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Published in:
International Journal of Public Health

DOI:
10.1007/s00038-015-0658-y

2015

Longitudinal trends in good self-rated health: effects of age and birth cohort in a 25-year follow-up study in Sweden

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Key words

Self-rated health, Longitudinal studies, Age effect, Cohort effect, Mixed models

Introduction

While average life expectancy has increased, researchers are debating whether this results in postponement of morbidity, compression of morbidity (number of healthy years increases faster than total life expectancy), or expanded morbidity (increased survival time for chronically ill and disabled persons) (Fries 2003; Rosen and Haglund 2005; Thorslund and Parker 2005). Self-rated health (SRH) based on a single question asking people to rate their overall health status has been shown to be a reliable measure of individuals' subjective health, and is associated with both morbidity and mortality (DeSalvo et al. 2006; Idler and Benyamini 1997; Kaplan et al. 1996; Nielsen et al. 2008; Singh-Manoux et al. 2007). The mechanisms behind this association are not fully known. However, the presence of low-grade inflammation may be an important determinant of individuals' subjective health. For example, a recent study from primary health care in Stockholm revealed that inflammatory cytokines were associated with poor subjective health, especially in participants over 65 years of age (Andreasson et al. 2013).

Some earlier studies on longitudinal trends in SRH reported worsening SRH over recent decades. However, this research area is incompletely explored and differences between cohorts and populations may exist (Halford et al. 2012; Sacker et al. 2011; Zack et al. 2004; Zheng et al. 2011). Several longitudinal studies have reported improved SRH among older individuals (Ishizaki et al. 2009; Zack et al. 2004). Furthermore, studies have shown that people generally tend to report poorer SRH with increasing age (Sacker et al. 2011; Zheng et al. 2011). However, in late life, SRH is improved, partly due to selective mortality. There are several methodological challenges in determining longitudinal changes in SRH. Cross-sectional studies cannot determine whether changes in SRH are attributable to an age effect or

to a cohort effect (Ishizaki et al. 2009). It is important to assess the age and cohort effect since it gives the possibility to distinguish changes over time within individuals (age effects) from differences among individuals at baseline (cohort effects). Few studies have followed several cohorts for longitudinal trends in SRH by age and cohort (Chen et al. 2007; Sacker et al. 2011). Another methodological issue when studying SRH trends is to control for potential confounding factors (Ishizaki et al. 2009; Mantzavinis et al. 2005). SRH has been associated with several variables, such as gender (af Sillen et al. 2005), age (Idler 1993), sociodemographic factors (Kachi et al. 2013; Sacker et al. 2011), and lifestyle factors (Hsu et al. 2013; Sodergren et al. 2008).

The aim of the present study was to analyze longitudinal trends in good SRH in the Swedish population between 1980/81 and 2004/05, when life expectancy at birth increased from 72.8 to 78.4 years in males and from 78.8 to 82.7 years in females (StatisticsSweden 2013). The novelty of the present study is to disentangle age and cohort effects, by using a mixed model with random intercept, to estimate changes in SRH within different age groups and birth cohorts. The analyses are based on four assessments on the same individuals at intervals of 8 years, during a 25-year period, for each sex separately. Another aim was to analyze whether any observed effects remain after adjustment for possible confounders/effect modifiers, such as education, urbanization, marital status, and lifestyle factors.

Methods

The Swedish Annual Level of Living Survey

The data in this study was drawn from the Swedish Annual Level of Living Survey (SALLS), which has been conducted annually since 1974 by Statistics Sweden, the Swedish

government-owned bureau of statistics. The SALLS includes a nationally representative sample of non-institutionalized persons aged 16-84 years. The surveyed individuals were invited by letter to take part in the survey. Professional interviewers from Statistics Sweden conducted face-to-face interviews, usually at the respondents' homes. The participants of the SALLS were followed up every 8th year after the survey participation. A simple random sampling procedure, systematically drawn by age group from the Swedish Total Population Register was used (StatisticsSweden 1996). Since 1979, the survey questionnaire has included questions that make it possible to follow changes in selected fields, such as SRH and lifestyle factors. The SALLS and follow-up data are not publicly available and the use and analysis of the data require permission from Statistics Sweden.

In this study, we included 2728 males and 2770 females aged 16-71 years, who were assessed every eighth year in 1980/81, 1988/89, 1996/97, and 2004/05, and who completed the SALLS at least once. New individuals aged 16-23 years were added for each assessment.

