DZNE
German Center for Neurodegenerative Diseases
within the Helmholtz Association

Rostock University

Dementia may become the leading disease at the time of death in Germany: Probabilistic disease-projections among the deceased up to the year 2060

Gabriele Doblhammer & Thomas Fritze

5th HMD Symposium, May Berlin 2019

Everything traces back to Lilienfeld & Perl 1993…

"According to projections of the World Health Organization (WHO) by 2040 neurodegenerative diseases such as Parkinson's and Alzheimer's disease will outrank cancer as the second most frequent cause of death (after cardio-vascular disease)." Spektrum der Wissenschaft 9_2013

similar claims in Neuroscience (2016), Nature (2014) referred to as WHO projections

…….but WHO projections only extend up to 2030 !

Projections by Lilienfeld & Perl (1993) up to 2040: mentioned but not cited in the Neurology Atlas WHO (2004)

Lilienfeld D, E, Perl D, P: Projected Neurodegenerative Disease Mortality in the United States, 1990–2040. Neuroepidemiology 1993;12:219-228. doi: 10.1159/000110320

DZNE
German Center for Neurodegenerative Diseases
within the Helmholtz Association

Projections of decedents up to 2060 by disease at the time of death

1. We used health claims data to estimate the prevalence among deceased persons that suffered from dementia and other diseases at the time of their death

2. Projected the number of deaths according the age- and sex-specific official population projections of Germany

3. We explored the uncertainty in our forecasts introduced by unknown trends in future life expectancy and morbidity

DZNE
German Center for Neurodegenerative Diseases
within the Helmholtz Association

Morbidity in the Quarter of Death

- 2% sample of AOK insured population in 2004 with a follow-up until 2015 with
- quaterly information of disease (ICDN-10) and month of death

- all deaths at ages 70 between 2006 and 2015 where decedents had been observed for at least eight quarters at the time of their death

- 51,924 deaths with 39% men, and 61% women

- applied WHO cause of death definition for the top five causes of death

- whether in the last two years of life a specific diagnosis was observed at least once

DZNE
German Center for Neurodegenerative Diseases
within the Helmholtz Association

Morbidity in the Quarter of Death
Comparison of Definitions, Ages 70+

WHO	IHD		Stroke		Dementia		COPD		Cancer	
Definition	%	rank	%	rank	%	rank	%	rank	%	rank
Men Total	56.6	1	42.9	4	38.3	5	45.1	2	43.8	3
Women Total	50.0	2	43.9	3	53.1	1	31.8	4	29.1	5

Source: AOK data, own calculations

DZNE
German Center for Neurodegenerative Diseases
within the Helmholtz Association

Morbidity in the Quarter of Death
Comparison of Definitions, Ages 70+

WHO	IHD		Stroke		Dementia		COPD		Cancer	
Definition	%	rank	%	rank	%	rank	%	rank	%	rank
Men Total	56.6	1	42.9	4	38.3	5	45.1	2	43.8	3
Women Total	50.0	2	43.9	3	53.1	1	31.8	4	29.1	5
UK Definition	IHD		Cerebro		Dementia		LRCD		Cancer	
Men Total	56.6	1	42.9	4	36.8	5	46.3	2	43.8	3
Women Total	50.0	2	43.9	3	52.1	1	33.5	4	29.1	5
German Definition	IHD		Cerebro		Dementia		LRCD		Hypertensive Disease	
Men Total	56.6	2	42.9	4	38.0	5	46.3	3	85.9	1
Women Total	50.0	3	43.9	4	52.8	2	33.5	5	87.5	1
US Definition	Heart		Cerebro		Alzheimer		COPD		Cancer	
Men Total	84.8	1	42.9	4	9.8	5	46.3	2	43.8	3
Women Total	85.1	1	43.9	2	14.8	5	33.5	3	29.1	4

Source: AOK data, own calculations

DZNE
German Center for Neurodegenerative Diseases
within the Helmholtz Association

