

Cause specific mortality within the first years of follow-up after diagnosis of cancer

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Background

- Cancer accounts for over 20% of all deaths in European countries.
- With improving survival, it is to be expected that other competing causes of death among cancer patients will become more relevant.
 - Shared risk factors
 - Long-term or late effects

Background

- Previous studies
 - on individual causes of death/comorbidities
 - e.g. suicide rates, cardiovascular diseases
 - focussing on specific tumour types
 - e.g. prostate cancer, breast cancer
- Only few cross-entity studies exploring causes of death in cancer patients
- Most studies from USA (based on SEER data)

Objectives

- To characterize the causes of death of cancer patients in Baden-Württemberg, Germany
- To compare the risk of death from non cancer causes with the expected risk in the general population

Material and methods

- **Baden-Württemberg Cancer Registry**
(established 2009, population 11 mio, 60.000 cases/year)
 - Cancer patients diagnosed between 2013 and 2020
 - Age 20+, ICD-10 C00-C97 excl. C44
 - Vital status follow-up (incl CoD) until 31.12.2020
- **Statistical Office Baden-Württemberg**
 - Population and cause specific mortality 2013-2020
- **Standardized mortality ratios (SMRs)**
including 95% confidence intervals (CI)

Definition of Outcome

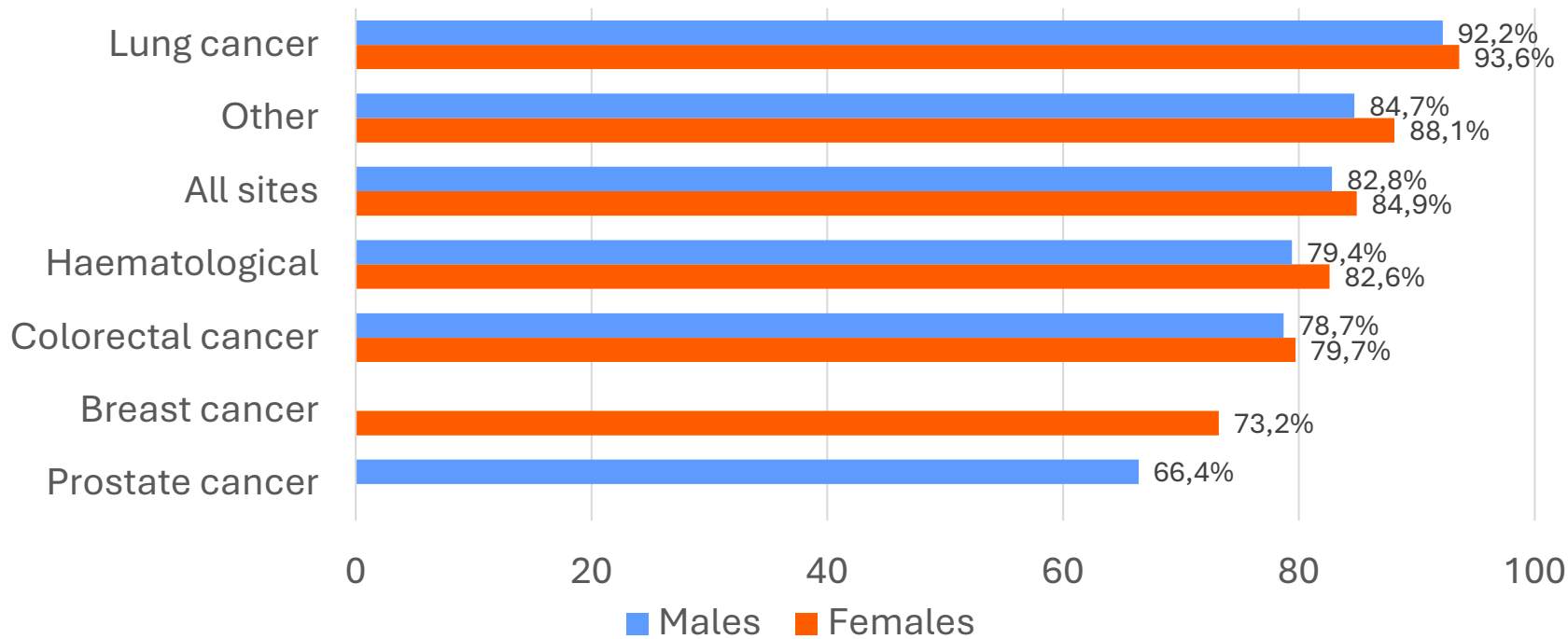
Categorisation of causes of death according to ICD-10 classification and previous studies

