

Norwegian Elderly Less Likely to Live Alone in the Future

Les Norvégiens âgés auront une probabilité plus faible de vivre seuls dans le futur

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Abstract We analyse the future household status of elderly men and women in Norway. An important finding is that persons aged 80+ are less likely to live alone in the future, and more often with a partner. The level of mortality, the mortality sex gap, union dissolution at young and intermediate ages, and entry into and exit from institutions for the elderly are possible determinants for this new trend. We use the macro simulation program LIPRO to simulate the household dynamics in Norway to 2032, and investigate the demographic reasons for the increased likelihood of living with a partner among Norwegian elderly. Mortality plays an important role, but part of the trend is already embodied in the household structure of the current population.

Keywords Elderly · Living arrangements · Household projection · Norway · LIPRO

Résumé Nous réalisons dans cette étude une projection de la situation de ménage des hommes et femmes âgés en Norvège. Il apparaît que les personnes âgées de 80 ans et plus vivront dans le futur moins souvent seuls et plus souvent avec un partenaire. Le niveau de la mortalité, l'écart de mortalité entre les deux sexes, les ruptures d'union aux âges jeunes et intermédiaires, et l'entrée et la sortie des institutions pour personnes âgées pourraient déterminer cette nouvelle tendance. Nous utilisons le programme de simulation macro LIPRO pour simuler la dynamique des ménages en Norvège jusqu'à 2032, et explorer les facteurs démographiques sous-jacents à l'élévation de la probabilité de vie en couple aux âges élevés en Norvège. La mortalité joue un rôle important, mais une partie de cette évolution est déjà inscrite dans la composition des ménages de la population actuelle.

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Mots-clés Personnes âgés · Situations de ménage · Projection de ménages · Norvège · LIPRO

1 Introduction

A new household forecast for Norway for the period 2002–2032 indicates that in the future, the elderly are more likely to live with a partner than they do at present, and less likely to live alone. Figure 1 shows an increase over time in the shares of elderly men and women who live with a partner (spouse or cohabitee). For men in particular, the increase is large: the age group 80+ as a whole will see its share growing from 54% in 2002 to 75% in 2032. An alternative way of looking at Fig. 1 is to interpret the increase as a consequence of the age pattern stretching to the right in the course of time. For ages beyond 70 years, curves are shifted over some 2–5 years towards higher ages.

Most of the changes occur in the first 10 years of the projection period, i.e. between 2002 and 2012. This is caused by the irregularities in the age–sex–household structure of the population in 2002, combined with the constant rates for household formation

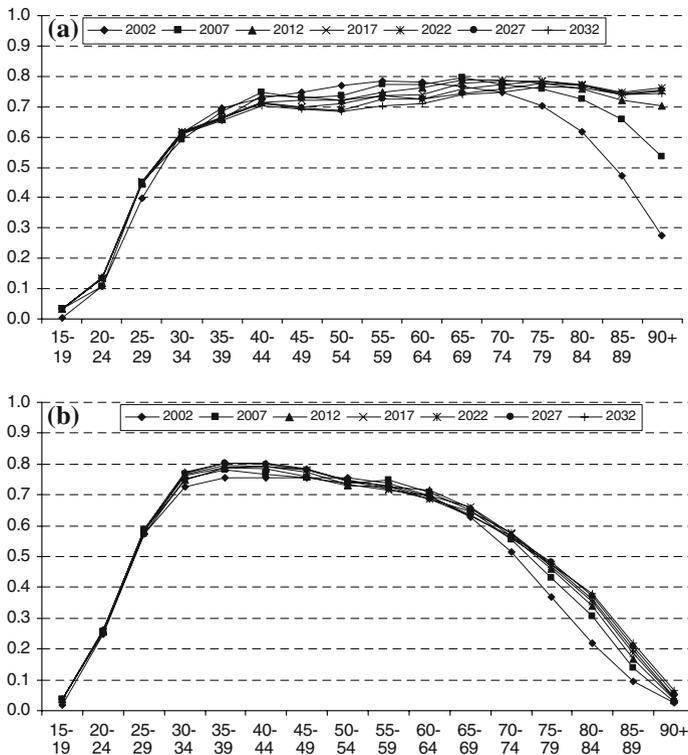


Fig. 1 a Proportion of men living with a partner. b Proportion of women living with a partner

and dissolution that we applied for the future (More details on this in Sect. 3). The ergodic theorem of stable population theory tells us that the age–sex–household structure will initially follow a wave-like pattern and that changes over time will be big, but that these changes will eventually damp out and the structure will become constant.

The purpose of this article is to analyse the reasons for the projected increases in the shares of elderly Norwegian men and women who live with a partner. The living arrangements of the elderly are important for policy makers because they affect not only their well being, but also the future demand for public services: those living alone tend to utilise certain public services to a larger degree than those who live with a partner. The effect is especially strong when it comes to nursing home places. Having a spouse or partner who is willing to help with household chores, personal care and nursing in case of illness makes it possible for old people to live independently, even when they can no longer look after themselves unaided. Indeed, a number of studies have shown that those elderly who live as part of a couple need less formal care, such as places at an institution, than those who live on their own (e.g. Grundy and Jital 2007). Another benefit of living in a union is a possible effect of household economies of scale. A study of nine OECD countries found that the disposable income of women aged 75 and over who had lost their spouse was reduced between 13 and 39%, mainly due to foregone economies of scale (Casey and Yamada 2002). Beyond these material benefits, a partner is a source of emotional and practical support and someone to turn to for help and consolation in difficult periods. Among the elderly in particular, the partner is a major source of social contact preventing loneliness, which in turn has beneficial health effects.

At the same time, all of the positive aspects mentioned here (more well being, lower demand for public services and institutional care, economies of scale, social contact and emotional support) are causal factors for the tendency of individuals to start living with a partner, or to stay in a partnership.

When analysing the reasons for the projected increases in the shares of elderly Norwegian men and women who live with a partner, we shall focus on possible demographic explanations. Future numbers of persons who live with a partner are the result of the current number of couples, and of processes of couple formation and dissolution. An important reason for couple dissolution among elderly couples is the death of one of the partners. Hence, we include the current household structure in our analyses, in addition to mortality, marriage, entry into a consensual union, divorce, and separation. Death of the partner and separation/divorce are not the only reasons for couple dissolution. In addition, one of the partners may move to an institution. Processes of entry into and exit from institutions for the elderly, both among those who live with a partner and those who live alone, are also part of our analyses.

The household forecast contains only a few demographic factors at the macro level. Thus, there are not many possibilities for a detailed analysis of the determinants of the living arrangements of the elderly in the future. Our strategy is to perform a series of sensitivity analyses, in order to trace the consequences of higher or lower parameter values in a number of components of change in elderly persons' chances of living with their partner. Those sensitivity analyses allow us to

identify the most important components among those analysed for the chances of living with a partner. Some of the sensitivity analyses imply unrealistically strong changes in one or more of the components. Thus, a large part of the article is concerned with counterfactual simulations.

The structure of this article is as follows.

We start by a review of projected and observed trends in the living arrangements of the elderly in industrialised countries (Sect. 2). Next, we introduce the new household forecast for the population of Norway and its methodology (Sect. 3). Section 4 reports the simulations for the jump-off population (4.1), mortality (4.2), pair formation and dissolution (4.3), entry into and exit from institutional households (4.4) and finally a set of simulations in which we combine the components of Sects. 4.2 to 4.4. Section 5 summarises our conclusions.

2 Observed and Projected Patterns of Elderly Living Arrangements in Industrialised Countries

Much of what follows is based on marital status information for the elderly, not their living arrangements. Data about living arrangements are very scarce. For the elderly, however, it is not unreasonable to assume that those with marital status ‘married’ in most cases live with a marital spouse. Census data for Norway (November 2001) show that among men (women) aged 80+, 53% (15%) lived with a marital spouse, whereas 57% (17%) had marital status ‘married’. This comment relates to the elderly at present. In the future, many people will have experienced cohabitation in their young adult years, and for those generations the situation will be different.

