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Beyond projections by age and sex

Extremity Injuries and Dementia disproportionately increase the risk for long-term care at older age. An analysis of counter-factual projection scenarios based on German Health Insurance Routine data.

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Summary

The demand for long term care (LTC) is expected to increase in the next decades in Germany. Several projections for LTC in Germany exist, but their conclusions vary, and they do not distinguish between LTC at home or in an institution. Lower extremity injuries (EI), e.g. due to falls, and dementia are important risk factors for LTC and mortality. We investigate their independent and combined effects on LTC and mortality. We use a multi-state projection model where the estimation of the transition and mortality rates is based on longitudinal health claims data. We projected a set of six different scenarios of LTC for ages 75+ in Germany from 2014 to 2044, among them counter-factual scenarios that remove the effects of lower EI, dementia, or both. Our multi-state projections distinguish between home and institutional LTC. The total number of LTC recipients will grow in the coming decades. We project an increase of 80% from 2014 in 2044 in our main status-quo scenario. This increase is mainly driven by the ageing of large baby boomer cohorts. Besides this demographic certainty, the most important factor influencing the amount of LTC increase is the future increase of life expectancy, i.e. the assumptions about future developments of mortality for individuals not in LTC, and in home and institutional LTC. The impact achievable by modifiable risk factors varies and is much lower, but can markedly influence the care type, e.g. the residency at home or an institution. Taking possible interactions between risk factors into account is advisable as well, when such interactions show a significant effect on LTC and mortality.

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I. Introduction

a) Background

1. Growing demand for long term care (LTC) is an important issue that nations with ageing populations are facing. Countries all across Europe are experiencing population ageing, and must consider how a growing demand for LTC services can be met. Two factors are responsible for population ageing: increasing life expectancy and declining fertility. During the past century, life expectancy has increased steadily. This increase continues in the 21st century, and no conclusive evidence regarding a possible maximum or change of pace is apparent. The majority of this increase is caused by lower mortality at higher age. Whether additional life years at older age are healthy life years, or life years spent in bad health, or with restrictions in activities of daily living, is another important question that is directly linked to the increasing life expectancy.[1] Ill health or the inability to perform basic tasks can be a cause for LTC. If increasing life expectancy were to lead to more years with LTC, it would directly lead to a growing demand for LTC services. If, on the other hand, the majority of gained life years were spent in good health and without LTC, increasing life expectancy would not necessarily be a cause for increasing demand for care services. The question of health in additional life years, however, is not the only influential factor. Even if the majority of gained life years were spent without serious limitations, large baby boomer cohorts born between the mid-1950s to the mid-1960s will be reaching ages in which LTC becomes prevalent between 2030 and 2050. The size of these cohorts will most likely lead to a growing absolute need for LTC, regardless of compression or expansion of morbidity and care need.[2]

2. Besides looking at the parameters and consequences of population ageing on a macro scale, individual determinants of LTC can be studied on the micro level. LTC need generally arises from the inability to perform basic tasks of daily living without assistance, caused by disease or injury. Two common examples that have been identified as important causes for LTC at older age are dementia or a fractured extremity, like a broken hip, often due to falls.[3–10] While LTC associated with population ageing on a macro level presents no direct opportunities for intervention, examining individual causes for LTC can shed light how to reduce LTC need by aiming to counteract influential individual causes of LTC.

3. Dementia and extremity injuries are common at older age, and are thus interesting candidates for a targeted intervention.[2] They are not only independent risk factors for LTC, but also act as risk factors or early indicators for each other. Mobility problems like gait instability, are recognized as predictors for cognitive decline. Especially lower extremity injuries act as a significant risk factor for dementia.[11] Also, dementia is often a condition that older fracture patients suffer.[12–14] If both are present together, they also disproportionately increase the LTC and mortality risks. When afflictions are present concurrently, the resulting LTC and mortality risk is larger than both individual risks together, which suggests a synergistic effect.[11,15] A comprehensive take on this matter can be found in Doblhammer et al[11], which examines the individual and combined effects of extremity injuries and dementia on LTC and mortality in terms of relative risks using the same process-generated dataset this paper is based on, while controlling for a large set of other known risk factors. Due to their individual and synergistic effects on LTC, both will be used as examples in counter-factual scenarios to quantify the effects of hypothetical, completely successful intervention strategies. While no intervention can be completely effective, this serves to assess to what

degree future developments in LTC can be influenced by targeting different causal factors, while also accounting for the effects of population ageing.

