General discussion
This thesis examined the ability of a one-item measure of SRH (self-rated health, people’s own health evaluation) to reflect overall health status in the older population. It was previously acknowledged that SRH measured at one point in time is a good predictor of mortality and is quite well able to distinguish between groups in poor and good health\(^1\), which was confirmed by the results of this thesis. Still, there is a need for recommendations regarding its use in longitudinal and trend studies. Results of this thesis confirmed the ageing paradox (i.e. older people rate their health better than younger people, given their worse objective health status), and showed that older people may lower their health standard in response to health decline. While this may be beneficial to older individuals who experience health decline, it means that SRH may not be sensitive enough to capture changes in chronic diseases and functional limitations when measured repeatedly in ageing individuals. In addition, we found indications for a slightly changed prioritization of relevant health aspects over historic time, contaminating the interpretation of trends in SRH.

This chapter summarises all findings from the studies described in this thesis and comments on some methodological issues. Although this thesis touched upon a broader range of topics, such as educational differences in SRH and in reporting chronic diseases, theoretical and practical implications described in this chapter will specifically focus on the ability of SRH to reflect overall health status in the general older population.

**Main findings**

*Existing health problems and self-rated health*

Table 1 shows a short summary of the studies reported in this thesis. In Chapter 2 we investigated the potential of SRH to reflect the number of chronic diseases people reported at one point in time, i.e. if the impact of chronic diseases on SRH depends on the presence of other diseases or not. A nonlinear association between multimorbidity and SRH was found: the initial effect of having a first, single chronic disease was larger than the additional effects of co-occurring diseases. From the second disease onward, each additional co-occurring disease caused cumulative declines in SRH. This gradual decline in SRH with each co-occurring chronic disease was observed irrespective of age.

In Chapter 3, the sensitivity of SRH to changes in chronic diseases and functioning was examined among nonagenarians (those aged 90 and over). In view of the high prevalence of chronic diseases and poor functioning, a remarkably high proportion (37%) of the oldest old rated their health as fairly good or very good. Within two years, most people (56.3%) had unchanged SRH, but declined SRH (22.3%) was associated with worse baseline functioning and declined functioning during follow-up. We found clear declines in SRH after six and nine years and these declines could be explained by an increased number of chronic diseases and declined functioning, providing evidence for the ability of SRH to reflect changes in underlying health...
status in nonagenarians. The impact of chronic diseases and functioning on SRH was smaller in institutionalised people than in people living independently.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Design</th>
<th>Study and wave(s)</th>
<th>Predictor*</th>
<th>Outcome</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing health problems and self-rated health</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>Cross-sectional</td>
<td>LASA 2005-06</td>
<td>CD</td>
<td>SRH</td>
<td>SRH sensitive to number of chronic diseases. First disease has largest impact on SRH</td>
</tr>
<tr>
<td>3</td>
<td>Longitudinal</td>
<td>Vitality 90+ 2001, 2003, 2007, 2010</td>
<td>CD, FL</td>
<td>Change in SRH</td>
<td>Relatively positive health ratings despite poor functioning. SRH still sensitive to chronic diseases and functioning, more pronounced at longer follow-up</td>
</tr>
<tr>
<td>Response shift</td>
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<td></td>
</tr>
<tr>
<td>4</td>
<td>Longitudinal</td>
<td>LASA 2001-03, 2005-06</td>
<td>CD, Various</td>
<td>Change in SRH</td>
<td>Recalibration response shift occurred in the measurement of SRH. Then-test may give additional information</td>
</tr>
<tr>
<td>5</td>
<td>Longitudinal</td>
<td>LASA 2001-03, 2005-06 Mortality till 2011</td>
<td>Change in SRH</td>
<td>Mortality</td>
<td>Prospective and retrospective change in SRH (obtained with then-test) not predictive for SRH, over a single measure of SRH alone</td>
</tr>
<tr>
<td>Trends in health and self-rated health</td>
<td></td>
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<tr>
<td>6</td>
<td>Trend</td>
<td>LASA 1992-93, 1995-96, 1998-99, 2001-03, 2005-06, 2008-09</td>
<td>CD, FL</td>
<td>SRH</td>
<td>SRH trends not sensitive to trends in chronic diseases and functioning. Possibly, the concept of health has slightly changed during this period</td>
</tr>
<tr>
<td>7</td>
<td>Trend</td>
<td>LASA 1992-93, 2008-09</td>
<td>SRH, Various</td>
<td>Agreement on CD</td>
<td>Increased over-reporting: GP reported chronic diseases showed smaller increases over time than self-reported diseases. Poor SRH associated with over-reporting</td>
</tr>
</tbody>
</table>

*CD, Chronic diseases; FL, Functional limitations
Response shift

Chapter 4 applied response shift theory to explain the stability in SRH that is often found, despite apparent health declines. It was investigated if reprioritization, reconceptualization and recalibration response shifts occur in the measurement of SRH in older people. The selected important predictors of SRH in four domains were similarly predictive for SRH at two waves, on average 3.6 years apart, providing no evidence that respondents changed their concept of health during follow-up. We did find indications for recalibration response shift, i.e. a change in internal health standards, depending on the occurrence of health decline during this period. In the subgroup that reported identical SRH at two waves, participants who experienced incident chronic diseases between the two waves were three times more likely to retrospectively overrate health at the first wave with the then-test (‘how was your health three years ago?’). These results suggested that an unchanged SRH despite health decline possibly results from a lowering of standards of good health over time.

