

ORIGINAL ARTICLE

Regional Differences in the Prevalence of Cardiovascular Disease

Results from the German Health Update (GEDA) from 2009–2012

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SUMMARY

Background: Cardiovascular disease continues to be the single most common cause of death and to account for the largest single portion of treatment costs in Germany. Reliable data on regional differences in the frequency of cardiovascular disease are important for the planning of targeted care structures and preventive measures.

Methods: Pooled data from the German Health Update (GEDA), a nationwide telephone health survey conducted in 2009, 2010 and 2012 (n = 62 214) were used to estimate the lifetime prevalence of major cardiovascular disease (self-reported medical diagnosis of myocardial infarction, other coronary heart disease, stroke, or congestive heart failure) in each of the German federal states. The influence of sociodemographic factors on regional prevalence differences was examined in adjusted logistic regression analyses. Prevalences were compared with mortality rates from cardiovascular disease that were obtained from cause-of-death statistics.

Results: The lifetime prevalence of cardiovascular disease in Germany ranged from 10.0% in Baden-Württemberg to 15.8% in Saxony-Anhalt. After adjustment for age, sex, socioeconomic status, and size of the communities of residence, nine of the other 15 states had significantly higher prevalences than Baden-Württemberg, with odds ratios ranging from 1.26 (Hesse) to 1.55 (Saxony-Anhalt). Four of the five states that previously constituted the German Democratic Republic (East Germany) had above-average figures for prevalence and mortality.

Conclusion: There are relevant differences among the German federal states in the lifetime prevalence of major cardiovascular disease, which are only partly accounted for by differences in age and sex distribution, socioeconomic status, and community size.

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Cardiovascular disease continues to be a major factor in the health of the German population. It has been the leading cause of death in Germany for decades and was responsible for 43.9% of deaths in women and 36.1% in men in the year 2012 (1–3). Cardiovascular disease also accounts for the greatest part of the costs due directly to disease in the German healthcare system (2, 4). More than two thirds of cardiovascular mortality (3) and around half of both overall cardiovascular hospital diagnoses (5) and total disease costs (6) are attributable to the four most important cardiovascular diseases: coronary heart disease (CHD), myocardial infarction, stroke, and heart failure. Mortality from cardiovascular disease in general has fallen considerably in recent decades, but the prevalence of major cardiovascular diseases such as myocardial infarction and stroke has remained largely unchanged (2, 7, 8).

In planning care structures and preventive strategies for the future, the question arises of whether there are interregional differences in the prevalence of cardiovascular disease and, if so, whether these differences correspond with the known variations in cardiovascular mortality (9, 10). Individual studies analyzing routinely collected outpatient and inpatient data have pointed to regional differences in the frequency of treated cases of cardiovascular disease (11, 12). The German Heart Report 2015 (*Deutscher Herzbericht 2015*) also found that the care of and mortality from cardiac disease vary among the federal states (13). To date, however, no data have published on the prevalence of cardiovascular disease in the German general population on a federal state level.

In this study we analyzed data from the telephone health survey German Health Update (GEDA) for the years 2009 to 2012 (14) to estimate the lifetime prevalence of major cardiovascular disease (CHD, myocardial infarction, stroke, or heart failure) in the federal states of Germany, expressed as a proportion of the population. In addition, we investigated the influence of sociodemographic characteristics on the variation among states. Finally, the lifetime prevalence and mortality rate of cardiovascular disease were compared at state level.

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TABLE 1

Lifetime prevalence of major cardiovascular disease*¹ by federal state*² and sex

	Total				Men			Women		
	n	%	95% CI	Rank	%	95% CI	Rank	%	95% CI	Rank
Schleswig-Holstein	2102	12.9	[10.9; 15.1]	5	15.4	[12.4; 18.9]	2	10.5	[8.2; 13.3]	11
Hamburg	1314	10.2	[8.0; 12.7]	15	13.1	[9.6; 17.5]	11	7.4	[5.2; 10.5]	16
Lower Saxony	5806	12.9	[11.7; 14.2]	5	15.0	[13.3; 16.9]	4	10.8	[9.2; 12.7]	9
Bremen	509	11.8	[8.3; 16.6]	11	11.3	[6.6; 18.9]	14	12.3	[7.8; 19]	4
North Rhine-Westphalia	12 289	12.2	[11.4; 13.1]	9	13.4	[12.2; 14.7]	10	11.0	[9.9; 12.2]	7
Hesse	4953	12.0	[10.8; 13.3]	10	14.1	[12.3; 16.2]	7	9.9	[8.4; 11.7]	14
Rhineland-Palatinate	3122	13.7	[12.0; 15.7]	2	14.6	[12.1; 17.5]	5	12.9	[10.6; 15.6]	2
Baden-Württemberg	7803	10.0	[9.0; 10.9]	16	11.0	[9.7; 12.5]	16	8.9	[7.7; 10.3]	15
Bavaria	9463	11.0	[10.1; 11.9]	13	11.8	[10.6; 13.2]	13	10.1	[8.9; 11.5]	12
Saarland	894	10.5	[8.1; 13.6]	14	11.1	[7.4; 16.2]	15	10.0	[7.1; 14]	13
Berlin	2873	11.5	[10.0; 13.1]	12	12.4	[10.2; 15]	12	10.6	[8.8; 12.8]	10
Brandenburg	2571	13.1	[11.4; 15.0]	4	15.1	[12.5; 18.1]	3	11.2	[9.1; 13.6]	6
Mecklenburg-West Pomerania	1158	12.7	[10.5; 15.3]	8	14.5	[11.4; 18.4]	6	10.9	[8; 14.7]	8
Saxony	3636	12.8	[11.5; 14.2]	7	13.7	[11.8; 15.8]	8	11.9	[10.2; 13.9]	5
Saxony-Anhalt	1647	15.8	[13.7; 18.1]	1	16.1	[13.1; 19.7]	1	15.4	[12.7; 18.6]	1
Thuringia	2074	13.2	[11.4; 15.3]	3	13.6	[11.1; 16.7]	9	12.9	[10.3; 15.9]	2
West (states of old FRG excl. Berlin)	48 255	11.7	[11.3; 12.1]		13.1	[12.5; 13.7]		10.4	[9.8; 11.0]	
East (states of old GDR incl. Berlin)	13 959	13.0	[12.3; 13.8]		14.1	[13.0; 15.2]		12.1	[11.1; 13.1]	
Germany	62 214	12.0	[11.6; 12.3]		13.3	[12.7; 13.8]		10.7	[10.2; 11.2]	