ICD-10	Causes of death
A00-B99	Infectious diseases
C00-D48	Neoplasms
E10-E14	Diabetes
F01, F03, G30	Dementia
I10-I15	Hypertension
I20-I25	Ischemic heart disease
I60-I69	Cerebrovascular disease
I01-I09, I16-I19, I26-I59, I70-I99	Other CVD
J09-J18	Influenza and pneumonia
J40-J47	COPD
K70-K77	Liver diseases
N00-N29	Kidney diseases
X60-X84	Suicide
Other	Other

Results

- 491.078 incident cases in 2013-2020
 - 52% females, 48% males
 - mean age 66,8 years
- Mean follow-up 2,8 years (IQR 0,7-4,5 years)
- 144.949 deaths (29,5%)
 - 121.403 cancer deaths (83,8% among all deceased)
 - 23.546 non-cancer deaths (16,2%)

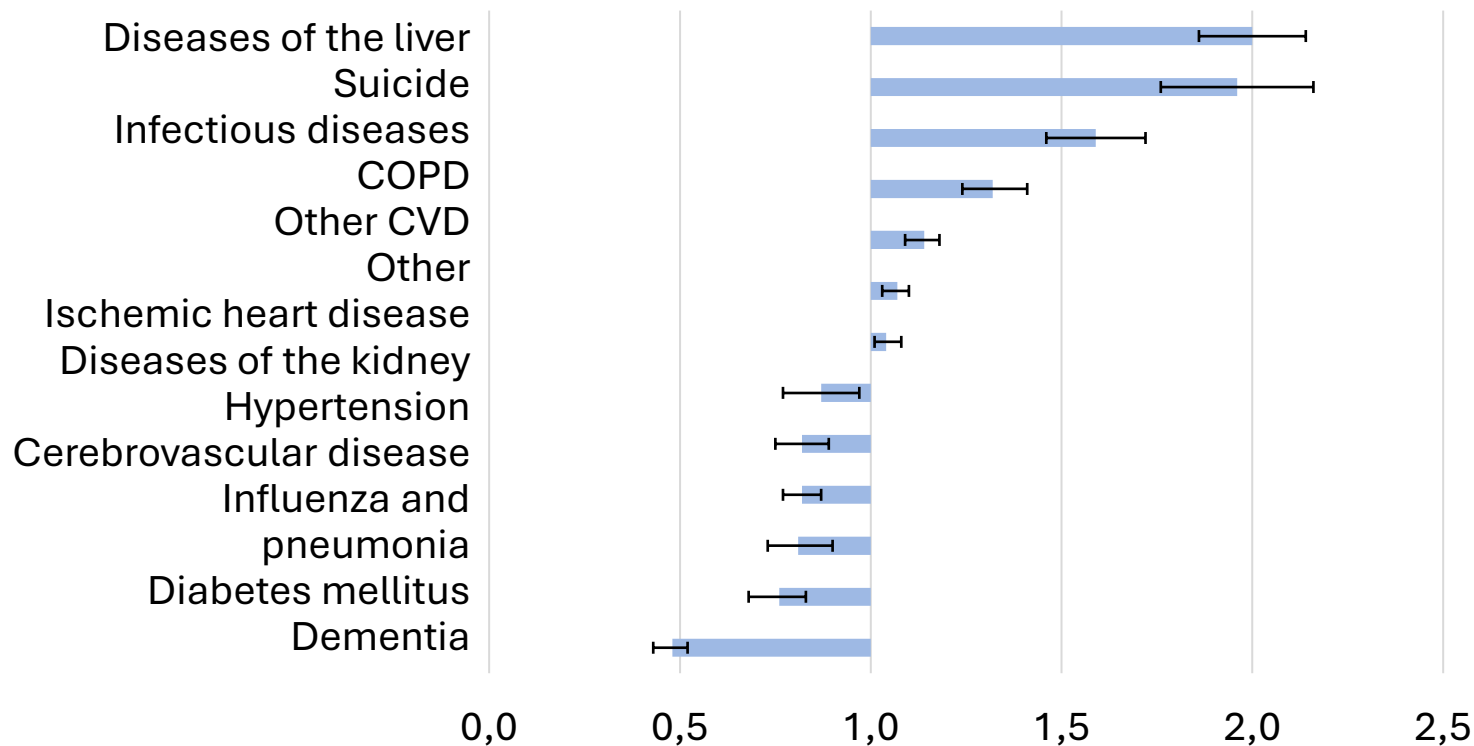
Proportion of cancer as cause of deaths out of all deaths by type of cancer at diagnosis



