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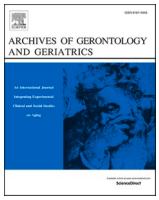

Self-rated health in old age, related factors and survival: A 20-Year longitudinal study within the Silver-MONICA cohort

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HIGHLIGHTS

- This study affirms self-rated health's value within in an aging population.
- This study explores established and novel factors, including depressive symptoms and social interactions.
- Despite lower ratings after 20 years, most participants still rated their health 'Quite good' or 'Very good'.
- Higher self-rated health in early old age was associated with survival in advanced old age.

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ABSTRACT

Introduction: Self-rated health (SRH) offers insights into the evolving health demographics of an ageing population.
Aim: To assess change in SRH from old age to very old age and their associations with health and well-being factors, and to investigate the association between SRH and survival.
Methods: All participants in the MONICA 1999 re-examination born before 1940 ($n = 1595$) were included in the Silver-MONICA baseline cohort. The Silver-MONICA follow-up started in 2016 included participants in the Silver-MONICA baseline cohort aged 80 years or older. Data on SRH was available for 1561 participants at baseline with 446 of them also participating in the follow-up. The follow-up examination included a wide variety of measurements and tests.
Findings: Most participants rated their health as "Quite good" (54.5 %) at baseline. Over the study period, 42.6 % had stable SRH, 40.6 % had declined, and 16.8 % had improved. Changes in SRH were at follow-up significantly associated with age, pain, nutrition, cognition, walking aid use, self-paced gait speed, lower extremity strength, independence in activities of daily living, weekly physical exercise, outdoor activity, participation in organized activities, visiting others, morale, and depressive symptoms. SRH at baseline was significantly associated with survival ($p < 0.05$).
Conclusion: This study demonstrates associations between changes in SRH and a multitude of health- and wellbeing-related factors, as well as a relation between survival and SRH, accentuating their relevance within the ageing population.

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1. Introduction

The ongoing demographic shift towards an older population calls for a corresponding shift to a proactive approach, aiming for health and well-being in old age (United Nations, 2019). To do this, it is crucial to expand the understanding of health measurements, monitoring, and the needs of older adults (WHO, 2015). Self-rated health (SRH) reflects biological, social, and environmental factors, as well as personal beliefs and behaviors (Jylhä, 2009).

Subjective health perceptions provide insights into the well-being of older adults, acknowledging the significance of personal experiences in shaping their overall health (Annele et al., 2019). Measures of SRH closely intertwine with well-being (Oguz et al., 2013) and have associations with various health outcomes such as rheumatic disease, diabetes, depression, mobility (Latham & Peek, 2013) and myocardial infarction (Waller et al., 2015), including life satisfaction (Qazi et al., 2021; Borim et al., 2021). SRH exhibits variations concerning age (Calvey et al., 2022; Krause & Jay, 1994), sex (Cui et al., 2021; Wuorela et al., 2020), education (Golini & Egidi, 2016), diagnoses (Jørgensen et al., 2015), and socioeconomic status (Wuorela et al., 2020) and can exhibit fluctuations over time (Zajacova & Dowd, 2011). Additionally, SRH has proven to predict survival in older adults even after adjusted for medical history and risk factors (Xiong et al., 2022). A study of individuals over 65, with an average four-year follow-up, showed an 88 % higher mortality risk within four years for those rating their health as poor/very poor compared to very good (Feng et al., 2016). Another study tracking individuals aged 37–73 over five years found that poor SRH was the predominant predictor for men, and cancer the strongest predictor for women (Ganna & Ingelsson, 2015).

As individuals age, the relevance of mental and social factors in SRH assessment tends to increase, while physical health becomes less critical (Spuling et al., 2015; Vogelsang, 2018). SRH predictive capacity on survival has been observed to increase from 1980 to 2002, with increased education and improved cognitive function identified as potential contributing factors (Schnittker & Bacak, 2014). Although SRH has been assessed among diverse populations it is important to further explore the concept, especially since there is a knowledge gap in understanding SRH from old to very old age. Recruiting a representative sample in this age group poses challenges due to availability and mobility, highlighting the importance of conducting data collection within the homes of older adults, irrespective of their living arrangements or need for assistance (Liljas et al., 2017; Goodwin et al., 2023; Davies et al., 2010).

SRH provides valuable aspects of health trends within an ageing population. However, studies that follow older adults (59–79 years) for an extended period of 20 years are relatively scarce. Longitudinal studies are essential to enhance the understanding of these trends, associated factors, and survival. In contributing to this understanding, we conducted a 20-year prospective study with two objectives: (1) to assess changes in SRH from old age to very old age and their associations with health and well-being factors, and (2) to investigate the association between SRH and survival over the study period.

2. Method

The WHO initiated MONICA (MONItoring of trends and determinants in CArdiovascular disease) in the 1980s. This project aimed to measure global trends in cardiovascular incidence and mortality and to assess the extent to which these trends were related to changes in cardiovascular risk factors (Böthig, 1989; Tunstall-Pedoe H, for the WHO MONICA Project Principal Investigators, 1988). The Northern Sweden MONICA site recruited participants from a representative population sample in the two northernmost counties in Sweden, i.e. Västerbotten and Norrbotten. While most participating countries ended the project at the 10-year mark, the Northern Sweden MONICA study continued recruiting participants, with the most recent survey being in 2022. The Silver-MONICA project was initiated and carried out in 2016–2019, aiming to study previous MONICA participants aged 80 years or older with at least two prior MONICA examinations with the 1999 survey as the final and baseline survey. All participants in the MONICA 1999 re-examination born before 1940 (n = 1595) were included in the Silver-MONICA baseline cohort. Altogether 889 individuals were eligible, whereof 541 participated, and 446 of them reported SRH both at baseline and at follow-up.