The then-test was used again in Chapter 5, to compute a retrospective change measure of SRH between two measurement waves, on average 3.6 years apart. Retrospective change in SRH is assumed to be less prone to changes in health standards. We expected that this measure had better predictive value for mortality than a prospective change measure and that it would improve the prediction of mortality of a single measurement of SRH alone. Results showed that decline in SRH between the first and second wave was associated with higher 5-year mortality risk, but only when measured prospectively. Neither change measure predicted mortality when SRH at the second- most recent- wave was included. These findings implied that using the most recent measurement of SRH might suffice to identify those with a high risk of future negative health outcomes.

Trends in health and self-rated health

Chapter 6 took a different perspective than the previous chapters. Changes in SRH were now studied in the older population in same-aged groups across different years. There was a stable trend in the prevalence of poor SRH and severe disability, while the mean number of chronic diseases (1.3-1.8) and the prevalence of mild disability (20.5-32.1%) increased between 1992 and 2009. The association between poor SRH and chronic diseases became weaker, whereas the association between poor SRH and severe disability became stronger over time. The most unfavourable trends were observed in the older old and the lower educated.

The final study, described in Chapter 7, investigated the agreement between self-reported and general practitioner (GP) reported chronic diseases. The self-reported prevalence of chronic diseases increased to a larger extent between 1992-93 and 2008-09 than the GP reported prevalence did. Over-reporting of chronic diseases (self-reported presence and GP reported absence of disease) became significantly more common while under-reporting (self-reported absence and GP reported presence of disease) became less common. Overall, this trend did not result in lower levels of agreement on specific chronic diseases between 1992-93 and 2008-09. At both waves, Cohen’s kappa ranged between .31 (arthritis) and >.85 (diabetes).
Agreement and change in agreement differed across the specific diseases. Under-reporting was associated with male gender; over-reporting with female gender, worse SRH and worse physical functioning. Older olds were less accurate in reporting their diseases than younger olds.

**Methodological considerations**

The results from the studies in this thesis should be interpreted in light of some methodological strengths and weaknesses. This section discusses the most important implications of these strengths and weaknesses for our results.

*Cohort studies and generalisability of our results*

Data from two cohort studies were used in this thesis. Both cohort studies comprise large community samples, which enabled studying a large number of covariates as well as subgroup effects. The Longitudinal Aging Study Amsterdam (LASA) consists of a community-based sample of people aged 55 and over in the Netherlands. A broad set of demographic, psychosocial, cognitive, physical health and lifestyle factors was available in this multidisciplinary study and could be included in prediction models of SRH. SRH, chronic diseases and functional limitations were measured at all waves using the same operational definition, which facilitated the investigation of longitudinal trajectories and trends. The addition of a new cohort in 2002-03 further contributed to the possibility of studying trends in SRH. In cohort studies in the general older population the proportion of nonagenarians is usually too low to study them as a separate group. The Vitality 90+ Study is one of the few studies that enables studying the health and functioning of the oldest old, since all nonagenarians living in Tampere, Finland, are invited to participate. The response rate was very high in this group, almost 80%.

An inevitable consequence of longitudinal studies among older people is loss to follow-up. In both LASA and the Vitality 90+ Study, attrition was predominantly due to mortality. Annual mortality was high in nonagenarians in particular, around 20%. In addition, a small proportion of the sample was lost to follow-up due to refusal or ineligibility (frailty). Analyses in LASA showed that those who refuse to participate were not different with respect to the health variables in our study. We expect that in particular drop-out due to frailty (<2% per wave in LASA) would lead to an underestimation of health problems. In all of the reported studies, participants included were healthier than participants lost to follow-up or with missing data. In all studies enough variation remained with respect to health characteristics, but associations may have been under-estimated since people with the most severe conditions were under-represented. One study specifically focused on prevalences (Chapter 6). In that study, similar results were found for trends in chronic diseases and disability in analyses which included people who were initially excluded because of missing SRH data. In addition, we found that the probability of attrition in LASA (due to refusal, frailty or mortality) did not change over time. Thus, although
attrition may have influenced the reported prevalences, health trends are likely not biased to a large extent by attrition.

