Background
It is not clear whether recent increases in life expectancy are accompanied by a concurrent postponement of activity limitations. The objective of this study was to give best estimates of the trend in the prevalence of activity limitations among the non-institutionalized population aged 55–84 years over the period 1990–2007 in The Netherlands.

Methods
We examined self-reports on 12 measures of moderate or severe activity limitations in stair climbing, walking and getting dressed as assessed by OECD long-term disability questionnaire or Short Form-36 (SF-36) items, using original data from five population-based cross-sectional and longitudinal surveys \(n = 54,847\) respondents. To account for heterogeneity between surveys, we used meta-analyses to study time trends.

Results
Time trends of 10 out of the 12 activity limitation variables studied were stable. The prevalence of at least moderate activity limitations in stair climbing \(\text{odds ratio (OR)} = 1.03\) and getting dressed \(\text{OR} = 1.04\) based on OECD items increased over the study period. Age- and gender-stratified time trend analyses showed consistent patterns.

Conclusions
No declines were observed in the prevalence of activity limitations in the Dutch older population over the period 1990–2007. The increase in life expectancy in this period is accompanied by a stable prevalence of most activity limitations.

Keywords
Activity limitation, meta-analysis, health transition

Introduction
Life expectancy is increasing. More people survive to old age, and people in old age live longer.\(^1,2\) However, it is not clear whether the increase in life expectancy is accompanied by a concurrent postponement of activity limitations. In this article, we will explore the time trend in the prevalence of activity limitations...
in the non-institutionalized older population in The Netherlands.

In the USA, time trends of activity limitations among older persons have shown large and consistent improvements over the period 1991–2006. However, a study on data from 12 Organization for Economic Cooperation and Development (OECD) countries shows that the prevalence of severe disability is rising in some countries and falling in others, with no clear overall trend. Within The Netherlands, different studies have reported different time trends of activity limitations. For example, Puts and colleagues reported a significant decrease of both mobility limitations as well as disability in activities of daily living (ADLs) in The Netherlands over the period 1987–2001, based on a sample of respondents from general practitioners’ registries. Earlier, Brinkkemper found an increase in disability over the period 1992/1993–2001/2002 when comparing baseline measurements of two cohorts of 55- to 64-year-old community-dwelling respondents in the Longitudinal Aging Study Amsterdam, and Picavet and Hoeymans found a small decrease in mobility limitations in men, but not in women, and a stable trend in ADL disability among respondents of the Netherlands Health Interview Survey over the period 1990–98.

These inconsistencies can be due to methodological differences such as differences in age groups, definition of type or level of activity limitation, sampling frame or method of data collection. To overcome these inconsistencies, we harmonized all relevant studies and then performed meta-analyses to find best estimates of time trends in self-reported activity limitations in the non-institutionalized older population in The Netherlands over the period 1990–2007.

Methods
First, we selected Dutch population-based studies relevant to the subject. Criteria were that the studies should: (i) have data on self-reported activity limitations; (ii) cover a minimum time frame of 10 years; (iii) have a minimum of three data collection moments; (iv) represent both genders; and (v) concern non-institutionalized respondents aged 55–84 years. Original data from two repeated cross-sectional surveys—the Amenities and Services Utilization Survey (Dutch abbreviation: AVO) and the Netherlands Health Interview Survey [in 1997 renamed Permanent Life Situation Survey; (Dutch abbreviation: POLS)] and three longitudinal surveys—the Longitudinal Aging Study Amsterdam (LASA), the Doetinchem Cohort Study (DCS)—were harmonized. General characteristics of these five surveys are listed in Table 1. A detailed description of each survey can be found in Appendix 1.

Characteristics of the harmonized data set
The surveys’ respondent identification numbers were recoded into unique numbers that were used to fill the harmonized data set with single self-reports from repeated cross-sectional surveys and repeated self-reports per respondent from longitudinal surveys.