b) Projection of long term care need for Germany

4. The projection of LTC need in Germany has been the focus of a couple of papers in recent years.[2] Projections of future care need are usually based on a single population scenario that is combined with the age-specific prevalence of LTC. Since future care need depends on the size of the cohorts that reach ages relevant for LTC in the coming decades, the primary source of uncertainty is the assumption about the future development of life expectancy, while different assumptions about future health developments have lower impact.

5. The different available projections span different time periods, start at different base years, and cover either all persons with LTC, or only a subset, e.g. from some specific age upwards. They employ different definitions of LTC, e.g. the objective definition used by the LTC insurance, or self-reported criteria. The focus is on the total number of LTC recipients, care at home and in institutions is not presented separately. They indicate rates of increase between 22% and 62% between 2005 and 2030, and between 45% and 123% between 2005 and 2050. The differences between the status quo-projections and the "health improvement" scenarios range between 400.000 – 600.000 individuals with LTC for 2030, and about a million for 2050.[2] The main conclusion from this projections is that the age structure dictates a marked increase in LTC that no realistic increase of good health and/or degree of compression of morbidity at older age will be able to compensate. The number of LTC recipients will increase markedly, the question is, how big this increase will be.

II. Methods

a) Estimation of transition and mortality rates

6. We use a multi-state projection model where the estimation of the transition and mortality rates is based on longitudinal health claims data. A random sample of 250.000 individuals who in the first quarter of 2004 were at least 50 years old and were insured with Germany's largest public health insurance (AOK, Allgemeine Ortskrankenkasse) was drawn. The sample was drawn from all insured persons, regardless of seeking medical treatment or not and followed until the end of 2010. After dismissing people younger than 65, data cleaning, consistency checking, removal of interrupted observations (e.g. due to a change of health insurance) and the implementation of a 2 year long validation period for incident dementia, 122.000 individuals aged 65+ at the first quarter of 2006 remained. Besides detailed records of medical diagnoses and prescriptions as ICD-10 codes, the data contain information on age, sex, LTC status (no LTC, LTC at home, LTC in institution) and date of death. Claims data is a process generated result of the reimbursement of medical doctors from the in- and outpatient sector. The whole population, including individuals living in LTC institutions, is included, which is a big advantage when studying health-related aspects at old age that are risk factors for LTC.

b) Definition of long term care

7. All individuals who received benefits from Germany's statutory LTC insurance are defined as being in need of LTC. The LTC insurance ("Pflegeversicherung") is a pay-as-you-go financed mandatory insurance and was founded in 1995. To receive benefits, applicants must pass an objective assessment primarily focused on ADL impairments. Depending on the score, the applicant is assigned to one of three LTC levels depending on the amount of care required. The lowest level is granted when at least one and a half hours of care are required, at least half of which concern basic tasks. The highest level is granted when at least five hours of care are required (four of which concerning basic tasks). In our study, we do not distinguish the different LTC levels. Whether to remain at home or to move into an institution is entirely up to the individual, however, the higher the care level, the higher the likelihood of receiving the necessary care in an institution. All individuals living in an institution receive LTC.