Non-response

The non-response rate varied between 20 and 25% over the assessments, but the pattern of non-response was similar according to sex, age, marital status, geographical area of residence, and income over the years. However, there were differences in distributions between responders and non-responders. We have taken this fact into consideration by including the post stratification variables (age, marital status, urbanization and education) in the models instead of using sampling weights. This way of handling missing data might even be better than using weights by Nordberg (Nordberg 1989).

We excluded those with missing values for weight or height. The reason to exclude was that there were many missing values in weight and/or height (1%). We excluded also those with missing in physical activity (very few). The variables sex, age, marital status, birth cohort and urbanization had no missing values (from register). What concerns education, we classified those with missing (also very few) as belonging to the highest level.

Outcome variable

Self-rated health status was assessed using the question "How would you rate your general health?" This was the first question about health during the interview. In the first two assessments, the possible answers were: "good," "poor," and "somewhere in between." In the last two assessments, the question was further developed, because a wider range was wanted. In these assessments there were five possible answers: "very good," "good," "fair," "poor," and "very poor." In the present study, SRH was dichotomized as (1) "good" (those who described their health as good (1980/81 and 1988/89), or good or very good (1996/97 and 2004/05)) and (0) "poor" (all other answers).

In order to justify the dichotomization of the two originally different scales, we compared two adjacent periods 1994/95 (3-grade scale) with 1996/97 (5-grade scale) in a logistic regression adjusted for age, in males and females separately, based on the entire samples. We found non-significant odds ratios between 1994/95 and 1996/97 for both males and females. Thus, we judge, that the dichotomization of the two different original scales is justified.

Explanatory variables

We analyzed three time-related variables: assessment period, age at the time of the assessment, and year of birth. We chose to also include the following explanatory variables,

based on previous studies: sex, education level, urbanization, marital status, smoking, leisure time physical activity, and body mass index (BMI) (Chen et al. 2007; Hsu et al. 2013; Ishizaki et al. 2009; Mantzavinis et al. 2005; Sodergren et al. 2008). These variables were measured in each survey and included in the models as time-varying covariates.

Assessment period comprised four categories: 1980/81, 1988/89, 1996/97, 2004/05.

Age at the time of interview was categorized into the following groups, reflecting the 8-year intervals between the assessments: 16–23, 24–31, 32–39, 40–47, 48–55, 56–63, and 65-71 years. Age was included as a continuous variable in the model, and was centered at 42 years in order to have a reference group within the studied age interval. Age was included as a time-varying variable.

Birth cohort (based on year of birth), comprised groups born in 1910-17, 1918-25, 1926-33, 1934-41, 1942-49, 1950-57, 1958-65, 1966-73, 1974-81, and 1982-89. Birth cohort was included as a continuous variable in the model, and was centered on 1950.

Sex: Separate analyses were undertaken for males and females.

Education level: During the study period, children in Sweden started school the year they became 7 years old. Nine years of school were compulsory, and after that one could choose two, three, or four years of practical or theoretical high school, before optional university studies. Education level (comparable over the entire study period) was categorized as: (1) high (theoretical high school and/or college, ≥12 years); (2) intermediate (practical high school, i.e., vocational school, 10–11 years); and (3) low (compulsory school or less, ≤9 years).

Urbanization: Residence in: (1) the three largest cities in Sweden; (2) medium-sized towns (population >90,000 and <230,000); and (3) small towns (population 27,000–90,000) and rural areas.

Marital status was dichotomized as married/cohabiting or non-married/non-cohabiting.

Smoking was dichotomized as (1) non-smokers, comprising never smokers, occasional smokers and former smokers (regardless of when they quit), and (2) daily smokers.
Leisure time physical activity was based on a question about how much physical activity the person does during leisure time, with five options from (1) "basically nothing" to (5) "regularly rather strenuously at least twice a week." The five options were dichotomized as (1) more than once a week (options 4-5) and (2) no or some physical activity, at most once a week (options 1-3).
BMI was calculated as weight (kg)/height $(m)^2$. Weight and height were self-reported. BMI was categorized into (1) normal weight (20.0-24.9 kg/m^2), (2) overweight (25.0-29.9 kg/m^2), and (3) obesity ($\geq$30.0 kg/m^2).