Morbidity in the Quarter of Death by Age WHO Definition

WHO Definition

WHO Definition	IHD %	IHD rank	Stroke %	Stroke rank	Dementia %	Dementia rank	COPD %	COPD rank	Cancer %	Cancer rank
Age					Men					
70-74	49.5	1	36.2	4	21.2	5	45.6	3	47.9	2
75-79	55.6	1	40.8	4	31.1	5	47.0	2	46.7	3
80-84	60.2	1	46.3	2	41.9	5	45.9	3	43.8	4
85-89	61.6	1	47.7	3	51.2	2	43.2	4	40.3	5
90+	56.9	2	45.1	3	60.6	1	40.8	4	33.8	5
Men Total	56.6	1	42.9	4	38.3	5	45.1	2	43.8	3
Age					Women					
70-74	40.3	2	32.7	4	22.6	5	35.0	3	44.5	1
75-79	47.4	1	40.5	2	34.3	4	34.3	4	38.5	3
80-84	51.5	1	46.2	3	48.7	2	32.0	5	32.4	4
85-89	52.4	2	46.4	3	59.9	1	31.5	4	26.0	5
90+	50.9	2	44.8	3	68.2	1	29.9	4	20.4	5
Women Total	50.0	2	43.9	3	53.1	1	31.8	4	29.1	5

Source: AOK data, own calculations

DZNE
German Center for Neurodegenerative Diseases
within the Helmholtz Association

Population Projections 2 Variants

Starting population: population counts by sex and five-year age-groups for the year 2015 (31.12.2015) from the 13. coordinated population forecast Statistik Wiesbaden

Assumptions mortality by 2060 Statistik Wiesbaden:
variant G1-L2-W2 HIGH: 86.7 years for men and 90.4 years for women SCENARIO 1
variant G1-L1-W2 LOW: 84,8 years for men and 88,8 years for women SCENARIO 2

Sex specific death-rates for 2015 by five-year age groups and five-year period came from the Human Mortality Database (humanmortality.org): LE 78.13 men
LE 82.98 women

No migration and no fertility, because we were only interested at ages 70 and above.

population projection tool “pde”:

Probabilistic Projections of Decedents by Morbidity

Projection of deaths up to 2060;
transformed the interpolated death rates m_x from 2015 to 2060 into death probabilities $q_x = \frac{m_x}{1+0.5m_x}$ and applied them to the projected population counts.

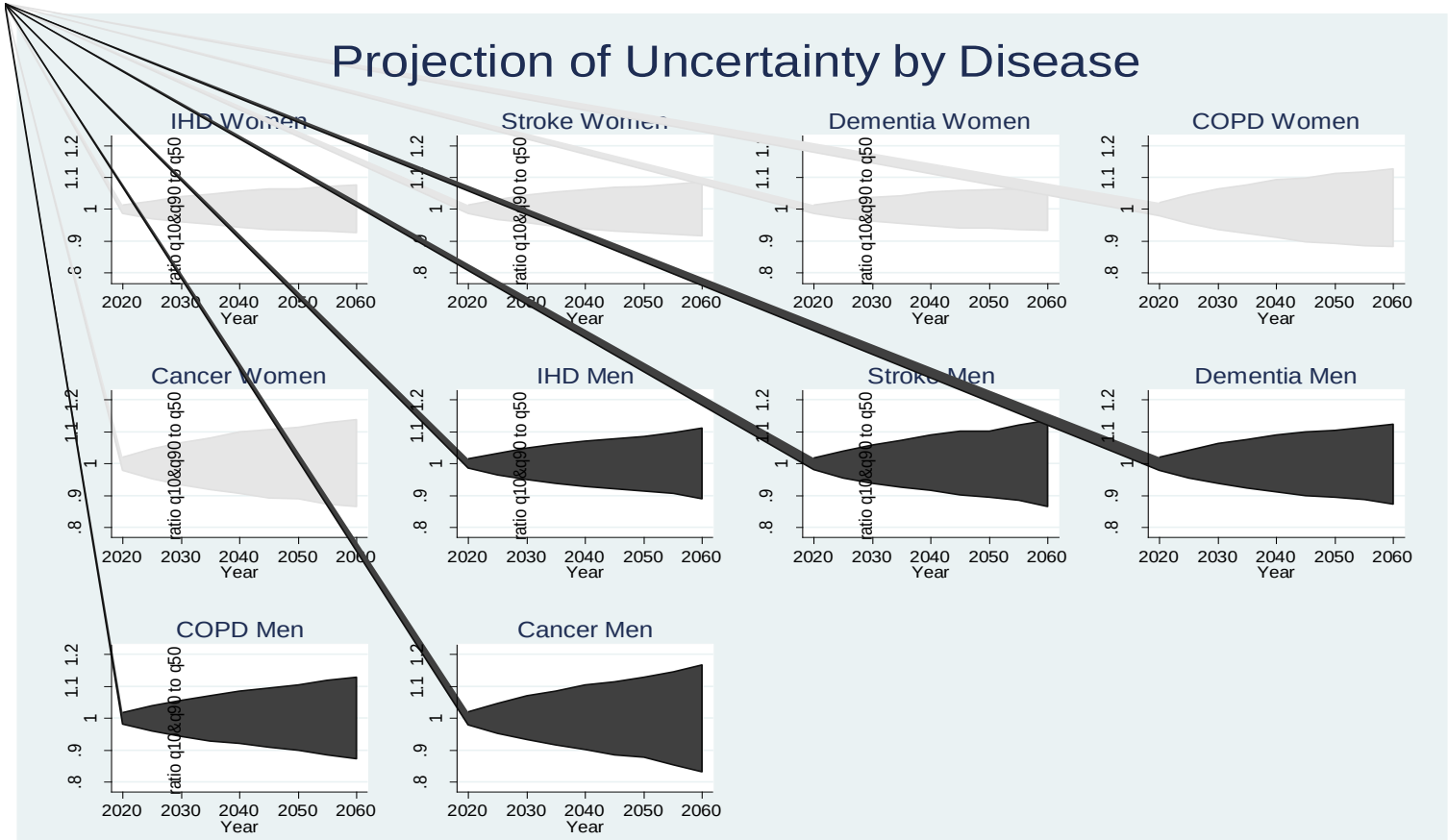
Applied age-specific disease prevalence F^0_{xij} (WHO definition) to death counts**