Follow-up measurements took place every three years in LASA and between two and four years in the Vitality 90+ Study. It might be that relevant health changes in these intervals were missed. Studying short-term health changes may in particular be relevant regarding the SRH of nonagenarians. Not only would shorter intervals have resulted in a larger study sample because a higher number would have survived until follow-up, but it might also have uncovered terminal health declines, which were shown to be important for SRH. Future studies with shorter follow-up periods should give insight into short-term (terminal) declines, and how SRH reflects these changes.

Finally, replication analyses in different cohort studies are needed to confirm our findings in Dutch but also other older populations. Important predictors of SRH may be similar across European countries, but it can be expected that contextually determined perceptions of health and their associations with chronic diseases and limitations have changed differently over time across countries. Also, the nonagenarians in Finland may not be directly comparable with nonagenarians in other countries, examples being differential war experiences and socioeconomic circumstances, which may affect long-term SRH trajectories as well as predictors of SRH.

Measuring and analysing self-rated health
Several variations exist in the way SRH is measured or analysed, which may lead to differences in meaning and thus hamper comparisons across studies. A 5-point scale is employed most often, but 3-, 4- and 7-point scales are being used as well. Some studies have asked respondents explicitly to make a comparison between their health and the health of age peers or of their own health at a younger age. Most commonly used is the non-comparative question with five response options. This version was used in LASA and the Vitality 90+ Study as well, but the wording of the response options deviated slightly from the wording that was often used in previous studies.

In LASA, respondents were asked: ‘How is your health in general?’ with response options (1) very good, (2) good, (3) fair, (4) sometimes good, sometimes poor or (5) poor. (Original Dutch question: ‘Hoe is over het algemeen uw gezondheidstoestand? (1) zeer goed, (2) goed, (3) gaat wel, (4) soms goed, soms slecht of (5) slecht?’) The WHO/European version has response options from very good to very bad, and the US version ranges from excellent to poor. Our associations are likely not influenced by this difference: when the WHO version was compared with the US version, similar associations with health factors were found. Distributions of these categories may not be directly comparable across studies. Still, when comparing the distribution of SRH in our sample with that of a comparable Dutch sample, which did have poor and very poor as the worst two response options, the percentages in that sample rating their health as good (very good or good) and less than good (i.e. fair, poor or very poor) were about 65% and 35%, respectively, resembling the percentages found in our sample (Chapter 2).
In the Vitality 90+ Study, the following question was asked: ‘How is your current state of health? Is it (1) very good, (2) fairly good, (3) average, (4) fairly bad or (5) bad? (Original Finnish question: Millaiseksi itse arvioitte nykyisen terveydentilanne? Onko terveytenne (1) erittäin hyvä, (2) melko hyvä, (3) keskiverto, (4) melko huono, (5) huono). It might be that the middle category, average, which does not have a negative connotation in the Finnish language, may be chosen more often than a middle category fair, which is often used in other studies. This may have resulted in less good-raters in our study as compared to previous nonagenarian studies\textsuperscript{14,15}. The extent to which associations between SRH and other health measures have been affected by this difference remains uncertain.

SRH responses may also have been influenced by questions on specific health problems that were asked before SRH in the interview, although conclusions on the direction of this influence were mixed\textsuperscript{16-18}. Comparisons regarding SRH levels with other studies may be hampered if this question order differs across studies. Both LASA and Vitality 90+ placed SRH before questions on chronic diseases, but the CES-D depression scale (LASA) or questions on functioning (LASA and Vitality 90+) were placed before the SRH question. More importantly, changes in the question order across waves may have affected longitudinal changes or trends in SRH. The placement of the SRH question was similar across waves in both LASA and the Vitality 90+ Study, but in the LASA telephone interviews SRH was asked before all other health questions. Since only between 4 and 7% of the interviews in each wave were held by telephone, we expect that this has had only a minor influence on our results and the comparability of our results.

Finally, methods of analysis might have caused differences between our results and those from other studies. Previous studies have applied linear regression models on SRH in its ordinal form\textsuperscript{19,20}, while others, in particular trend studies, used logistic regression models with the most widely adopted dichotomization between good and less than good\textsuperscript{21-24}. One study showed that similar conclusions could be drawn from logistic regression and ordinal regression models concerning the relationship between socioeconomic position and SRH\textsuperscript{25}. In this thesis, the response options of SRH were both dichotomised between good and less than good, and used in its ordinal form. Chapter 2 clearly shows that if SRH is to be used as a dichotomous variable, a split between response options good and less than good may be the most sensitive to underlying health problems. Generalised ordered regression analysis with constrained estimation of coefficients, as used in Chapter 2, may be the best option to take the ordinal nature of SRH into account. Since this analysis does not produce easily interpretable regression coefficients, in subsequent analyses we applied regular linear regression. In Chapters 3 and 6, the extent to which our definition of poor SRH may have influenced the results was specifically investigated. In Chapter 3, investigating the impact of chronic diseases and functioning on SRH in nonagenarians, a dichotomisation between poor and average or good SRH was more sensitive to the number of chronic diseases and the level of functioning than the ordinal measure of SRH. Thus, it might be that in some of the analyses the impact of chronic diseases on SRH would have been larger when SRH was used as a dichotomous outcome variable. With respect to trends
in SRH, Chapter 6 showed similar results, regardless the use of a dichotomous or an ordinal measure of SRH.

