to 0.88)	0.60 (0.44 to 0.82)

*The GEE model with age (continuous variable) and survey period (categorical variable) as predictors. †Age, OR for one year's difference in age. ‡Study period, ORs for other periods compared with the 1981 period (=reference category; OR=1.00).

Table 6 Estimated odds ratios (OR) and 95% confidence intervals (CI) of disability in walking, stair climbing, and running according to age and birth cohort* among men (n=758) and women (n=1033)

Task	Predictor	Men OR (95% CI)	Women OR (95% CI)
Walking	Age (y)†	1.10 (1.08 to 1.13)	1.09 (1.08 to 1.11)
	Cohort‡		
	I (1917–1921)	1.00	1.00
	II (1922–1926)	1.23 (0.78 to 1.92)	0.97 (0.67 to 1.42)
	III (1927–1931)	1.19 (0.75 to 1.89)	0.81 (0.56 to 1.18)
	IV (1932–1936)	1.44 (0.87 to 2.38)	1.04 (0.70 to 1.55)
	V (1937–1941)	1.22 (0.70 to 2.13)	0.87 (0.56 to 1.36)
	p for linear trend	0.23	0.63
Stair climbing	Age (y)†	1.05 (1.04 to 1.07)	1.05 (1.04 to 1.06)
	Cohort‡		
	I (1917–1921)	1.00	1.00
	II (1922–1926)	1.01 (0.64 to 1.61)	0.69 (0.46 to 1.03)
	III (1927–1931)	0.65 (0.41 to 1.03)	0.64 (0.43 to 0.94)
	IV (1932–1936)	0.62 (0.38 to 1.02)	0.62 (0.41 to 0.93)
	V (1937–1941)	0.42 (0.25 to 0.71)	0.45 (0.29 to 0.68)
	p for linear trend	<0.001	<0.001
Running	Age (y)†	1.09 (1.07 to 1.11)	1.07 (1.06 to 1.09)
	Cohort‡		
	I (1917–1921)	1.00	1.00
	II (1922–1926)	1.05 (0.61 to 1.83)	1.08 (0.64 to 1.81)
	III (1927–1931)	0.83 (0.49 to 1.42)	0.83 (0.51 to 1.35)
	IV (1932–1936)	0.91 (0.53 to 1.58)	0.73 (0.44 to 1.19)
	V (1937–1941)	0.62 (0.36 to 1.09)	0.59 (0.35 to 0.98)
	p for linear trend	0.020	0.002

*The GEE model with age (continuous variable) and survey period (categorical variable) as predictors. †Age, OR for one year's difference in age. ‡Birth cohort, ORs for other cohorts compared with the cohort I (=reference category; OR=1.00).

Key points

- The population based data on age related changes in functional status are inconsistent.
- Often the age effect on changes in functional status cannot be distinguished from the cohort or the time period effect.
- The age effect on changes in functional status of five birth cohorts was disentangled from the cohort and the period effect.
- Improved functional status was observed over 16 years, with the largest relative gain in the latest birth cohort.
- The findings may help health and social service producers to weigh future use of health and social care resources.

The interpretation of the cohort and period differences in age related prevalence of disability should take into account the possibility of selection and measurement bias. The non-response is unlikely to affect the findings because it was very low in the three surveys. The higher age standardised rates in walking disability at baseline (in 1981) among those who died than among those who survived until the end of the 16 year follow up (33% versus 18%) may suggest an effect of selective drop out because of death. Such bias would tend to underestimate the baseline prevalence of disability in the study population, which would decrease the cohort and period differences in disability and limit generalisability of the findings. As the disability proportions were conditional on survival and on participation in the 1996 survey, the interpretation of the findings should bear this effect of a selective survival in mind. Bias because of the survey measures, or bias because of prevailing attitudes to the survey measures independent of functional status, may also explain the cohort and period differences in age related disability. However, mobility self ratings have been shown to correlate moderately with their objective measures[45 46] and to be highly consistent over six months among older persons, independent of age and disability status.[47] In addition, the mobility self ratings have provided consistently higher disability rates than interviewer administered surveys, but only for surveys that differ in methodology.[48] In this study the survey methods were comparable and the data on functional status were gathered from mobility self ratings on everyday physical tasks such as walking, climbing, and running, which are not sensitive to cultural expectations about roles and changes in the environment.[49] The survey respondents also shared similar life circumstances. They were born between the first world war and second world war and they were aging in a technically advanced welfare state. A slightly different introductory text for the mobility self ratings was used in the 1981 survey than in the 1990 and 1996 surveys, which may have caused a higher number of missing values in the 1981 survey compared with the other two surveys. The introductory text in the 1981 survey read: " . . .Circle the task and response alternative . . .". The text in the 1990 and the 1996 survey read: " . . .Circle for each task the response alternative . . .". Levels of missing data were 22%–32% in 1981 compared with 10%–11% in 1990 and 3%–5% in 1996, depending on the task. The effect of the missing data on the findings is minimal because of a compound symmetry covariance structure that was used to link the disability data between the surveys of the study. In addition, a separate analysis on the impact of the missing values on the odds of disability did not change the results in the age-period model.

Even with the limitations mentioned above, the findings of this study are in line with others showing a gradual improvement in functional status with succeeding birth cohorts. Although the findings provide only limited support for the compression of morbidity hypothesis, they may have implications for future health and social care planning. Given the continuing growth in the older population, an improved time trend in functional status may serve to postpone the need of health and social care services associated with disabilities in the aging population. In terms of public healthcare spending, the findings may provide guidance to health and social service producers how to allocate resources to institutional and community care, to treatment and prevention strategies of disabilities, and to early diagnosis of functional status decline. However, additional population based studies are needed to confirm whether the improved time trend in functional status

Policy implications

- Performance based ability questions can be used to monitor functional ability in the population. These kinds of methods should be implemented in population health surveys to follow time trends and population differences in functional ability.
- The population at risk of losing their independence are those with impairments or physiological decrements that affect their functional ability. Research should be conducted in the short-term and medium term to develop feasible physical performance measures for the primary care to identify as early as possible those at risk of losing their independence.
- Local health and social service providers need more accurate information about risk factors for the onset of functional decline. Researchers should identify these risk factors and help service providers to develop risk factor modification programmes for maintaining and improving independence among high risk people.
- The Finnish Ministry of Health and Social Affairs could in the long term provide guidelines to assist local and regional service providers to implement and evaluate programmes for promoting functional ability and independence in the population.

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reported here reflect the national experience. A more direct analysis of risk factors for functional status decline would also enhance the understanding of preventive strategies that drive the time trend in functional status among the middle aged and elderly persons.

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