For women, trends similar to those in Fig. 1 have been predicted for other European countries, but for men the findings are more diverse. The FELICIE (Future Elderly Living Conditions In Europe) project has provided results for the elderly in nine European countries¹ by age, sex and marital status towards 2030; see <http://www.felicie.org/index.asp>, Gaymu et al. (2008) and Kalogirou and Murphy (2006), among others. Projections reported in the latter study indicate that the share of married women aged 75+ will increase by 16% points in the nine countries in the period 2001–2031. This growth is accompanied by a sharp decrease in the shares of elderly widows and of elderly never-married women. For married men the shares are stable (widowers 6% points down due to improved longevity, divorced men 7% points up as a consequence of increased divorce rates in the past). Looking at the projections for the 85+ age group, there is a 17% point growth in the proportion of women who are married, and a 12% point increase among married men; see also Gaymu et al. (2008). For both sexes, the increase goes together with lower shares of persons who have been bereaved. When each country is considered separately, it is interesting to note the striking similarities across the countries with almost identical patterns; this is true both for the age groups 75+ and 85+.

¹ The countries are Belgium, the Czech Republic, Finland, France, Germany, Italy, the Netherlands, Portugal and the United Kingdom.

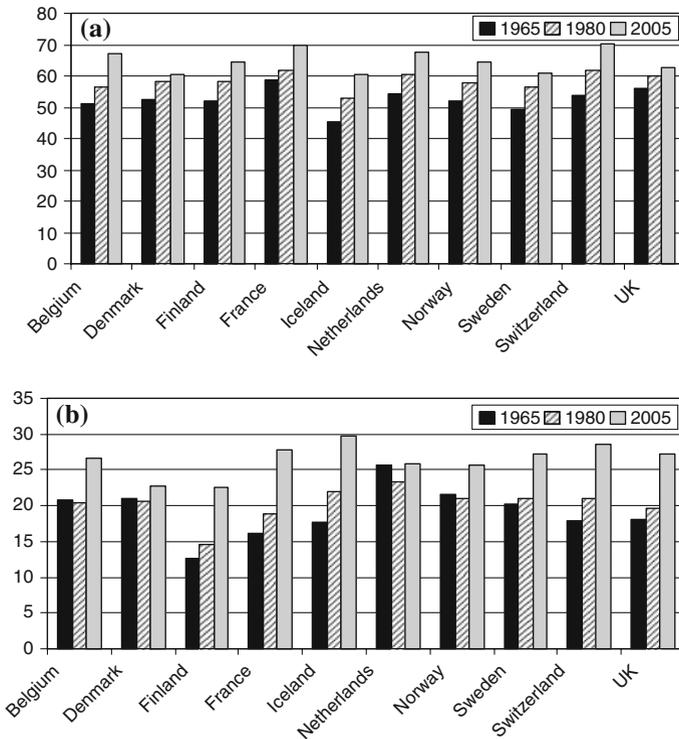


Fig. 2 **a** Percentage of married men aged 75+, selected countries. **b** Percentage of married women aged 75+, selected countries

Liefbroer and Dykstra (2000) predict a modest increase in the share of Dutch women aged 80+ who live with a partner (8% points up from generation 1911–1920 to 1931–1940). They do not give results for men. Alders and Manting (1999) project that the share of women 80+ who live with a partner in EU15-countries will increase from 15% in 1995 to 20–33% in 2025. For men, the projected trend in this share depends strongly on the assumptions applied.

As to historical patterns, the last decades have witnessed an increase in the proportion of elderly living with a partner in a number of Western European countries as can be seen in Fig. 2.²

The increases in the proportion married among the 75+ have been stronger and more persistent among men, whereas for women the trend did not begin until around

² Sources: UN Demographic Yearbook (various years), the UNECE Statistical Database <http://w3.unece.org/pxweb/Dialog/> and country data. For Belgium, Norway and Switzerland the data for 1965 refer to the average of the numbers for 1960 and 1970. The numbers for 1965 refer to 1966 for Iceland and the UK, and to 1967 in Denmark, France, and the Netherlands. The numbers for 2005 refer to 2004 for Belgium. We have selected age group 75+ because in many of the data sources this was the highest age category for which data were available.

1980 in some countries. For men, the increase between 1965 and 2005 ranges from 6.5 (UK) to 16% points or more (Belgium, Switzerland)—the average increase across these ten countries is 12.3% points. For women, the range is from 0.24 (the Netherlands) to almost 12% points (Iceland and France), with an average increase across the countries equal to 7.2% points.

The patterns for the other marital statuses vary across countries as well as between the sexes. For men, the increase in the proportion married goes together with a decrease in the proportion of widowers, averaging 13.8% points. Changes in the shares of single (that is, never-married) and divorced men are much more moderate, with a decline of 1.9% points and an increase of 3.4% points on average, respectively. This basic pattern, with a strong decline in widowers, seems to be universal among the countries under survey.

For women, there are greater disparities across countries. Between 1965 and 2005, the proportion of single women fell by 8.7% points on average. Although this proportion decreased in all ten countries, it fell more slowly than on average in France, where the share of widows fell more steeply. In Belgium, Finland and Switzerland, the decreases in the shares of single and widows were about equal. In other countries, the share of widows among elderly women actually increased (while that of single women continued to decrease). Nowhere does this pattern stand out more clearly than in Norway, where the proportion of single elderly women diminished by 14% points between 1965 and 2005, and the proportion of elderly widows increased by 6.5% points over the same period. In all countries considered here, the proportion of elderly divorced women went up, on average 4% points.

It is reasonable to assume that these differences between men and women can be explained, at least partly, by the sex differences in mortality in these countries since the 1950s. For women, survival improved more or less continuously during the 20th century, leading to lower chances for men of becoming a widower. However, the improvement in survival stagnated for adult and elderly men during the 1950s and 1960s. In some countries, middle-aged men even saw their survival chances falling. This unfavourable trend was strongly related to post-war life styles, and caused high mortality due to neoplasms, cardiovascular diseases and motor vehicle accidents (Preston 1974). Around 1970, the stagnation of male life expectancy came to an end, and in recent decades, men's life expectancies have increased faster than those of women in a number of countries. This is driven by differences in smoking behaviour between men and women. Women adopted smoking after World War II (WWII), a few decades later than men. However, men also began reducing cigarette consumption earlier than women (Pampel 2002). We shall analyse the importance of mortality as one of the possible factors to explain the increasing likelihood for elderly persons of living with a partner.

Figure 3 shows the development in Norway in more detail. It clearly exhibits the steady increase in the proportion of married men, which went together with a declining proportion of widowers. The increase in the share of elderly married women did not begin until 1980 and is accompanied by a systematic reduction in the share of single women.

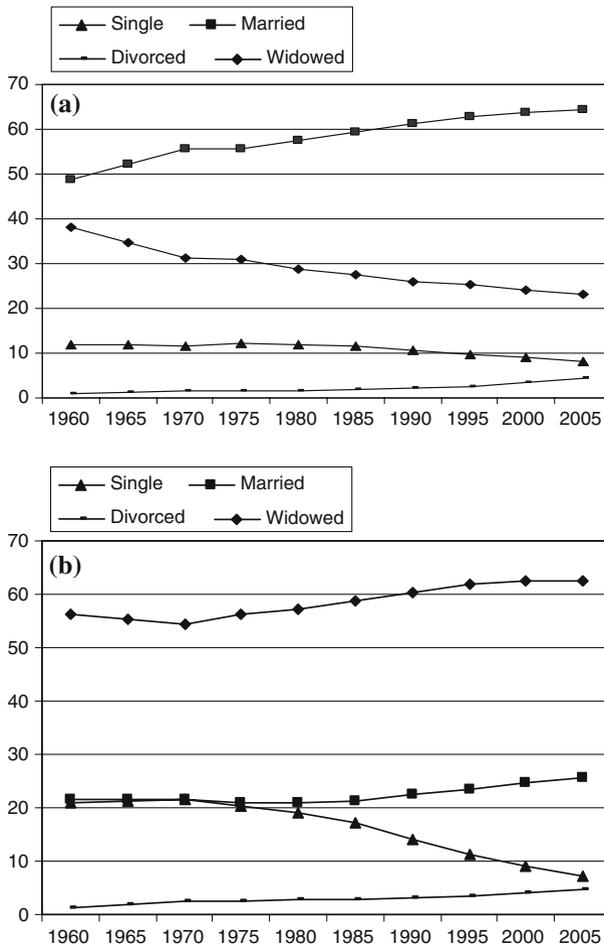


Fig. 3 **a** Percentage of men aged 75+ in different marital statuses in Norway. **b** Percentage of women aged 75+ in different marital statuses in Norway

