

**Regional Disparities in Avoidable Cancer Mortality in Germany:
Does the North-South Gradient Supersede the ‘Traditional’ East-West
Divide?**

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Abstract

Regional variations in avoidable cancer mortality (ACM) in Germany have been dominated by the ‘traditional’ East-West divide for many years. However, Eastern Germany has experienced a fundamental political and economic transition with corresponding advancements of the healthcare system, which led to a partial adjustment of ACM to the level of Western Germany. This development raises the question if the East-West divide in ACM will be replaced by other regional disparities. We provide long-term trend analyses with estimates of standardized death rates of preventable and amenable cancer mortality for three geographic super-regions – Northwestern, Southwestern and Eastern Germany – for the period of 1990–2014, using rate ratios for relative comparisons. As a result, the ‘traditional’ East-West divide is still evident in men but our analyses provide strong evidence for an establishing north-south divide in ACM, particularly among women. This north-south gradient will potentially drive the future trends of cancer-related mortality in Germany.

Keywords

Amenable cancer mortality, preventable cancer mortality, regional disparities, Germany

Background

There are regional disparities in avoidable cancer mortality in Europe, known as a northwest-southeast divide (Znaor et al. 2013). This geographic gradient was accounted by increasing smoking-related cancer incidence affecting men in Southeastern Europe. In contrast, cancer incidences in Northern and Western Europe were declining or stable because of lower smoking prevalence in men and improved breast cancer screening technology for women (Jansen et al. 2012).

Germany has experienced such geographic variations as well, especially to the disadvantage of the East. But after the German Reunification, Eastern Germany started to gain an intensive economic and political transition with fundamental improvements of its health care system according to the standards of Western Germany. This led to a process of adjustment for cancer-related mortality in Eastern and Western Germany (Mons 2011, Sundmacher et al. 2012, Medewald et al. 2017, Vogt et al. 2017).

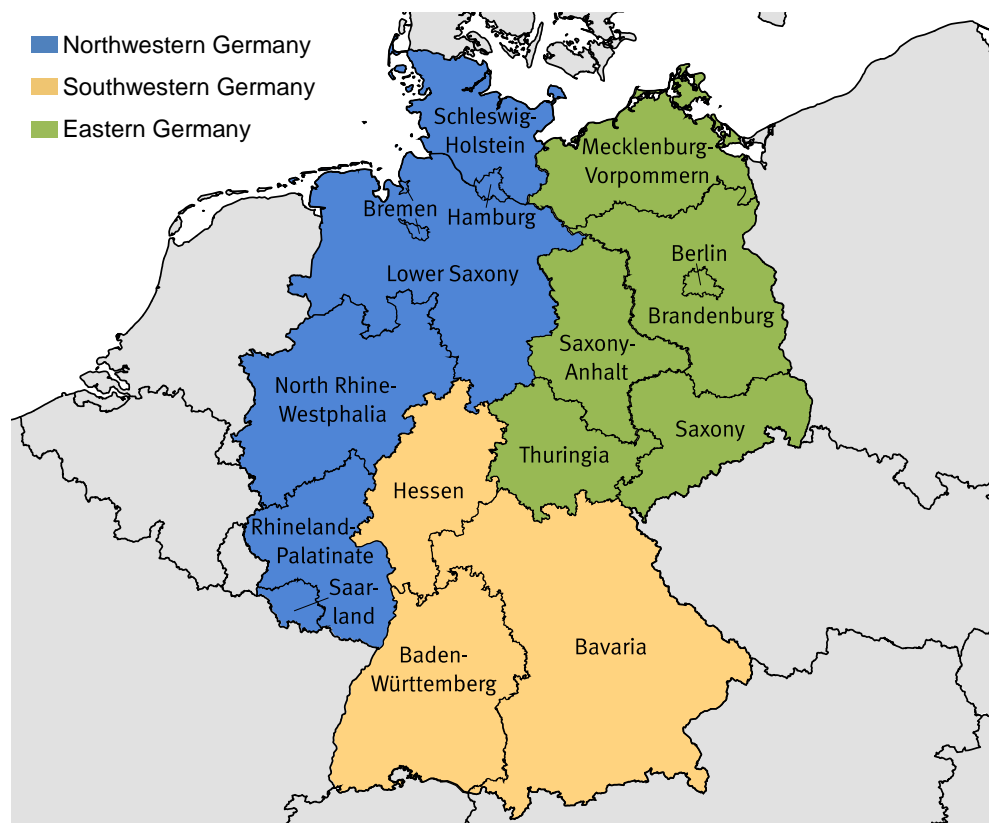
Nevertheless, the regional variations in avoidable cancer mortality quantified as a northeast-south gradient remained. Plausible explanations for this gradient are related to unfavorable life time risks, particularly among men in northeastern Germany. In this region, men were more likely affected by a higher risk of premature death because of less compliance of healthcare screening, higher smoking and alcohol consumption, overweight and lower physical activity (Stöckl et al. 2016). These harmful health behaviors correspond with social factors and individual lifestyle choices in males. Men in the northeast were also more likely to be affected from poorer socioeconomic conditions, including redundancy, unemployment, low income and lower educational attainment that is also associated with unhealthy behavior.