Respondents from the longitudinal surveys MAAS and DCS who turned 55 years in between cycles of data collection were added to the harmonized data set in the subsequent cycle. Also, in 2003, a new cohort of respondents aged 55–65 years was added to the surviving LASA cohort. These ‘new’ respondents lack self-reports in the years prior to their 55th birthday or prior to 2003, respectively.

Independent variable: time in years
The independent variable was defined as (calendar) years between 1990 and 2007 in which the cycle of data collection of the survey took place. If the data collection of a specific cycle took >1 year, the mid-year of a survey’s data collection cycle was considered the year of data collection. For example, the second cycle of data collection of DCS took place from 1998 to 2002. Hence, the year 2000 was considered the year of that specific cycle of data collection (Table 1).

Dependent variables: activity limitations in stair climbing, walking and getting dressed
The selected surveys had activity limitation items in common on three activity domains: stair climbing, walking and getting dressed. AVO, POLS and LASA all used variants of items from the OECD long-term disability questionnaire to assess activity limitations in these domains. MAAS and DCS used items based on the Physical Function subscale of the Short Form-36 (SF-36) to assess activity limitations in these domains. POLS and LASA also used items based on the Physical Function subscale of the SF-36 to assess activity limitations in stair climbing.

In our analyses, we distinguished between activity limitations assessed by items from the OECD long-term disability questionnaire and the SF-36 and OECD and SF-36 activity limitations in future reference. We did so because of differences in wording between items in the OECD questionnaire and in the SF-36 (difficulty in the ability to perform actions vs health limiting effects in the execution of activities, respectively), and since earlier studies suggested differences in criterion validity between items from the OECD questionnaire and the SF-36. Although wording of all OECD activity limitation items as well as their response categories differed between surveys, three roughly uniform categories were distinguished per domain: (i) Yes, without difficulty, (ii) Yes, with some or great difficulty and (iii) I cannot, or I cannot without the help of others. Phrasing and wording of all SF-36 activity limitation
### Table 1 General characteristics of the selected surveys

<table>
<thead>
<tr>
<th></th>
<th><strong>AVO</strong></th>
<th>**POL$$^\text{S}$$</th>
<th><strong>LASA</strong></th>
<th><strong>MAAS</strong></th>
<th><strong>DCS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning organisation</td>
<td>The Netherlands Institute for Social Research</td>
<td>Statistics Netherlands</td>
<td>VU University Amsterdam</td>
<td>Maastricht University</td>
<td>National Institute for Public Health and the Environment</td>
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<tr>
<td>Design</td>
<td>Repeated survey</td>
<td>Repeated survey</td>
<td>Longitudinal survey</td>
<td>Longitudinal survey</td>
<td>Longitudinal survey</td>
</tr>
<tr>
<td>Study method</td>
<td>Interview &amp; questionnaire</td>
<td>Interview &amp; questionnaire</td>
<td>Interview &amp; questionnaire</td>
<td>Questionnaire</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Method regarding relevant items</td>
<td>Interview &amp; questionnaire</td>
<td>Interview &amp; questionnaire</td>
<td>Interview &amp; questionnaire</td>
<td>Questionnaire</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Location</td>
<td>At home of respondent</td>
<td>At home of respondent</td>
<td>At home of respondent</td>
<td>University laboratory (examination) &amp; at home (questionnaire)</td>
<td>Regional health center (examination) &amp; at home (questionnaire)</td>
</tr>
<tr>
<td>Geographical representation</td>
<td>National</td>
<td>National</td>
<td>Multiregional</td>
<td>Provincial</td>
<td>Municipal</td>
</tr>
<tr>
<td>Use of proxies</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Not allowed</td>
<td>Not allowed</td>
</tr>
<tr>
<td>Frequency</td>
<td>Every 4 years since 1979</td>
<td>Yearly since 1981</td>
<td>Every 3 years since 1992</td>
<td>Every 3 years since 1994</td>
<td>Every 5 years since 1987</td>
</tr>
<tr>
<td>Study sample entity/entities</td>
<td>Households &amp; persons</td>
<td>Persons within households</td>
<td>Persons</td>
<td>Persons</td>
<td>Persons</td>
</tr>
<tr>
<td>Sampling frame</td>
<td>Sample of postal addresses</td>
<td>Centralized municipal registry</td>
<td>Centralized municipal registry</td>
<td>Collaborating GP patient registries</td>
<td>Centralized municipal registry</td>
</tr>
<tr>
<td>Range of sample response</td>
<td>43%-70% of households</td>
<td>60%-85%</td>
<td>62%-82%</td>
<td>54%-75%</td>
<td>62%-80%</td>
</tr>
<tr>
<td>(Baseline) Age range of respondents</td>
<td>6 and older</td>
<td>0 and older</td>
<td>55-84</td>
<td>24-81</td>
<td>20-59</td>
</tr>
<tr>
<td>Activity limitation instruments</td>
<td>OECD</td>
<td>OECD</td>
<td>OECD</td>
<td>SF-36</td>
<td>SF-36</td>
</tr>
<tr>
<td>(See also table 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study (mid)year, numbers of respondents 55 and over in each (mid)year</td>
<td>1991 2744</td>
<td>1990 1645</td>
<td>1992 1322</td>
<td>1993 1735</td>
<td>1994 1024</td>
</tr>
</tbody>
</table>