Statistical analysis

In the analysis, descriptive statistics were used to present the distributions of the explanatory variables, as well as unadjusted proportions of good SRH according to the explanatory variables. We considered differences/trends as significant if p was <0.05. No adjustment of p-values was done. We tested trends by applying a method suggested by Cuzick (1985), which was implemented in STATA as nptrend (Cuzick 1985).

A mixed logistic model with random intercepts (generalized linear mixed model) was applied to test the change in good SRH over time, for age groups and cohorts. Including random slopes did not improve the model. The unadjusted model included age, cohort, the age-by-cohort interaction, and age-squared. A second model was also adjusted for all explanatory variables. Age was centered at 42 years and cohort was centered at 1950. The effect of time period does not need to be estimated for a longitudinal panel study, as age and time express the same effect. Instead the focus can be on the age-by-cohort interaction. Odds ratios (ORs) with 95% confidence intervals (95% CIs), as well as annual rates of change according to age

and birth cohort, were calculated separately according to sex. Adjustments were made for education level, urbanization, marital status, smoking, leisure time physical activity, and BMI. Finally, predicted proportions (%) of good SRH were calculated using the adjusted mixed logistic model, by using gllapred (with option mu) within the gllamm framework within STATA. Birth cohort trends (change per birth year) and age trends (change per year) were also calculated. The trends for each age group and cohort were estimated by applying a linear regression model with time as the independent variable and with the estimated proportions as the dependent variable.

STATA version 12 (StataCorp 2011) was used for the statistical analyses.

Results

The characteristics of the study participants are presented, separately according to sex and assessment period, in Table 1. There was a reduction in the proportion of younger age groups in the last two assessments, which reflects the age structure of the Swedish population at that time. During the study period, education level and urbanization tended to increase, as well as non-smoking, leisure time physical activity, and overweight/obesity.

In Table 2, unadjusted proportions of good SRH by the different explanatory variables are presented separately according to sex and assessment period. The overall proportion of good SRH did not differ much between the four assessments. In general, SRH was poorer (i.e. the proportion of good SRH was lower) in females than in males. At each assessment, SRH was poorer in older than in younger age groups. In order to show the change in SRH over time in each birth cohort, the ten different birth cohorts are marked with numbers 1-10 in superscript in Table 2. Reading the numbers 1-10 diagonally shows that all male and female cohorts reported poorer SRH with increasing age. However, when studying the age groups as cross-

sections (reading the table horizontally), there was a time trend towards improved SRH (i.e. increasing proportions of good SRH) in the three older age groups (48-71 years). By contrast, SRH in the younger age groups was stable or became poorer between 1980/81 and 2004/05.

The p-values for the tests for longitudinal trends in SRH across the covariates strata are also shown in Table 2. In most subgroups, SRH became poorer (or showed no statistically significant trends), except for in overweight males, whose SRH improved.

The results for the mixed models are presented in Table 3a (males) and 3b (females). In males, the adjusted OR for good SRH by age (centered on 42 years) was 0.936 (95% CI=0.927-0.946) per year above 42 years, reflecting poorer SRH with increasing age. The corresponding OR for good SRH by cohort (centered on the 1950 birth cohort) was 0.994 (95% CI=0.985-1.003), reflecting no statistically significant change in SRH for those born in later/younger cohorts. In females, the corresponding ORs were 0.922 (95% CI=0.913-0.931) for good SRH by age and 0.978 (95% CI=0.969-0.986) for good SRH by cohort, reflecting poorer SRH with increasing age and in later/younger cohorts. There was a statistically significant interaction between age and cohort in females (the interaction was borderline significant in males), indicating that the effect of age differed between cohorts in both males and females, i.e. older age groups (48-71 years) improved their SRH over time, while SRH in younger age groups (16-47 years) remained unchanged or became poorer during the follow-up. Age-squared was also significant, reflecting the non-linear association. In summary, these analyses show significant trends of poorer SRH with increasing age in males, and with both increasing age and later/younger cohort in females.

Tables 3a and 3b also show the relationships between good SRH and covariates. In both males and females, poorer SRH was related to lower education level, living in rural areas, being non-married/not cohabiting, smoking, low physical activity, and overweight/obesity.