*¹ Myocardial infarction, other coronary heart disease, heart failure, or stroke

*² Arranged according to official code number for state

CI, Confidence interval; FRG, Federal Republic of Germany; GDR, German Democratic Republic

Methods

Study design

The analysis was based on pooled data from three waves (2009, 2010, and 2012) of the GEDA study (German-language website: www.geda-studie.de) (14–17). In each of the three waves an independent nationwide telephone health survey covered a representative sample of German-speaking members of the German population aged 18 years or more living in private households. The participants were drawn from a random sample of all landline telephone numbers in Germany (14, 18). Data acquisition was identical in each of the three survey periods: July 2008 to May 2009 (GEDA 2009) (15), September 2009 to July 2010 (GEDA 2010) (16), and March 2012 to March 2013 (GEDA 2012) (17). The data were pooled to increase the statistical power for analysis of the differences among regional samples (14). The number of completed interviews as a proportion of all likely households (response rate 3 according to the American Association for Public Opinion Research) ranged from 23.9% (GEDA 2012) to 34.5% (GEDA 2009) (14). The cooperation rate of the persons reached varied between 51.2% (GEDA 2009) and 76.6% (GEDA 2012) (14). Pooling the three survey waves, 62 606 persons were interviewed on the telephone by trained interviewers (14).

Prevalence of cardiovascular disease

The GEDA data on cardiovascular disease are based on the participants' reports regarding the following diseases:

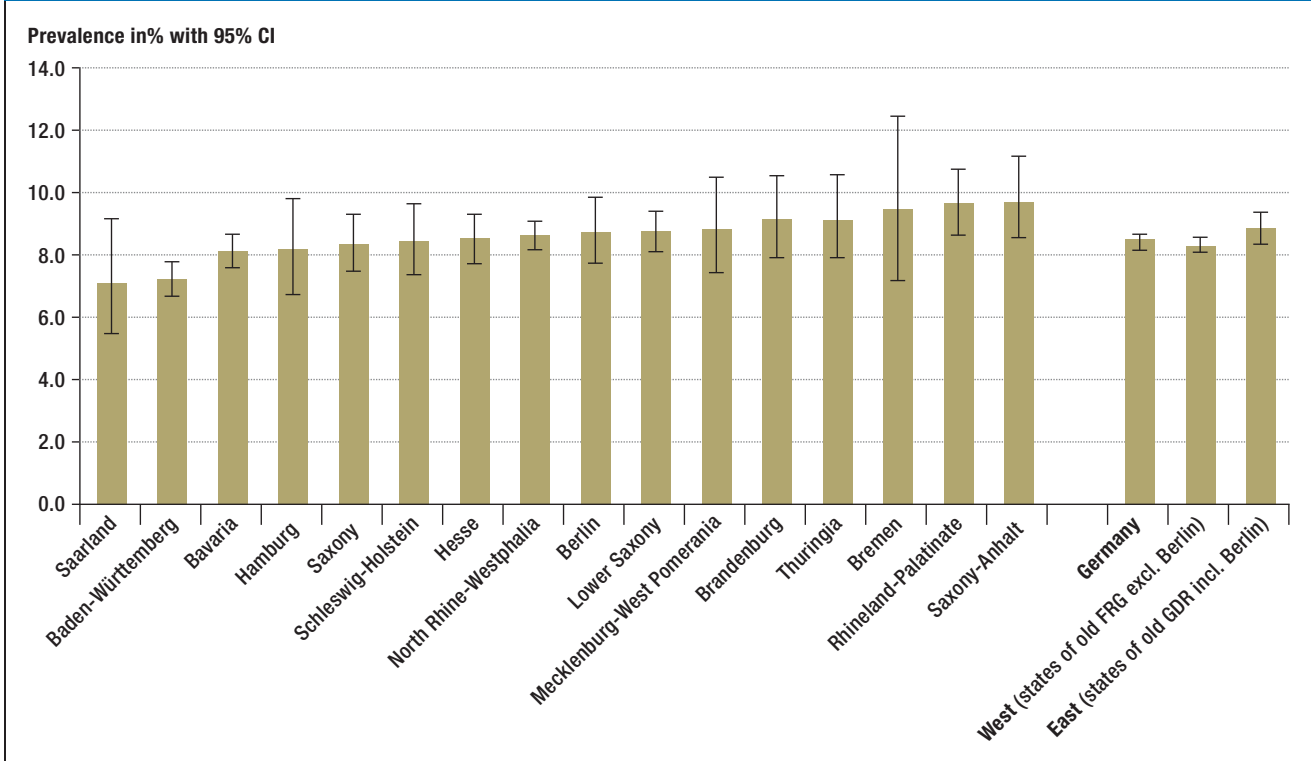
- Myocardial infarction
- Other manifestations of CHD, e.g., angina pectoris
- Heart failure
- Stroke

Standardized questions were asked to determine whether these diseases had ever been diagnosed by a physician. In analogy with other studies, the four diseases were combined to form a composite variable of major cardiovascular disease (19). The prevalence of the individual diseases could not be estimated owing to the small sample sizes in the less populous federal states.

Other variables

In the survey waves of 2009 and 2010, data on federal state and community size were based on participants' reports about where they lived, while in 2012 this information was derived using the telephone area code. Data on age and sex were supplied by the interviewees.

FIGURE 1



Standardized*¹ lifetime prevalence of major cardiovascular disease*² by federal state (n = 62 214) (in ascending order of prevalence)

*¹ Standard population: old European standard population (WHO 1976) (23)

*² Myocardial infarction, other coronary heart disease, heart failure, or stroke

CI, confidence interval; WHO, World Health Organization; FRG, Federal Republic of Germany; GDR, German Democratic Republic

Social status was ascertained using a multidimensional index on the basis of educational and occupational qualification, occupational status, and net equivalent income and was classified as low, intermediate, or high (20).