The Silver-MONICA design was a merger of procedures used in the MONICA study and the Umeå85+/Gerontological Regional Database (GERDA) project (Wågert et al., 2006). At baseline, the following areas were covered: marital status and residence, tobacco habits, health, employment, physical activity, women's health, quality of life and social support and life outlook. At follow-up, these areas were maintained but were expanded into additional domains to cover relevant areas related to very old age.

The Silver-MONICA protocol encompassed various health- and well-being-related measures, instruments, questionnaires, and biomarkers. Additionally, it included a comprehensive collection of medical history, present medication, and numerous other aspects. Data at follow-up were collected at home visits by a nurse, a physiotherapist, or a physician. Each home visit lasted 2 to 4 h, with a follow-up visit for blood sampling.

2.1. Measurements and instruments

2.1.1. Self-rated health

The following question was used both at baseline and at the follow-up: "*How do you think your general state of health has been over the past year?*", with the alternatives being "Very good", "Quite good", "Fair", "Rather bad", or "Bad".

2.1.2. Health and well-being factors

The selection of health and well-being factors was based on an understanding of older adults' overall health. Each factor represents a unique facet of health within its context, contributing independently to overall health and well-being. These factors encompass a broad spectrum, including sensory functions (unimpaired hearing and vision), oral health, nutritional status, educational background, economic well-being, daytime tiredness, pain perception, functional independence, cognitive function, physical activity, gait speed, lower extremity strength, social engagement, emotional well-being (depressive symptoms and morale), and fear of falling. Following factors were included I the present study:

1. Unimpaired hearing refers to hearing a normal voice from one meter away with or without a hearing aid.
2. Unimpaired vision refers to being able to read 5 mm block letters at a distance of 30 cm with or without glasses.
3. Oral health was assessed with questions regarding difficulties chewing food.
4. Nutritional status was assessed with the Mini-Nutritional Assessment scale (Vellas et al., 1999).
5. Education refers to the number of years of schooling.
6. The question of economically making ends meet was measured on a four-item Likert scale with three items dichotomized to any number of difficulties or no difficulties.
7. Daytime tiredness was dichotomized from a five-item scale into "Yes" (always, almost always, sometimes) or "No" (almost never, never). The dichotomization was due to few participants having daytime tiredness.
8. Pain refers to any pains or aches in the last week; this was self-rated using a 100 mm visual analogue scale, where 0 represents no pain, and 100 represents worst possible pain.
9. An independence score was derived from the activities of daily living (ADL)-staircase, including the Katz ADL index (defined according to a cumulative scale) (Sonn & Asberg, 1991).

10. Cognition was assessed using the Mini-Mental State Examination (Folstein et al., 1975), where 0 indicates severe cognitive impairment, and 30 indicates no cognitive impairment.
11. Weekly physical exercise was described as a "Yes" or "No".
12. Gait speed, in meters per second, was calculated from the mean time in seconds from two tries, with the participant walking at a preferred (self-paced) speed over 2.4 m with or without a walking aid (Guralnik et al., 1994).
13. Lower extremity strength was assessed with the number of sit-to-stand transitions within 30 s without support from arms (Jones et al., 1999).
14. The number of times being outdoors referred to being outdoors during the past month with or without company.
15. Visits from and visits to others refer to the last week, excluding visits from healthcare staff.
16. Engagement in organized activity stated for the previous year.
17. Depressive symptoms were assessed using the 15-item Geriatric Depression Scale (GDS-15) (Sheikh & Yesavage, 1986), which ranges from 0 to 15, with 0 indicating an absence of depressive symptoms and 15 signifying pronounced depressive symptoms.
18. Morale was assessed with the Philadelphia Geriatric Center Morale Scale (PGCMS) (Lawton, 1975), a scale ranging from 0 to 17, where higher scores indicate higher morale.
19. Fear of falling indoors and outdoors was assessed with "Never", "Sometimes", or "Often".

2.1.3. Survival

Vital status and date of death were obtained from the Swedish Cause of Death register up to January 2022.

2.1.4. Statistical analysis

Participants with SRH at baseline and follow-up (n = 446) were compared to those who declined participation, were not contacted, or participated only in the review of medical records (n = 259). Participants had more years of education and were more likely men than nonparticipants ($p < 0.05$), whereas age at baseline did not differ.

ANOVA was utilised to assess differences in average health rating between age groups at baseline via a least significant difference (LSD) post hoc test. For analysing differences in health- and well-being-related factors at follow-up between the changes in SRH groups, Chi-square tests were carried out for categorical variables (continuity correction for 2 × 2 categorical), and the t-test or Mann–Whitney U test was used for continuous variables.

Cox regressions and Kaplan–Meier plots with log-rank test (Mantel-Cox) were used to investigate the association between SRH and mortality, with vital status updated until 22 January 2022. Subgroup analysis was conducted using Cox regressions with the sample age-stratified into quartiles and by sex and adjusted for years of education. In the subgroup analysis, the two lowest categories of SRH ("Rather bad" or "Bad") were merged due to few cases, and the highest level of SRH ("Very good") was set as the reference. Proportional hazard assumptions were met, as assessed with Schoenfeld residuals (Kleinbaum & Klein, 2005). Age was used as the time scale in the Kaplan–Meier plots. Missing value cases were excluded from the analysis.

Se Fig. 1 for overview.

An alpha level of 0.05 was used for all statistical tests. All analyses were conducted using SPSS v.26 (IBM Corporation, Armonk, NY, USA). Alluvial plot was generated using R ggplot2 package.