3 LIPRO Simulations³

We used the program LIPRO (‘Lifestyle projections’) version 4.0 to compute the household forecast for Norway for the years 2002–2032, and the sensitivity variants. LIPRO (see <http://www.nidi.knaw.nl/en/projects/270101/> and Van Imhoff and Keilman 1991) is based on the methodology of multi-state demography, but it includes several extensions to solve the particular problems of household modelling. The forecast updates an earlier one for Norway, which applied to the years 1990–2020 (Keilman and Brunborg 1995).

³ Cf. also Alho and Keilman (2009) for the household forecast.

3.1 Population Structure

The number and types of household position (also called living arrangement) that we selected are a compromise between conflicting arguments. On the one hand, we want to have many household positions, in order to provide the forecast user with detailed results. However, the available data considerably restrict the options open to us. We have used the following nine household positions for individuals:

1. CHLD—dependent child living with one or both parents.
2. COH0—living in a consensual union without dependent children.
3. COH+—living in a consensual union with dependent children.
4. MAR0—living with a spouse without dependent children.
5. MAR+—living with a spouse and dependent children.
6. SIN0—person living in a one-person household.
7. SIN+—single mother or father.
8. OTHR—living in a private household, but not in any of the positions 1-7.
9. INST—living in an institution for the elderly.

‘Children’ are defined as persons under 25 years of age who live in the household of one or both parents. A young adult aged 25 or over who still lives with his or her parent(s) belongs to the category ‘other’. The latter category also includes persons who live in a multi-person household but who have no relationship (parent–child, or partner in consensual or marital union) to the other household members. The category of cohabiting persons includes those who report having a marriage-like relationship with another person without being married to the partner, but irrespective of the partner’s sex. Cohabiting persons can have any marital status. The category of married persons consists of those who are currently married and live together with the spouse. The institutionalised population is restricted to ages 65 and older.

Multi-state projections are inherently more complex than single-state projections. In particular, they require more extensive data. We will now sketch the main aspects of the LIPRO calculations and refer to Van Imhoff and Keilman (1991) for the full details.

LIPRO implements a multi-state demographic book-keeping model that focuses on flows between the states. We have:

$$\mathbf{V}_{t+1} = P_t \cdot \mathbf{V}_t + Q_t \cdot \mathbf{I}_t,$$

where \mathbf{V}_t is a column vector of the population at time t , broken down by household position, age (0–4, 5–9, ... 85–89, 90+) and sex; \mathbf{I}_t is a column vector of immigrants during the time period $(t, t + 1)$ with the same format as \mathbf{V}_t ; and P_t and Q_t are square matrices that depend on time-dependent rates for births, deaths and household events, by age, sex and household position. The unit time interval $(t, t + 1)$ is 5 years. The jump-off time $t = 0$ corresponds to 1 January 2002.

The model is driven by assumptions, for each time interval, on net immigration by age, sex and household position, and on occurrence-exposure rates for household events, mortality and fertility (see Sect. 3.2). In order to specify the jump-off

population (V_0), we used data from the Population and Housing Census of Norway, 3 November 2001, and assumed that the data would apply to 1 January 2002.

3.2 Events

3.2.1 Household Events

We have estimated occurrence-exposure rates for household events from the Survey of Living Conditions (SLC). The SLC is a panel survey with annual waves in the spring of each year since 1997 (see Normann 2004). We have used data from the six waves conducted between 1997 and 2002.⁴ The target population each year was the population aged 16–79 in 1997 living in private households. The sample size in 1997 was 5000. In later waves, additional persons were drawn from new members of the target population (either immigrants or new persons aged 16). Between 1997 and 2002, 5,525 persons were drawn. Among these, 2,562 persons took part in all six waves. Remaining persons either refused to respond in one or more rounds, or they left the target population (due to death or emigration). Response rates were relatively low among persons aged over 80. Otherwise, response was of good quality.

Each respondent reported the relationship with the other members in his or her household at each interview. We coded the respondent's household position according to the eight private household categories mentioned above and identified household events by comparing the household positions at subsequent interviews.⁵ Due to both left censoring and right censoring, a number of events imply a change from, or to, an unknown household position. Added over all five calendar years, we obtained 3,645 events of 27 different types, and 22,462 years of exposure. We computed occurrence-exposure rates for each of the 27 events, specific for sex and 5 year age group.

For a number of household events, the age patterns looked irregular, or even implausible. In those cases, we had to take executive decisions to obtain plausible patterns. We used occurrence-exposure rates from the previous household forecast of Keilman and Brunborg (1995) in some of the adjustments. Data on entries into and exits from institutions are extremely scarce. We used the entry and exit rates employed in the previous household forecast, which were based on observed flows for the year 1991 of total entries into an institutional household from private households, total returns back to private households, and the number of deaths in institutions. Details of the breakdown of these flow into numbers for relevant combinations of sex, age and household position are given by Keilman and Brunborg (1995, p. 32).

⁴ Starting in 2003, the SLC has a very different format compared to earlier years, and data from before 2003 are not directly comparable to the later data.

⁵ In principle, individuals may experience two or more household events during one calendar year. However, this is rare, because a 1-year time interval is rather short. We have disregarded these multiple events.

3.2.2 External Events

In addition to household events, we distinguish the following external events: birth, death, immigration and emigration.

Birth rates broken down by mother's age (5 year age groups) and household position were taken from the previous household forecast and adjusted proportionally so that the predicted number of live-born children during the years 2002–2006 would correspond to the number that Statistics Norway has registered for that period.

Death rates by 5 year age group and household position were estimated based on data from the Norwegian population registers. Øystein Kravdal kindly supplied us with deaths and exposure times broken down by marital status, age and sex for the years 1995–99.⁶ We applied

- death rates for persons with marital status 'currently married' to persons with household position 'cohabiting' or 'married', irrespective of the number of children in the household;
- death rates for the never-married to persons with household position 'child', 'living alone', or 'other';
- death rates for the divorced to persons with household position 'lone parent';

Finally, based on the experience with the previous household forecast, we assumed that death rates for institutionalised persons are twice as large, given age and sex, as those for persons who live alone (ages 65 and over only). Keilman and Brunborg (1995) found this factor for age-specific rates to be consistent with the crude death rate among the institutionalised.

International migration was specified as net immigration in absolute numbers, for each combination of age, sex and household position. The level of net immigration for the years 2002–2006 was taken from data available from the population registers, and that for later years from Statistics Norway's population forecast (see below). Its distribution by age, sex and household position was borrowed from the previous household forecast. One implication is that migration for ages 70 and higher is negligible.

3.2.3 Consistency

Parameters for household events and for external events, when applied to the jump-off population, do not result in realistic predictions for the events. The reason is that events for different groups of persons in the household model are not linked to each other, whereas in reality there is a clear relation between some of those events. For instance, the number of men who marry during a certain period is equal to the number of marrying women.⁷ Similar constraints apply to marriage dissolution (due to divorce, separation or death of the spouse) and to formation and dissolution of consensual unions. In the context of multi-state household models, we speak of consistency relations between events.

⁶ Mortality data by marital status for more recent years are not available.

⁷ Here, we have assumed that the net effect of marriages across country boundaries is zero.