**Chronic diseases and functional limitations as measures of overall health**

In the LASA study, the presence of seven ‘major’ and two ‘other’ chronic conditions was assessed. Both were included in the disease counts used in this thesis. The selection of seven major chronic diseases in LASA was based on their prevalence (>5%) in the Dutch population aged 55 years and over: chronic non-specific lung disease (CNSLD; including asthma, bronchitis and pulmonary emphysema), cardiac disease, peripheral arterial disease (PAD), stroke, diabetes mellitus, arthritis (osteoarthritis and rheumatoid arthritis) and cancer. All diseases, except for arthritis, showed a strong relationship with mortality. Respondents could additionally report a maximum of two other diseases, which had been present for at least three months. A large variety of health problems was mentioned in this ‘other’ category. Commonly reported diseases were for example thyroid disease, intestinal disease and back problems. Although the prevalence of some of these diseases in the older population is lower than the seven major conditions, their impact on SRH may be considerable. Table 2 shows that the impact of diseases reported in the ‘other’ category on SRH was in the same range as the impact of the seven major diseases. This justifies our decision to include these conditions when a chronic disease count was used.

<table>
<thead>
<tr>
<th>Separate models</th>
<th>Adjusted model</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNSLD</td>
<td>0.54 (0.43;0.65)</td>
</tr>
<tr>
<td>Cardiac disease</td>
<td>0.51 (0.42;0.60)</td>
</tr>
<tr>
<td>PAD</td>
<td>0.66 (0.52;0.80)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0.46 (0.34;0.58)</td>
</tr>
<tr>
<td>Stroke</td>
<td>0.52 (0.37;0.67)</td>
</tr>
<tr>
<td>Arthritis</td>
<td>0.48 (0.40;0.55)</td>
</tr>
<tr>
<td>Cancer</td>
<td>0.30 (0.19;0.41)</td>
</tr>
<tr>
<td>Other</td>
<td>0.40 (0.31;0.49)</td>
</tr>
</tbody>
</table>

*Adjusted for age and gender
*Adjusted for age, gender and the other diseases in the model

A limitation of our study might be that self-reported information about chronic diseases and problems with functioning was used. This method might introduce some response bias: interrelations between health dimensions might be artificially inflated since all are influenced by respondents’ beliefs about their own health. Self-reports of chronic diseases were fairly accurate as compared to general practitioner reports (Chapter 7). Unlike a previous study,
our study indicated that respondents in 2008-09 more often over-reported chronic diseases when compared to GP records than in 1992-93. Kappa coefficients did not decrease during this period, but the increasing trend in the prevalence of chronic diseases we found in Chapter 6 may be partly attributed to changes in reporting behaviour.

We also found that poor SRH was associated with over-reporting in most chronic diseases, which indicates that people with poorer SRH indeed may have been more likely to report chronic diseases (without being actually diagnosed). In that case, the associations reported between chronic diseases and SRH may have been overestimated. Table 3 nevertheless shows that the impact of GP reported chronic diseases on SRH was not significantly different from the impact of self-reported chronic diseases. Only the negative effect of arthritis on SRH is smaller when GP records are used. Since the prevalence of arthritis is relatively high (44%, Chapter 2), this might have affected the strength of the associations between chronic diseases and SRH in this thesis. It remains unknown to what extent response bias has influenced our finding that first diseases have a relatively large impact on SRH. Future research using more objective measures of chronic diseases is needed to confirm our conclusion. Regarding our study on trends in SRH, the same measures were used in all six waves. In addition, the association between poor SRH and over-reporting did not change over time, which indicates that results on trends in health indicators and their associations are not likely biased.

With respect to our nonagenarian study it was found that these oldest olds more often under-report (defined as GPs reporting a disease present while respondents do not) their conditions than younger old\textsuperscript{30}. This indicates that the prevalence of chronic diseases in the oldest old may be an underestimation of the true prevalence. The effect this may have had on the reported associations remains uncertain and should be examined in future research.