2.1.5. Ethics considerations

This study was approved by the Regional Ethical Review Board in Umeå, Sweden (2015-11-31M/Ö 29-2015, 2016/241-32M). Participation in the study was preceded by the distribution of oral and written information before each participant signed a written consent form. When cognitive impairment was known or suspected during the recruitment process, communication was initiated with the next of kin or the individual's conservator to assess the advisability of participation.

3. Results

3.1. Sample

Altogether 446 participants answered the questions of SRH at the Silver-MONICA baseline in 1999 and at the follow-up between 2016 and 2019 (Table 1). For the analysis of survival, 1561 participants in 1999

Table 1
Participant characteristics.

	Baseline Total Cohort (n = 1561)	SRH SRH at baseline (n = 446)	SRH at follow up (n = 446)
Women	785 (50.3)	246 (55.2)	246 (55.2)
Age	67.6 ± 5.1	65.2 ± 4.1	84.5 ± 3.5
Education (years)	8.1 ± 3.9	9.4 ± 3.5	9.4 ± 3.5
Country of birth – Sweden	1469 (94.1)	415 (93)	415 (93)
Married/domestic partner	1132 (72.5)	350 (78.5)	212 (47.3)
Widow(er)	227 (14.5)	53 (11.9)	199 (44.6)
BMI	27.2 ± 4.3	27.0 ± 4.0	26.6 ± 4.2
Hypertension	1026 (65.7)	292 (65.5)	338 (75.8)
Diabetes	114 (7.3)	26 (5.8)	84 (18.8)
Myocardial infarction	134 (8.6)	23 (5.2)	87 (19.5)

Note: Reported by mean ± standard deviation or n (%). BMI= Body Mass Index. Diabetes and myocardial infarction were self-reported at baseline and follow-up. Hypertension: At baseline, at or above 140/90 systolic/diastolic, respectively, or on antihypertensive treatment. At follow-up, hypertension according to medical records or examination at visit.

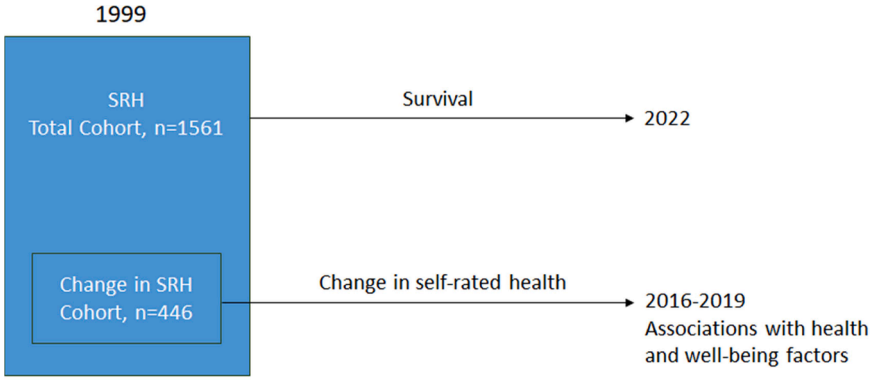

Fig. 1. Analyses overview.

had data on SRH and had the potential to turn 80 years of age or more between 2016 and 2019, of which 1069 were deceased by January 2022. At the Silver-MONICA baseline, the mean age was 67.6 ± 5.1 years, and 50.3 % were women, and at the Silver-MONICA follow-up, the mean age was 84.5 ± 3.5 years, and 55.2 % were women.

3.2. Changes in self-rated health and follow-up associations

Fig. 2 shows the distribution of SRH of four age groups at baseline.

The oldest age group (71.6–79.2) rated their health lower compared to the other age groups (age group 59.1–63.2 mean difference 0.115, 95 % CI 0.01–0.23, $p < 0.046$; age group 63.3–67.3 mean difference 0.146, 95 % CI 0.03–0.26, $p < 0.012$; age group 67.4–71.5 mean difference 0.149, 95 % CI 0.4–0.26, $p < 0.006$).

Fig. 3 illustrates the changes between baseline and the follow-up assessments.

Table 2 provides an overview of the participants' SRH at baseline and follow-up, presenting the changes over time. Health was at baseline predominantly rated as "Quite good" (54.4 %), followed by "Very good" (22 %), "Fair" (18.6 %) and "Rather bad" at (4.7 %). No participant alive at the follow-up rated their health as "Bad" at baseline. During this period 42.6 % of the participants reported no change in their SRH, while 40.6 % reported a decline and 16.8 % of the participants reported an improvement in SRH.

Having a higher or the same SRH at follow-up was associated with younger age ($p < 0.001$), fewer depressive symptoms (GDS-15) ($p < 0.001$), higher degree of independence in daily life (Katz ADL) ($p < 0.01$), higher nutritional status ($p < 0.01$), higher cognitive functioning (MMSE) ($p < 0.05$), higher morale (PGCMS) ($p < 0.01$), less pain ($p < 0.05$), higher low extremity strength (30-sec chair stand test) ($p < 0.01$), higher self-paced gait speed ($p < 0.05$), more often weekly physical exercise ($p < 0.05$), more time outdoors ($p < 0.05$), more involvement in organized activities in past year ($p < 0.01$), having more frequent visits to others last week ($p < 0.01$), and less use of walking aids ($p < 0.01$) (Table 3).

3.3. Self-rated health and survival

In the survival analysis of the baseline cohort, rating health as "Bad" at baseline was associated with higher mortality at a hazard ratio of 3.2 (1.75–5.81) (Table 3). However, only 11 individuals self-rated their health as "Bad". Rating health as "Fair" and "Rather bad" had similar hazard ratios (1.4 and 1.6, respectively). There was no difference between "Quite good" and "Very good" health at baseline and mortality (Table 4).