We assumed that the future prevalence of disease follows a random walk with variance increasing by the square root of the projection step.

**For each projection step t and disease group i we drew five multivariate normal distributed random variables with means F^0_{xij}, variances $t^2\sigma^2_{xij}$ which were correlated for each age x by correlation matrix C.
C was observed by calculating the yearly age-specific correlations between the five disease groups over the period 2004 to 2015.

We ran 2000 replications for each disease x age group and combined the resulting proportions with the death forecasts.
We used median and the 10% and 90% quantiles

Random Walk Projections of Disease Ages 70+



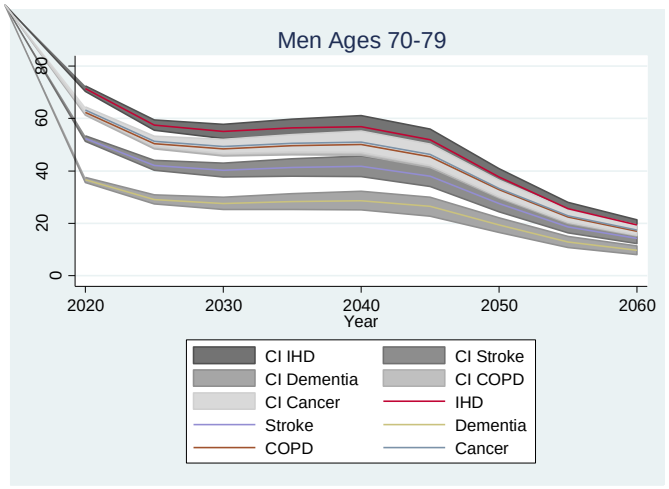
q10=10% quantile, q90=90% quantile, q50=median
Source data: AOK 2004-2015, own calculations

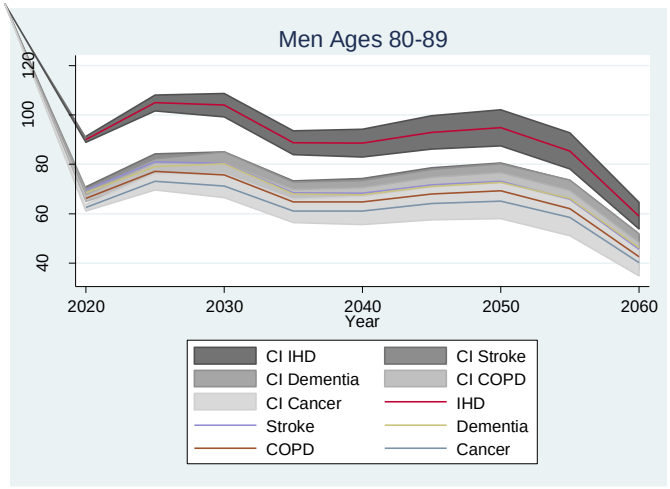
DZNE
German Center for Neurodegenerative Diseases
within the Helmholtz Association