Table 3. The impact of self-reported and GP-reported chronic diseases on SRH, linear regression analysis

<table>
<thead>
<tr>
<th>Disease</th>
<th>Self-reported</th>
<th>GP-reported</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Separate models\textsuperscript{a}</td>
<td>Adjusted model\textsuperscript{b}</td>
</tr>
<tr>
<td>CNSLD</td>
<td>0.55 (0.40;0.70)</td>
<td>0.50 (0.32;0.69)</td>
</tr>
<tr>
<td>Cardiac disease</td>
<td>0.51 (0.39;0.61)</td>
<td>0.39 (0.20;0.57)</td>
</tr>
<tr>
<td>PAD</td>
<td>0.72 (0.54;0.91)</td>
<td>0.47 (0.20;0.75)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0.49 (0.33;0.64)</td>
<td>0.46 (0.30;0.63)</td>
</tr>
<tr>
<td>Stroke</td>
<td>0.53 (0.31;0.75)</td>
<td>0.30 (0.01;0.59)</td>
</tr>
<tr>
<td>Arthritis</td>
<td>0.41 (0.30;0.51)*</td>
<td>0.20 (0.07;0.33)*</td>
</tr>
<tr>
<td>Cancer</td>
<td>0.31 (0.17;0.41)</td>
<td>0.25 (0.12;0.37)</td>
</tr>
</tbody>
</table>

\*Significant difference between self-reported and GP-reported
\textsuperscript{a}Adjusted for age and gender
\textsuperscript{b}Adjusted for age, gender and the other diseases in the model
In most of the studies reported in this thesis we examined the impact of somatic chronic diseases and not that of mental diseases, such as depression and anxiety. Further research may focus on these illnesses, which may complicate associations between physical health and SRH. Depression may induce an opposite effect compared to what we expected with incident somatic diseases. Symptoms of depression showed an increasing association with SRH with increasing age\textsuperscript{31}. Also, when compared with non-depressed people, depressed people may rate their health more negatively relative to their acquired health problems\textsuperscript{32,33}. Furthermore, recall bias, concentration and memory problems, which are all related to depression, may influence the reliability of the then-test. Anxiety disorders were not taken into account in this study either. Since these disorders were shown to be associated with both SRH and chronic somatic diseases\textsuperscript{34}, they may have been of influence on the results of this thesis.

**Theoretical implications and implications for future research**

All studies in this thesis corroborate results from previous studies, showing clear associations between chronic diseases, functioning limitations and SRH\textsuperscript{31,35}. In addition, our results confirm that functional limitations partly mediate the association between chronic diseases and SRH (Chapter 3)\textsuperscript{36}. Previous studies have revealed that the link between symptoms, diagnosed conditions and poor functioning on the one hand and SRH on the other hand weakens with age\textsuperscript{31,37-39}. This phenomenon has been termed the ageing paradox: older people have better SRH than would be expected based on their more objective health status. This thesis further explored how a higher age and a higher level of existing health problems change the meaning of SRH, thereby challenging the interpretation of SRH as a proxy for more objectively measured health status. Below, we discuss the implications of our findings for the current knowledge on SRH.

**Existing health problems and self-rated health**

Our results confirm that, given a level of objective health problems, older olds rate their health relatively positively compared with younger olds (Chapter 4). Moreover, the gap between objective measures of health and SRH is still increasing at very old age. When matched according to their level of functioning, older nonagenarians rated their health better than younger nonagenarians (Chapter 3). This resulted in relatively optimistic health ratings among nonagenarians: 37% rated their health as fairly good or very good, similar to the 39% reported in a sample of 60-89 year-old Finns\textsuperscript{40}.

This moderating effect of age may have resulted from cohort differences and selective survivorship\textsuperscript{41}. For example, early life experiences with respect to health and health care that shape the conceptualization of health and the frame of reference have been different for older than for younger cohorts. There is also clear evidence that the evaluation of health in older
people has changed in response to declines in health and functioning: longitudinal studies, following the same individuals over time, showed that SRH remains relatively stable despite apparent health declines\textsuperscript{33,42}. The studies in this thesis confirm that SRH not always shows a decline in response to incident chronic diseases or functional limitations. The SRH of people with pre-existing health problems in particular appeared to be less likely influenced by new health problems\textsuperscript{39,43}. Heller and colleagues\textsuperscript{43} found that higher age was still of influence, next to baseline morbidity, but we found a larger impact of first chronic diseases compared with the effect of subsequent diseases, irrespective of age (Chapter 2). This difference might partly be explained by differences in the samples included and in study methods, for example the inclusion of different chronic diseases. Whether adaptation to existing health problems fully accounts for the age difference in the meaning of health ratings needs to be assessed in future research.

Some notes on adaptation to health deterioration
The development of a chronic disease or functional limitation may be viewed by older people as stressful, especially when symptoms are severe, or when functional limitations lead to restrictions in social participation or to dependence on others. People can also have enduring beliefs about their health, which may be challenged by these health changes\textsuperscript{44,45}. After a period of health deterioration, people may accept that health is declining, or may compensate the loss of good health with other resources still available to them\textsuperscript{46,47}. This way, the adverse effect of health decline on the level of wellbeing can be reduced. Other examples of adaptation mechanisms in relation to SRH are that people change their conceptualization of health when they age, or lower their standard of good health, for example by comparing themselves with people their own age\textsuperscript{48-50}. In particular the effect of social comparison on SRH has been examined in previous studies\textsuperscript{37,51}, showing that downward comparison (choosing as a reference group people whose health is worse) plays an important role in the maintenance of good SRH despite deteriorating health.