Mortality from cardiovascular diseases

Mortality rates were calculated using cause of death statistics and the population projection of the German Federal Statistical Office (Destatis) from 2011, the reference year for the weighting of the GEDA data (3, 21). The number of deaths in the federal states was ascertained for the ICD-10 codes (ICD: International Statistical Classification of Diseases and Related Health Problems) to which the four diseases are assigned (3):

- CHD and myocardial infarction: I20–25
- Heart failure: I50
- Stroke: I60–69

Furthermore, the population figures of the federal states on 31 December 2011 were derived from the population projections of the German Federal Statistical Office (Destatis) based on the censuses carried out in 1987 in the Federal Republic of Germany (FRG) and in 1990 in the German Democratic Republic (GDR) (21). This procedure was selected because the weight-

ing factor for GEDA was created before the 2011 census (22) and was based on the same population figures.

Statistical analysis

The lifetime prevalence of major cardiovascular disease was estimated as the proportion of all participants with valid responses who reported at least one of the four diseases. Prevalences and 95% confidence intervals (CI) were calculated for all 16 federal states of Germany and additionally stratified by sex. For comparison of prevalence among states, the data were standardized by age and sex with the old European standard population (23) as reference. The corresponding 95% CI were calculated according to the method of Fay and Feuer (24).

Differences in the prevalence of major cardiovascular disease among the federal states were investigated with a logistic regression model adjusted for age, sex, social status, community size, and survey wave. The explanatory variable was the federal state as categorical variable with 16 values. The state with the lowest prevalence was defined as reference category.

Raw and age- and sex-standardized [reference: old European standard population (23)] mortality rates in the federal states were calculated as number of deaths

per 100 000 members of the population. Standardized mortality rates and lifetime prevalences were descriptively compared.

In order to enable conclusions representative for the national population, the GEDA sample was adjusted to the age, sex, educational, and regional distribution of the German population on 31 December 2011 by using a weighting factor (14–17). The Complex Samples module of IBM SPSS Statistics 20 and the survey procedures in STATA 13.1 were used for statistical analysis.

Results

After exclusion of 392 persons (0.6%) with incomplete data on cardiovascular disease, data on 62 214 participants were included in analysis (*eTable 1*).

The overall lifetime prevalence of major cardiovascular disease in Germany was 12.0%. The rate was 2.6% higher in men (13.3%) than in women (10.7%). The prevalence rose steeply with increasing age, reaching 45% in the over-80s. In every age group the prevalence was higher in men (*eTable 2*). Analysis of the separate diseases showed that prevalences among men were particularly higher for myocardial infarction and CHD (*eTable 1*).

Variation in prevalence among federal states

The lifetime prevalence of major cardiovascular disease in the different federal states ranged from 10.0% to 15.8%. Saxony-Anhalt and Rhineland-Palatinate showed the highest prevalence, Baden-Württemberg and Hamburg the lowest (*Table 1*).

The sex-specific prevalences ranged from 7.4% and 15.4% in women and from 11.0% to 16.1% in men. Women had a lower lifetime prevalence than men in almost all federal states, and the rankings of the individual states were similar for men and women (*Table 1*).

The ranking of the states changed only slightly after standardization for age and sex (*Figure 1*). The positions differed most for Bremen (higher) and for Saxony and Schleswig-Holstein (lower). Sex-specific analysis showed comparable changes for women after age and sex standardization, but for men the highest prevalences were found for Hamburg and Mecklenburg-West Pomerania (*eFigure 1*).

Influence of sociodemographic characteristics

In comparison with Baden-Württemberg (the state with the lowest prevalence), regression analysis after adjustment for age, sex, social status, and community size revealed significantly higher rates of major cardiovascular disease in nine federal states (*Table 2*). The odds ratios (OR) varied from 1.26 (95% CI [1.06; 1.5]) in Hesse and 1.55 [1.25; 1.92] in Saxony-Anhalt. The adjusted analysis showed no difference between the states of the old FRG and those on the territory of the former GDR.

Comparison of prevalence and mortality

The ranking of federal states for standardized mortality rates (*eTable 3*) differed in parts from the ranking as for

TABLE 2

Results of logistic regression analysis of relationship between federal state*¹ and prevalence of major cardiovascular disease*²

State	Odds ratio* ³	95% CI	p-value
Schleswig-Holstein	1.34	[1.06; 1.68]	0.01
Hamburg	1.17	[0.86; 1.60]	0.2
Lower Saxony	1.33	[1.12; 1.57]	0.001
Bremen	1.21	[0.77; 1.89]	0.4
North Rhine-Westphalia	1.27	[1.1; 1.48]	0.002
Hesse	1.26	[1.06; 1.5]	0.01
Rhineland-Palatinate	1.48	[1.21; 1.81]	< 0.001
Baden-Württemberg	1.00	Reference	
Bavaria	1.15	[0.98; 1.34]	0.09
Saarland	0.93	[0.66; 1.31]	0.7
Berlin	1.32	[1.06; 1.63]	0.01
Brandenburg	1.30	[1.06; 1.59]	0.01
Mecklenburg-West Pomerania	1.27	[0.97; 1.67]	0.09
Saxony	1.16	[0.97; 1.39]	0.1
Saxony-Anhalt	1.55	[1.25; 1.92]	< 0.001
Thuringia	1.30	[1.04; 1.62]	0.02
West (states of old FRG excl. Berlin)	1.00	Reference	
East (states of old GDR incl. Berlin)	1.07	[0.98; 1.16]	0.1

(n = 62 214)

*¹ Arranged according to official code number for state

*² Myocardial infarction, other coronary heart disease, heart failure, or stroke

*³ Adjusted for age, sex, social status, community size, and survey wave

CI, Confidence interval; FRG, Federal Republic of Germany; GDR, German Democratic Republic