LIPRO includes a feature that takes account of such consistency relations (see Van Imhoff and Keilman 1991; or Van Imhoff 1992). LIPRO's consistency algorithm assumes that the relations between the numbers of events of various types are linear, and it handles both internal consistency and external consistency. We speak of internal consistency when there is a relation between numbers of household events. A constraint for new marriages of men and women during a unit time interval is one example. LIPRO adjusted the numbers of household events in such a way that all relationships were fulfilled. In addition to internal consistency relations, we also imposed external consistency constraints to some of the events. Specifically, we constrained total numbers of births, deaths and net immigration to be equal to observed numbers published by Statistics Norway for the years 2002–2006, and to corresponding numbers taken from the Medium Variant of Statistics Norway's 2005-based population forecast for later years (see <http://www.ssb.no/emner/02/03/folkfram/arkiv/>).⁸ Thus, our results for fertility, mortality and net migration agree with those of the 2005-based forecast, but only in terms of total numbers for each of these components in every 5 year period. For the period to 2032, Statistics Norway assumed a constant Total Fertility Rate equal to 1.84 children per woman on average. This leads to annual numbers of births that fluctuate between 54,700 and 61,300. The life expectancy was assumed to increase from 77.5 years in 2004 to 82.5 years in 2032 for men and from 82.1 to 86.8 years for women during that period. This implies annual deaths between 42,800 and 49,400. Net immigration was assumed to be 16,000 per year for each year after 2010 and somewhat higher in the early years. Finally, we constrained the total population living in an institution to 41,000 for the entire projection period, by imposing a constraint which guarantees that the sum of all entries equals the sum of all exits during each unit projection interval. The number of 41,000 is the level observed in the years 2003, 2004 and 2005. If the health situation of the elderly in the future is the same as it is nowadays, a constant capacity of institutions for the elderly in a period of rapid population ageing will clearly lead to increasing pressure on these institutions. At the same time, it would lead to an increase in proportions in other (i.e. in private) living arrangements. If the health conditions of the elderly improve in the next few decades, the pressure will be lower. Whether the current 41,000 is also a realistic number for the future is difficult to judge. An alternative assumption is to apply current entry and exit rates (by age, sex and household position) to future years. However, we prefer an assumption in terms of total numbers, rather than entry and exit rates, for two reasons. First, the capacity of institutions is a variable largely determined by policy makers and private actors. It is unlikely that they think in terms of entry and exit rates. Second, a control for the total numbers living in an institution minimises the risks associated with the admittedly crude approximations we had to make for entry into and exit from institutions.

Based on the consistent events for household formation, household dissolution, births, deaths and net immigration for the period 2002–2006, we used LIPRO to recompute rates for that period for household events and for external events that

⁸ Statistics Norway published a new population forecast in May 2008, but we were unable to include that in the present analyses.

correspond with the consistent events and with the jump-off population. The resulting set of rates will be labelled as Benchmark rates henceforth.

3.2.4 A Summary View of the Rates

For some of the household events we will present the age patterns of the Benchmark rates, with some emphasis on rates that are relevant for the elderly.

Figure 4 shows Benchmark rates for entering the position ‘living alone’ for married and cohabiting persons. For the elderly, death of the spouse/partner is an important reason. The excess mortality of men is clearly reflected in the high rates for elderly women in Fig. 4. A second reason is entry of the spouse/partner into an institution. These two causes cannot be distinguished in Fig. 4. In adult ages, dissolution of the existing marriage or consensual union is an important cause. Note the different scales for Fig. 4a and b—dissolution rates of cohabiters are clearly higher than those of spouses. When a couple with dependent children at home splits up, it is most often the man who starts living alone (at least initially), while the woman becomes a lone mother.

Figure 5 presents death rates of men and women in selected household positions. It confirms the well-known fact that persons who live with a partner have lower mortality than those who live without.

Figures 6 and 7 plot entry and exit rates for persons in institutions. Figure 6 shows very clearly that entry rates into an institution are higher for men than women, and higher for those who live alone compared to couples. This reflects the morbidity patterns underlying differential mortality for men and women in different living arrangements, and the differential need for care. Exit rates from institutions back to private households decline with age, while men without a partner are less likely to return to their one-person household than women are. The high death rates for men and women who live in an institution are the same as those in Fig. 5, but the scales are different.

Table 1 gives a summary view of the Benchmark rates. The numbers in this table are computed by means of two multidimensional life tables, one for each sex. Such a life table explores the life course of a fictitious cohort by assuming that the members follow the Benchmark rates during their life spans.

A woman who experienced the Benchmark rates during her whole life course could expect to live 82.7 years. On average, she would give birth to 1.8 children, of which 0.79 children would be born when she cohabits, and 0.74 when married. She would be a dependent child during 20.4 years, live alone for 15.9 years (of which 7.1 years after age 65, not shown in Table 1) and she would spend 28.2 years of her life with a husband (possibly more than one), of which 19.3 years without children at home. The average man would die at the age of 76.6 years. He would spend 15.2 years living alone (of which 2.6 years after age 65) and 25 years with a wife.⁹

⁹ Table 1 gives different numbers of years spent with a spouse or consensual partner for men and women. This is explained by the fact that these numbers result from two different *life tables*, one for each sex. The *projection model*, however, guarantees consistency between men and women.

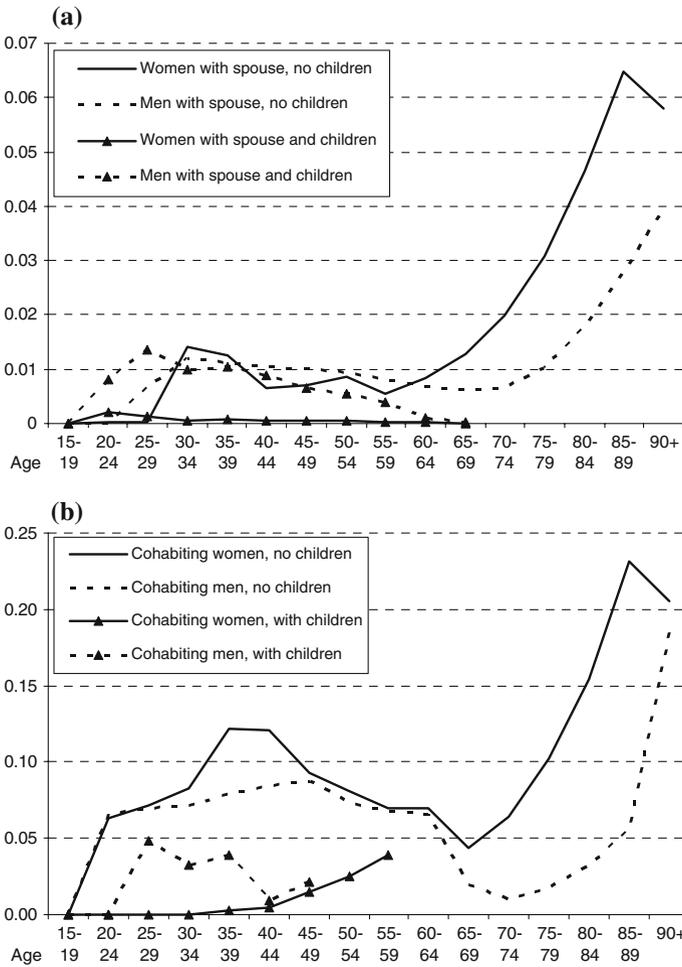


Fig. 4 **a** Entry rates into household position ‘living alone’ for men and women with marital spouse. **b** Entry rates into household position ‘living alone’ for cohabiting men and women

3.3 Benchmark Results

We computed a deterministic household forecast for men and women in 5 year age groups in nine household positions for the years 2007, 2012, ..., 2032 (1 January). Apart from adjustments for consistency, parameters for household events were assumed constant over the forecast period, because the possible trends visible in our data were erratic. The simulations obtained this way will be labelled as Benchmark from here onwards.