Survival curves for each health rating are plotted in Fig. 4 (log-rank $p < 0.001$). All cases, including censored data, are incorporated in the figure. However, censored cases are not visually differentiated in the figure to maintain readability (For the detailed figure, refer to Appendix A). Among the SRH items, 'Very good' and 'Good' were closely related, demonstrating similar patterns in self-rated health (SRH). Further, 'Fair' and 'Rather bad' exhibited slightly lower survival rates compared to the aforementioned items. Lastly, 'Bad' deviated from the observed trends but was represented by a limited number of individuals ($n = 11$) in the study.

Subgroup analysis according to age groups in quartiles and sex was carried out and is reported in Appendix B.

4. Discussion

During the 20-year study period, our findings illustrate that changes in SRH remain primarily stable, with the most frequent change observed as a one-step deterioration in rating. Age, nutritional status, pain, depressive symptoms, physical ability, frequency of outdoor activities, and visiting others all display associations with changes in SRH. Furthermore, our study demonstrates that SRH is associated with survival among older individuals.

However, our findings reveal changes that encompass stability, deterioration, and improvement, consistent with prior studies (Barghouth et al., 2023; Wu & Zhang, 2023). In contrast, another study (Chu et al., 2021), only disclosed stability or deterioration. Despite observing a 'response shift,' Wu and Zhang (2023) found SRH stability in adults aged 45 to 70, even in response to health changes. According to Gunasekara et al., 2012 SRH does not necessarily reflect actual changes in health status. Mainly if SRH is used as a repeated measure over an extended timespan, it may be less sensitive to capture significant health events, thus yielding biased results (Gunasekara et al., 2012). However, to study changes and their associated factors thoroughly over such an extended timespan, other methods of analysis may be necessary.

To our knowledge, studies have yet to undertake a similar examination of health and well-being factors. However, studies exploring various aspects of health and well-being support a deeper understanding of our findings. A five-year longitudinal study yielded similar results, where an association between change in SRH and physical activity was identified (Feenstra et al., 2020). Furthermore, our study emphasizes the associations between physical activity, physical ability, and self-rated

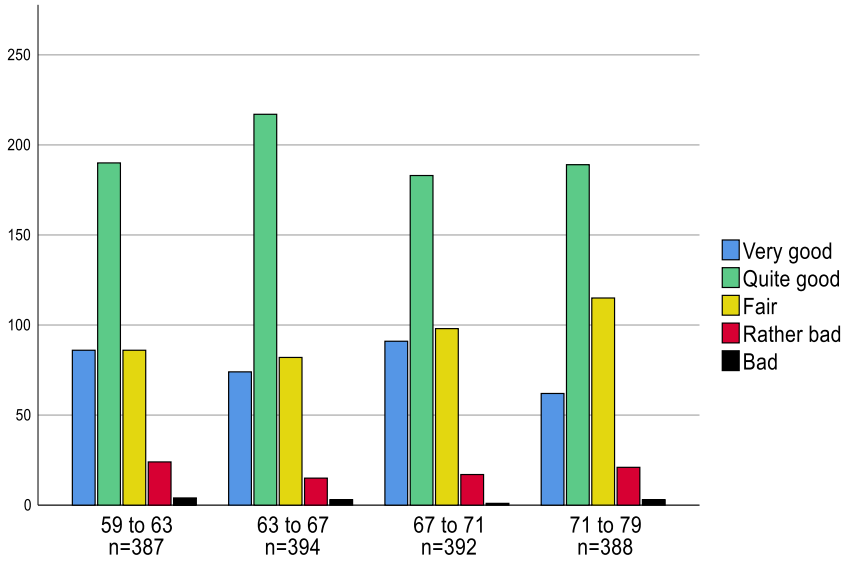

Fig. 2. Self-rated health at 1999 baseline according to age group.

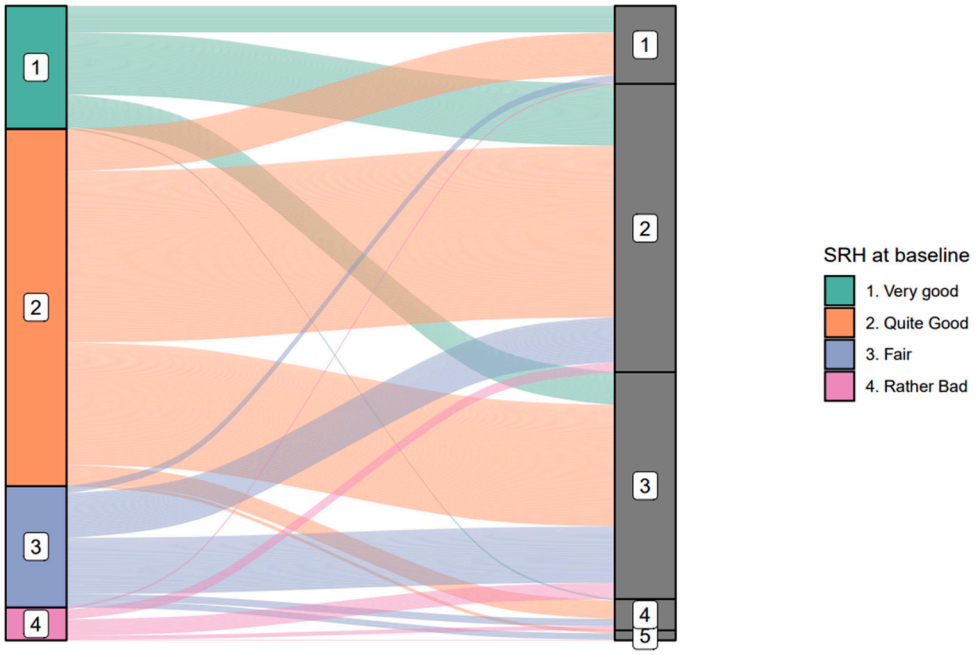

Fig. 3. Alluvial plot illustrating changes in SRH from baseline to the left, to follow-up on the right ($N = 446$). Rating 5, "Bad" shown at follow-up but not at baseline is due to no participant rating as such at baseline surviving until follow-up.