c) Definition of dementia

8. Dementia is defined as one or more of the following diagnoses: Alzheimer's disease (ICD-10 codes F00/G30), vascular dementia (F01), Lewy body dementia (G31.82), circumscribed brain atrophy (G31.0), dementia as a side-effect of another disease, e.g. Parkinson's disease (F02, F05.1, G23.1), as well as other/not specified dementia (F03). To ensure validity, we considered only diagnoses flagged as "secure diagnosis" for outpatients or "discharge diagnosis" for inpatients. Second, concurrent diagnoses either by an inpatient and an outpatient physician or from different outpatient specialists were required. If the first dementia diagnosis was given in the last quarter of the observation period, it was deemed valid. Dementia was coded as present from the first validated occurrence onwards.

d) Definition of lower extremity injury

9. Lower extremity injuries are defined using diagnostic data of fractures and injuries. Lower extremities are defined from the hip and pelvis downwards, and relevant injuries are fractures, wounds, luxations, contusions, burns, frostbites and amputations (ICD codes S70–S99, relevant parts of T). Lower extremity injury was coded as present from the first occurrence onwards.

e) Projections

10. We projected a set of six different scenarios of LTC in Germany from 2014 to 2044, gained from closed, deterministic multi-state population projections. (Table 1) Multi-state projections divide the population not only by age and sex, but also into several functional states. In our case, the included states are healthy (i.e. no LTC), LTC at home and LTC in an institution. Transitions (the internal mobility between states) are possible from healthy to care at home (1) and to institutional care (2), and additionally from home care to institutional care (3). Every functional state can lead to death (4-7). All transitions are irreversible, i.e. the transition from a care state back to the healthy state and from institutional care to home care is not possible. For each of these transitions in all projection scenarios, we computed age- and sex-specific transition and mortality rates using parametric survival regressions

with the baseline hazard following a Gompertz distribution using *streg* in Stata 12. In the case of a counter-factual scenario, only data spells without the respective condition were used, e.g. for the counter-factual scenario without dementia, only observed episodes without dementia were used in the estimation of the rates. The transition rates obtained from the models were then applied unchanged for the entire time span of the projection scenarios, while the mortality rates were reduced by 1.5% each year to conservatively account for increasing life expectancy. A reduction of this amount is congruent with the observed decrease of mortality rates for the ages 75 and upwards in the last 10 years in Germany. To account for the uncertainty in conjunction with this deterministic assumption, we also calculated two additional status-quo projections with 1% and 2% yearly reductions of mortality rates as alternative scenarios (1B, 1C). In our closed projections, fertility and migration are not considered, because fertility does not impact projections of individuals aged 75+ within the timeframe of our projections, while migration would only have a marginal effect in the considered age groups and would also rely on highly uncertain assumptions in terms of quantity. Not considering migration allows us to focus on the effects of demographic ageing and also makes interpreting the outcomes of the counter-factual scenarios easier. A direct comparison between the endpoints of other projections and our scenarios is not possible because of the different base years and the focus on the 75+ year age group, but it is certainly possible to compare whether our projections are generally compatible with previous results.

11. The starting population (2014) for all projection scenarios is based on census data (general population structure at the end of 2014) and statistics on LTC status by age and sex based on data from Germany's mandatory public LTC insurance ("Pflegeversicherung"). Combining those allows us to model the status quo of age and sex-specific no /home/institutional LTC distribution at the end of 2014.

	A	B	C
1. Status Quo	Mortality rates -1.5% each year Includes dementia & EI cases	Mortality rates -1% each year Includes dementia & EI cases	Mortality rates -2% each year Includes dementia & EI cases
2. No Dementia	Mortality rates -1.5% each year Excludes dementia cases		
3. No Extremity Injuries	Mortality rates -1.5% each year Excludes EI cases		
4. No Dementia & Extermity Injuries	Mortality rates -1.5% each year Excludes dementia & EI cases		

Table 1: Overview of assumptions of all projection scenarios and variants.