It has been shown previously that the negative effects of persistent health decline on wellbeing may be moderated by adaptation mechanisms\textsuperscript{44}. As the results of this thesis showed, adaptation might also occur as soon as people are faced with a first decline in health. It might be that after a first chronic disease people have succeeded in achieving a first, major adaptation to being chronically ill. Since our study was a cross-sectional one, this hypothesis needs to be confirmed in future longitudinal studies and against qualitative accounts of people themselves about their adaptation process. It should be acknowledged here that chronic diseases have distinct characteristics, in terms of course, symptoms and the level of controllability over these symptoms\textsuperscript{52}. Apart from Table 2, which shows that the impact of different chronic diseases is quite comparable, disease-specific effects have not been addressed in this thesis. Further research may focus specifically on resources that enable older people to adapt to specific types of diseases, to maintain a good level of SRH.
Personal resources, such as perceived support and sense of control, influence the potential of older people to adapt to health decline\textsuperscript{53,54}. These resources may also directly influence perceived health, irrespective of the presence of chronic diseases or problems with functioning\textsuperscript{53}. The results from this thesis suggest that adaptation in nonagenarians may differ according to their social environment\textsuperscript{55}. The impact of chronic diseases and poor functioning on SRH was larger when people were living at home. From our study it remained uncertain to what extent this moderating effect was influenced by a higher prevalence of dementia in people living in institutions. Future research, for example using qualitative interviews, are needed to explain how health evaluations in response to health decline differ according to living situation and if adaptation mechanisms can be improved in very old people living at home.

To conclude, adaptation to objective health decline plays an important role in older individuals to maintain relatively good wellbeing. This suggests that in particular in groups with multiple chronic diseases, such as nonagenarians, the level of SRH and decline in SRH (although to some extent sensitive to chronic diseases and functioning) provides an underestimation of older people’s objective health status and health decline. The following section more specifically discusses how adaptation mechanisms may challenge the interpretation of change in SRH as a measure of change in objective health.

**Adaptation and measuring objective health decline using SRH - Response shift theory**

Response shift was defined by Sprangers and Schwartz\textsuperscript{56} as ‘a change in the meaning of one’s self-evaluation of a target construct as a result of: (a) a change in the respondent’s internal standards of measurement (i.e. scale recalibration), (b) a change in the respondent’s values (i.e. the importance of component domains constituting the target construct), (c) a redefinition of the target construct (i.e. reconceptualization)’. Response shift has mainly been studied in the context of treatment effects. Our study for the first time explored the role of response shift in a non-clinical ageing population. Referring to the process of individual health evaluation\textsuperscript{1} (p.13), reconceptualization and reprioritization were regarded as changes in the selection of relevant health problems. Recalibration was viewed as an indication of changes in the frame of reference that older people apply when rating their health.

We expected that a change would occur in the selection of relevant health aspects and in the importance of physical health aspects in particular. This expectation was based on the finding that SRH in older people is less strongly associated with physical health than in younger people\textsuperscript{36,38,50}. An explanation for our finding that reconceptualization and reprioritization did not occur may be that three to four years follow-up is too short to indicate relevant changes in the conceptualization of health. There have also been studies indicating that older olds more often, instead of less often, mention physical health aspects when rating their health compared with younger olds\textsuperscript{57,58}. This suggests that after health decline the selection of relevant health aspects might not change in the direction we had expected. Personalized techniques\textsuperscript{59} might be used in future research to confirm our findings, although these are quite expensive. For example,
respondents may be asked to select which domains they view as important and to subsequently rate the relative importance of these domains.

Using a then-test (asking respondents: ‘How was your health three years ago?’), we found that people may lower their health standard after experiencing health decline (i.e. recalibration). This may be explained by prospect theory. According to this theory, current health serves as the reference level for health ratings. If people’s current health standard is lower than before, their previous health is rated relatively high in retrospect. Or, reversely, we found that previous health was rated higher in retrospect, which can be viewed as an indication that people’s current health standard is lower than before.

To conclude, actual declines in objective health in older people are not always accompanied by a decline in SRH, which is beneficial to the individual, but challenges the interpretation of longitudinal changes in SRH. It seems that older people after experiencing health decline lower their health standard – all or some of the SRH categories reflect worse objective health states than before – but that they do not change their conceptualization of health. As Benyamini recently noted, more research is needed to examine the specific mechanisms underlying response shift, which enable older people to maintain similar levels of SRH even in the face of serious health decline. A then-test may have advantages in longitudinal studies on SRH when evaluating the impact of new, incident chronic diseases in a large number of older adults. But the then-test has shortcomings as well. For example, scores may be influenced by implicit theories of change and recall errors. These may also have accounted for the lack of association between change in SRH obtained with the then-test and 5-year mortality (Chapter 5). Future studies are needed to disentangle the different sources of bias in the estimation of change in SRH.