Table 2
Self-rated health at baseline and follow up ($N = 446$).

		Self-rated health at 2016–2019 follow-up					
		Very good	Quite good	Fair	Rather bad	Bad	Total
Self-rated health at 1999 baseline	Very good	27 (6.1)	44 (9.9)	26 (5.8)	1 (0.2)	0 (0)	98 (22)
	Quite good	25 (5.6)	115 (25.8)	90 (20.1)	11 (2.5)	2 (0.5)	243 (54.5)
	Fair	5 (1.1)	27 (6.1)	46 (10.3)	3 (0.7)	3 (0.7)	84 (18.8)
	Rather bad	1 (0.2)	6 (1.3)	11 (2.4)	2 (0.5)	1 (0.2)	21 (4.7)
Total		58 (13)	192 (43.1)	173 (38.7)	17 (3.8)	6 (1.4)	446

Note: The color intensity represents the frequency of changes from baseline to follow-up in self-rated health, presented as n (%).

health, confirming cross-sectional findings (Simonsson & Molarius, 2020) and a 14-year longitudinal study (Lee et al., 2012). An additional study focusing on older adults and utilizing accelerometers revealed an association between physical activity and SRH, noting higher activity levels among women than men (Stalling et al., 2020). Additionally, our research introduces novel variables, such as the frequency of outdoor

Table 3
Differences in health outcomes between those with improved or same vs declined self-rated health ($N = 446$).

Continuous variable	Improved/Same ($n = 265$)	Declined ($n = 181$)	p
Age	84.0 ± 3.3	85.2 ± 3.6	**<0.001**
Years of education ($n = 444$)	9.5 ± 3.7	9.2 ± 3.4	0.41
BMI	26.8 ± 4.3	26.4 ± 4.3	0.37
MNA ($n = 445$)	25.8 ± 2.8	25.1 ± 3.1	**0.003**
MMSE	25.5 ± 4.2	24.4 ± 5.5	**0.04**
Pain severity VAS ($n = 254$)	41.1 ± 23.6	48.8 ± 23.5	**0.013**
GDS-15 ($n = 445$)	1.9 ± 1.7	2.8 ± 2.1	**<0.001**
PGCMS ($n = 444$)	13.2 ± 2.5	12.3 ± 3.0	**0.001**
ADL Katz ($n = 407$)	1.2 ± 1.7	1.9 ± 2.2	**0.001**
Chair stand test ($n = 398$)	11.4 ± 4.6	10.0 ± 5.0	**0.006**
Gait speed, m/s ($n = 429$)	1.4 ± 0.5	1.6 ± 0.7	**0.012**
Number of times outdoors last month ($n = 434$)	82.7 ± 118.2	57.6 ± 90.4	**0.019**
Falls last year	3.6 ± 8.5	2.2 ± 1.8	0.29
Visits from others last week ($n = 429$)	2.8 ± 2.8	2.9 ± 2.4	0.94
Visiting others last week ($n = 429$)	1.9 ± 1.9	1.4 ± 1.5	**0.002**
Categorical variable	Improved/Same ($n = 265$)	Declined ($n = 181$)	p
Sex			*0.14*
Woman	138 (56.1)	108 (43.9)	
Man	127 (63.5)	73 (36.5)	
Married			0.44
Yes	115 (43.4)	71 (39.2)	
No	150 (56.6)	110 (60.8)	
Widow(er)			0.36
Yes	113 (42.6)	86 (47.5)	
No	152 (57.4)	95 (52.5)	
Apartment			0.47
Yes	117 (44.2)	73 (40.3)	
No	148 (55.8)	108 (57.7)	
Nursing home			0.27
Yes	8 (3.0)	10 (10)	
No	257 (97.0)	171 (94.5)	
Can you make ends meet financially? ($n = 434$)			0.11
Without difficulty	14 (5.4)	17 (9.8)	
With difficulty	246 (94.6)	157 (90.2)	
No	143 (54.0)	102 (56.4)	
Unimpaired vision ($n = 443$)			0.63
Without glasses	112 (42.4)	82 (45.8)	
With glasses	143 (54.2)	93 (52.0)	
Impaired vision	9 (3.4)	4 (2.2)	
Unimpaired hearing ($n = 445$)			0.99
Without aid	174 (63.7)	118 (65.6)	
With aid	59 (22.3)	41 (22.8)	
Impaired hearing	32 (12.1)	21 (11.7)	
Difficulties chewing ($n = 445$)			0.12
Yes	258 (97.4)	169 (93.9)	
No	7 (2.6)	11 (6.1)	
Walking aid use ($n = 438$)			**0.001**
Yes	119 (45.6)	109 (61.6)	
No	142 (54.4)	68 (38.4)	
Fear of falling indoors ($n = 445$)			0.17
Never	220 (83.3)	142 (78.5)	
Sometimes	34 (12.9)	25 (13.8)	
Often	10 (3.8)	14 (7.7)	
Fear of falling outdoors ($n = 444$)			0.34
Never	177 (67.3)	118 (65.2)	
Sometimes	65 (24.7)	41 (22.7)	
Often	21 (8.0)	22 (12.2)	
Physical exercise every week			**0.045**
Yes	185 (70.6)	110 (61.5)	
No	77 (29.4)	69 (38.5)	
Engagement in organized activity last year ($n = 445$)			**0.006**
Yes	164 (62.1)	88 (48.6)	
No	100 (37.9)	93 (51.4)	
Loneliness			0.07
Yes	82 (31.2)	72 (40.0)	
No	181 (68.8)	108 (60.0)	
Receiving Visitors ($n = 442$)			0.24
Often	97 (36.9)	53 (29.6)	
Sometimes	115 (43.7)	87 (48.6)	
Rarely	49 (18.6)	39 (21.8)	
Never	2 (0.8)	0 (0.0)	
Visiting others ($n = 441$)			**0.022**
Often	55 (20.9)	18 (10.1)	
Sometimes	126 (47.9)	91 (51.1)	
Rarely	75 (28.5)	62 (34.8)	
Never	7 (2.7)	7 (3.9)	