12. We present four main scenarios, all with the same extent of life expectancy increase: The status-quo scenario (1A), the counter-factual scenario free from dementia (2A), the counter-factual scenario free from lower extremity injuries (3A), and the counter-factual scenario free from both dementia and lower extremity injuries (4A). All scenarios were calculated for a time span of 30 years, i.e. from 2014 up to 2044, for the states free from care, home care, institutional care and

death, by age and sex. We show the results for the population in the relevant age group for LTC, i.e. 75 years and older. All scenarios were calculated using the PDE Population Module program

(http://webarchive.iiasa.ac.at/Research/POP/pub/software/pde/).

III. Results

		Long term care recipients aged 75+ in 2044		
Scenario		Home	Institution	Total
Status Quo (1A)		1.997.012	1.281.420	3.278.432
	% change from 2014	67%	105%	80%
No Dementia (2A)		2.182.140	971.606	3.153.746
	% change from 2014	82%	55%	73%
No Extremity Injuries (3A)		1.985.348	1.273.943	3.259.291
	% change from 2014	66%	104%	79%
No Dementia & Extremity Injuries (4A)		2.107.444	791.725	2.899.169
	% change from 2014	76%	27%	59%

Table 2: Overview of scenario endpoints. Source. Own calculations.

a) Status Quo Scenario

13. The status quo scenario (1A) serves as a basis of reference against which the counter-factual scenarios can be compared.

14. In 2014, about 1.8 million people 75+ received LTC in Germany. Broken down by residency, 1.2 million, or about two thirds, received care at home, and 600.000 people received care in an institution. In 2044, about 3.3 million receive LTC, which is an increase of 80% from the base year 2014. (Table 1) Institutional care more than doubles, with an increase of 105% to 1.28 million people; home care demand increases by 67% to nearly 2 million people.

15. The marked increase in the demand for institutional LTC is caused mainly by males. In 2014, nearly 136.000 males received care in an institution, and in 2044, there is an increase of 151% to 340.000 males; the increase for females is at 92%, from 490.000 to 941.000. (Table 3)

16. This pattern is also visible for home care with a larger increase for men (105%, from 379.000 to 777.000) than for females (49%, from 818.000 to 1.22 million).

		Male						Female						Total					
		Home Care	%	Institut.	%	All Care	%	Home Care	%	Institut.	%	All Care	%	Home Care	%	Institut.	%	All Care	%
	2014	379.057		135.681		514.738		818.280		489.399		1.307.679		1.197.337		625.080		1.822.417	
Status Quo	2044	776.917	105%	340.081	151%	1.116.998	117%	1.220.095	49%	941.339	92%	2.161.434	65%	1.997.012	67%	1.281.420	105%	3.278.432	80%
No Dementia	2044	825.351	118%	266.356	96%	1.091.707	112%	1.356.789	66%	705.250	44%	2.062.039	58%	2.182.140	82%	971.606	55%	3.153.746	73%
No EI	2044	768.630	103%	334.925	147%	1.103.555	114%	1.216.718	49%	939.018	92%	2.155.736	65%	1.985.348	66%	1.273.943	104%	3.259.291	79%
No Dem. & EI	2044	788.969	108%	257.323	90%	1.046.292	103%	1.318.475	61%	534.402	9%	1.852.877	42%	2.107.444	76%	791.725	27%	2.899.169	59%

Table 3: Scenario endpoints by sex and care type. Source: Own calculations.

b) Counter-factual scenario: No dementia

17. The counter-factual scenario without dementia (2A), in 2044 results in about 125.000 less people with care need than in the status quo projection (3.15 million). Compared to the 80% increase of the status quo-variant, this is an increase of only 73%. The difference can be attributed to fewer people entering institutional LTC. In the dementia-free scenario, in 2044, about 972.000 people receive institutionalized care (+55%), about 310.000 care recipients fewer than in the status quo-scenario. On the other hand, more people than in the status quo-scenario remain in care at home, with a total of 2.18 million people (+82%). This pattern holds true for females and males alike, because for both sexes, dementia is a strong risk factor for institutional LTC. Overall, this scenario would considerably relive institutional care providers, because it only indicates a total increase of institutional care demand of 55% rather than 105%.