Tables 4a and 4b present predicted proportions of good SRH according to cohort and age group, based on the models in Table 3. All birth cohorts (reading the table horizontally) had trends towards poorer SRH with increasing age, from 1980/81 to 2004/05. Reading the table vertically reveals improved SRH over time in the older age groups. By contrast, in younger age groups SRH was stable or became poorer during the 25-year follow-up. These tables also show annual changes in good SRH in the studied birth cohorts and age groups. In males, there were significant annual changes towards poorer SRH in those aged 16-23, and improved SRH in those aged 48-71. In females, SRH became poorer in those aged 16-39, and improved in those aged 56-71.

Discussion

In this longitudinal study between 1980/81 and 2004/05, we found trends of poorer SRH with increasing age in males, and with both increasing age and later/younger cohort in females, after adjustments for covariates. SRH was generally poorer in females than in males, as was reported earlier (Halford et al. 2012; McCullough and Laurenceau 2004; Singh-Manoux et al. 2007). Furthermore, we found improved SRH over time in individuals aged ≥48 years, but stable or poorer SRH in younger individuals. In females, there was a significant interaction between age and cohort (borderline significant in males).

Thus, in this study, younger age groups and females constitute vulnerable groups regarding subjective health. The time trends of poorer SRH in males aged 16-23 years and in females

aged 16-39 years were in agreement with a recent regional report from southern Sweden (Fridh M 2013). It is alarming that young individuals report poorer health in modern society, when life expectancy and economic prosperity overall have increased (Chen et al. 2007; Thorslund and Parker 2005). Although it is possible that economic prosperity has not reached all age groups to an equal extent, the mechanisms behind the worsening trend in younger age groups cannot be elucidated in the present study. Obesity is related to poorer SRH, and a recent study from the SALLS study population showed increasing BMI in all cohorts over the same study period, especially in younger cohorts, with larger annual increases in BMI in females aged 24-39 years and in males aged 32-47 years (Caman et al. 2013; Marques-Vidal et al. 2012). Earlier studies have reported increases in mental health complaints, anxiety, and stress among adolescents, especially girls (Hagquist 2010; Wiklund et al. 2012). Socioeconomic factors and social support have been related to inequalities in SRH in adolescents (Salonna et al. 2012). Furthermore, the increasing unemployment rates in Europe and lack of affordable housing may affect younger people to a higher extent. This may lead to a feeling of alienation, hopelessness, and a lack of belief in the future. If the trend of worsening SRH in young individuals endures, it will result in a growing burden on the health care system.

Previous studies investigating changes in SRH by age and cohort are scarce and not consistent (Ishizaki et al. 2009; Zheng et al. 2011). American studies have reported worsening trends in SRH in several age groups in recent decades (Chen et al. 2007; Zack et al. 2004). A study of Britain, Germany, Denmark, and the USA found worsening SRH in older cohorts in Denmark and improved SRH in younger cohorts in USA (Sacker et al. 2011). Several studies have reported poorer SRH with increasing age, which is consistent with our findings and in line with the increased morbidity with increasing age (McCullough and Laurenceau 2004; Sacker

et al. 2011; Zack et al. 2004). Socioeconomic differences in health have been shown to increase with age (Leopold and Engelhardt 2013; Sacker et al. 2005). However, in contrast to the younger age groups, our study showed a time trend towards improved SRH in individuals over 47 years. This may reflect improvements in the treatment of chronic diseases such as cardiovascular diseases during recent decades (Rosen and Haglund 2005). Several studies have concluded that improved lifestyle and better treatments resulted in the compression of morbidity in older individuals during the latter part of the twentieth century (Fries 1980; Mor 2005). Furthermore, in Europe the rate of smoking decreased during this period, which affects the frequency and severity of smoking-related diseases (Giskes et al. 2005). Earlier research confirms our results of longitudinal trends of better subjective health in the elderly (Ishizaki et al. 2009; Thorslund and Parker 2005; Zack et al. 2004). However, it is still controversial whether older individuals have fewer or more years of morbidity or whether the morbidity is only postponed (Thorslund and Parker 2005).

Methodological limitations

This study had several limitations. One limitation is that the number of SRH categories increased from three to five between the second and third assessments. We have investigated this question in detail, by comparing two adjacent surveys, one with the old 3-point scale and one with the new 5-point scale. We found that the two adjacent surveys resulted in essentially the same estimates. Thus we conclude that, irrespective of the number of points on the scale, people answer in a comparable way.