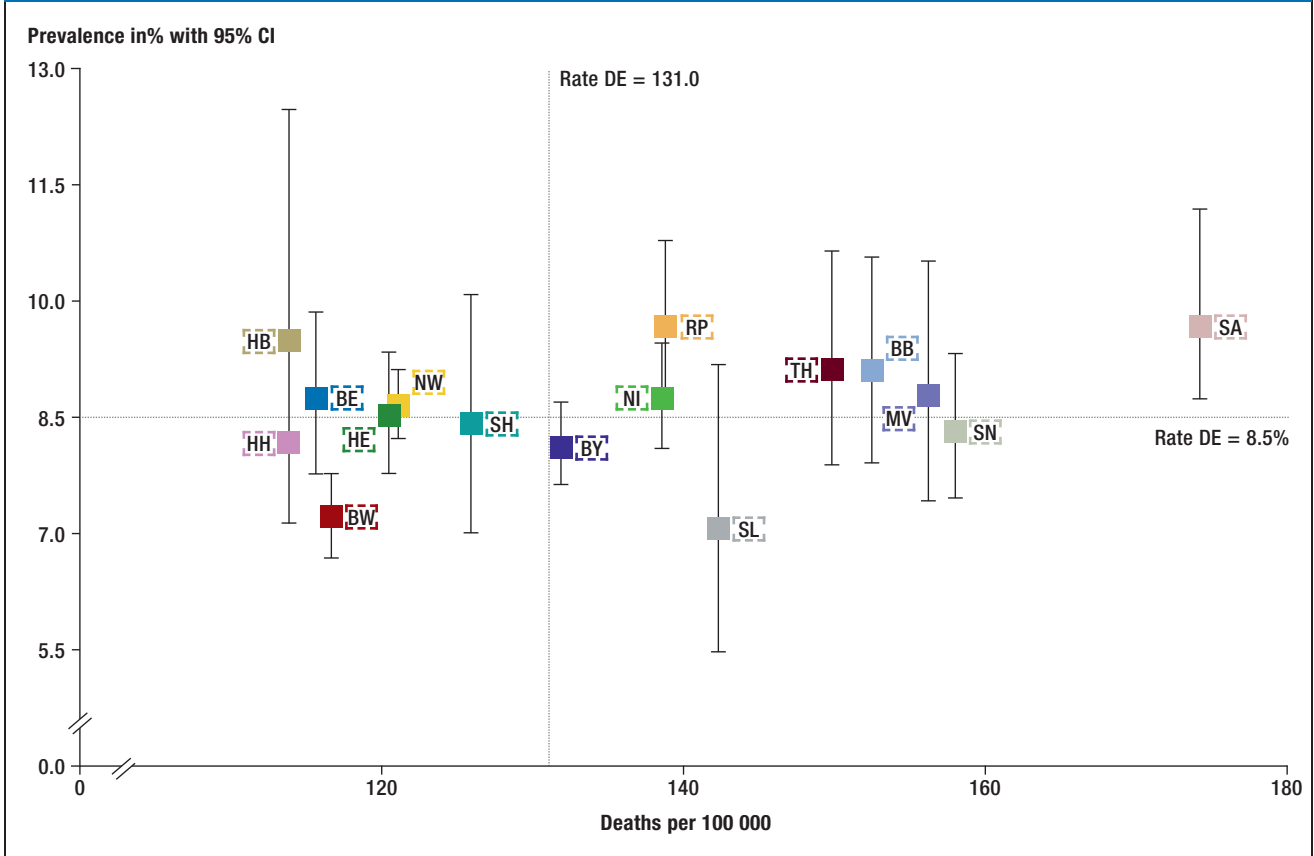
prevalences. The city states Berlin, Bremen, and Hamburg showed the lowest mortality, Saxony-Anhalt, Saxony, and Mecklenburg-West Pomerania the highest.

Comparison of lifetime prevalences and mortality rates showed that both indicators were above average in all the ex-GDR states except Saxony as well as in Rhineland-Palatinate and Lower Saxony (*Figure 2*). While Saxony-Anhalt was the state ranked highest for both prevalence and mortality, a few states such as Baden-Württemberg and Hamburg were below average for both indicators. The greatest differences in ranking for prevalence and for mortality were seen in Bremen, Saxony, and Saarland. Gender-specific analysis showed similar results (*eFigures 2 and 3*).

Discussion

The analyses showed distinct variations among the federal states of Germany in the frequency of major cardiovascular disease. The lifetime prevalence ranged from 10.0% (Baden-Württemberg) to 15.8% (Saxony-Anhalt). Broadly speaking, the ex-GDR states were ranked higher than the states of the old FRG. A trend towards higher prevalence in northeastern than in southwestern states could be discerned, but was weaker after standardization for age and sex. In almost all

FIGURE 2



Comparison of standardized mortality rates*¹ and lifetime prevalence of major cardiovascular disease*² by federal state

*¹ ICD-10 codes I20–25; I50; I60–69

*² Myocardial infarction, other coronary heart disease, heart failure, or stroke

ICD, International Statistical Classification of Diseases and Related Health Problems; CI, confidence interval; HB Bremen; HH, Hamburg; BE, Berlin; HE, Hesse; BW, Baden-Württemberg; NW, North Rhine-Westphalia; SH, Schleswig-Holstein; BY, Bavaria; NI, Lower Saxony; RP, Rhineland-Palatinate; SL, Saarland; TH, Thuringia; BB, Brandenburg; MV, Mecklenburg-West Pomerania; SN, Saxony; SA, Saxony-Anhalt; DE, Germany

states men had a higher lifetime prevalence than women. The differences among the states can be explained only partly by variations in age structure, social circumstances, and community size. Four of the five states of the former GDR were above the average for both prevalence and mortality.

The results of this study are in good agreement with previous research in Germany and complement the existing findings. For example, the German Heart Report (*Deutscher Herzbericht*), analyzing routinely collected data from hospital diagnosis records and cause of death statistics, revealed differences among the federal states in the inpatient treatment rates and mortality for selected cardiac diseases such as CHD, heart valve disease, and heart failure (13). The inpatient morbidity figures in the Heart Report (13), together with an analysis of hospital claims data (diagnosis-related groups statistics) for the year 2007 (12), indicate a trend towards decreasing treatment rates from the northeastern to the southwestern states. These morbidity estimates are based on secondary data but are sup-

ported by the present study's population-wide survey data on the prevalence of major cardiovascular disease; the results are comparable. One exception to this trend is the southwestern state of Rhineland-Palatinate, which we found to have the second highest lifetime prevalence (13.7%). A study of billing data from the health insurance provider Barmer GEK for the year 2009 reported an east–west difference in the prevalence of cardiovascular disease diagnoses (11).