OECD instruments are based on items from the OECD long-term disability questionnaire. The SF-12 and SF-36 refer to the Short-Form 12 and 36, respectively. New cohort. Old and new cohort were merged; years in bold represent years of data collection, included as independent variable in the harmonized study sample.
questions and their response categories—ranging from (i) no, not limited at all to (ii) yes, limited a little and (iii) yes, severely limited—were uniform across surveys.

Table 2 shows the available original OECD and SF-36 activity limitation variables and the uniform response categories. To gain a more complete insight into the time trends in activity limitations per activity domain, these uniform response categories were further dichotomized into two variables indicating either severe (3 vs 1 and 2) or at least moderate (including severe; 2 and 3 vs 1) limitations, resulting in 12 activity limitation outcome variables.
Covariates: demographic variables

The following demographic variables were available in all surveys: gender, age, educational level, marital status and household size. We categorized highest educational level attained into: elementary education, up to elementary school; lower education, lower vocational education, lower secondary education or the first 3 years of higher secondary education; intermediate education, intermediate vocational education or the last 3 years of higher secondary education; and higher education, higher vocational education, university or higher education (International Standard Classification of Education). We categorized marital status into not married (never married, divorced or widowed) and married (married or living together in a relationship). Household size was categorized into living alone or living with one or more others.

Analyses

The harmonized data set was described in terms of proportions of self-reports stratified by age category. Age- and gender-based probability weights were constructed by dividing 5-year age and gender strata proportions in the sample by proportions of the same strata in the averaged Dutch population over the period 1990 to 2007. Inverse probability weights were used to calculate and compare age- and gender-weighted prevalence rates of activity limitations across surveys over the study period.

In determining the best estimate for overall time trends in activity limitations in The Netherlands over the period 1990–2007, a two-step approach was used. The first step involved modelling the survey-specific time trends in activity limitations. To get a first impression of the data, survey-specific, weighted prevalence rates of activity limitations were plotted against time in years. Then, for each combination of activity limitation variable and study, a separate regression model was run of activity limitations regressed on time in years, adjusted for age and gender. After finding the relationship between age and time on the one hand and the outcome variables on the other hand to be linear, age and time in years were considered to be continuous variables. Inverse probability weights were used in the regression models to account for survey-specific probability sampling designs.

The second step involved transforming all regression coefficients and standard errors for time in years into survey-specific odds ratios (ORs) and corresponding standard errors, and then performing a meta-analysis for each activity limitation variable. Since there might be unexplained heterogeneity between surveys which could be attributed to survey-specific aspects such as data sampling and interviewing methods, a random effects model based on the DerSimonian–Laird method was used. The meta-analyses yielded overall ORs for time trends in activity limitations, which were visualized in forest plots together with the survey-specific ORs with 95% confidence intervals [CIs]. The same two-step approach was used in determining the estimate for gender- and age-stratified time trends in activity limitations.