All variables were self-reported during interviews. This may have led to underestimation of unhealthy lifestyle such as smoking, overweight, and low physical activity, because people tend to report better lifestyles than they have and because non-responders probably have poorer lifestyles (Adams et al. 2005). Another limitation is that the non-response rate was 20-

25%. However, in earlier analyses of non-responders, we found that the pattern of non-response is similar according to sex, age, marital status, geographical area of residence, and income over time. We have also studied mortality in the entire sample and among responders only, and found only minor differences. The largest groups of non-responders, those who refused to take part in the survey, had the same mortality rate as the responders. Another potential limitation was that the age structure of the study sample showed a reduction in younger age groups in the later assessments. However, the change in the total Swedish population was mirrored by the sample in a satisfactory way. A final limitation is that loss to follow-up may have resulted in selection bias.

Strengths

The study also has several strengths. Key strengths include the long period of follow-up (25 years) and the fact that the SALLS is one of the most comprehensive national surveys to date (StatisticsSweden 1996). The surveys were mainly conducted in the respondents' homes as face-to-face interviews by well-trained interviewers. The reliability of the survey questions has been estimated by re-interviewing a subsample of the participants (test-retest method). The kappa coefficients were 0.64 for SRH and 0.58 for physical activity (Wärneryd 1991). The SALLS represents a random sample with a longitudinal "panel" with repeated measurements, drawn from the Total Population Register, and is thus representative of the entire Swedish population. The statistical approach with a mixed model made it possible to distinguish changes over time within individuals (age effects) from differences among individuals at baseline (cohort effects), which is a novelty of the present study.

An earlier study of the SALLS showed that SRH was associated with mortality, which strengthens the validity of the variable (Sundquist and Johansson 1997). Furthermore, we were able to control for several potential confounding factors – education level, urbanization,

marital status, smoking, leisure time physical activity, and BMI – which have previously been reported to influence SRH trends (Kachi et al. 2013; Sacker et al. 2011).

Conclusions

Between 1980/81 and 2004/05, SRH improved in individuals aged ≥48 years in Sweden; by contrast, SRH became poorer or was unchanged in the 16-47 years age group. These findings are important for health care policies. The trend of poorer SRH in younger age groups is deeply worrying for the affected individuals, and may also have a negative impact on the health care system. If subjective health continues to deteriorate in younger age groups, the demand for medical care might increase and become more focused on younger individuals. Interventions in this area should focus on younger adults, especially females. Further research is needed to determine whether this negative trend continues and whether it also exists in other countries. Although mental illness, socioeconomic factors, and lifestyle may be potential mechanisms, future studies are also needed to investigate the reasons behind the poorer SRH in younger individuals.

Ethics

This study was approved by the ethics committee in Stockholm (approval no. 12/2000).

Competing interests

The authors declare that they have no conflicts of interest.

Table 1. Characteristics of the study participants according to sex and assessment period (longitudinal samples of the Swedish population from 1980/81, 1988/89, 1996/97, and 2004/05) in individuals aged 16-71 years. The characteristics are shown as distribution (%) and half the 95% confidence interval of the different variables.