c) Counter-factual scenario: No lower extremity injuries

18. The counter-factual scenario without lower extremity injuries (3A) differs only slightly from the status quo-projection. In 2044, it indicates about 3.26 million people in LTC (+79% compared to 2014), which is only 20.000 individuals lower than the status quo-projection. Thus, in term of total outcome, both scenarios are virtually identical. In terms of care at home or in an institution, and in terms of differences between sexes, this scenario is also practically identical with the status-quo projection. On its' own, the absence of lower extremity injuries does not affect the sum total of LTC recipients or the ratio between home and institutional care.

d) Counter-factual scenario: No dementia, no lower extremity injuries

19. The counter-factual scenario that removes both dementia and lower extremity injuries (4A) shows marked differences from the status-quo projection and the two previous counter-factual scenarios. With 2.9 million people in any type of LTC, it results in 380.000 LTC recipients less than the status quo-projection. Compared to the counter-factual scenario without dementia, there are 255.000 less

people in any type of LTC. The marked decrease in total care need is attributable to a much lower demand for institutional care. Compared to the status quo-projection, which sees an increase of institutional care of 105% , this counter-factual scenario only yields an increase of +27%. About 110.000 people more than in the status quo-projection do, however, end up in LTC at home (2.1 million, or +76%, 9 points more than the +67% increase in the status quo-scenario). This general pattern of a slight increase of care at home and a marked decrease of institutional care in comparison to the other scenarios holds true for females and males alike. For women, this effect is especially pronounced, as the scenario indicates only a 9% (45.000 persons) increase of institutional care for women (92% in the status quo-scenario) from 2014. For males, this scenario indicates a 90% increase (122.000 persons), which is, however, still much smaller than the 151% increase in the status quo-projection. In short, the counter-factual scenario without dementia and lower extremity injuries shows that the removal of both afflictions has a larger effect on LTC than the two other counter-factual scenarios, which removed either dementia or lower extremity injuries.

e) Total number of long term care recipients over time

20. Figure 1 shows the progression of the total number of LTC recipients (recipients of care at home and care in institutions combined) of scenarios 1A-4A over time. Two paces of increase become apparent. The first period from 2014 to 2035 sees a steady increase of the absolute number of persons in LTC of 20.000 to 40.000 per year, and from 2036 to 2044, when large baby boomer cohorts start entering ages relevant for LTC, this increase grows to 80.000 to 110.000 persons per year. Approximately, one year in the 2040s sees as many new entries into LTC than a three year period in the 2020s. The structural population ageing drives the overall development of LTC, while increasing life expectancy is responsible for more transitions into institutional care.