The major scope of the study is to analyze the regional long-term trends in avoidable cancer mortality since the German reunification under consideration of a generalized approach for the avoidable cancer mortality definition that is suitable for the German regional perspective and considers both amenable and preventable cancer deaths. Moreover, sex-specific disparities in avoidable cancer mortality were used to explain the recent trends for three German super-regions: Eastern, Northwestern and Southwestern Germany.

Data and Methods

Our analyses are based on official German cause-of-death data, provided by the Federal Statistical Office, aggregated for Germany's 16 federal states by age and sex for the period of 1990–2014. In order to address the north-south gradient as well as the east-west gradient, we defined three geographic regions: Eastern, Northwestern and Southwestern Germany (see Figure 1). This regional distinction is based on minimal internal group variation in the level of cancer mortality and its change over time and similarities in socioeconomic characteristics and age structure.

Figure 1 Composition of the study regions



Base map: © GeoBasis-DE / Bundesamt für Kartographie und Geodäsie

Causes of death were classified according to the concept of avoidable mortality which can be referred to as a selection of causes of death that should be either amenable to health care (amenable mortality) or avoidable through primary prevention (preventable mortality). Currently, there are different approaches for avoidable mortality that include different typologies of premature death but there is no common concept of avoidable cancer mortality. Our classification of avoidable cancer mortality and its division into preventable and amenable cancers basically follows the concepts of Page et al. (2006), Nolte and McKee (2003), Tobias et al. (2010) and Mackenbach et al. (2015).

The first group of preventable cancer mortality considers all cancer-related deaths that could be avoided or reduced through effective inter-sectoral health policies by means of primary prevention, especially with regard to smoking, unhealthy diet and alcohol consumption. This involves cancers of lip, oral cavity, pharynx, esophagus, stomach, liver, larynx, lung, bronchus, trachea and bladder. The second group of amenable cancer mortality includes all cancer-related deaths that should be avoided or reduced through timely and effective health care regarding both, diagnosis and treatment. This involves cancers of colon and rectum, bone, skin, eye and thyroid as well as Hodgkin's disease and leukemia and the sex-specific cancers of female breast, cervix, uterus, prostate and testis (see Table 3 in the appendix).

Standardized death rates were used to show differences in preventable and amenable cancer mortality over time and between regions and sex, based on textbooks like Preston et al. (2000) but adjusted for the use of 3-year intervals and year-end population figures:

$$SDR_t = \sum_x \left(\frac{D_{x;t-1} + D_{x;t} + D_{x;t+1}}{0.5 \cdot N_{x;t-2} + N_{x;t-1} + N_{x;t} + 0.5 \cdot N_{x;t+1}} \cdot C_x \right)$$

with SDR_t being the standardized death rate at time t (in years); D_x being the number of deaths at age x , N_x being the age-specific year-end population size and C_x being the age-specific standard population. The major benefit of standardization is that death rates are not affected by differences or changes in the age structure. Moreover, standardized death rates are additive: “the sum of death rates by cause equals the death rate from all causes” (Meslé 2006: 36).