Given a forecast of the population by age, sex and household position, households of various types are easily computed. The number of cohabiting and married households was estimated as one-half of the total number of persons with

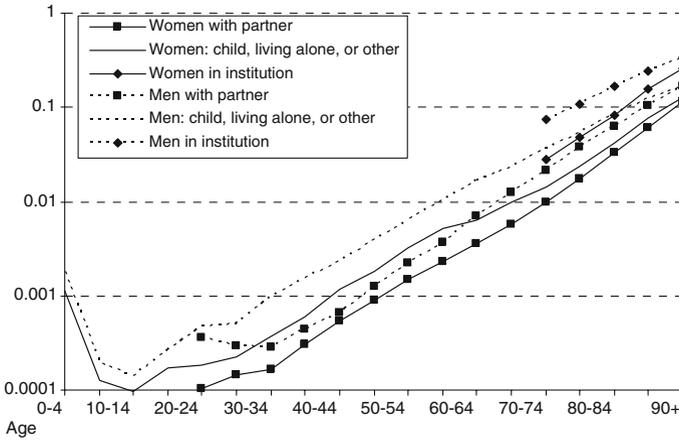


Fig. 5 Death rates of men and women by household position. NB Logarithmic scale

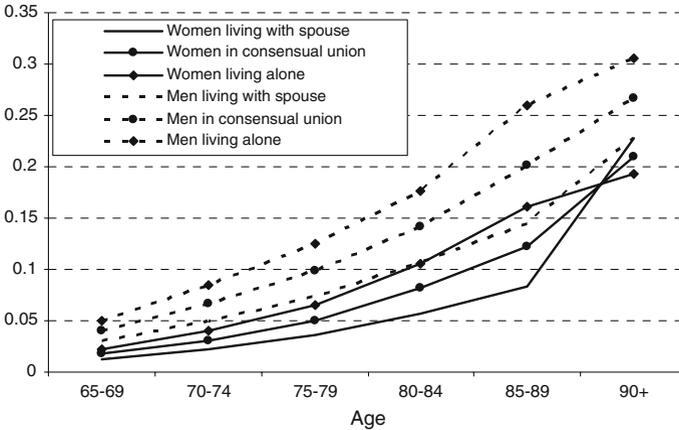


Fig. 6 Entry rates into institution

that household position. The number of one-person and lone-parent households equals the number of persons with that household position. The number of other households was estimated as the number of persons with that position divided by 2.5, which was the mean size in the 2002 wave of the SLC.

In terms of total population, the predicted number is 5.47 million in 2032. This result agrees quite well with the number predicted by Statistics Norway in its 2005-based population forecast, which is 5.43 million. The two numbers are close, as expected, because numbers of births, deaths and net immigration for the period 2002–2032 were constrained to be equal between the two forecasts. The remaining small difference is due to different jump-off populations. Figure 8 shows an expected one-third increase in the number of private households, from 2.02 million in 2002 to 2.67 million in 2032. A strong growth is seen for one-person households

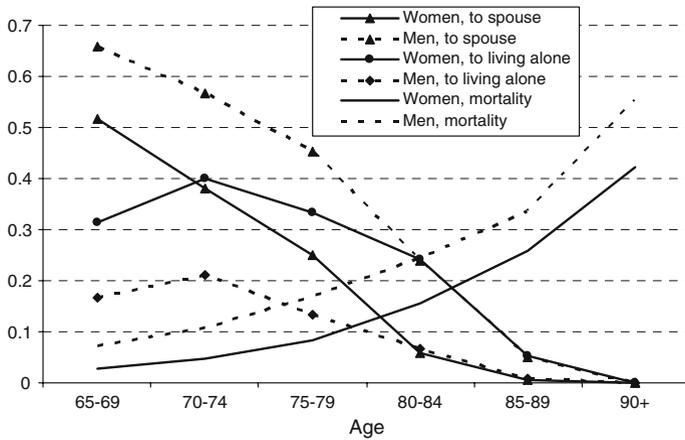


Fig. 7 Exit rates from institution

Table 1 Expected duration spent in different household positions, and expected number of children born, by mother’s household position

	CHLD	COH0	COH+	MAR0	MAR+	SIN0	SIN+	OTHR	INST	TOTAL
Duration (years)										
Men	20.6	5.6	4.8	15.7	9.3	15.2	1.7	2.7	1.1	76.6
Women	20.4	5.4	5.4	19.3	8.9	15.9	3.8	2.1	1.5	82.7
Number of children										
	0.02	0.50	0.29	0.35	0.39	0.11	0.02	0.11	0.00	1.80

Benchmark rates

Note: Labels for household positions specified in Sect. 3.1

(SIN0) in particular. Their number increases by 46% in the 30 year period, from 744,000 to 1.084 million.

The average size of private households will fall from 2.2 persons per household in 2002 to 2.0 in 2032. Important determinants of this trend towards smaller households are the growth of one-person households (due to divorce and separation), the decrease in households consisting of a couple and one or more children (due to low fertility since the 1980s), and the ageing of the population in general (older persons live in relatively small households, other factors being the same).

Figure 9 illustrates the household composition of men and women broken down by age, and the changes therein between 2002 and 2032. We see very clearly the big post-WWII cohorts who move from middle to old ages during these 30 years. Marriage was popular when these cohorts were in their prime marriage ages, and this suggests that marriage behaviour in the past is one possible explanation for the large shares of elderly living with a partner in the future. The upper part of the pyramid of 2002 shows excess mortality of men, but this is much less in the case for the pyramid of 2032. Thus, mortality could be a second explanation. Possible

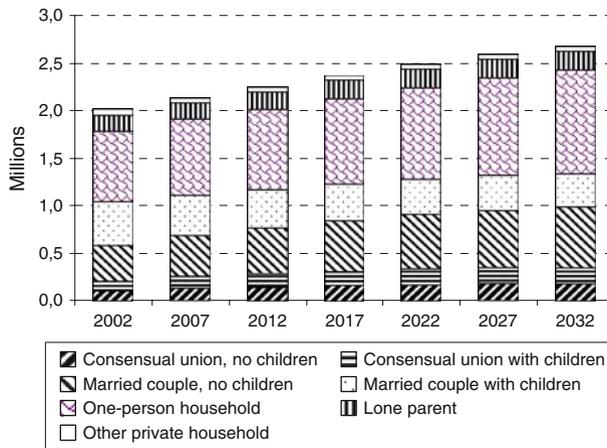


Fig. 8 Projected number of private households, Norway

changes in shares of elderly who live with a partner (spouse or cohabitee) are not visible in this figure—Fig. 1 illustrates them much better. Note that there are very few women aged 90 or older who live with a partner in 2032, while for men the numbers are still considerable. This obviously reflects the fact that a man tends to be a few years older than his wife or his cohabitee.

4 Simulations

In order to analyse the demographic determinants of the projected increases in the shares of elderly men and women who live with a partner, we computed a number of sensitivity variants of the household forecast, based on different assumptions for the following events in the years to come: death (Sect. 4.2), couple formation and dissolution (Sect. 4.3), and entry into and exit from an institution (Sect. 4.4). However, future numbers of persons who live with a partner do not only depend on these events, but also on the current population structure in terms of household position. Hence, we included a sensitivity variant with a different jump-off population as well (Sect. 4.1). Details of each of the sensitivity variants are given below.

In our analyses, we have focused on the age group 80+, while other studies deal with 75+ or 85+ (see Sect. 2). The role of mortality becomes more visible at ages 80+ or 85+ than at ages 75+. On the other hand, focusing on 85+ could easily lead to erratic patterns for components other than mortality, due to the small numbers involved.