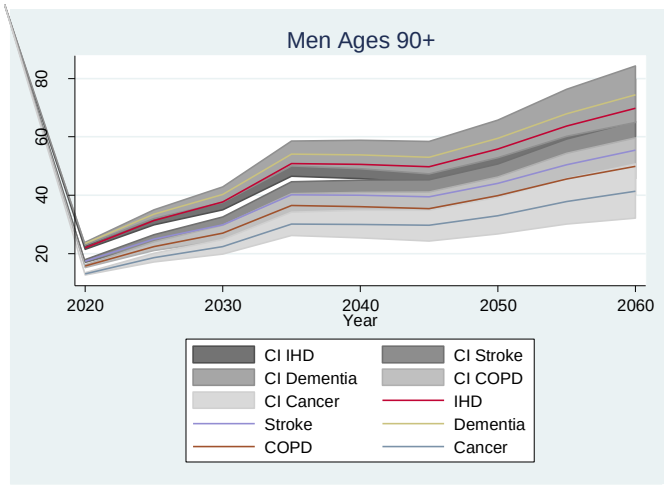
Projections: Ranking of Disease at the Time of Death

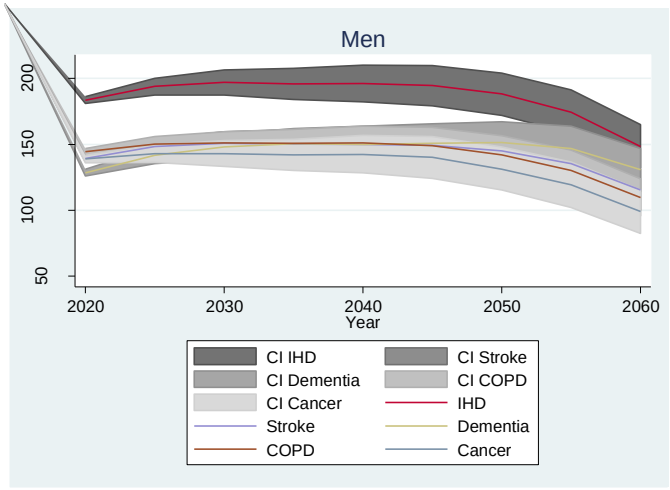
Szenarios 1&2	IHD	Stroke	Dementia	COPD	Cancer
Men					
AOK 2004-2015	1	4	5	2	3
2030	1	3	4	2	5
2060	1	3	2	4	5
Women					
AOK 2004-2015	2	3	1	4	5
2030	2	3	1	4	5
2060	2	3	1	4	5
Total					
AOK 2004-2015	1	3	2	4	5
2030	1	3	2	4	5
2060	2	3	1	4	5

Projections Scenario 1 – Total number of male decedents by disease groups 2020-2060