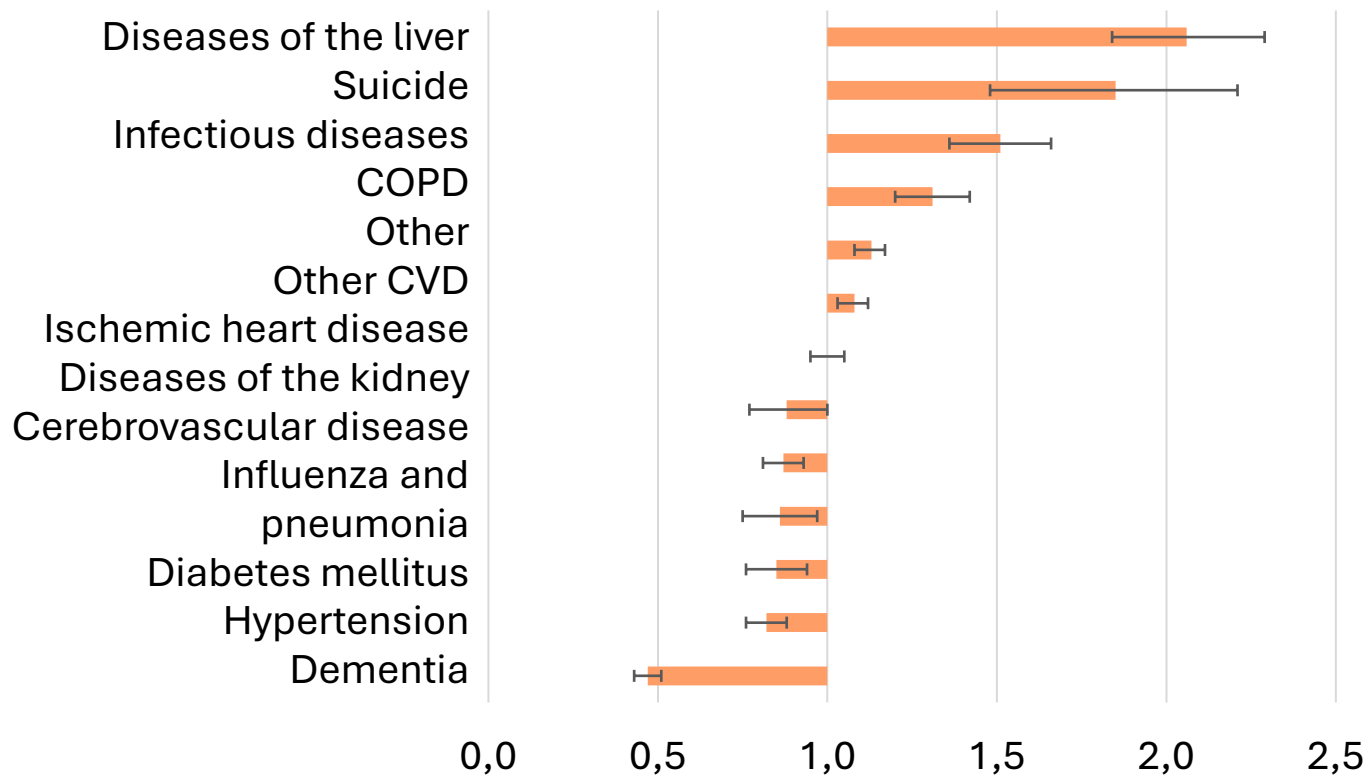
“Non cancer deaths” in cancer patients

Non cancer cause of death	N	% / all deaths	% / non cancer deaths
Infectious diseases	897	0,6%	3,8%
Diabetes	725	0,5%	3,1%
Dementia	914	0,6%	3,9%
Hypertension	1.005	0,7%	4,3%
Ischemic heart disease	4.189	2,9%	17,8%
Cerebrovascular disease	1.688	1,2%	7,2%
Other CVD	4.245	2,9%	18,0%
Influenza and pneumonia	556	0,4%	2,4%
COPD	1.371	0,9%	5,8%
Liver diseases	980	0,7%	4,2%
Kidney diseases	474	0,3%	2,0%
Suicide	420	0,3%	1,8%
Other	6.082	4,2%	25,8%
Total	23.546	16,2%	100,0%