Results

The harmonized data set contained 54,847 respondents from the five population-based cross-sectional and longitudinal surveys, each contributing to the 54,355 self-reports over the period 1990–2007 on OECD activity limitations (13,249 from AVO, 34,321 from POLS and 7812 from LASA), and to the 22,913 self-reports on SF-36 activity limitations (9785 from POLS, 4212 from LASA, 2844 from MAAS and 6072 from DCS). Data on covariates were available for 66,539 self-reports, since POLS and LASA contained 9785 and 4208 self-reports, respectively, on both types of activity limitations. There were 3264 missing self-reports regarding activity limitations. The majority of all self-reports per age category came from the POLS survey, followed by AVO. The study population was a fair representation of the Dutch older population, although married individuals were slightly overrepresented and men were oversampled (Table 3).

Figure 1 shows survey-specific, age- and gender-weighted trends in activity limitations prevalence on the y-axes against time in years on the x-axes. Weighted prevalence rates of severe OECD limitations in stair climbing, walking and getting (un)dressed averaged 3.7%, 5.6% and 0.9%, respectively, over the study period. For at least moderate OECD limitations these rates averaged 23.6%, 18.2% and 9.7%, respectively. Weighted prevalence rates of severe SF-36 limitations in stair climbing, walking and getting (un)dressed averaged 8.5%, 9.6% and 0.7%, respectively, over the study period. For at least moderate SF-36 limitations these rates averaged 37.2%, 29.8% and 6.7%, respectively.

Time trends for 10 out of the 12 activity limitation variables studied in the meta-analyses were stable (Figure 2). Two variables showed an increasing trend over time: the prevalence of at least moderate OECD limitations in stair climbing (OR = 1.03, 95% CI 1.00–1.05) and in getting (un)dressed increased (OR = 1.04, 95% CI 1.00–1.07). The direction of the trend in both at least moderate OECD limitations climbing stairs and at least moderate OECD
Table 3 Characteristics of the harmonized study population by age category ($n=66,539$ self-reports)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>55–64 years</th>
<th>65–74 years</th>
<th>75–84 years</th>
<th>Total Pop.</th>
<th>Avg.a</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men (%)</td>
<td>31,470</td>
<td>49.4</td>
<td>47.1</td>
<td>42.6</td>
<td>47.3</td>
</tr>
<tr>
<td>Women (%)</td>
<td>35,069</td>
<td>50.6</td>
<td>52.9</td>
<td>57.4</td>
<td>52.7</td>
</tr>
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<td><strong>Marital status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing observations</td>
<td>907</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never married, divorced, widowed (%)</td>
<td>18,257</td>
<td>19.1</td>
<td>28.6</td>
<td>48.2</td>
<td>27.8</td>
</tr>
<tr>
<td>Married (%)</td>
<td>47,375</td>
<td>80.9</td>
<td>71.4</td>
<td>51.8</td>
<td>72.2</td>
</tr>
<tr>
<td><strong>Household size</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing observations</td>
<td>793</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living alone (%)</td>
<td>15,464</td>
<td>13.9</td>
<td>24.9</td>
<td>44.6</td>
<td>23.5</td>
</tr>
<tr>
<td>Living with others (%)</td>
<td>50,282</td>
<td>86.1</td>
<td>75.1</td>
<td>55.4</td>
<td>76.5</td>
</tr>
<tr>
<td><strong>Educational level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing observations</td>
<td>940</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary (%)</td>
<td>21,521</td>
<td>24.4</td>
<td>36.4</td>
<td>46.4</td>
<td>32.8</td>
</tr>
<tr>
<td>Lower (%)</td>
<td>24,667</td>
<td>41.4</td>
<td>36.4</td>
<td>30.6</td>
<td>37.6</td>
</tr>
<tr>
<td>Intermediate (%)</td>
<td>11,129</td>
<td>19.0</td>
<td>16.0</td>
<td>13.8</td>
<td>17.0</td>
</tr>
<tr>
<td>Higher (%)</td>
<td>8,282</td>
<td>15.2</td>
<td>11.2</td>
<td>9.2</td>
<td>12.6</td>
</tr>
<tr>
<td><strong>Study</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVO</td>
<td>13,249</td>
<td>20.0</td>
<td>20.8</td>
<td>18.2</td>
<td>19.9</td>
</tr>
<tr>
<td>POLS</td>
<td>34,321</td>
<td>51.2</td>
<td>52.3</td>
<td>51.0</td>
<td>51.6</td>
</tr>
<tr>
<td>LASA</td>
<td>8,190</td>
<td>8.4</td>
<td>13.8</td>
<td>19.2</td>
<td>12.3</td>
</tr>
<tr>
<td>MAAS</td>
<td>4,668</td>
<td>5.2</td>
<td>7.1</td>
<td>11.3</td>
<td>7.0</td>
</tr>
<tr>
<td>DCS</td>
<td>6,111</td>
<td>15.2</td>
<td>6.0</td>
<td>0.3</td>
<td>9.2</td>
</tr>
</tbody>
</table>