4.1 Jump-off Population

We performed a counterfactual simulation in which each population category (defined as a combination of 5 year age group, sex and household position) of the

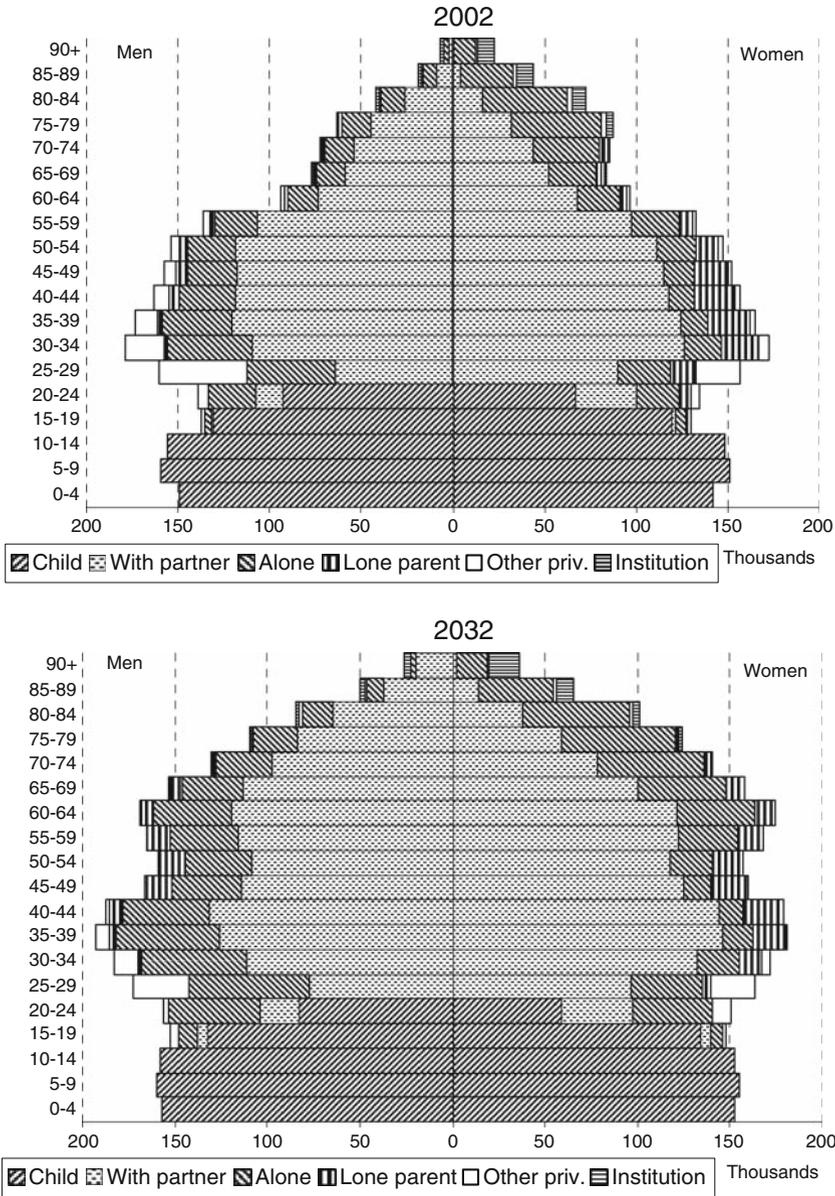


Fig. 9 Household structure of the population of Norway, by age and sex. 2002 (*observed*) and 2032 (*Benchmark projection*)

jump-off population was set equal to 100 persons (CHLD up to age 25, INST from age 65 onwards). The number of births during each 5 year period was set to 200, and we assumed a net migration level of zero.

For the population aged 80+, there are four positions with partner (COH0, COH+, MAR0 or MAR+) and four positions without a partner (SIN0, SIN+, OTHR or INST). With 100 persons in each category, half of the men and half of the women aged 80 or over were living with a partner in the jump-off situation. For women, the share living with a partner dropped quickly to 13% in 2017, and 8% in 2032. For men, the decrease was much slower: 34% in 2017 and 20% in 2032. Hence, instead of an *increase* by 12% points for women and of 31% points for men in the Benchmark situation, the ‘rectangular’ jump-off population results in *decreases* of 42 and 30% points, respectively. Based on this result, we conclude that much of the increase in the share of the 80+ who live with a partner is already embodied in the observed population as of 2002.

This conclusion is confirmed by Table 2, which applies to the Benchmark projection. In this table, we analyse the changes between 2002 and 2032 in proportions of elderly who live with a partner from two points of view: following age groups, and following birth cohorts.

Men aged 85–89 are more likely to live with a partner in 2032 (73.5%) than they are in 2002 (47%). The increase is 26.5% points between 2002 and 2032. In this comparison, we follow the same age group (85–89) over time. The men who are aged 85–89 in 2032 were born in 1943–1947. 30 years earlier, in 2002, these men were aged 55–59. At that time, their share was 5% points higher than the share of the same cohort in 2032 (see the last column of Table 2). For women in the age group 80–84, we notice a 16% point increase in the share that lives with a partner. However, when we follow the birth cohort 1948–1952, we see a *decrease* of 37% points. Thus, the shares in these cohorts who live with a partner were already high in 2002, in particular for women.

The conclusion based on Table 2 and on the counterfactual simulation in this section is that much of the increase in the share of the 80+ who live with a partner is already embodied in the observed population as of 2002. In other words, the current population structure (age, sex, and household position) will largely determine the structure for the next few decades.

We tried to analyse historical patterns for Norwegian elderly men and women who live with a partner, but an investigation of this kind is hampered by a lack of data. However, an analysis of the married (NB marital status, not household position!) population broken down by age and sex shows that higher shares of the cohorts born in 1930s and 1940s are married than in both earlier and later cohorts. Economic

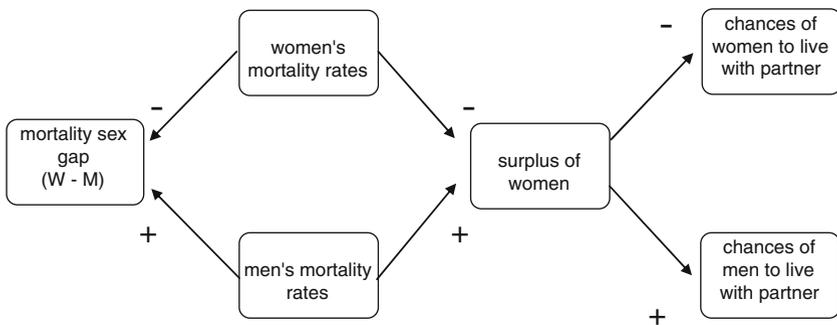
Table 2 Share of elderly men and women who live with a partner, Benchmark values

Sex and age	2002	2032	% Points increase over 30 years	Sex and cohort in 2032	% Points increase over 30 years
Following age groups				Following birth cohorts	
Men 80–84	61.8	76.0	14.2	Men 1948–52	–1.0
Men 85–89	47.0	73.5	26.5	Men 1943–47	–5.0
Women 80–84	21.9	37.9	16.0	Women 1948–52	–36.9
Women 85–89	9.6	21.5	11.9	Women 1943–47	–49.3

hardship during the 1930s and the Second World War hit the earlier cohorts. Later cohorts postponed marriage, and did not compensate this fully by cohabitation. They also experienced couple dissolution much more frequently than did the cohorts born in the 1930s and 1940s. Indeed, long-term projections of the Benchmark computations indicate that shares of elderly men and women who live with a partner will decrease again around 2050–2060. However, here one has to be cautious, because projected household structures in such a distant future are extremely uncertain.

4.2 Mortality

When we analysed the impact of mortality on the chances of elderly men and women living with a partner, we used the following scheme. The surplus of women compared to men plays a key role here. When death rates of women increase, the surplus of women goes down, other factors remaining the same. Next, with fewer women compared to men, the chances for a woman of living with a partner (of the opposite sex) go up. Thus, there is a positive relationship between the mortality of women and their chances of living with a partner, but it works through two *negative* paths: one from mortality to the surplus, and one from the surplus to the chances of living with a man.



For men, there is also a positive effect of mortality on the chances of living with a partner. However, here the surplus of women is linked to mortality and those chances through two *positive* links. When death rates of men and women change at the same time, the effects on the chances of living with a partner are determined by the mortality differentials between the sexes, and cannot be predicted—this is an empirical matter.