Note: Continuous variables are presented as mean ± standard deviation and p-value. Categorical variables are presented as n (%) and p-value. BMI=Body Mass Index. MNA=Mini-Nutritional Assessment scale. GDS=Geriatric Depression Scale. MMSE=Mini-Mental State Examination. PGCMS=Philadelphia Geriatric Centre Morale Scale. ADL Katz= Activities of Daily Living. Chair stand test, the mean number of sit-to-stand performances within 30 s. Receiving visitors and visiting others refers to visits last week, not including care staff.

Table 4
Self-rated health and mortality ($n = 1561$).

	Unadjusted			Adjusted*		
Variable	HR	95 % CI	*P*	HR	95 % CI	*P*
Very good ($n = 313$)**						
Quite good ($n = 779$)	1.11	(0.92–1.31)	0.21	1.09	(0.92–1.28)	0.28
Fair ($n = 381$)	1.46	(1.21–1.75)	<0.001	1.41	(1.18–1.70)	<0.001
Rather bad ($n = 77$)	1.39	(1.04–1.87)	0.03	1.57	(1.17–2.11)	0.003
Bad ($n = 11$)	3.23	(1.76–5.93)	<0.001	3.15	(1.71–5.81)	<0.001

Note: *Adjusted for age, sex and years of education. Hazard ratio (HR) above 1 indicates higher mortality association. *P* refers to significance level for HR with 95 % confidence interval (CI). **Reference level.

activities and visiting others, which may impact older adults' SRH. Within our finding of the frequency of outdoor visits, a cross-sectional study found that living close to nature is associated with higher SRH in older adults (Huang et al., 2019). The findings of our study related to spending time outdoors may exhibit common attributes with the advantages of living near nature. Another study of the effects of exercising with others versus exercising alone only found health benefits for the former (Kanamori et al., 2016). Our study's findings regarding visiting others may share common attributes with the benefits of exercising. Research concerning older adults' health after hip replacement surgery showed that visits from or to friends had a greater impact on health than visits from children or siblings (Câmara et al., 2023), adding to our understanding of social interactions. Our study's findings regarding outdoor activities and visits to others suggest a potential overlap with the benefits of exercising or engaging in social activities, especially with peers, reinforcing the importance of exploring these associations with SRH.

In our analysis, depressive symptoms, as indicated by GDS-15, were one of the health and well-being factors associated with changes in SRH. Previous research has consistently suggested an association between SRH and depressive symptoms in older adults (Ambresin et al., 2014; French et al., 2012; Han & Jylha, 2006; Jones, J. W. et al., 2018; Öjefors Stark & Olofsson, 2021; Peleg & Nudelman, 2021; Sigurdardottir et al., 2019). This association appears to exist both in individuals assessed as objectively healthy (Peleg & Nudelman, 2021) and those with comorbidities or a history of stroke (Bjälkefur et al., 2020; Nützel et al., 2014; Sheridan et al., 2019). Previous studies have indicated a high prevalence