aPopulation average of Dutch people aged 55–84 years over the period 1990–2007 for gender and marital status, and over the period 1995–2007 for household size. n.av., Not available; n.ap., Not applicable.

Figure 1 Survey-specific, weighted prevalence rates of self-reported OECD and SF-36 activity limitations
limitations getting (un)dressed was consistent in all age and gender strata (Table 4), and across all corresponding surveys. In contrast, the trend in OECD limitations in walking observed in LASA was inconsistent with the trend in AVO and POLS (Figure 2).

Age- and gender-stratified analyses revealed an increasing trend for OECD limitations in climbing stairs among women (OR severe \(= 1.02, 95\%\) CI 1.00–1.04; OR moderate \(= 1.03, 95\%\) CI 1.01–1.06; Table 4), whereas a decreasing trend was found in men for at least moderate SF-36 limitations in climbing stairs (OR \(= 0.98, 95\%\) CI 0.96–1.00). An increasing trend was found for at least moderate SF-36 limitations in getting dressed among men (OR \(= 1.03, 95\%\) CI 1.00–1.06). Furthermore, an increasing trend was found for at least moderate OECD and SF-36 limitations in climbing stairs among 75- to 84-year-old respondents (both ORs \(= 1.04, 95\%\) CIs 1.01–1.07).

Discussion

The time trends in the prevalence of activity limitations among the Dutch older non-institutionalized population over the period 1990–2007 can be characterized as not declining. For different domains of activity (stair climbing, walking or getting dressed), levels of limitations (severe or at least moderate) and instruments (OECD or SF-36), overall time trends were observed to be stable, except for an increase in at least moderate OECD limitations in stair climbing and getting dressed.

Strengths and weaknesses

One of this study’s explicit strengths is that we had the availability of many years of follow-up from repeated cross-sectional as well as longitudinal surveys, leading to large numbers of self-reports being available for analysis. Moreover, questionnaire items within surveys hardly changed over time, offering good conditions for trend research.

Given the large heterogeneity between surveys, using meta-analysis to calculate best estimates of the time trends in activity limitations seemed most appropriate. We dealt with this heterogeneity by calculating survey-specific time trends in activity limitations, which then served as input for random-effects meta-analysis. Unfortunately, it was not possible to pin down the sources of heterogeneity and quantify their effects on the results. Potential sources are the use of different sampling frames, differences in exact wording of the separate OECD items and their response categories, place of the relevant questions in the interviews or questionnaires, the use of proxies and differences in non-response rates. However, these sources of heterogeneity could only have led to inaccurate estimations of the time trend in activity limitations if they would have differed substantially within surveys and non-randomly over time. This was not the case for the surveys included.
Generally speaking, attrition in panel data would leave the healthiest respondents in the cohorts. Our results might therefore reflect underestimated effects in the analyses that involve panel data. Additionally, the above-mentioned healthy survivor effect would have greater effects in meta-analyses with relatively greater proportions of panel data versus survey data—in our case the analyses on severe and at least moderate SF-36 limitations in climbing stairs. This is important to keep in mind when interpreting our results and when comparing our findings with the international literature.