Death from cardiovascular disease has also been reported to show interregional differences with a decreasing trend from northeast to southwest; these differences persist despite the continuing harmonization of circumstances between east (former GDR) and west (old FRG) (9, 10, 12, 25, 26). Our analysis broadly shows an east–west difference with regard to mortality: raw death rates for the major cardiovascular diseases we studied lay between 324.2 and 413.0 per 100 000 inhabitants in the ex-GDR states but were lower, at 208.5 to 333.0 deaths per 100 000 inhabitants, in the states of the old FRG. The sex-specific differences, with higher

prevalence in men, are confirmed in the literature (2, 7, 8, 27).

The possible explanations for the observed differences among the federal states of Germany include regional variations in cardiovascular risk factors, healthcare, health awareness, socioeconomic status, and underlying demographic factors (28–30). A selective review of data on social factors, risk factors, and cardiovascular mortality in the federal states revealed indications that regional differences may be of great importance in the distribution of cardiovascular risk factors (31). Saxony-Anhalt, Mecklenburg-West Pomerania, and Brandenburg, which also showed high prevalences in our study, ranked highly (1–3) for the prevalence of the most important risk factors. A publication on the distribution of metabolic syndrome as a cardiovascular risk factor found higher prevalences in the ex-GDR states (23.5 to 27.5%) than in those of the old FRG (18.2 to 22.0%) (32). The German Health Interview and Examination Survey for Adults (*Studie zur Gesundheit Erwachsener in Deutschland*, DEGS1) found the highest prevalence of hypertension (39.0% in men, 39.8% in women) in the east-central region (Saxony-Anhalt, Saxony, Thuringia) (33).

Comparison of lifetime prevalences and mortality rates showed that four of the five states of the former GDR were above average for both indicators. Only Saxony had a prevalence slightly below average, but there too the mortality was high. The partial discrepancies in rankings for prevalence and for mortality reflect the fact that these are two different epidemiological measures. They represent different aspects of disease frequency in the population. Any conclusive interpretation of prevalence and mortality would have to include consideration of incidence and case fatality rate. However, there are no nationwide data for these measures in Germany, so the federal states cannot be compared with one another. It can be assumed that states such as Saxony-Anhalt with uniformly high prevalence and mortality also have high incidence, and that the incidence is low in states such as Baden-Württemberg where prevalence and mortality are low. Harder to interpret are the results from states with contrasting rankings for the two indicators. On the one hand, the above-average prevalence yet below-average mortality in Bremen could be caused by high incidence, perhaps due to a high frequency of risk factors but simultaneous low case fatality, attributable for example to good acute care structures. On the other hand, the combination of low prevalence and high mortality could point to a high case fatality rate—as might be the case if there were deficiencies in care. However, these questions cannot be investigated in depth on the basis of the available data.

Strengths and limitations

The GEDA study is a large, cross-sectional nationwide survey of a representative sample of the German population. Its results can be extrapolated to the whole adult German-speaking population resident in private house-

holds. A limiting factor is that the data on cardiovascular disease are based on self-reported medical diagnoses. Diseases that were not diagnosed and those that did not occur to the participants during the telephone interview are therefore not recorded. While good validity of the data for the acute events of myocardial infarction and stroke can be assumed, this is not necessarily the case for CHD and heart failure (34). Incorrect classification of individual disease events may be partly compensated by the fact that the diseases were considered together. Moreover, persons with recent myocardial infarction or stroke, those with severe long-term complications, and those with other serious illnesses are probably under-represented in the GEDA sample. Other possible sources of selection bias are the preferential participation of particularly health-conscious persons and the exclusion of persons in care facilities. The estimates of prevalence are therefore likely to be conservative. The mortality data are limited by the fact that cardiovascular disease was not recorded if it was not the immediate cause of death. Furthermore, state-level differences in the coding of causes of death could also lead to variation in mortality rates (35). In view of the range of findings, however, it is unlikely that this a major factor (31).

Conclusion

The federal states of Germany differ widely in the prevalence of major cardiovascular disease, and only a small part of this variation can be explained by differences in age, sex, social status, and community size. Looking at prevalence and mortality together, Saxony-Anhalt is the most unfavorable state, ranking highest for both indicators, while Baden-Württemberg is at the other end of the scale, ranked lowest for both.

Potential ways of decreasing cardiovascular morbidity and the variation among federal states are nationwide expansion of prevention programs and reduction of the variations in medical care across Germany. In recent years, for example, many measures for prevention, treatment, and reduction of cardiovascular disease have been promoted by the German Heart Foundation (*Deutsche Herzsiftung*) through its Heart Week initiative (36). More insight into the reasons for the differences among the federal states might be yielded by detailed regional analysis at district level or model-based small-scale estimates (37). Finally, further analyses of the GEDA data will examine the differences in cardiovascular risk factors among states.

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Conflict of interest statement

The authors declare that no conflict of interest exists.

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KEY MESSAGES

- The lifetime prevalence of major cardiovascular disease varies greatly among the federal states of Germany. The raw lifetime prevalence ranges from 10.0% in Baden-Württemberg to 15.8% in Saxony-Anhalt.
- The prevalence is largely higher in the states on the territory of the former German Democratic Republic (GDR). Overall, there is a discernable trend towards a difference between northeastern and southwestern states; this difference persists after standardization according to age and sex.
- Even after statistical adjustment for age, sex, social status and community size, the variation among federal states in the prevalence of major cardiovascular disease remains. Compared with Baden-Württemberg, the state with the lowest rate, nine states show significantly higher prevalence, with odds ratios ranging up to 1.55 in Saxony-Anhalt.
- Comparison of prevalence and mortality reveals that four of the five former GDR states (Saxony-Anhalt, Mecklenburg-West Pomerania, Brandenburg, and Thuringia) are above average for both of these indicators.
- Possible reasons for the differences among the federal states are variations in the distribution of individual and environmental risk factors, in the reduction of risk factors, and in the prevention and care of cardiovascular disease.