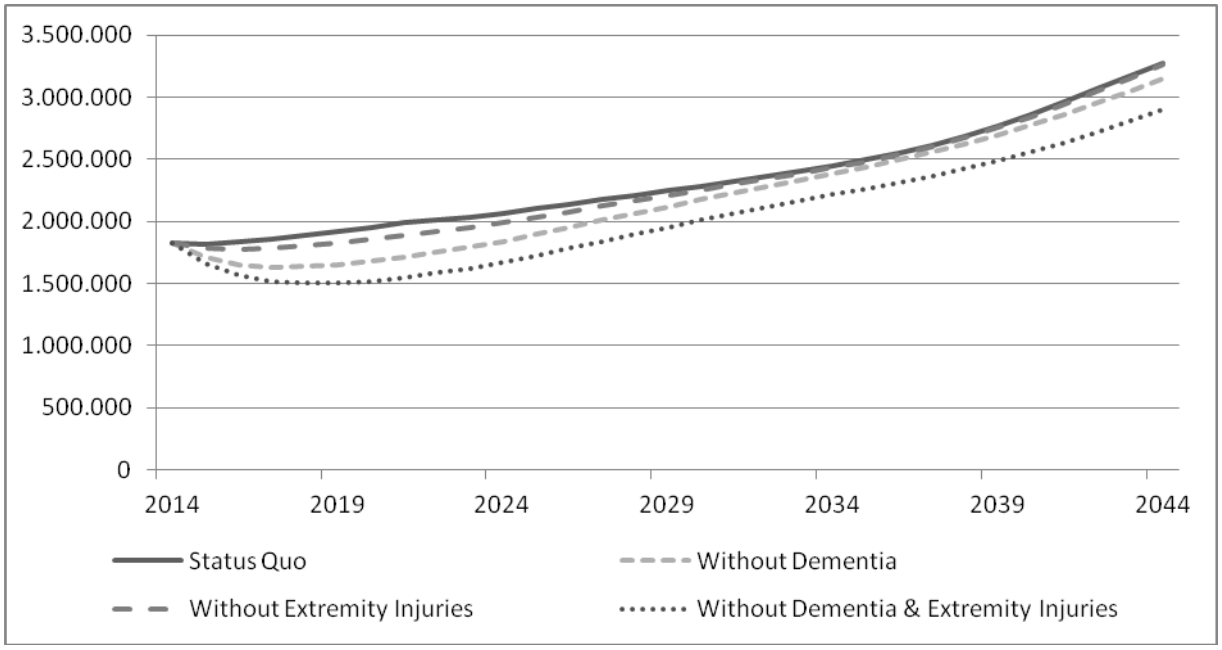

Figure 1: Total number of long term care recipients over time, all scenarios. Source: Own calculations.

21. The next set of figures shows the distribution of individuals in LTC by care type over time (1A-4A). The total number of LTC recipients increases in all scenarios, and reaches over 3 million individuals in all scenarios except the last one. The major difference lies in the share of care recipients in institutional care, which for the dementia-free and especially the dementia and lower extremity injury-free scenarios, is significantly lower over time. It is, however, instantly evident that no counter-factual scenario is able to compensate the increase of total care recipients caused by the ageing of the baby-boomers.