### International comparisons

When placing our results in an international context, it should be stressed again that the variety of settings, age and severity categories, and instruments used to assess activity limitations or disability complicates comparisons. Still, our finding of mainly stable trends in activity limitations concurs with findings from Canada and Australia where relatively stable rates of severe disability were found between 1996 and 2003 and between 1998 and 2003, respectively. In the Canadian study, severe disability was defined as needing the help of another person in personal care such as washing, dressing or eating, due to any condition or health problem; in the Australian study, this was defined as sometimes or always needing help with self-care, mobility or communication.

Our results contrast with findings from the USA, where evidence for a decrease in disability is plentiful. Also, a Swedish study showed a decrease between 1980 and 2005 in the proportion of 65- to 74-year-olds who needed help with self-care. The differences between studies may be due to varying definitions of severe disability, the variety of settings, and the instruments used to assess activity limitations or disability.
85-year-old persons unable to take a short walk or to walk up and down stairs. The decrease was most pronounced in the period between 1980 and 1996/1997. Two Spanish studies showed a decrease in disability prevalence between 1986 and 1999, and 1993 and 1999, respectively. In Denmark and Finland, an overall decline in the prevalence of severe disability was observed between 1987 and 2005. In the case of Denmark, disability was defined as having major difficulty, including inability, doing one or more of the following: walking, climbing stairs, carrying a bag, seeing, hearing, and speaking, or in performing one or more ADLs (including getting in and out of bed, dressing and moving within the home).

However, it should be noted that in countries reporting decreasing trends, results are not always consistent. A recent UK study among persons aged ≥75 years show reduced prevalence rates of disability affecting activities of daily living between 1998 and 2008. But earlier, a comparison of two cohorts of 65- to 69-year-old persons had revealed small increases in the prevalence of mobility limitation and instrumental activities of daily living (IADL)/ADL disability between 1991/1992 and 1996/1997. In Finland, Sulander and colleagues found an increase in mobility limitations, including stair climbing, for women but not for men in biennially collected cross-sectional data over the period 1993–2003. However, they also found a decrease in basic ADL difficulties, including getting dressed, both in men and women. Furthermore, Parker and colleagues found an increase over the period 1992–2002 in the prevalence of mobility limitations for the oldest old Swedes, but not in ADL or IADL—with the exception of an increase in mild IADL impairments. Finally, a recent study from the USA based on data from the NHANES study indicated that mobility disability, defined as at least some difficulty walking a quarter of a mile or climbing stairs, increased in the period 1988–2004 for older persons aged 60–79 years.

Possible explanations

Several developments might have had an effect on the prevalence of activity limitations over the years, such as: (i) changes in self-perception of activity limitations, (ii) changes in institutionalization rate and (iii) real changes in the health of the population.

(i) Self-reports of activity limitations or disability can be seen as individuals’ estimates of their own functioning. These estimates depend not only on standards, expectations and appraisals regarding one’s own functioning and ability, but also on mood or previous experiences. There might have been societal shifts in the acceptance of disability activity limitations. Older aged persons may have become, more than before, empowered and articulate consumers no longer willing to accept limitations in their activities, increasing the prevalence of self-reported activity limitations. On the other hand, these shifts may also be reflected in better and wider availability and use of assistive devices, of improvements in medical treatment for disabling conditions, such as hip and knee replacements and cataract surgery, and a greater societal acceptance of their increased use. These latter developments should have led to a downward trend in activity limitations.