**Implications for the use of self-rated health in future studies**

Some authors have indicated for which goals SRH is a useful health indicator, but there is still a need for recommendations on the use of SRH in population health research. Recommendations for its use in longitudinal and trend studies in particular are lacking. This chapter so far has discussed which mechanisms account for possible discrepancies between overall health status and SRH in older people in cross-sectional and longitudinal studies. The following section brings forward some practical implications, derived from the previous chapters, for using SRH in future studies on ageing. Figure 1 summarises the recommendations regarding specific research goals and designs.
When and how should self-rated health be used?

I am planning to use SRH as...

A measure of health perceptions

- A proxy measure of more objective health status

Cross-sectionally:
Screening populations

Yes, use SRH for example as:
- A measure of adaptation to more objective health decline
- A predictor of health care use or engagement in preventive behaviours

Longitudinally:
Health trajectories

Yes, use SRH as a concise measure to distinguish between those in good and poor health

Estimating trends

Use SRH with other measures of health
Changes in health standards may mask underlying health declines

Use SRH with other measures of health
Social comparison and reprioritization may mask underlying health trends

Figure 1. Summary of recommendations for the use of SRH in the older population
Self-rated health as a measure of health perceptions

SRH does not necessarily have to be used as a proxy measure of more objective or “true” health, although most researchers use it that way. First, SRH may be the most important health measure from a holistic point of view. The meaning of health is difficult to pinpoint and so far there is no uniformly accepted consensus theory of health available. The WHO in 1948 defined health as ‘a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity’. It often occurs that people still rate their health as good despite experiencing decreased physical or mental wellbeing, which became clear in particular in our nonagenarian study. Other definitions of health have also been proposed, such as recently the one by Huber and colleagues, who changed the emphasis towards ‘the ability to adapt and self manage in the face of social, physical, and emotional challenges’. Following these aforementioned definitions, SRH may actually be the best measure of health. The level of SRH is influenced by many factors other than physical wellbeing, and also indicates people’s ability to adapt to physical, social and emotional challenges. Second, SRH reflects judgments that may guide people’s behaviours, for example seeking medical care or engaging in prevention programs. In LASA, poorer SRH was also associated with a higher probability of using of acute care (contact with medical specialists or hospital admission) and with having contact with one’s GP (Figure 2), independent of other health measures.

Figure 2. The association between SRH and health care use in the past 6 months
Self-rated health as a proxy measure of more objective health status

1. Cross-sectional studies

Studies have repeatedly shown that SRH, measured at one point in time, has good predictive ability for mortality\(^\text{73,74}\), which we were able to confirm in our sample of older adults as well. Across different age groups, first chronic diseases showed a larger impact than subsequent diseases, but in people who had already one chronic disease there was a linear association between the number of chronic diseases and the prevalence of fair or poor SRH. These results provide evidence for the ability of SRH to reflect more objective measures of health in cross-sectional studies including older people in a wide age range (57-98 years). Thus, researchers may use SRH in cross-sectional studies with older people, for example to screen for groups who have a higher risk of poor specific health outcomes\(^2\).

Comparisons of SRH across population groups should be made with caution. For example, SRH may not be used to compare the overall health status of older and younger adults, to come to a decision on health care provision. It seems necessary for older people to adapt to health declines to maintain a certain level of wellbeing, sometimes resulting in a large discrepancy between health care needs and SRH. Positive SRH does no guarantee good physical health\(^1\), which became apparent in our nonagenarian study in particular. Previous studies have investigated the validity of SRH across different population groups (mostly socioeconomic groups), using anchoring vignettes\(^\text{75-77}\). These studies aimed to estimate the extent of reporting heterogeneity, i.e. the extent to which SRH deviates from ‘true health’ in each of the groups, as a result of systematic differences in reporting behaviour. SRH has also been compared with specific indicators of morbidity, like cardiovascular risk factors\(^\text{78}\), biomarkers\(^\text{79}\), or more inclusive health indices such as the Health Utilities Index\(^\text{80}\), to come to a conclusion about reporting differences between groups. These studies are valuable in that they emphasise that ways of making health evaluations may differ across population groups. However, results across different studies and countries have found to be mixed\(^\text{66}\), and general conclusions cannot (yet) be drawn about the direction of reporting differences. It also remains unknown how to adjust for reporting differences to make SRH better comparable between groups.