Variable	Males				Females			
	1980/81	1988/89	1996/97	2004/05	1980/81	1988/89	1996/97	2004/05
n	2728	2688	2570	2177	2770	2666	2634	2211
Age (years)								
Mean (±half CI)	40.4 ±0.6	41.2 ±0.6	41.8 ±0.5	43.5 ±0.6	41.8 ±0.6	41.7 ±0.6	42.4 ±0.6	43.2 ±0.7
16-23	16.3	16.3	12.8	12.7	16.2	16.0	12.0	13.1
24-31	17.6	15.5	16.5	13.1	15.9	15.8	16.5	13.0
32-39	19.6	16.1	16.5	16.6	17.0	15.8	16.6	16.2
40-47	13.2	18.1	16.1	15.2	12.3	16.8	16.1	16.1
48-55	10.6	12.4	17.9	14.5	12.9	11.1	16.5	15.3
56-63	12.4	9.5	11.3	17.1	13.0	12.2	11.0	15.4
64-71	10.3	12.1	8.9	10.8	12.7	12.3	11.3	10.9
Education level								
Low	42.8 ±1.9	32.9 ±1.8	25.5 ±1.7	20.8 ±1.8	48.7 ±1.8	34.6 ±1.8	25.5 ±1.7	19.2 ±1.7
Intermediate	26.4 ±1.7	31.3 ±1.8	30.9 ±1.8	26.8 ±1.9	31.1 ±1.7	36.0 ±1.9	33.6 ±1.9	26.8 ±1.9
High	30.8 ±1.8	35.8 ±1.8	43.6 ±2.0	52.4 ±2.1	20.2 ±1.5	29.4 ±1.8	40.9 ±1.9	54.0 ±2.1
Urbanization								
Large cities	30.8 ±1.7	31.0 ±1.7	31.2 ±1.8	34.3 ±2.1	30.5 ±1.8	30.0 ±1.8	31.4 ±1.8	33.5 ±2.0
Medium towns	31.5 ±1.8	33.8 ±1.8	36.5±1.8	36.0 ±2.0	32.6 ±1.8	34.7 ±1.8	37.4 ±1.8	36.1 ±2.1
Small towns	37.7 ±1.8	35.2 ±1.9	32.3 ±1.8	29.7 ±2.0	36.9 ±1.8	35.3 ±1.8	31.2 ±1.8	30.4 ±2.0
Marital status								
Married/cohabiting	65.5 ±1.8	64.5 ±1.8	64.8 ±1.9	64.6 ±2.0	68.2 ±1.8	67.7 ±1.7	67.6 ±1.8	65.6 ±2.0
All others	34.5 ±1.8	35.5 ±1.8	35.2 ±1.9	35.4 ±2.0	31.8 ±1.8	32.3 ±1.7	32.4 ±1.8	34.4 ±2.0
Smoking								
Non-smokers	65.9 ±1.8	73.1 ±1.8	81.8 ±1.6	86.5 ±1.5	68.9 ±1.7	71.3 ±1.8	75.8 ±1.6	81.3 ±1.7
Daily smokers	34.1 ±1.8	26.9 ±1.8	18.2 ±1.6	13.5 ±1.5	31.1 ±1.7	28.7 ±1.8	24.2 ±1.6	18.7 ±1.7
Leisure time physical activity								
None to once a week	67.9 ±1.8	64.7 ±1.8	61.3 ±1.9	54.7 ±2.1	75.0 ±1.6	70.6 ±1.8	64.8 ±1.8	51.9 ±2.1
More than once a week	32.1 ±1.8	35.3 ±1.8	38.7 ±1.9	45.3 ±2.1	25.0 ±1.6	29.4 ±1.8	35.2 ±1.8	48.1 ±2.1
Body mass index								
Normal	66.6 ±1.8	63.0 ±1.9	54.3 ±1.9	47.8 ±2.2	75.8 ±1.6	74.0 ±1.7	67.0 ±1.8	64.0 ±2.0
Overweight	29.2 ±1.8	31.9 ±1.8	38.7 ±1.9	42.3 ±2.1	19.8 ±1.6	20.9 ±1.5	26.2 ±1.7	26.3 ±1.9
Obesity	4.2 ±0.8	5.1 ±0.9	7.0 ±1.1	9.9 ±1.4	4.4 ±0.9	5.1 ±0.9	6.8 ±1.0	9.7 ±1.3

Table 2. Unadjusted proportions of good self-rated health (%) in individuals aged 16-71 years and tests for trends in the different explanatory variable groups, presented separately according to sex and assessment period (longitudinal samples of the Swedish population from 1980/81, 1988/89, 1996/97, and 2004/05)