In addition to the mortality effects discussed above, there is an additional effect caused by differential mortality, which operates over time. With lower mortality, more men and women reach age 80, and they live longer beyond age 80. If mortality were the same for those who live with a partner and those who live alone, increased longevity would not have an impact on the chances of living with a partner. However, married men and women live longer than unmarried men and women.

We performed a number of sensitivity computations. The most important ones are:

- A 30% increase or decrease in all death rates, irrespective of age or household position
 - M1. only for women
 - M2. only for men
 - M3. -30% for men, +30% for women
 - M4. No sex difference: women's rates are those used in the Benchmark projection, while men's rates are the same as women's rates
- A 30% increase/decrease in the death rates for those who live with a partner (i.e. those with household position COH0, COH+, MAR0, or MAR+), irrespective of age
 - M5. only for women
 - M6. only for men

Labels M1–M6 identify these six sensitivity variants for mortality in the results below.

The 30% change that we used throughout was found after some experimentation—smaller changes implied effects on the chances of living with a partner that were not worth analysing. We increased or decreased death rates uniformly across all ages, and did not experiment with age-specific changes in the rates. The reason is that most of the mortality in Norway (as in many other developed countries) occurs in a limited age span, from age 60 and onwards, approximately. Thus, the changes we assumed for the ages below 60 are not important for our findings.

Computations M1–M4 assume no change in differential mortality, neither between age groups, nor (more importantly) across household positions. However, computation M5 assumes a widening of the gap in mortality between women with a partner and women without, while M6 implies similar assumptions for men.

Other parameters than death rates were set equal to their Benchmark values. Since we explicitly wanted to trace the effect of mortality on the chances of living with a partner, we did not include any consistency requirement for the number of deaths. Table 3 summarises the findings of these sensitivity computations.

Table 3 Share of elderly women and men who live with a partner

	% Women 80+ with partner			% Men 80+ with partner		
	2002	2017	2032	2002	2017	2032
Benchmark	14.8	22.9	25.8	54.0	74.9	77.5
M1. +30% women		+1.5	+1.4		-4.1	-3.2
M2. +30% men		-2.0	-2.0		+6.4	+5.9
M3. -30% men, +30% women		+4.8	+4.4		-11.1	-9.5
M4. no sex difference		+4.6	+4.4		-10.5	-10.3
M5. +30% women with partner		-0.9	-1.1		-2.4	-2.1
M6. +30% men with partner		-1.6	-1.7		+1.9	+1.6

Benchmark projections and percentage point deviations from Benchmark values in various sensitivity variants for mortality

The deviations are computed as the Benchmark value minus the value in the sensitivity variant. Strong effects are found for two cases: first, when we reduce men's death rates by 30%, and at the same time we increase those for women by 30% (M3); second, when we reduce the mortality of men such that it equals women's mortality (M4). In both the cases, the effects for men are stronger than those for women. Yet, in spite of the large changes in death rates compared to the Benchmark values, these sensitivity variants are not able to neutralise the increases in shares of elderly who live with a partner.

When we restrict the changes in death rates to those who live with a partner (variants M5 and M6), we notice smaller effects than those that result from changed death rates for all persons, irrespective of household position (M1 and M2). Hence, differential mortality plays only a minor role in the increases in shares of elderly who live with a partner. The results obtained for elderly women in variant M5, namely *lower* shares who live with a partner compared to the Benchmark situation, deserve some explanation. The flow diagram given above suggests that higher mortality leads to a lower surplus of women, and hence to a larger chance of living with a partner. While this still may be true, there is a second effect operating here, which must be stronger: When more women who live with a partner die, the share of those who do not live with a partner increases, and hence our variable of interest (the share that lives with a partner) decreases. We do not see the same effect for men in variant M6: here the share of elderly men with a partner is *higher* than in the Benchmark situation. A possible explanation is that in this case, the impact of the female surplus (i.e. 'shortage' of men) dominates the direct effect of higher death rates for men with a partner.

4.3 Pair Formation and Dissolution

Processes of pair formation and pair dissolution are governed by rates that reflect changes in household positions. For pair formation, these are *from* CHLD, SINO and SIN+, or OTHR to COHO, COH+, MAR0 or MAR+. For pair dissolution, the rates reflect changes in the opposite direction. One specific reason for pair dissolution is the death of one's partner. In many cases, this will imply that the surviving partner becomes a widow(er), at least for the elderly of today. Another reason is that a partner becomes institutionalised. Thus, the simulations for pair dissolution combine separation/divorce with entry into widowhood and with a partner entering an institution. Note that these three reasons for pair dissolution cannot be disentangled.

We increased or decreased the rates for pair formation and dissolution by 50% for both sexes simultaneously. The reason why we did not analyse the effect of changes for one sex at the time is the following. LIPRO models the marriage market (and the cohabitation market) as a two-step procedure: initial rates lead to inconsistent numbers of men and women summed over all ages who 'want to' marry (start a consensual union) during a certain projection interval; next, the consistency algorithm takes the harmonic mean of these inconsistent numbers, and adjusts initial age-specific numbers up for one sex, and down for the other sex. Thus, if we were to change the rates for one sex only, the results would partly be the consequence of implausibly strong imbalances in the marriage/cohabitation market. By changing

Table 4 Share of elderly women and men who live with a partner

	% Women 80+ with partner			% Men 80+ with partner		
	2002	2017	2032	2002	2017	2032
Benchmark	14.8	23.0	27.1	54.0	75.5	75.1
P1. +50% pair formation		+0.2	+0.9		+0.2	+0.1
P2. -50% pair formation		+0.1	-0.6		-0.7	-0.7
P3. +50% pair dissolution		-4.0	-5.9		-6.2	-6.8
P4. -50% pair dissolution		+5.7	+9.2		+6.4	+7.1

Benchmark projections and percentage point deviations from Benchmark values in various sensitivity variants for pair formation and dissolution

the rates for both sexes at the same time, we avoid that problem to a large extent, since the Benchmark rates reflect the actual situation as observed in the Survey of Living Conditions during the years 1997–2002.

Table 4 shows a much stronger effect on the share of the 80+ who live with a partner caused by changes in pair dissolution (for instance, for women -6 and +9% points in P3 and P4, respectively), compared with the effect caused by pair formation (+1 and -1% point for women in P1 and P2, respectively). The reason is the fact that dissolution is observed, on average, at a higher age than pair formation. Thus, it takes fewer years to see an effect of changes in pair dissolution on the population aged 80 and over, compared to changes in pair formation. Multi-state life tables based on household formation and dissolution rates as in the Benchmark projections show that the partnership is dissolved at a mean age of 44.4 years for men and 50.2 years for women; for pair formation the mean ages are 33.3 and 28.1 years, respectively. In the sensitivity variants, those mean ages are slightly different, but the general pattern remains. As noted above, dissolution of the partnership includes the death of the partner. This explains the high mean age of women, compared to that of men.

4.4 Entry into and Exit from Institutions

We changed the entry rates into institutional households for persons who live as a couple (i.e. COH0, COH+, MAR0 or MAR+) by 50%, irrespective of age (>65) or sex. Exit rates from institutions back to a partner were also changed by that amount. Table 5 gives the results of these four sensitivity variants.

The assumption of a constant capacity of the institutional households (41,000 persons) implies that higher entry rates for persons who live with a couple, *ceteris paribus*, cause lower entry rates for persons in private households who do not live with a partner (most of them have household positions SIN0 or OTHR). When more persons who live in a couple move to an institution, and fewer who do not live in a couple do so, the effect is a decrease in the chances of living with a partner in a private household; see the results for sensitivity variant I1 (labelled as '+50% entry'). In addition, the directions of the effects of the other three variants are as expected. However, the magnitudes are rather modest.