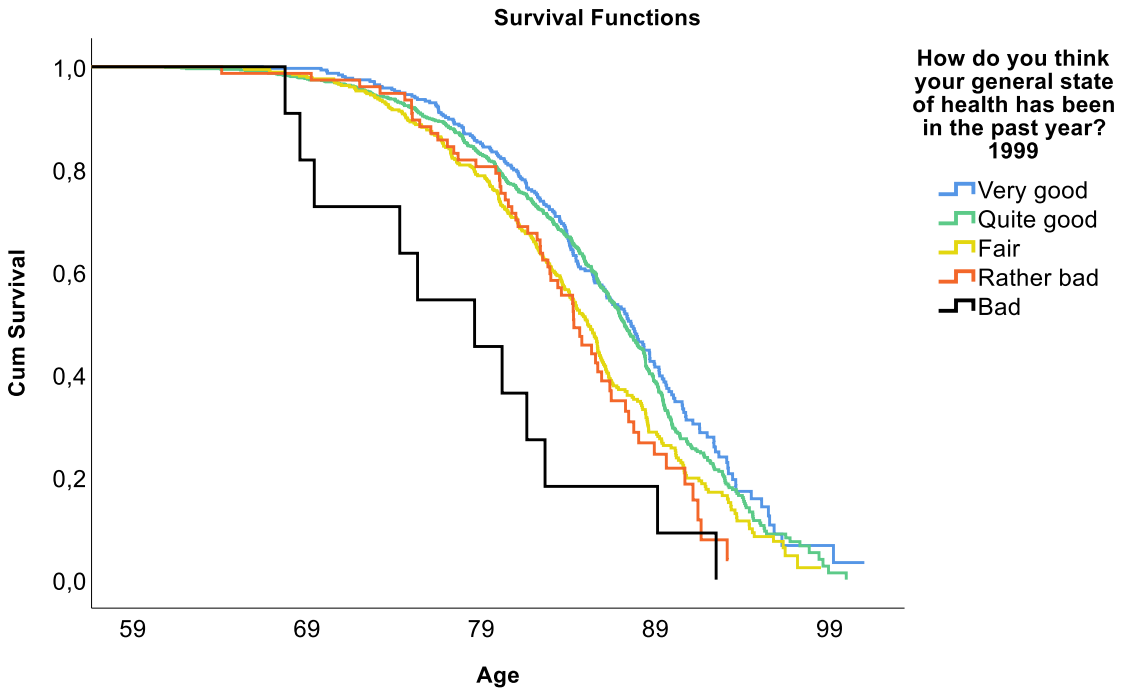

Fig. 4. Kaplan–Meyer survival function, self-rated health at baseline and age at death or censored (n = 1561).

of depressive symptoms among older adults and their associated challenges in treatment (Petersson et al., 2014). Moreover, depressive symptoms have been identified as a potential risk factor for mortality in this population (Bergdahl et al., 2005; Schulz et al., 2000). However, one study showed that healthcare professionals' ability to identify depressive symptoms in older adults is sometimes hindered by the perception that depressive symptoms are a normalized component of ageing (Burroughs et al., 2006). Adding to these complexities surrounding depressive symptoms, healthcare professionals have reported challenges in identifying depressive symptoms, as they often manifest as physical symptoms rather than being explicitly recognized as signs of depression (Borglin et al., 2006).

Our study emphasizes the predictive value of higher SRHs in older adults' survival, which aligns with recent research (Dramé et al., 2023; Wuorela et al., 2020). A limitation of our study is the lack of objective health measurements. However, a separate 21-year cohort study indicates that despite being influenced by diseases and mental health, SRH remains a robust predictor for survival even after adjusting for objective health measurements (Lorem et al., 2020). A separate study within the same cohort found that physical health gained increased significance concerning SRH among older individuals (Lorem et al., 2017). These findings suggest that physical health could be particularly important in relation to SRH.

Lorem et al. (2020) had an age range between 25 and 97 at baseline and a follow-up period of approximately 20 years, demonstrating that SRH predicted mortality not only immediately after self-reporting but also over an extended period. Although the associations were strongest at the beginning of the follow-up period, SRH maintained its ability to predict mortality even 15–20 years after self-reporting. Lorem et al. (2020) indicate that the effect of SRH on mortality varies with age. Other factors more influence younger individuals, while SRH has a stronger independent association with mortality in older individuals. Shan et al. (2023) have shown the association between SRH and mortality over a ten-year follow-up period. Mutz and Lewis (2022) observed similar in individuals aged 37–73, with a median follow-up time of 11.75 years. However, a sense of purpose in life, alongside SRH, has emerged as positively associated with survival in the age group of 34–84 within a 12–14-year timeframe (Friedman & Teas, 2023). Such findings invite understanding how mental health, sense of purpose, and SRH intersect, potentially affecting survival outcomes.

Additionally, our study suggests that a 3-item Likert-type scale may be sufficient for predicting and studying survival since "Very good" and "Quite good", as well as "Fair" and "Rather bad", exhibit similar trends, whereas the 'Bad' response predicts a steeper decline in the Kaplan–Meyer survival function. However, few participants rated their health as "Bad", which reduces certainty in concluding the survival-predictive capability of this item. Previous research has shown that Likert-type SRH instruments with more response options have higher dropout rates, particularly among the older age groups (Eriksson et al., 2001). Furthermore, in prior research on long-term SRH and mortality in older persons, 5-item SRH instruments have been reduced to 3 due to few responders in specific answer categories (Wuorela et al., 2020).

4.1. *Strengths and limitations*

While this study enables a comprehensive analysis of health within this age group, its limitations are primarily rooted in its inability to track health and well-being associations from baseline, as well as challenges posed by age heterogeneity and a limited number of participants rating their health as poor. Nevertheless, its strength resides in its sample and extended timespan.

The sample's age range, from 59 to 79 at baseline, indicates that individuals in the cohort were at different life stages, particularly regarding retirement status and susceptibility to age-related diseases. This age heterogeneity adds complexity to interpreting the results, as participants' health statuses and changes may have been influenced by various factors linked to their specific life phases. In the survival analysis, there may be a bias in the participants who rated their health as poor, and this interpretation should be made with caution. It is possible that potential participants who rated their health as poor were less likely to participate in the study to the same extent as those who rated their health higher. This could mean that the "bad" health group is more diverse than our findings suggest. The follow-up data collection of this study was conducted within participants' own homes, regardless of their residential settings, which included urban and rural areas, assisted living facilities, and various housing types. This approach aligns with

research by Liljas et al. (2017); Goodwin et al. (2023); Davies et al. (2010), supporting inclusivity in studies involving older populations concerning transportation and accessibility. Moreover, this design enhances the likelihood of obtaining a representative sample of the older population (Davies et al., 2010).

5. Conclusion

This study has examined changes in SRH within an ageing cohort with a 20-year follow-up period. The results contribute to the knowledge of SRH in the context of ageing. This study shows that age, pain, nutrition, cognition, walking aid use, self-paced gait speed, lower extremity strength, independence in activities of daily living, weekly physical exercise, outdoor activity, participation in organized activities, visiting others, morale, and depressive symptoms exhibit associations with long-term, self-rated health changes. In addition, the study shows an association between SRH and survival from old age to very old age.