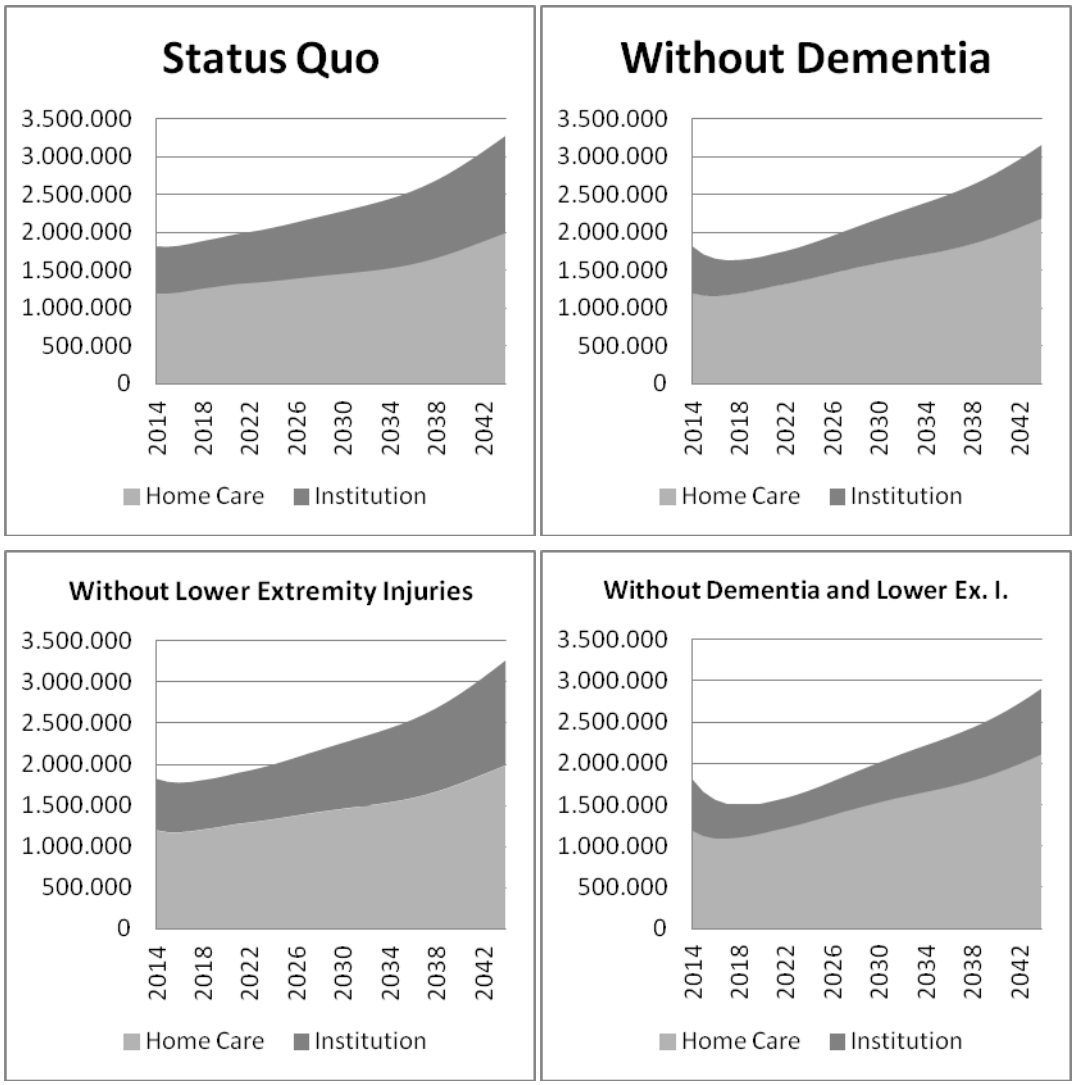

Figure 2: Total number of long term care recipients by care type over time, all scenarios. Source: Own calculation.

f) Sensitivity Analysis: Status quo scenario with different assumptions on increasing life expectancy

22. The total number of LTC recipients depends to a large extent on the assumptions about mortality. The effects of two alternative assumptions about future development of mortality in the status quo-variant (1B, 1C) are shown in figure 3. The black line represents the total number of persons receiving LTC over time in the status quo-scenario with the assumption of a 1.5% decrease of mortality rates per year (1A). This is the assumption that is generally used in this paper. The other two lines depict the status-quo scenario with either only a 1% yearly decrease (1B) or a 2% (1C) yearly decrease of mortality rates. The difference of LTC in 2044 between the 1% and 2% decrease assumptions is about 900.000 individuals, which is markedly more than the difference between the status quo- and the dementia-free scenario.