2. Longitudinal studies

Changes in SRH may be predicted by changes in underlying health status\(^\text{81,82}\). However, this thesis as well as previous studies have indicated that SRH changes reflect increases in underlying health status only to a certain extent\(^\text{42,81}\). Our response shift analysis revealed that this may partly be caused by a lowering of health standards, and not, as hypothesised earlier, to change in the conceptualization of health\(^\text{48}\). Evidence on the use of SRH in clinical trials among older people is limited. It might be that response shift particularly influences the measurement of SRH before and after treatment interventions\(^\text{56}\).

The potential of change measures of SRH to predict long-term mortality seems to be limited\(^\text{83}\). This might be due to the fact that SRH is a very inclusive measure: next to one’s current
health status, based on all health aspects possibly imaginable, people probably also incorporate previous and future changes in health. Computing a change score from two subsequent measurements of such an inclusive measure may not accurately reflect the actual, i.e. objective, changes in health that occurred.

Measuring trajectories of SRH, alongside changes in other measures of health, can provide valuable information. Due to a changed health evaluation, stable good SRH is no guarantee of preserved good physical health, but rather indicates an individual’s ability to adapt to objective health declines. A declining SRH trajectory, on the other hand, may warrant further attention, given the predictive value of poorer SRH for health care use and mortality. If one’s interest is in trajectories in more objective measures of health, other health indicators should always be measured. These indicators should be more specific, depending on the research question at hand. In addition, they may be more objective, such as diagnosed chronic diseases or physical performance tests.

3. Trend studies
The trend analyses described in this thesis revealed that the level of SRH was not sensitive to increases in the prevalence of chronic diseases and disability (Chapter 6). Previous studies have also shown that trends in SRH not always follow trends in other dimensions of health, but our study was the first to show that associations changed statistically significant over time. Older people in 2009 focus more on poor functioning than seventeen years earlier, but less on their chronic diseases. These changes have resulted in no overall change in the prevalence of poor SRH. Results from our trend analyses may improve the interpretation of trends in SRH, which is done for example for the Dutch Public Health Status and Forecasts Reports. In terms of response shift, a slight reprioritization of health has occurred: within the physical health domain two factors have been given a new priority. The response shift framework is, however, not applicable to studies that assess changes across cohorts over historic time. Methods to detect reprioritization, reconceptualization and recalibration response shifts are designed for longitudinal data and not for repeated cross-sectional measurements.

Upward, downward or stable trends in SRH may result from recent generations having a changed concept of health compared with previous ones, for example induced by changes in the availability of treatment for certain conditions. In addition, change or stability in SRH over time may be caused by social comparison mechanisms. Idler described that: ‘self-ratings of health are based on knowledge and experience, knowledge which is developed and refined by the firsthand experience of illness, and honed in social settings where comparisons can be made.’ Social comparison, which plays an important role in people’s health ratings, may cause relatively stable trends in SRH, despite underlying changes in health and health care. SRH trends thus may not be a good reflection of trends in overall health status. Studies aimed at estimating trends in health should use other indicators, such as disability or mortality, which are more specific or more objective measures of health. SRH trends might be useful as a measure of
trends in health perceptions, for example reflecting how inclined older people are to use health care, but this should be examined in future research.

**Conclusions**

This thesis addressed the ability of SRH to reflect the overall health status of older people. First, it was found that existing health problems moderate the impact of new health declines on SRH. Still, SRH measured at one point in time has the potential to reflect underlying health status, even in groups with a high morbidity level, such as nonagenarians. Second, the mechanism through which adaptation to health declines leads to changes in health ratings was examined. It was found that after health decline, older people may lower their standard of good health, but no evidence was found that they select different health aspects when rating their health. Third, when studying trends in health on a population level, changes in the prevalence of chronic diseases and functional limitations may not bring about changes in SRH: slight reprioritizations of health aspects were found to occur over historic time.

Distinctive characteristics of SRH are that it measures people’s own perception of their health, it is cheap and easy to measure and it is a very inclusive and non-specific measure. As such, SRH can be particularly useful when other health indicators are not measured, or if other indicators capture only some aspects of health. A single measure of SRH is a consistent predictor of mortality and it has the potential to differentiate between those in poor and those in good health. This characteristic is highly valuable for screening populations and deciding which subgroups have the highest risks for mortality, institutionalisation or other consequences of poor global health status. In longitudinal studies, measuring SRH trajectories alongside changes in other measures of health may be useful to indicate people’s inability to adapt to health declines. To estimate the health decline itself SRH does not seem to be a useful tool: older people may change their health standards in response to health decline, which results in stable SRH ratings. When studying trends in health on a population level, changes in the prevalence of chronic diseases and functional limitations may also not bring about changes in SRH: more recent generations may attach more importance to different health aspects compared to previous ones. Thus, when researchers are interested in changes in health in ageing individuals longitudinally or on a population level over time, they should include specific, more objective, indicators of morbidity in their studies.
Chapter 8

References


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