Cause and sex specific SMRs (95% CI): Males

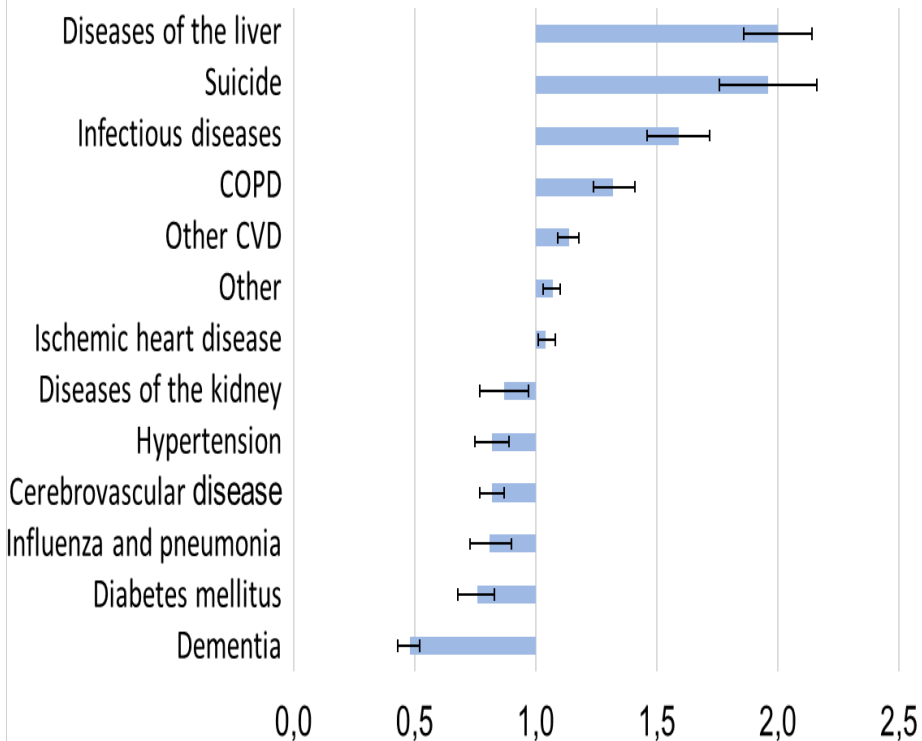


Cause and sex specific SMRs (95% CI): Females

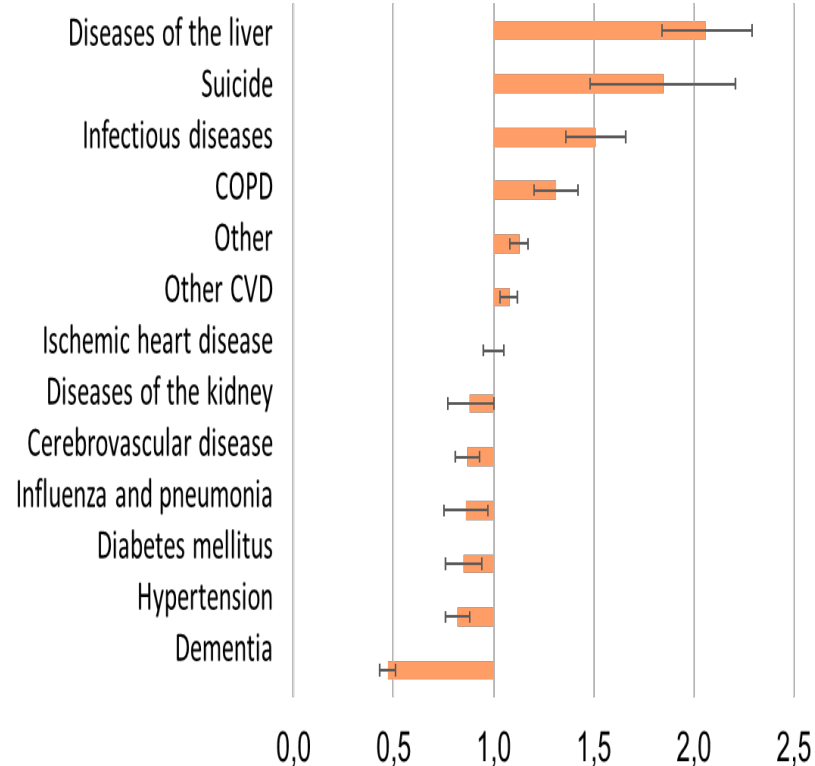


Cause and sex specific SMRs (95% CI) by sex

Males



Females



Results

- Compared with the general population, cancer patients showed increased mortality rates from
 - liver disease (2,02 [CI: 1,90-2,14])
 - suicide (1,94 [CI: 1,76-2,11])
 - infections (SMR: 1,56 [CI: 1,46-1,65])
- Overall, the highest SMRs were found in patients after a lung cancer diagnosis, young patients, and during the first year after diagnosis.