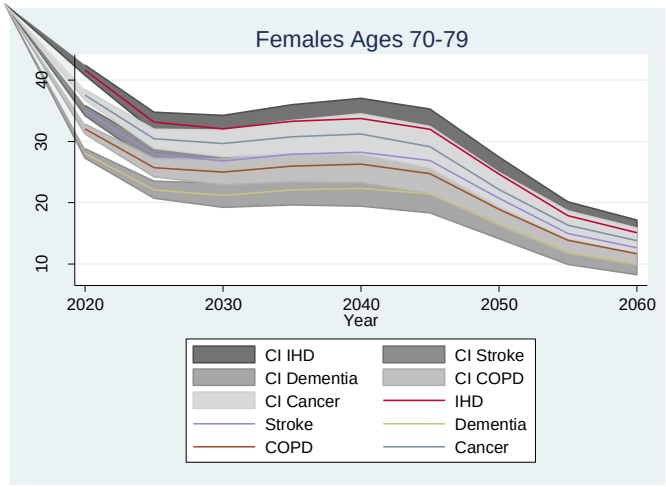


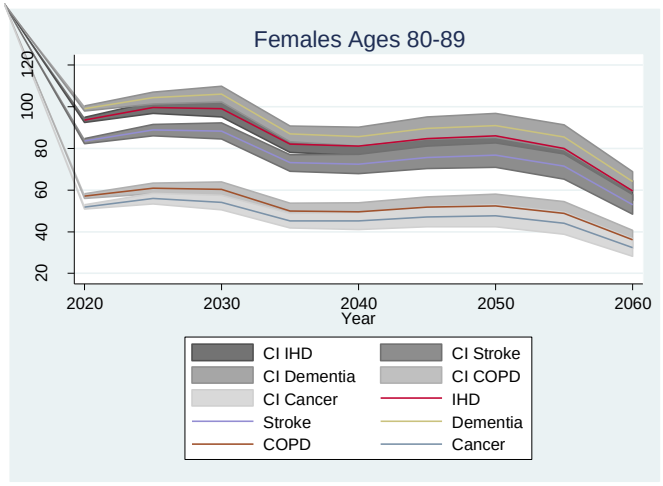


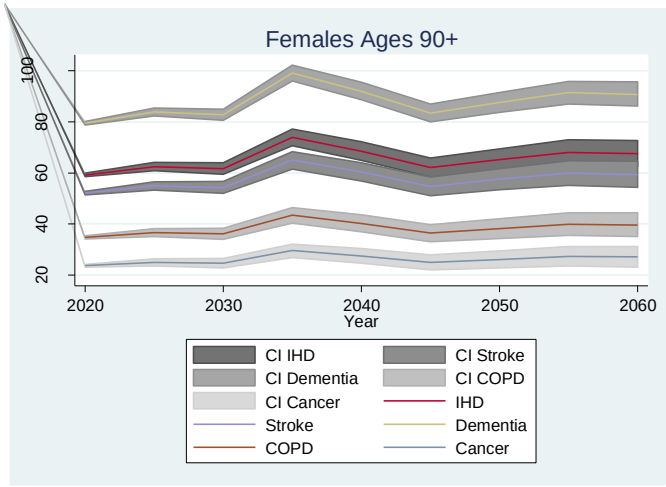


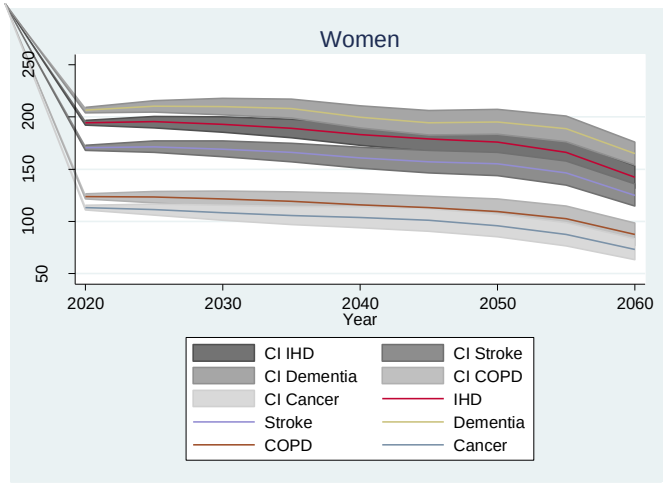


Projections Scenario 1 – Total number of female decedents by disease groups 2020-2060









Conclusions

The ranking of the first five disease groups is similar in the German cause of death statistics and the claims data (exception hypertensive heart disease)

Dementia with 53% among women has, thus, already overtaken total cancer mortality at the beginning of the 21st century. Thus for women aged 70+, the claim of Lilienfeld & Perl (1993) has already become true. Among men (36%) it was still below cancer mortality and COPD.

WHO's own cause of death projections suggest that dementia will rank third in Europe by 2030. Our projections for Germany suggest that dementia will rank second, mainly because of its top position among women and its increase in frequency among men.

The top ranking of dementia by 2060 among both sexes is possible but brings large uncertainties with it.

Under our assumptions the morbidity component introduces a slightly larger uncertainty than the mortality component.

Thank you!