REFERENCES

1. Plass D, Vos T, Hornberg C, Scheidt-Nave C, Zeeb H, Krämer A: Trends in disease burden in Germany—results, implications and limitations of the Global Burden of Disease study. *Dtsch Arztebl Int* 2014; 111: 629–38.
2. Robert Koch-Institut (ed.): *Gesundheit in Deutschland 2015. Gesundheitsberichterstattung des Bundes*. www.rki.de/DE/Content/Gesundheitsmonitoring/Gesundheitsberichterstattung/GesInDtId/GesInDtId_inhalt.html (last accessed on 7 June 2016).
3. *Gesundheitsberichterstattung des Bundes: Sterbefälle, Sterbeziffern (je 100.000 Einwohner, altersstandardisiert) (ab 1998). Gliederungsmerkmale: Jahre, Region, Alter, Geschlecht, Nationalität, ICD-10, Art der Standardisierung*. www.gbe-bund.de/gbe10/ (last accessed on 6 November 2015).
4. Robert Koch-Institut: *Krankheitskosten*. Heft 48. *Gesundheitsberichterstattung des Bundes Berlin 2009*. www.rki.de/DE/Content/Gesundheitsmonitoring/Gesundheitsberichterstattung/Themenhefte/Krankheitskosten_inhalt.html (last accessed on 7 June 2016).
5. *Gesundheitsberichterstattung des Bundes: Diagnosedaten der Krankenhäuser ab 2000 (Fälle/Sterbefälle, Fälle je 100000 Einwohner (altersstandardisiert))*. www.gbe-bund.de/gbe10/ (last accessed on 15 February 2016).
6. *Gesundheitsberichterstattung des Bundes: Krankheitskosten in Mio. € für Deutschland*. www.gbe-bund.de/gbe10/ (last accessed on 15 February 2016).
7. Busch M, Schienkiewitz A, Nowossadeck E, Gößwald A: Prävalenz des Schlaganfalls bei Erwachsenen im Alter von 40 bis 79

Jahren in Deutschland. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitschutz* 2013; 56: 656–60.

8. Gößwald A, Schienkiewitz A, Nowossadeck E, Busch M: Prävalenz von Herzinfarkt und koronarer Herzkrankheit bei Erwachsenen im Alter von 40 bis 79 Jahren in Deutschland. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitschutz* 2013; 56: 650–5.
9. Willich SN, Löwel H, Mey W, Trautner C: [Regional variations in mortality of cardiovascular diseases in Germany]. *Dtsch Arztebl* 1999; 96: A-483–8
10. Müller-Nordhorn J, Rossnagel K, Mey W, Willich S: Regional variation and time trends in mortality from ischaemic heart disease: East and West Germany 10 years after reunification. *J Epidemiol Community Health* 2004; 58: 481–5.
11. Repschläger U: Die Verteilung von Morbidität in Deutschland. In: Repschläger U, Schulte C, Osterkamp N (eds.): *BARMER GEK Gesundheitswesen aktuell* 2011; 170–93.
12. Robert Koch-Institut: *Herz-Kreislauf-Erkrankungen*. In: 20 Jahre nach dem Fall der Mauer: Wie hat sich die Gesundheit in Deutschland entwickelt? *Beiträge zur Gesundheitsberichterstattung des Bundes*. Berlin: Robert Koch-Institut 2009; 52–61.
13. Deutsche Herzstiftung e. V.: *Deutscher Herzbericht 2015*. Frankfurt am Main: 2015.
14. Lange C, Jentsch F, Allen J, et al.: Data Resource Profile: German Health Update (GEDA)—the health interview survey for adults in Germany. *Int J Epidemiol* 2015; 44: 442–50.
15. Robert Koch-Institut: *Daten und Fakten: Ergebnisse der Studie Gesundheit in Deutschland aktuell 2009. Beiträge zur Gesundheitsberichterstattung des Bundes*. www.rki.de/DE/Content/Gesundheitsmonitoring/Gesundheitsberichterstattung/GBEDownloadsB/GEDA09.pdf (last accessed on 7 June 2016).
16. Robert Koch-Institut: *Daten und Fakten: Ergebnisse der Studie Gesundheit in Deutschland aktuell 2010. Beiträge zur Gesundheitsberichterstattung des Bundes*. www.rki.de/DE/Content/Gesundheitsmonitoring/Gesundheitsberichterstattung/GBEDownloadsB/GEDA2010.pdf (last accessed on 7 June 2016).
17. Robert Koch-Institut: *Daten und Fakten: Ergebnisse der Studie Gesundheit in Deutschland aktuell 2012. Beiträge zur Gesundheitsberichterstattung des Bundes*. www.rki.de/DE/Content/Gesundheitsmonitoring/Gesundheitsberichterstattung/GBEDownloadsB/GEDA12.pdf (last accessed on 7 June 2016).
18. Gabler S, Hader S: Idiosyncrasies in telephone sampling. The case of Germany. *Int J Public Opin Res* 2002; 14: 339–45.
19. Mitchell GF, Hwang SJ, Vasan RS, et al.: Arterial stiffness and cardiovascular events: the Framingham Heart Study. *Circulation* 2010; 121: 505–11.
20. Lampert T, Kroll LE, Müters S, Stolzenberg H: Messung des sozioökonomischen Status in der Studie „Gesundheit in Deutschland aktuell“ (GEDA). *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitschutz* 2013; 56: 131–43.
21. *Gesundheitsberichterstattung des Bundes: Bevölkerung zum Stichtag 31.12. des jeweiligen Jahres. Gliederungsmerkmale: Jahre, Region, Alter, Geschlecht, Nationalität (Grundlage Zensus BRD 1987, DDR 1990)*. www.gbe-bund.de/gbe10/ (last accessed on 6 November 2015).
22. *Statistische Ämter des Bundes und der Länder: Zensus 2011*. www.zensus2011.de (last accessed on 10 August 2016).
23. Waterhouse J, Muir C, Correa P, Powell J, (eds.): *Cancer incidence in five continents*. Volume 3. Lyon: International Agency for Research on Cancer 1976; 456.
24. Fay MP, Feuer EJ: Confidence intervals for directly standardized rates: a method based on the gamma distribution. *Stat Med* 1997; 16: 791–801.