By age at diagnosis	All cancers		Breast Ca		Prostate Ca		CRC		Lung Ca		Hematological	
	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)
Infectious diseases (ICD-10 A00-B99)												
20-64 years	192	4,40 (3,81-4,99)	10	1,34 (0,70-1,99)	6	0,71 (0,29-1,13)	12	2,55 (1,41-3,70)	15	6,46 (3,69-9,22)	43	11,4 (8,4-14,4)
65-74 years	211	1,80 (1,57-2,03)	14	0,95 (0,55-1,36)	21	0,61 (0,39-0,83)	24	1,78 (1,18-2,39)	28	4,54 (3,10-5,97)	38	4,02 (2,89-5,15)
75-84 years	351	1,30 (1,17-1,43)	37	0,95 (0,68-1,22)	45	0,73 (0,54-0,92)	54	1,26 (0,95-1,56)	21	1,99 (1,28-2,69)	55	2,29 (1,76-2,83)
≥85 years	143	0,98 (0,83-1,14)	26	0,90 (0,60-1,20)	14	0,77 (0,44-1,10)	27	0,89 (0,61-1,17)	7	2,06 (0,95-3,18)	17	1,51 (0,92-2,09)
Ischemic heart disease (ICD-10 I20-I25)												
20-64 years	345	1,25 (1,13-1,38)	15	0,57 (0,34-0,80)	45	0,63 (0,47-0,79)	35	1,07 (0,77-1,38)	51	3,20 (2,42-3,97)	39	1,58 (1,14-2,02)
65-74 years	905	1,14 (1,07-1,21)	40	0,60 (0,44-0,77)	186	0,67 (0,58-0,77)	121	1,29 (1,08-1,50)	124	2,93 (2,46-3,41)	84	1,33 (1,07-1,60)
75-84 years	1.909	1,02 (0,98-1,07)	168	0,79 (0,68-0,91)	389	0,80 (0,72-0,87)	328	1,11 (0,99-1,22)	148	1,97 (1,67-2,26)	199	1,22 (1,06-1,37)
≥85 years	1.030	0,91 (0,85-0,96)	186	0,96 (0,83-1,09)	136	0,84 (0,71-0,97)	190	0,82 (0,71-0,93)	28	1,08 (0,74-1,43)	88	0,99 (0,80-1,18)
Chronic lower respiratory disease (ICD-10 J40-J47)												
20-64 years	189	2,00 (1,73-2,27)	17	0,98 (0,60-1,36)	10	0,53 (0,27-0,78)	18	1,77 (1,08-2,46)	74	14,4 (11,5-17,4)	8	1,01 (0,49-1,53)
65-74 years	487	1,63 (1,49-1,77)	39	1,03 (0,75-1,31)	61	0,68 (0,53-0,84)	52	1,49 (1,12-1,85)	178	11,2 (9,7-12,7)	23	0,96 (0,63-1,28)
75-84 years	525	1,15 (1,06-1,25)	48	0,89 (0,67-1,12)	85	0,72 (0,58-0,86)	78	1,12 (0,89-1,34)	103	5,36 (4,42-6,30)	34	0,84 (0,60-1,08)
≥85 years	170	0,89 (0,76-1,01)	23	0,80 (0,53-1,08)	12	0,40 (0,22-0,59)	35	0,89 (0,63-1,15)	16	3,36 (2,02-4,71)	11	0,73 (0,38-1,07)
Diseases of the liver (ICD-10 K70-K77)												
20-64 years	315	2,62 (2,36-2,88)	35	1,71 (1,22-2,20)	16	0,58 (0,35-0,81)	40	2,72 (1,99-3,45)	24	3,26 (2,14-4,37)	25	2,13 (1,40-2,87)
65-74 years	345	2,03 (1,82-2,23)	15	0,91 (0,54-1,27)	32	0,58 (0,41-0,75)	44	2,23 (1,65-2,81)	13	1,39 (0,78-1,99)	16	1,24 (0,74-1,73)
75-84 years	236	1,55 (1,37-1,74)	21	1,25 (0,81-1,70)	24	0,57 (0,38-0,77)	25	1,13 (0,75-1,50)	9	1,32 (0,67-1,98)	24	1,76 (1,17-2,36)
≥85 years	48	1,63 (1,22-2,05)	5	1,23 (0,48-1,98)	2	0,43 (0,07-0,78)	11	1,87 (1,02-2,72)	0	---	5	2,05 (0,78-3,33)
Suicide (ICD-10 X60-X84)												
20-64 years	157	2,25 (1,92-2,57)	20	1,93 (1,21-2,64)	17	1,42 (0,88-1,97)	16	2,17 (1,30-3,04)	14	3,88 (2,23-5,53)	18	2,67 (1,66-3,68)
65-74 years	118	1,99 (1,66-2,32)	3	0,72 (0,14-1,30)	29	1,41 (0,96-1,85)	15	2,15 (1,27-3,02)	11	3,31 (1,77-4,85)	13	2,82 (1,59-4,05)
75-84 years	109	1,56 (1,29-1,83)	3	0,74 (0,18-1,30)	17	0,75 (0,46-1,04)	16	1,54 (0,93-2,14)	13	4,22 (2,42-6,01)	15	2,45 (1,47-3,44)
≥85 years	36	2,01 (1,44-2,57)	2	1,91 (0,28-3,54)	5	1,13 (0,46-1,80)	5	1,47 (0,55-2,39)	2	3,57 (0,77-6,38)	3	1,97 (0,52-3,42)

SMRs by primary cancer, age, and years since dx

Highest SMRs...