Variable	Males				p-value	Females				p-value
	1980/81	1988/89	1996/97	2004/05		1980/81	1988/89	1996/97	2004/05	
n	2728	2688	2570	2177		2770	2666	2634	2211	
Overall %	81.5	82.7	82.9	81.7		77.0	77.6	78.5	75.4	
Age (years)										
16-23	92.8[7)]	94.5[8)]	91.8[9)]	92.1[10)]		89.1[7)]	89.5[8)]	88.6[9)]	87.9[10)]	
24-31	91.1[6)]	90.5[7)]	93.2[8)]	89.5[9)]		89.6[6)]	90.5[7)]	88.9[8)]	88.5[9]	
32-39	86.0[5)]	87.7[6)]	87.3[7)]	86.5[8)]		87.9[5)]	82.9[6)]	87.2[7)]	78.6[8)]	
40-47	84.7[4)]	81.7[5)]	85.5[6)]	81.9[7)]		78.8[4)]	80.4[5)]	81.4[6)]	73.0[7)]	
48-55	73.1[3)]	77.5[4)]	76.4[5)]	81.0[6)]		71.4[3)]	70.8[4)]	74.7[5)]	73.2[6)]	
56-63	62.3[2)]	67.3[3)]	70.1[4)]	68.5[5)]		58.1[2)]	60.6[3)]	63.1[4)]	65.1[5)]	
64-71	65.7[1)]	68.9[2)]	67.7[3)]	73.9[4)]		54.5[1)]	58.2[2)]	56.6[3)]	60.8[4)]	
Education level										
Low	74.9	78.8	75.7	78.5	ns	70.3	67.6	66.3	66.4	0.046
Intermediate	83.9	82.3	83.0	77.7	0.012	80.5	79.7	77.5	67.4	<0.001
High	88.5	86.7	87.1	85.0	0.039	87.7	87.0	87.0	82.6	0.002
Urbanization										
Large cities	83.7	83.7	84.3	83.4	ns	78.7	79.7	81.8	78.9	ns
Medium towns	81.6	85.0	85.7	83.5	ns	77.5	77.4	79.2	77.6	ns
Small towns	79.5	79.6	78.4	77.4	ns	75.1	76.2	74.5	68.7	0.05
Marital status										
Married/ cohabiting	80.5	82.0	82.4	80.9	ns	77.6	78.1	79.0	76.0	ns
All others	83.3	84.0	84.0	83.0	ns	75.8	76.7	77.6	74.1	ns
Smoking										
Non-smokers	83.0	84.8	84.6	83.3	ns	77.2	79.0	81.1	78.0	ns
Daily smokers	78.4	77.0	75.5	71.2	0.012	76.7	74.3	70.5	63.8	<0.001
Leisure time physical activity										
None to once a week	77.2	78.9	78.0	77.1	ns	74.1	74.3	73.5	69.2	0.007
More than once a week	90.5	90.2	90.6	87.1	0.025	85.6	85.8	87.8	81.9	0.05
Body mass index										
Normal	85.2	86.3	87.0	85.9	ns	80.8	81.0	83.0	81.2	ns
Overweight	74.3	77.9	80.2	79.8	0.003	68.6	71.6	73.3	68.2	ns
Obesity	71.9	68.3	66.3	69.4	ns	50.4	53.7	55.2	56.1	ns

Cohort: [1)]1910-1917;[2)]1918-25; [3)]1926-33; [4)]1934-41; [5)]1942-49; [6)]1950-57; [7)]1958-65; [8)]1966-73;[9)] 1974-81; [10)] 1982-89

p-values: Test for trend row-wise for males and females separately; ns, non-significant

Table 3a. Odds ratios (ORs) with 95% confidence intervals (95% CIs) for good self-rated health in *males* aged 16-71 years in Sweden in 1980/81–2004/05, estimated using mixed models with random intercepts

		Unadjusted model		Adjusted model	
Variable	Category	OR	95% CI	OR	95% CI
Fixed effects					
Rate of change					
Age-centered	Centered at 42 years	0.942	0.933-0.951	0.936	0.927-0.946
Agec*cohortc		1.0003	0.995-1.013	1.0003	0.999-1.0009
Agec-squared		1.0006	1.000-1.0013	1.0008	1.0001-1.0014
Cohort-centered	Centered at 1950	1.004	0.995-1.013	0.994	0.985-1.003
Education level	High			1	Reference
	Intermediate			0.74	0.60-0.91
	Low			0.59	0.48-0.74
Urbanization	Large cities			1	Reference
	Medium towns			1.02	0.81-1.28
	Small towns			0.70	0.56-0.88
Marital status	Married/cohabiting			1	Reference
	All others			0.61	0.50-0.73
Smoking	Non-smokers			1	Reference
	Daily smokers			0.65	0.54-0.79
Leisure time physical activity	More than once a week			1	Reference
	None to once a week			0.45	0.38-0.53
Body mass index	Normal			1	Reference
	Overweight			0.75	0.63-0.89
	Obesity			0.44	0.33-0.61
Variance components		Variance	Standard error	Variance	Standard error
	Var (cons)	4.01	0.36	3.25	0.30

Agec, age-centered; cohortc, cohort-centered

Table 3b. Odds ratios (ORs) with 95% confidence intervals (95% CIs) for good self-rated health in *females* aged 16-71 years in Sweden in 1980/81–2004/05, estimated using mixed models with random intercepts