Our findings underscore the complex interplay of SRH in our population and its utility for research and clinical implications.

Author agreement

All the authors certify that the manuscript has not been published previously in any journal or any other citable form and is not being considered for publication elsewhere. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us. We understand that the Corresponding Author is the sole contact for the Editorial process. She is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs.

CRediT authorship contribution statement

Ariel Almevall: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Albin Dahlin Almevall:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization. **Jerry Öhlin:** Writing – review & editing, Visualization, Methodology, Formal analysis. **Yngve Gustafson:** Funding acquisition, Visualization, Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization, Data curation. **Karin Zingmark:** Writing – review & editing, Supervision. **Johan Niklasson:** Funding acquisition, Visualization, Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization, Data curation. **Peter Nordström:** Writing – review & editing, Methodology. **Erik Rosendahl:** Writing – review & editing, Methodology. **Stefan Söderberg:** Funding acquisition, Visualization, Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization, Data curation. **Birgitta Olofsson:** Funding acquisition, Visualization, Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization, Data curation.

Declaration of competing interest

No potential conflict of interest was reported by the authors.

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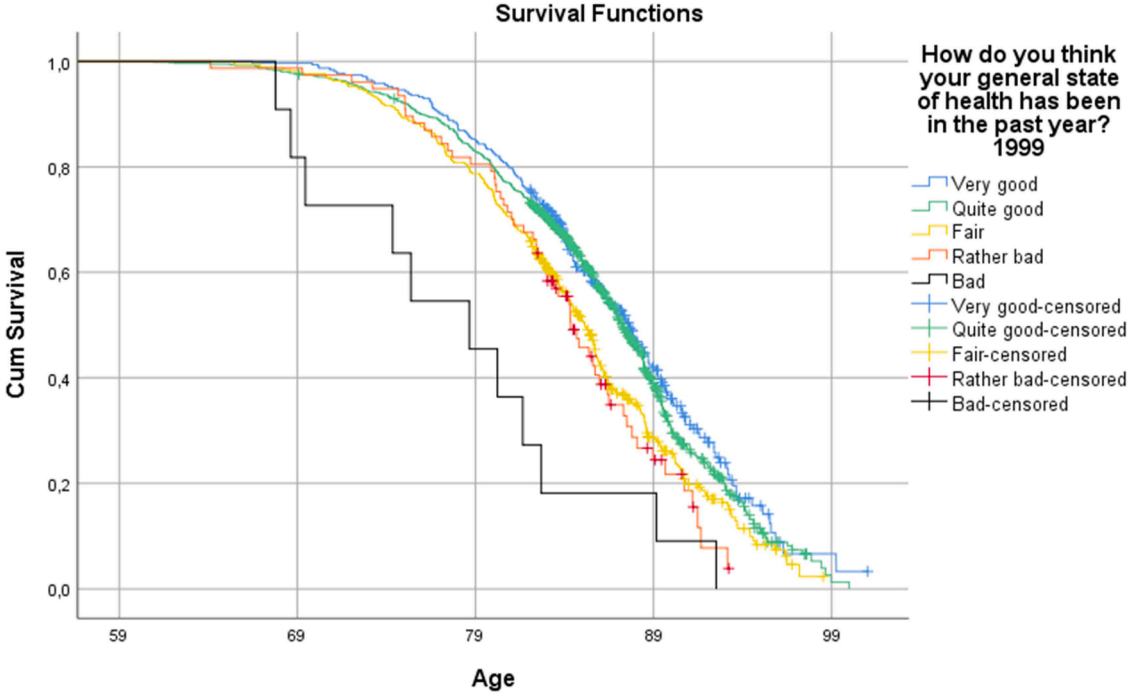
Appendix A



Appendix B

Cox regression SRH and survival subgroup analysis; age groups and sex

Age group	Self-rated health	HR	95 % CI for HR		*P*
			Lower	Upper	
59.1–63.2	Very Good (reference)				
(*n* = 390)	Good	0.97	0.65	1.44	0.87
	Fair	1.14	0.71	1.81	0.59
	Rather Bad to Bad	1.64	0.91	2.97	0.10
63.3–67.3	Very Good (reference)				
(*n* = 391)	Good	1.36	0.93	1.99	0.12
	Fair	1.78	1.16	2.74	**0.009**
	Rather Bad to Bad	1.87	0.99	3.55	0.06
67.4–71.5	Very Good (reference)				
(*n* = 390)	Good	1.09	0.83	1.45	0.53
	Fair	1.38	1.00	1.89	**0.048**
	Rather Bad to Bad	1.07	0.67	1.87	0.83
71.6–79.2	Very Good (reference)				
(*n* = 390)	Good	1.11	0.80	1.51	0.52
	Fair	1.62	1.16	2.25	**0.005**
	Rather Bad to Bad	3.14	1.90	5.22	**<0.001**
Sex					
Women	Very Good (reference)				
(*n* = 785)	Good	1.18	0.91	1.51	0.22
	Fair	1.72	1.30	2.25	**<0.001**
	Rather Bad to Bad	2.13	1.13	2.43	**<0.001**
Men	Very Good (reference)				
(*n* = 776)	Good	1.03	0.83	1.28	0.80
	Fair	1.25	0.98	1.60	0.08
	Rather Bad to Bad	1.52	1.01	2.24	**0.039**

Age groups regressions adjusted for sex and years of education. "Very Good" is used as reference level. Regressions for men and women adjusted for age and years of education. Items “Rather bad” and “Bad” merged in analysis.

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