By age at diagnosis	All cancers		Breast Ca		Prostate Ca		CRC		Lung Ca		Hematological	
	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)
Infectious diseases (ICD-10 A00-B99)												
20-64 years	192	4,40 (3,81-4,99)	10	1,34 (0,70-1,99)	6	0,71 (0,29-1,13)	12	2,55 (1,41-3,70)	15	6,46 (3,69-9,22)	43	11,4 (8,4-14,4)
65-74 years	211	1,80 (1,57-2,03)	14	0,95 (0,55-1,36)	21	0,61 (0,39-0,83)	24	1,78 (1,18-2,39)	28	4,54 (3,10-5,97)	38	4,02 (2,89-5,15)
75-84 years	351	1,30 (1,17-1,43)	37	0,95 (0,68-1,22)	45	0,73 (0,54-0,92)	54	1,26 (0,95-1,56)	21	1,99 (1,28-2,69)	55	2,29 (1,76-2,83)
≥85 years	143	0,98 (0,83-1,14)	26	0,90 (0,60-1,20)	14	0,77 (0,44-1,10)	27	0,89 (0,61-1,17)	7	2,06 (0,95-3,18)	17	1,51 (0,92-2,09)
Ischemic heart disease (ICD-10 I20-I25)												
20-64 years	345	1,25 (1,13-1,38)	15	0,57 (0,34-0,80)	45	0,63 (0,47-0,79)	35	1,07 (0,77-1,38)	51	3,20 (2,42-3,97)	39	1,58 (1,14-2,02)
65-74 years	905	1,14 (1,07-1,21)	40	0,60 (0,44-0,77)	186	0,67 (0,58-0,77)	121	1,29 (1,08-1,50)	124	2,93 (2,46-3,41)	84	1,33 (1,07-1,60)
75-84 years	1.909	1,02 (0,98-1,07)	168	0,79 (0,68-0,91)	389	0,80 (0,72-0,87)	328	1,11 (0,99-1,22)	148	1,97 (1,67-2,26)	199	1,22 (1,06-1,37)
≥85 years	1.030	0,91 (0,85-0,96)	186	0,96 (0,83-1,09)	136	0,84 (0,71-0,97)	190	0,82 (0,71-0,93)	28	1,08 (0,74-1,43)	88	0,99 (0,80-1,18)
Chronic lower respiratory disease (ICD-10 J40-J47)												
20-64 years	189	2,00 (1,73-2,27)	17	0,98 (0,60-1,36)	10	0,53 (0,27-0,78)	18	1,77 (1,08-2,46)	74	14,4 (11,5-17,4)	8	1,01 (0,49-1,53)
65-74 years	487	1,63 (1,49-1,77)	39	1,03 (0,75-1,31)	61	0,68 (0,53-0,84)	52	1,49 (1,12-1,85)	178	11,2 (9,7-12,7)	23	0,96 (0,63-1,28)
75-84 years	525	1,15 (1,06-1,25)	48	0,89 (0,67-1,12)	85	0,72 (0,58-0,86)	78	1,12 (0,89-1,34)	103	5,36 (4,42-6,30)	34	0,84 (0,60-1,08)
≥85 years	170	0,89 (0,76-1,01)	23	0,80 (0,53-1,08)	12	0,40 (0,22-0,59)	35	0,89 (0,63-1,15)	16	3,36 (2,02-4,71)	11	0,73 (0,38-1,07)
Diseases of the liver (ICD-10 K70-K77)												
20-64 years	315	2,62 (2,36-2,88)	35	1,71 (1,22-2,20)	16	0,58 (0,35-0,81)	40	2,72 (1,99-3,45)	24	3,26 (2,14-4,37)	25	2,13 (1,40-2,87)
65-74 years	345	2,03 (1,82-2,23)	15	0,91 (0,54-1,27)	32	0,58 (0,41-0,75)	44	2,23 (1,65-2,81)	13	1,39 (0,78-1,99)	16	1,24 (0,74-1,73)
75-84 years	236	1,55 (1,37-1,74)	21	1,25 (0,81-1,70)	24	0,57 (0,38-0,77)	25	1,13 (0,75-1,50)	9	1,32 (0,67-1,98)	24	1,76 (1,17-2,36)
≥85 years	48	1,63 (1,22-2,05)	5	1,23 (0,48-1,98)	2	0,43 (0,07-0,78)	11	1,87 (1,02-2,72)	0	---	5	2,05 (0,78-3,33)
Suicide (ICD-10 X60-X84)												
20-64 years	157	2,25 (1,92-2,57)	20	1,93 (1,21-2,64)	17	1,42 (0,88-1,97)	16	2,17 (1,30-3,04)	14	3,88 (2,23-5,53)	18	2,67 (1,66-3,68)
65-74 years	118	1,99 (1,66-2,32)	3	0,72 (0,14-1,30)	29	1,41 (0,96-1,85)	15	2,15 (1,27-3,02)	11	3,31 (1,77-4,85)	13	2,82 (1,59-4,05)
75-84 years	109	1,56 (1,29-1,83)	3	0,74 (0,18-1,30)	17	0,75 (0,46-1,04)	16	1,54 (0,93-2,14)	13	4,22 (2,42-6,01)	15	2,45 (1,47-3,44)
≥85 years	36	2,01 (1,44-2,57)	2	1,91 (0,28-3,54)	5	1,13 (0,46-1,80)	5	1,47 (0,55-2,39)	2	3,57 (0,77-6,38)	3	1,97 (0,52-3,42)