We chose the German 2011 Census as standard population without disaggregation by sex. As a statistical test for the standardized death rates, we estimated 95% confidence intervals according to Chiang (1984) with the age-specific probability of death computed according to Farr (1859). For relative comparison between the three regions, we computed rate ratios from the standardized death rates, with Southwestern Germany as the reference population.

Because of limited numbers of deaths, especially in the younger age groups, we divided age into the following groups: 0–29, 30–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69 and 70–74. The 75+ age group was not included because the concept of avoidable mortality involves premature mortality only “as ‘avoidability’ of death and reliability of death certification become increasingly questionable at older ages” (Nolte and McKee 2004: 65). Since we use 3-year intervals to avoid random fluctuations, all analyses refer to the period of 1990/92 to 2012/14.

Results

Preliminary results show a remarkable decrease in preventable cancer mortality in males of 29% in Eastern Germany, 34% in Northwestern Germany and 36% in Southwestern Germany between 1990/92 and 2012/14 (see Table 1). There is a similar trend in amenable cancer mortality among men: 28% in Eastern Germany, 32% in Northwestern Germany and 36% in Southwestern Germany. For women, however, the trend in preventable cancer mortality has followed the opposite direction: Amounting to 27%, preventable cancer mortality showed a strong relative growth in Northwestern Germany, followed by Southwestern Germany with 19% and Eastern Germany with 1.4%. In contrast,

the amenable cancer mortality pattern for women is similar in comparison to men, showing a slightly higher relative decline with 40% in Eastern Germany, 35% in Northwestern Germany and 37% in Southwestern Germany.

Table 1 Relative trend in preventable and amenable cancer mortality and all-cause mortality at ages 0-74 between 1990/92 and 2012/14 for men and women in Northwestern, Southwestern, Eastern and total Germany (in %)

	Preventable cancer mortality	Amenable cancer mortality			Premature all-cause mortality
		Total	Sex-specific	Other	
<i>Men</i>					
Southwest	-35,8	-35,7	-36,6	-35,3	-41,2
Northwest	-33,8	-31,9	-28,8	-33,2	-37,6
East	-29,1	-28,2	-21,2	-30,8	-46,0
Total Germany	-33,5	-32,4	-30,2	-33,3	-40,9
<i>Women</i>					
Southwest	+18,5	-36,6	-32,8	-42,5	-35,0
Northwest	+26,9	-34,8	-31,0	-40,7	-29,6
East	+1,4	-40,3	-37,3	-44,6	-49,6
Total Germany	+18,2	-36,7	-33,0	-42,2	-36,8

Table 2 Ratio of the standardized death rates in preventable and amenable cancer mortality and all-cause mortality at ages 0-74 in 1990/92 and 2012/14 for men and women in Northwestern, Southwestern, Eastern and total Germany

	Preventable cancer mortality	Amenable cancer mortality			Premature all-cause mortality
		Total	Sex-specific	Other	
<i>Men 1990/92</i>					
Southwest	1	1	1	1	1
Northwest	1,22*	0,99	1,00	0,98	1,09*
East	1,20*	1,00	0,92	1,04	1,36*
Total Germany	1,14*	1,00	0,99	1,00	1,12*
<i>Men 2012/14</i>					
Southwest	1	1	1	1	1
Northwest	1,25*	1,05*	1,13*	1,01	1,16*
East	1,32*	1,12*	1,15*	1,11*	1,25*
Total Germany	1,18*	1,05*	1,09*	1,03	1,12*
<i>Women 1990/92</i>					
Southwest	1	1	1	1	1
Northwest	1,26*	1,03*	1,02	1,04*	1,09*
East	1,22*	1,03	1,00	1,06*	1,40*
Total Germany	1,16*	1,02	1,01	1,03*	1,13*
<i>Women 2012/14</i>					
Southwest	1	1	1	1	1
Northwest	1,35*	1,06*	1,05*	1,08*	1,18*
East	1,04*	0,97	0,93*	1,03	1,08*
Total Germany	1,16*	1,02	1,01	1,04	1,09*

Note: Significant differences based on 95% confidence intervals are marked with an asterisk (*).