Table 5 Share of elderly women and men who live with a partner

	% Women 80+ with partner			% Men 80+ with partner		
	2002	2017	2032	2002	2017	2032
Benchmark	14.8	23.0	27.1	54.0	75.5	75.1
I1. +50% entry		-3.6	-3.9		-2.4	-2.3
I2. -50% entry		+4.8	+5.3		+2.6	+2.5
I3. +50% exit		+2.3	+2.5		+2.5	+2.8
I4. -50% exit		-3.2	-3.6		-4.5	-5.1

Benchmark projections and percentage point deviations from Benchmark values in various sensitivity variants for entry into and exit from institutions

4.5 Combined Changes

So far, we have seen that mortality is more important for the chances of elderly men and women of living with a partner than pair formation, pair dissolution or entry into or exit from an institution. However, the various sensitivity variants cannot be compared directly because we used a 50% change in pair formation, and a 30% change in mortality. In the sensitivity variant that follows we asked ourselves: what changes in rates of mortality, pair dissolution and entry into or exit from an institution are necessary, compared to the Benchmark, in order to neutralise the projected increase in the share of elderly men who live with a partner? In other words, how large a change in Benchmark rates is necessary to keep that share at its level as observed in 2002, i.e. 54%?

In order to answer this question, we tried to discover a number $0 < K < 1$, such that changing rates for

- mortality of women, pair dissolution of both sexes and entry into institutions of men by a factor $(1 + K)$, and
- mortality of men and exit from institutions of men by a factor $(1 - K)$,

would result in a share of men aged 80+ who live with a partner equal to 54% in 2032.

Trial and error resulted in $K = 0.41$. In other words, an increase (compared to Benchmark levels) of female death rates, dissolution rates for both sexes and entry rates of men into institutions by almost one-half, combined with a decrease of male death rates and exit rates from institutions by more than 40% will result in a share in 2032 that equals its 2002 value. By no means do we claim that the share of elderly men who live with a partner is certain to increase by more than 20% during the 30 year period. However, in order to maintain that any increase whatsoever is unrealistic, one must be ready to believe that female death rates, dissolution rates for both sexes and entry rates of men into institutions will be much higher than current ones, and male death rates and exit rates from institutions much lower.

Note that the search for a specific combination of variables that neutralises the increase in the share of elderly men with a partner is not meant to imply that such an increase is to be avoided in the future. It is a counterfactual analysis purely of the

‘what if’ type, which tells us under which circumstances such an increase would *not* occur. The circumstances (rates that are 41% higher or lower than the Benchmark rates, for the entire period to 2032) are unrealistic. Hence, we are convinced that the share of elderly men with a partner *will* increase in the future.

The 41% change in four components simultaneously (mortality, pair dissolution, entry into an institution and exit from an institution) results in a share of elderly men with partner in 2032 that is $77.5 - 54.0 = 23.5\%$ points lower than in the Benchmark situation. If only one of these four components is changed by 41% at the time, we obtain smaller differences compared to the Benchmark situation (all values expressed as percentage points): mortality 13.1, pair dissolution 5.3, entry into an institution 0.3 and exit from an institution 4.2.¹⁰ The sum of these values is 22.9% points, slightly lower than the difference of 23.5% points mentioned above. Thus, small interaction effects are at work when we change the four components simultaneously. At the same time, we note that mortality is by far the most important component, as expected.

5 Conclusions

The physical and emotional well being of elderly persons depends strongly on their living arrangements—at the same time it is one of the determinants of their living arrangements. In addition, there is considerable interest from policy makers in the living arrangements of the elderly. Those who live with a partner need less formal care than those who live alone, other things being equal. Thus, when we note in a new household forecast that the number of elderly men and women in Norway who live with a partner will increase faster than the total number of elderly (irrespective of living arrangement), an analysis of the factors that could cause this new trend is warranted. Our variable of interest has been the share of individuals aged 80+ who live with a partner. For men, this share is expected to increase from 54% in 2002 to 77% in 2032; for women, the expected increase is 11% points, up from 15% in 2002.

We identified two factors that explain these increases: the household composition of the current population, and the future path of mortality. Much of the increase in the share is already embodied in the forecast’s jump-off population. The over 80s in 2032 were born in the 1930s and 1940s. Members of those cohorts lived and will live more often in a relationship than earlier cohorts. The earlier cohorts were hit by economic hardship in the 1930s, and suffered from WWII. In contrast, those born during the 1930s and 1940s were in their prime marriage ages in the 1950s and 1960s, when marriage was almost universal. Thus, the increasing likelihood for the

¹⁰ These numbers for pair dissolution and entry into/exit from an institution are not directly comparable to those in Tables 4 and 5, for two reasons. First, we did not apply any mortality constraint in Sect. 4.5, whereas in Tables 4 and 5 deaths were constrained to numbers predicted by Statistics Norway. Second, the simulations in this paper revealed a problem with LIPRO’s handling of consistency requirements, in particular under extreme conditions (e.g. -30% men and $+30\%$ women for mortality, or $\pm 41\%$ for four components combined). Under such conditions, LIPRO could not always satisfy the constant capacity requirement towards the end of the period. In order to keep these problems to a minimum, we formulated the constant capacity constraint for both sexes simultaneously in Sects 4.2 and 4.5, but for men and women separately in Tables 4 and 5.

elderly of living with a partner, which results from the household projections to 2032, is a direct effect (at least partly) of the increased popularity of marriage for subsequent birth cohorts up to those born towards the end of the 1940s. Moreover, the cohorts born before 1930 experienced high male mortality in the 1950s and 1960s, when male life expectancies stagnated or even declined. Hence, many women in these cohorts were widowed.

For the elderly in later cohorts, i.e. those born after 1950, one may expect a decrease in the likelihood of living with a partner. First, the later cohorts adopted a different behaviour with more frequent divorce and separation than those born in the 1930s and 1940s. This is a direct factor leading to fewer men and women living with a partner. Second, unmarried cohabitation became popular in these later cohorts, at the expense of marriage. Since consensual unions have a larger risk of being dissolved than marital unions, the popularity of unmarried cohabitation is an indirect factor leading to lower chances of living with a partner.

A second important factor is the future path of mortality. At present, there is a large surplus of elderly women, caused by unfavourable mortality developments among adult men in the 1950s and 1960s, as noted above. In recent decades, mortality of men improved more quickly than that of women, and this trend is expected to continue into the future. This will reduce the surplus of elderly women, which in turn implies higher chances for elderly women living with a partner.

The impact of mortality on the chances for elderly men living with a partner is more difficult to explain. Male mortality is expected to improve in the future; however, falling death rates should imply *lower* chances for men living with a partner (other factors remaining the same), because they become more numerous. When we find an expected *increase* in this share, it might be the result of a simultaneous improvement in female mortality.

Our simulations suggest that the low mortality of persons who live with a partner compared to those without (given age and sex) plays a minor role only. In addition, other components of change, such as pair formation and dissolution, or the entry into/exit from an institution, have only small effects on the chances for elderly men and women living with a partner.

Although we have not been able to give an entirely satisfactory explanation for the increasing share of elderly men with a partner (other than that it is already embodied in the current population), we believe that it is real, and not an artefact of the household simulations. In a counterfactual simulation, we succeeded in neutralising the expected increase, by applying 41% *higher* death rates for women, divorce and separation rates for both sexes, and entry rates into institutions of men, *together with 41% lower* death rates and exit rates from institutions. We consider a 41% change in the parameters of the household forecast as rather unrealistic. Hence, the increase in the share of elderly men who live with a partner is real, although it could be weaker or stronger than the household forecast shows.

Chances for living with a partner are important, for the reasons given above. From a policy maker point of view, the focus would rather be on people living alone. When there is no spouse present to provide care, elderly persons who live alone will have to rely on their children or other persons, if any, or otherwise on the state. Thus, from this point of view the current analysis could equally well have

focused on the elderly who live alone. The results would largely be mirrored by those parts of our analysis in which we focused on pairs. The reason is that household positions ‘living alone’ and ‘living with a partner’ dominate for the group aged 80+ (for higher ages, e.g. 90–94, the proportion who are institutionalised also becomes large). Indeed, the chances of living alone decrease by 18 and 9% points over the period 2002–2032 for men and women aged 80+, respectively. The reasons for these decreases are the same as those that cause an increase in the chances of living with a partner for these elderly men and women.

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