SMRs by primary cancer, age, and years since dx

Highest SMRs

- lung cancer
- hematological diseases

By age at diagnosis	All cancers		Breast Ca		Prostate Ca		CRC		Lung Ca		Hematological	
	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)
Infectious diseases (ICD-10 A00-B99)												
20-64 years	192	4,40 (3,81-4,99)	10	1,34 (0,70-1,99)	6	0,71 (0,29-1,13)	12	2,55 (1,41-3,70)	15	6,46 (3,69-9,22)	43	11,4 (8,4-14,4)
65-74 years	211	1,80 (1,57-2,03)	14	0,95 (0,55-1,36)	21	0,61 (0,39-0,83)	24	1,78 (1,18-2,39)	28	4,54 (3,10-5,97)	38	4,02 (2,89-5,15)
75-84 years	351	1,30 (1,17-1,43)	37	0,95 (0,68-1,22)	45	0,73 (0,54-0,92)	54	1,26 (0,95-1,56)	21	1,99 (1,28-2,69)	55	2,29 (1,76-2,83)
≥85 years	143	0,98 (0,83-1,14)	26	0,90 (0,60-1,20)	14	0,77 (0,44-1,10)	27	0,89 (0,61-1,17)	7	2,06 (0,95-3,18)	17	1,51 (0,92-2,09)
Ischemic heart disease (ICD-10 I20-I25)												
20-64 years	345	1,25 (1,13-1,38)	15	0,57 (0,34-0,80)	45	0,63 (0,47-0,79)	35	1,07 (0,77-1,38)	51	3,20 (2,42-3,97)	39	1,58 (1,14-2,02)
65-74 years	905	1,14 (1,07-1,21)	40	0,60 (0,44-0,77)	186	0,67 (0,58-0,77)	121	1,29 (1,08-1,50)	124	2,93 (2,46-3,41)	84	1,33 (1,07-1,60)
75-84 years	1.909	1,02 (0,98-1,07)	168	0,79 (0,68-0,91)	389	0,80 (0,72-0,87)	328	1,11 (0,99-1,22)	148	1,97 (1,67-2,26)	199	1,22 (1,06-1,37)
≥85 years	1.030	0,91 (0,85-0,96)	186	0,96 (0,83-1,09)	136	0,84 (0,71-0,97)	190	0,82 (0,71-0,93)	28	1,08 (0,74-1,43)	88	0,99 (0,80-1,18)
Chronic lower respiratory disease (ICD-10 J40-J47)												
20-64 years	189	2,00 (1,73-2,27)	17	0,98 (0,60-1,36)	10	0,53 (0,27-0,78)	18	1,77 (1,08-2,46)	74	14,4 (11,5-17,4)	8	1,01 (0,49-1,53)
65-74 years	487	1,63 (1,49-1,77)	39	1,03 (0,75-1,31)	61	0,68 (0,53-0,84)	52	1,49 (1,12-1,85)	178	11,2 (9,7-12,7)	23	0,96 (0,63-1,28)
75-84 years	525	1,15 (1,06-1,25)	48	0,89 (0,67-1,12)	85	0,72 (0,58-0,86)	78	1,12 (0,89-1,34)	103	5,36 (4,42-6,30)	34	0,84 (0,60-1,08)
≥85 years	170	0,89 (0,76-1,01)	23	0,80 (0,53-1,08)	12	0,40 (0,22-0,59)	35	0,89 (0,63-1,15)	16	3,36 (2,02-4,71)	11	0,73 (0,38-1,07)
Diseases of the liver (ICD-10 K70-K77)												
20-64 years	315	2,62 (2,36-2,88)	35	1,71 (1,22-2,20)	16	0,58 (0,35-0,81)	40	2,72 (1,99-3,45)	24	3,26 (2,14-4,37)	25	2,13 (1,40-2,87)
65-74 years	345	2,03 (1,82-2,23)	15	0,91 (0,54-1,27)	32	0,58 (0,41-0,75)	44	2,23 (1,65-2,81)	13	1,39 (0,78-1,99)	16	1,24 (0,74-1,73)
75-84 years	236	1,55 (1,37-1,74)	21	1,25 (0,81-1,70)	24	0,57 (0,38-0,77)	25	1,13 (0,75-1,50)	9	1,32 (0,67-1,98)	24	1,76 (1,17-2,36)
≥85 years	48	1,63 (1,22-2,05)	5	1,23 (0,48-1,98)	2	0,43 (0,07-0,78)	11	1,87 (1,02-2,72)	0	---	5	2,05 (0,78-3,33)
Suicide (ICD-10 X60-X84)												
20-64 years	157	2,25 (1,92-2,57)	20	1,93 (1,21-2,64)	17	1,42 (0,88-1,97)	16	2,17 (1,30-3,04)	14	3,88 (2,23-5,53)	18	2,67 (1,66-3,68)
65-74 years	118	1,99 (1,66-2,32)	3	0,72 (0,14-1,30)	29	1,41 (0,96-1,85)	15	2,15 (1,27-3,02)	11	3,31 (1,77-4,85)	13	2,82 (1,59-4,05)
75-84 years	109	1,56 (1,29-1,83)	3	0,74 (0,18-1,30)	17	0,75 (0,46-1,04)	16	1,54 (0,93-2,14)	13	4,22 (2,42-6,01)	15	2,45 (1,47-3,44)
≥85 years	36	2,01 (1,44-2,57)	2	1,91 (0,28-3,54)	5	1,13 (0,46-1,80)	5	1,47 (0,55-2,39)	2	3,57 (0,77-6,38)	3	1,97 (0,52-3,42)