(ii) Changes in the size and characteristics of the institutional population may have had an impact on our trend estimates for the community-dwelling population. Dutch public policy since the 1980s stimulated and facilitated independent living of the older population despite (severe) disability. Consequently, the proportion of people aged 55–84 years living in homes for the elderly and nursing homes decreased from ~2.3% to 1.3% in the period 1995–2007. This may have resulted in a higher prevalence of activity limitations in the non-institutionalized population.

(iii) Real trends in the prevalence of activity limitations can be due to better health of subsequent cohorts because of better health care, or other circumstances affecting health status, such as improvements in lifestyle and educational attainment. These changes are likely to have contributed to the increased life expectancy. Our study indicates that this increasing life expectancy in The Netherlands in the period 1990–2007 is not accompanied by a decrease in the age-specific prevalence of activity limitations. If the stable age-specific prevalence of activity limitations persists, the total number of older persons with activity limitations would increase due to the relative increase of the older population. This implies a future increase in care needs and a corresponding burden on the health system.

OECD vs SF-36

The trends for similar OECD and SF-36 activity limitations were found to be inconsistent, in particular for activity limitations in stair climbing and getting dressed. This supports the earlier suggestion that OECD items and the SF-36 measure different constructs of activity limitations. Whereas OECD items ask about (difficulty in) the ‘ability’ to perform actions, the SF-36 asks about ‘limitations’ in executing activities because of someone’s health. Furthermore, the wording of the SF-36 questions explicitly labels health as a cause of limitations. Whether persons attribute limitations in executing activities to their health or not—besides the appraisal of experiencing limitations—can in itself be regarded as an additional appraisal. Seen in longitudinal perspective, this additional layer of judgment in the...
SF-36 questions compared with the OECD questions might have been influenced by society’s changing views of what (ill) health encompasses and what can be seen as normal ageing, thereby influencing the direction of the trend in SF-36 activity limitations. The above considerations should be borne in mind when interpreting our results of trends in activity limitations based on both OECD long-term disability questionnaire and SF-36 items.

Compression or expansion of limitations?
A stable or increasing age-specific prevalence of activity limitations together with the increasing life expectancy will result in an expansion of activity limitations. However, to see this total picture we also need data on trends in the institutionalized population. Data on the size of the institutionalized population show a large decrease, as mentioned before. Including the older population in institutions in the analysis could therefore potentially reveal that the stable trends in the non-institutionalized population might in fact correspond to a decreasing trend in the total older population, and what seems an expansion of limitations might actually turn out to be a compression. However, the effect of including the institutionalized population is expected to be small, since relatively few older persons live in institutions. Furthermore, unpublished data from a study on Dutch nursing homes and homes for the elderly showed that the prevalence of limitations in this older population increased over the past 10 to 15 years. We therefore conclude that most likely the trend in life expectancy and activity limitations should be interpreted as an expansion of activity limitations.

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KEY MESSAGE
The age-standardized prevalence of activity limitations in the non-institutionalized older population in The Netherlands in the period from 1990 to 2007 was generally stable. This was concluded after trend analyses on harmonized data from five surveys of activity limitations.

References
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### Appendix 1

AVO is a four-yearly repeated cross-sectional population survey, from 1979 onward, coordinated by The Netherlands Institute for Social Research. Its purpose is to collect data on the use of social and cultural amenities and services in the Netherlands and to collect data on the users of these amenities and services. As a sampling strategy a gross sample of postal addresses is drawn. If available, the names and telephone numbers of residents are added. Shortly before the interview an advance letter and a brochure are sent to the residents. The survey allows comparisons over time as it repeats a large set of questions in every cycle. The interviewer visits the participating family at home, interviews one person after receiving informed consent (or makes an appointment) and leaves extensive written drop-off questionnaires for each member of the household aged six years or older. Children aged 6–15 years are given an adapted questionnaire which may be filled in by their parents.
Then the interviewer comes back to collect the questionnaires. In the case of multiple household addresses up to three families are interviewed. Net participation ranges between just over 13,000 to well over 17,000 individuals. Response percentages range from 43% to 70%. AVO surveys are being held in full compliance with the Dutch Personal Data Protection Act.