		Unadjusted model		Adjusted model	
Variable	Category	OR	95% CI	OR	95% CI
Fixed effects					
Rate of change					
Age-centered	Centered at 42 years	0.930	0.922-0.939	0.922	0.913-0.931
Agec*cohortc		1.0006	1.00002-1.001	1.0007	1.0001-1.0012
Agec-squared		1.0002	1.0000-1.0008	1.0007	1.00015-1.0013
Cohort-centered	Centered at 1950	0.9994	0.986-1.003	0.978	0.969-0.986
Education level	High			1	Reference
	Intermediate			0.58	0.47-0.73
	Low			0.40	0.32-0.51
Urbanization	Large cities			1	Reference
	Medium towns			0.96	0.77-1.19
	Small towns			0.78	0.62-0.97
Marital status	Married/cohabiting			1	Reference
	All others			0.66	0.56-0.79
Smoking	Non-smokers			1	Reference
	Daily smokers			0.54	0.45-0.65
Leisure time physical activity	More than once a week			1	Reference
	None to once a week			0.51	0.43-0.60
Body mass index	Normal			1	Reference
	Overweight			0.72	0.60-0.86
	Obesity			0.33	0.24-0.44
Variance components		Variance	Standard error	Variance	Standard error
	Var (cons)	4.57	0.37	3.70	0.31

Agec, age-centered; cohortc, cohort-centered

Table 4a. Predicted proportions (%) of good self-rated health (SRH) in *males* based on the adjusted model in Table 3a and annual change in good SRH (ΔSRH per year by age and cohort, test of trend) in individuals aged 16-71 years, presented according to age, cohort (birth year), and assessment period (longitudinal samples of the Swedish population from 1980/81, 1988/89, 1996/97, and 2004/05)

Variable	Age group								
Birth cohort	16-23	24-31	32-39	40-47	48-55	56-63	64-71	ΔSRH cohort	p-value
1910-17	-	-	-	-	-	-	64.1	-	
1918-25	-	-	-	-	-	67.4	65.6	-0.22	0.28
1926-33	-	-	-	-	73.9	68.9	67.3	-0.42	0.001
1934-41	-	-	-	81.9	77.3	73.1	72.7	-0.41	0.0001
1942-49	-	-	86.6	80.4	76.0	71.8	-	-0.62	0.0001
1950-57	-	91.4	87.9	83.3	79.1	-	-	-0.51	0.0001
1958-65	93.8	90.6	87.0	81.7	-	-	-	-0.49	0.0001
1966-73	94.0	91.7	87.4	-	-	-	-	-0.41	0.0001
1974-81	92.6	90.6	-	-	-	-	-	-0.24	0.015
1982-89	92.5	-	-	-	-	-	-	-	
ΔSRH age-group	-0.063	-0.011	0.022	0.037	0.17	0.21	0.39		
p-value	0.008	0.71	0.62	0.48	0.007	0.002	0.0001		

Color code: 1980/81, 1988/89, 1996/97, and 2004/05

Table 4b. Predicted proportions (%) of good self-rated health (SRH) in *females* based on the adjusted model in Table 3b and annual change in good SRH (ΔSRH per year by age and cohort, test of trend) in individuals aged 16-71 years, presented according to age, cohort (birth year), and assessment period (longitudinal samples of the Swedish population from 1980/81, 1988/89, 1996/97, and 2004/05)

Variable	Age group								
Birth cohort	16-23	24-31	32-39	40-47	48-55	56-63	64-71	ΔSRH cohort	p-value
1910-17	-	-	-	-	-	-	54.4	-	
1918-25	-	-	-	-	-	61.6	55.6	-0.75	0.001
1926-33	-	-	-	-	71.5	62.3	55.6	-1.0	0.0001
1934-41	-	-	-	78.3	72.1	62.5	59.3	-0.84	0.0001
1942-49	-	-	86.2	79.6	73.5	67.0	-	-0.80	0.0001
1950-57	-	89.9	84.2	79.2	73.2	-	-	-0.69	0.0001
1958-65	91.3	88.6	84.1	77.6	-	-	-	-0.56	0.0001
1966-73	90.2	87.3	81.8	-	-	-	-	-0.52	0.0001
1974-81	89.1	88.2	-	-	-	-	-	0.34	0.39
1982-89	87.7	-	-	-	-	-	-	-	
ΔSRH age-group	-0.15	-0.09	-0.17	-0.04	0.08	0.20	0.17		
p-value	0.0001	0.021	0.0001	0.53	0.24	0.006	0.031		

Color code: 1980/81, 1988/89, 1996/97, and 2004/05

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