With regard to regional gradients, we find remarkable differences between the two sexes in preventable cancer mortality (see Table 2): Despite a strong decrease in all regions among men, there is still a considerable east-west divide in the northern half of Germany but there is also an even more significant north-south divide in Western Germany. In 2012/14, preventable cancer mortality among men was significantly higher in Eastern (+32%) and Northwestern Germany (+25%) than in Southwestern Germany. Referring to women, however, preventable cancer mortality has increased in

both parts of Western Germany but had decreased in Eastern Germany until the late 2000s. Since then it has almost converged to the pattern of Southwestern Germany. Preventable cancer mortality was significantly higher among women in Northwestern (+34%) and Eastern Germany (+4%) than in the southwest at the end of the observation period.

Regional disparities in amenable cancer mortality are considerably smaller. The east-west divide still dominates among men (+12% in Eastern Germany and +5% in Northwestern Germany compared to the southwest in 2013) but a north-south gradient in Western Germany has developed in recent years as well. Among women, the pattern is even more determined by a north-south gradient in Western Germany: Compared to the southwest, amenable cancer mortality was significantly higher in the northwest (+6%), while Eastern Germany (-3%) showed the lowest level among the three regions in 2012/14.

The level in sex-specific amenable cancer mortality is generally lower in men than in women because men-specific cancers are less frequent and less likely fatal than women-specific cancers. Among men, there is a significant north-south divide to the advantage of the southwest but there are no systematic differences between Northwestern (+13% in 2012/14 in comparison to the southwest) and Eastern Germany (+15%). Among women, however, the pattern is completely different: Northwestern Germany (+5%) showed the highest level, while Eastern Germany (-7%) showed the lowest one.

The regional pattern which favors men and women in Southwestern Germany and disadvantages men in Eastern Germany and females in Northwestern Germany becomes visible in other amenable cancer as well.

Conclusion

All in all, the results reveal that the regional variation in avoidable cancer mortality in Germany is stronger among men, where the ‘traditional’ east-west gap is still evident. However, a north-south divide has evolved in preventable cancer mortality among men as well. Among women, however, the north-south divide in Western Germany meanwhile determines the avoidable cancer mortality pattern, particularly due to a catch-up process of Eastern Germany to the level of Southwestern Germany, while the northwest has increasingly become left behind. Whereas the male pattern can be explained by higher risk-relevant behavior in Eastern Germany, e.g. with regard to smoking and alcohol, the female pattern is largely due to the smoking rates of Northwestern German women who increasingly reach the age that is relevant for cancer mortality. Generally, our study shows that regional disparities in avoidable cancer mortality are more related to differences in risk-relevant behavior than differences in the effectiveness of health care.

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Appendix

Table 3 Selection of causes of death

	Cause of death	Age	ICD-9	ICD-10
<i>Preventable cancer mortality</i>	Cancer of lip, oral cavity, pharynx	0-74	140-149	C00-C14
	Cancer of esophagus	0-74	150	C15
	Cancer of stomach	0-74	151	C16
	Cancer of liver	0-74	155	C22
	Cancer of larynx ^a	0-74	161	C32
	Cancer of lung, bronchus and trachea	0-74	162	C33-C34
	Cancer of bladder ^b	0-74	188	C67
<i>Amenable cancer mortality</i>	Colorectal cancer	0-74	153-154	C18-C21
	Bone cancer ^b	0-74	170	C40-1
	Skin cancer	0-74	172, 173	C43, C44
	Eye cancer	0-74	190	C69
	Thyroid cancer	0-74	193	C73
	Hodgkin's disease	0-74	201	C81
	Leukemia ^c	0-44	204-208	C91-C95
→ <i>women only</i>	Breast cancer	0-74	174	C50
	Cervical cancer	0-74	180	C53
	Uterine cancer	0-74	179, 182	C54, C55
→ <i>men only</i>	Prostate cancer ^a	0-74	185	C61
	Testicular cancer	0-74	186	C62

Note: This classification is based on Page et al., with the following exceptions:

^a Laryngeal and prostate cancer were added according to Mackenbach et al. 2015.

^b Bladder and bone cancer were added according to Tobias et al. 2010.

^c Leukemia group was widened according to Nolte & McKee, 2012 .