POLS, formerly known as the Netherlands Health Interview Survey, is a yearly repeated cross-sectional population survey, from 1981, coordinated by Statistics Netherlands. Its purpose is to give an overview of (developments in) Dutch lifestyle, health, medical consumption, preventive behavior and well-being. Before 1997 this survey used to be sampled on households. Since 1997 it has been sampled from person records from a centralized municipal registry. The survey allows comparisons over time as it repeats a large set of questions in every cycle. The interviewer visits the participants at home, asks for informed consent and leaves a written drop-off questionnaire. Yearly net participation currently ranges around 10,000 individuals. Response percentages range around 60%. POLS surveys are being held in full compliance with the Dutch Personal Data Protection Act and the Fundamental Principles of Official Statistics of the United Nations.

LASA (http://www.lasa-vu.nl) is a longitudinal survey on predictors and consequences of changes in physical, cognitive, emotional, and social functioning in the older population (birth years 1908–1937). In 1992, a sample of individuals initially aged 55–85 years, stratified for age, gender, and expected attrition due to mortality after 5 years was drawn from the population registries of 11 municipalities in three culturally distinct geographical areas in the west, north-east, and south of the Netherlands. In each area one middle to large-size city and two or more rural municipalities were included. The initial LASA sample consisted of 3107 participants at baseline (1992/1993, response rate 62.3%). The cohort was re-examined approximately every three years with mid-years in 1996, 1999, 2002, and 2006. In 2003, a new cohort (birth years 1938–1947) was added using the same sampling frame as the surviving cohort. This second cohort included 1002 individuals. All subjects gave informed consent and were interviewed and tested at home (two separate visits). Participants’ medical history was obtained from self-reports as well as from the general practitioner. Since the baseline measurement of activity limitations comprised response categories that were incomparable to those of later years, we used data from 1996 onwards. The medical ethical review board of the VU University Medical Center approved the study, and informed consent was obtained from all respondents.

MAAS (http://www-np.unimaas.nl/maas/) is a longitudinal survey of determinants of normal cognitive aging. Participants in MAAS were recruited from a registration network of 15 general practices in the south of the Netherlands, and were stratified by age (12 groups), gender, and occupational achievement (two groups). These individuals were asked to complete and return a postal questionnaire and (for a smaller group) to participate in a series of medical and neuropsychological examinations at the university laboratory of Maastricht. Initial response rate for the questionnaires was 54%. Individuals were excluded if they had a history of stroke, mental retardation, or chronic neurological pathology (e.g., dementia, epilepsy, Parkinson, or central nervous system malignancy). At baseline (1993–1995), 1823 individuals who were part of the longitudinal phase of the program - men and women in the age range of 24 to 81 years – provided questionnaire data. The cohort was re-examined every three years with mid-years in 1997, 2000, 2003, and 2006. MAAS was approved by the Medical Ethics Committee of the Maastricht University Medical Center and is being held in full compliance with the Dutch Personal Data Protection Act. All participants gave their written informed consent.

The aim of DCS (http://doetinchemcohortstudie.nl) is to study the impact of (changes in) lifestyle factors and biological risk factors on aspects of health, such as the incidence of chronic diseases, physical and cognitive functioning and quality of life. The baseline measurements were carried out from 1987 to 1991 in 12,405 respondents from Doetinchem. This was a general population sample, drawn as an age (5-year age group) and gender stratified sample, from the municipal registers. A sample of these men and women aged 20–59 years (N=7769) are subsequently followed as a cohort. The cohort was re-examined every five years, with mid-years in 1989, 1995, 2000, and 2005. Response rate at baseline was 62%. Subjects filled in questionnaires at home, and visited a regional health center to give written informed consent and to be interviewed and tested. This study was approved according to the guidelines of the Helsinki Declaration by the external Medical Ethics Committee of the Netherlands Organization of Applied Scientific Research Institute. All participants gave written informed consent.