25. Robert Koch-Institut: Sterblichkeit, Todesursachen und regionale Unterschiede. Heft 52. Gesundheitsberichterstattung des Bundes. www.rki.de/DE/Content/Gesundheitsmonitoring/Gesundheitsberichterstattung/GBEDownloadsT/sterblichkeit.pdf (last accessed on 7 June 2016).
26. Kibele EU, Klüsener S, Scholz RD: Regional mortality disparities in Germany: long-term dynamics and possible determinants. *Kolner Z Soz Sozpsychol* 2015; 67: 241–70.
27. Pencina MJ, D'Agostino RB, Larson MG, Massaro JM, Vasan RS: Predicting the 30-year risk of cardiovascular disease The Framingham Heart Study. *Circulation* 2009; 119: 3078–84.
28. Sundmacher L: Regionale Variationen in der Gesundheit und Gesundheitsversorgung. *Soziologie von Gesundheit und Krankheit*. Wiesbaden: Springer 2016; 197–209.
29. Lampert T, Richter M, Schneider S, Spallek J, Dragano N: Soziale Ungleichheit und Gesundheit. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2016: 1–13.
30. Latzitis N, Sundmacher L, Busse R: Regionale Unterschiede der Lebenserwartung in Deutschland auf Ebene der Kreise und kreisfreien Städte und deren möglichen Determinanten. *Das Gesundheitswesen* 2011; 73: 217–28.
31. Stang A, Stang M: An inter-state comparison of cardiovascular risk in Germany—towards an explanation of high ischemic heart disease mortality in Saxony-Anhalt. *Dtsch Arztebl Int* 2014; 111: 530–6.
32. Moebus S, Hanisch J, Bramlage P, et al.: Regional differences in the prevalence of the metabolic syndrome in primary care practices in Germany. *Dtsch Arztebl Int* 2008; 105: 207–13.
33. Diederichs C, Neuhauser H: Regional variations in hypertension prevalence and management in Germany: results from the German Health Interview and Examination Survey (DEGS1). *J Hypertens* 2014; 32: 1405–13; discussion 14.
34. Okura Y, Urban LH, Mahoney DW, Jacobsen SJ, Rodeheffer RJ: Agreement between self-report questionnaires and medical record data was substantial for diabetes, hypertension, myocardial infarction and stroke but not for heart failure. *J Clin Epidemiol* 2004; 57: 1096–103.
35. Schelhase T, Weber S: Die Todesursachenstatistik in Deutschland. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2007; 50: 969–76.
36. Deutsche Herzstiftung e. V.: Herzwochen. www.herzstiftung.de/herzwochen.html (last accessed on 4 July 2016).
37. Kroll LE, Lampert T: Regionalisierung von Gesundheitsindikatoren. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2012; 55: 129–40.

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Supplementary material
 eTables, eFigures:
www.aerzteblatt-international.de/16m704

Supplementary material to:

Regional Differences in the Prevalence of Cardiovascular Disease

Results from the German Health Update (GEDA) from 2009–2012

by Christina Dornquast, Lars E. Kroll, Hannelore K. Neuhauser, Stefan N. Willich, Thomas Reinhold, and Markus A. Busch

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eTABLE 1

Characteristics of the participants included in the German Health Update 2009–2012*¹

	Total n = 62 214	Men n = 27 891	Women n = 34 323
Age, years (n = 62 214)			
18–34	24.3%	25.4%	23.2%
35–44	16.3%	17.1%	15.6%
45–54	19.8%	20.7%	19.0%
55–64	15.2%	15.5%	15.0%
65–74	14.6%	13.9%	15.2%
≥ 75	9.7%	7.4%	11.9%
Socioeconomic status (n = 62 118)			
Low	19.1%	17.1%	20.9%
Intermediate	59.7%	58.6%	60.7%
High	21.3%	24.3%	18.4%
Community size, inhabitants (n = 58 654)			
Rural (<5000)	19.1%	20.0%	18.1%
Small town (5000 to <20 000)	27.2%	27.1%	27.3%
Town (20 000 to <100 000)	25.7%	25.9%	25.4%
City (≥ 100 000)	28.0%	26.9%	29.2%
Cardiovascular disease overall (n = 62 214)	12.0%	13.3%	10.7%
Coronary heart disease* ² (n = 62 135)	8.3%	10.0%	6.7%
Myocardial infarction (n = 62 186)	3.5%	4.9%	2.1%
Heart failure (n = 62 034)	4.7%	4.8%	4.6%
Stroke (n = 62 194)	2.5%	2.7%	2.4%

German Health Update (GEDA) (14)

*¹ All percentages calculated by weighting based on the German population on 31 December 2011.

*² Myocardial infarction or other coronary heart disease

eTABLE 2

Age-specific lifetime prevalence of major cardiovascular disease* by sex

Age group (years)	Total		Men		Women	
	%	95% CI	%	95% CI	%	95% CI
18–24	1.1	[0.8; 1.4]	1.3	[0.9; 1.8]	0.9	[0.6; 1.3]
25–29	1.4	[1.0; 1.9]	1.6	[0.9; 2.6]	1.1	[0.7; 1.8]
30–34	1.8	[1.4; 2.3]	1.7	[1.1; 2.7]	1.8	[1.3; 2.4]
35–39	2.6	[2.0; 3.3]	3.5	[2.5; 4.9]	1.7	[1.2; 2.3]
40–44	3.2	[2.6; 3.8]	3.7	[2.9; 4.8]	2.6	[1.9; 3.4]
45–49	4.9	[4.3; 5.7]	5.5	[4.5; 6.7]	4.3	[3.5; 5.3]
50–54	8.5	[7.6; 9.5]	11.1	[9.6; 12.8]	5.8	[4.9; 6.9]
55–59	11.8	[10.7; 13.1]	15.6	[13.7; 17.7]	8.1	[6.9; 9.5]
60–64	16.3	[14.9; 17.7]	21.6	[19.4; 23.9]	11.1	[9.5; 12.8]
65–69	20.9	[19.3; 22.6]	25.6	[23.0; 28.3]	16.5	[14.6; 18.6]
70–74	29.4	[27.5; 31.3]	34.7	[31.9; 37.6]	25	[22.5; 27.5]
75–79	37.0	[34.5; 39.6]	43.9	[39.9; 48.0]	32.3	[29.1; 35.7]
≥ 80	45.1	[42.2; 48.0]	50	[45.1; 55.0]	42.6	[39.1; 46.2]
Total	12.0	[11.6; 12.3]	13.3	[12.7; 13.8]	10.7	[10.2; 11.2]