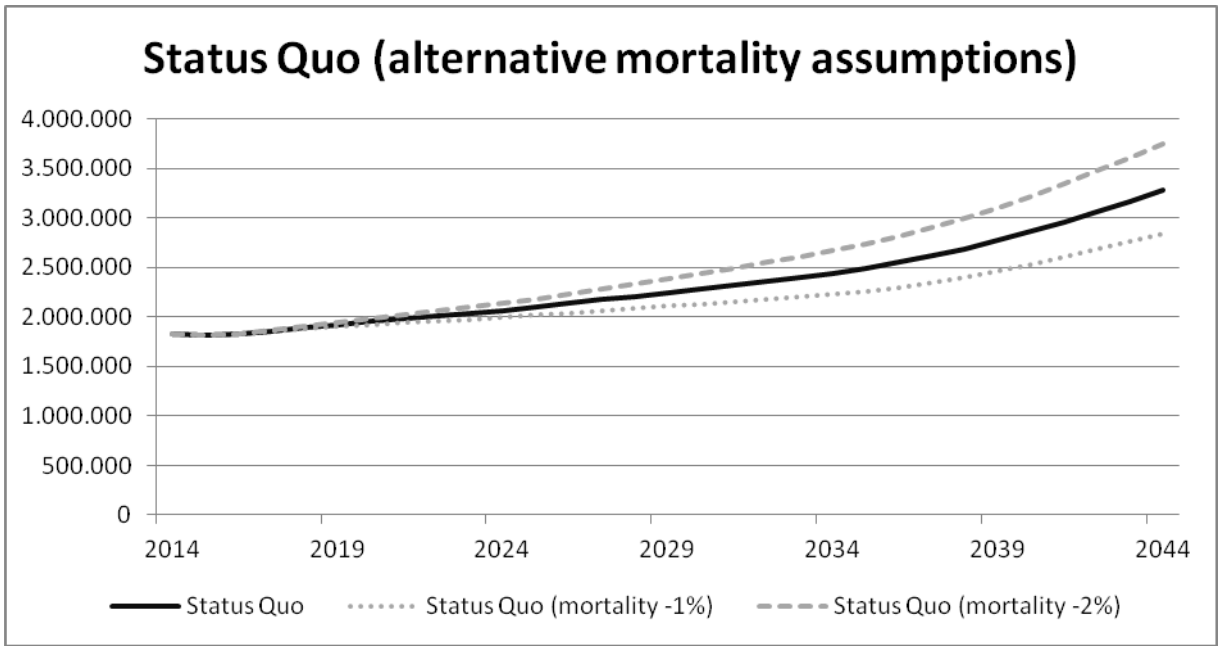

Figure 3: Total number of long term care recipients over time, status quo scenario with alternative mortality assumptions. Source: Own calculations.

IV. Discussion

23. The total number of LTC recipients will grow in the coming decades. This is mainly driven by the ageing of large baby boomer cohorts. Besides this demographic certainty, the most important factor influencing the amount of LTC increase is the future increase of life expectancy, i.e. the assumptions about future developments of mortality for individuals not in LTC, and in home and institutional LTC. The impact achievable by modifiable risk factors varies and is

much lower, as our two examples of extremity injury and dementia show. On its' own, the removal of lower extremity injuries shows only a very small effect, but combined with the absence of dementia, the resulting reduction in total care need is much larger than expected, which is in line with the increased LTC risk associated with the combined presence of dementia and lower extremity injuries. We thus showed that interactions between risk factors should be taken into account, as the counter-factual scenario without dementia and lower extremity injuries yielded a much larger reduction of care need than would be expected were there no significant interaction between the two. Generally, examining risk factors such as those for LTC should not only be done individually, but also take possible interactions between risk factors into account. While the counter-factual scenario that removed dementia yielded a marked reduction of long term need in 2044, especially as far as institutional care is concerned, its' impact was smaller than the alternative scenario with slightly higher mortality. One might, on the other hand, focus on the lower share of institutional care associated with the dementia-free counter-factual scenarios and, e.g. think about possible financials effects, if home care were less cost-intensive than institutional care.

24. The main strength of this study is that it provides projections of future LTC demand based on empirical data (transitions and mortality) gained from a very large, representative dataset, the AOK routine data, separated by sex, age and home or institutional care. Furthermore, we provide examples for contra-factual scenarios which allow us to assess the effect of the hypothetical removal of a single care risk, or also more risks at the same time, which is especially interesting if a significant interaction between them was found.

25. Several weaknesses of the results presented in this paper can be addressed. One big external uncertainty that affects our projections of LTC is the definition of LTC, which will definitely change from the definition in place when our data was collected. Recent legislation to reform Germany's mandatory public LTC insurance includes formerly excluded dementia-only cases as beneficiaries. The number of LTC recipients might inflate somewhat due to this change – however, dementia has already been a very strong risk factor for care need in our data, despite the non-coverage, so this might not have a very large effect after all. Second, as was shown, the assumptions of future developments of mortality are central to the results. This is the same for any projection, and we showed different scenarios to account for this.

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