SMRs by primary cancer, age, and years since dx

Highest SMRs

- lung cancer
- hematological diseases
- younger patients

By time since diagnosis	All cancers		Breast Ca		Prostate Ca		CRC		Lung Ca		Hematological	
	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)	N	SMR (KI)
Infectious diseases (ICD-10 A00-B99)												
<1 year	411	2,53 (2,29-2,76)	19	0,85 (0,54-1,16)	21	0,69 (0,44-0,94)	56	2,23 (1,71-2,75)	44	4,66 (3,46-5,86)	67	4,86 (3,81-5,92)
≥1 year	486	1,18 (1,07-1,29)	68	1,03 (0,79-1,27)	65	0,67 (0,50-0,84)	61	0,89 (0,67-1,11)	27	2,28 (1,53-3,03)	86	2,47 (1,96-2,99)
Ischemic heart disease (ICD-10 I20-I25)												
<1 year	1.553	1,37 (1,31-1,44)	103	0,84 (0,70-0,99)	150	0,63 (0,53-0,72)	270	1,53 (1,35-1,70)	211	3,12 (2,73-3,52)	155	1,63 (1,39-1,87)
≥1 year	2.636	0,89 (0,85-0,92)	306	0,81 (0,72-0,90)	606	0,78 (0,71-0,84)	404	0,82 (0,74-0,91)	140	1,51 (1,26-1,75)	255	1,05 (0,92-1,18)
Chronic lower respiratory disease (ICD-10 J40-J47)												
<1 year	569	1,94 (1,79-2,10)	36	1,07 (0,76-1,38)	35	0,56 (0,39-0,72)	65	1,55 (1,21-1,88)	195	10,2 (8,91-11,6)	32	1,30 (0,90-1,69)
≥1 year	802	1,05 (0,97-1,12)	91	0,82 (0,65-0,99)	133	0,69 (0,57-0,81)	118	1,01 (0,82-1,19)	176	6,66 (5,68-7,65)	44	0,69 (0,49-0,88)
Diseases of the liver (ICD-10 K70-K77)												
<1 year	517	3,64 (3,34-3,93)	22	1,54 (0,99-2,08)	18	0,53 (0,33-0,72)	61	3,32 (2,57-4,07)	28	2,65 (1,83-3,47)	29	2,47 (1,69-3,25)
≥1 year	463	1,39 (1,26-1,52)	54	1,30 (0,97-1,62)	56	0,59 (0,44-0,73)	59	1,36 (1,02-1,70)	18	1,47 (0,89-2,06)	41	1,41 (1,00-1,82)
Suicide (ICD-10 X60-X84)												
<1 year	184	2,91 (2,52-3,31)	7	1,32 (0,61-2,03)	24	1,47 (0,98-1,96)	20	2,45 (1,57-3,34)	28	6,14 (4,20-8,09)	22	4,07 (2,66-5,49)
≥1 year	236	1,55 (1,35-1,75)	21	1,46 (0,89-2,04)	44	1,00 (0,71-1,29)	32	1,52 (1,02-2,02)	12	2,12 (1,16-3,07)	27	1,94 (1,28-2,61)

SMRs by primary cancer, age, and years since dx

Highest SMRs

- lung cancer
- hematological diseases
- younger patients
- during the 1st year

Discussion

- Validity of cause of death?
- Short follow-up period
- Limited sample size
which restricted stratification by tumor stage and treatment

Outlook: Nationwide study including “older” cancer registries

- larger sample
- longer follow-up