(n = 62 214)

* Myocardial infarction, other coronary heart disease, heart failure, or stroke
CI, confidence interval

TABLE 3

Mortality rates by federal state*1 and sex in 2011 (deaths per 100 000 inhabitants)

	Total			Men			Women			
	Coronary heart disease (20–25) ² , heart failure (50–69) ² or stroke (60–69) ²			Coronary heart disease (20–25) ² , heart failure (50–69) ² or stroke (60–69) ²			Coronary heart disease (20–25) ² , heart failure (50–69) ² or stroke (60–69) ²			
	Raw	Rank	Standardized ³	Raw	Rank	Standardized ³	Raw	Rank	Standardized ³	
Schleswig-Holstein	277.3	9	125.8	246.5	10	147.9	318.8	9	103.7	10
Hamburg	228.5	15	113.7	199.4	16	136.9	267.1	15	92.4	14
Lower Saxony	306.2	8	138.4	281.5	8	170.1	340.5	8	110.5	8
Bremen	253.3	13	113.8	230.5	13	140.1	288.4	13	89.3	16
North Rhine-Westphalia	259.4	12	121.0	232.3	12	144.7	298.6	11	99.6	11
Hesse	261.5	11	120.4	241.6	11	145.8	290.6	12	97.4	12
Rhineland-Palatinate	313.5	7	138.7	283.6	7	165.8	353.9	7	113.3	6
Baden-Württemberg	246.0	14	116.5	221.1	14	139.9	277.7	14	94.9	13
Bavaria	273.7	10	131.7	250.3	9	161.6	305.7	10	105.3	9
Saarland	333.0	4	142.2	312.9	6	177.8	370.5	4	113.1	7
Berlin	208.5	16	115.4	186.8	14	139.2	238.3	16	92.4	14
Brandenburg	324.5	5	152.4	289.1	4	183.1	365.7	5	123.7	3
Mecklenburg-West Pomerania	324.2	6	156.1	297.5	3	196.8	357.4	6	121.0	4
Saxony	403.1	2	157.9	346.1	2	198.2	476.3	1	124.8	2
Saxony-Anhalt	413.0	1	174.1	377.9	1	225.5	464.6	2	134.5	1
Thuringia	343.9	3	149.7	307.3	4	188.2	388.9	3	118.4	5
Germany	283.0		131.0	255.3		159.2	320.7		105.8	

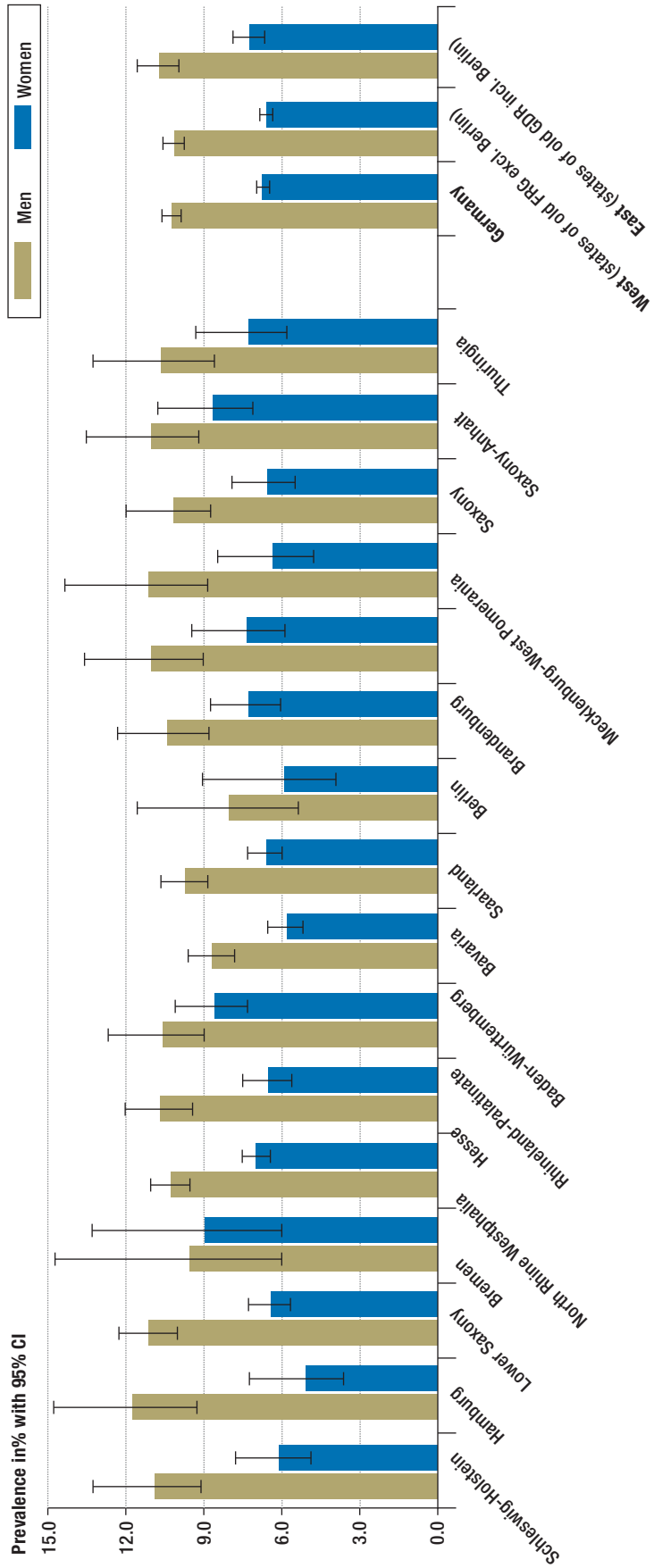
*1 Arranged according to official code number for state

*2 ICD-10 codes

*3 Standard population: old European standard population (WHO 1976) (23)

ICD, International Statistical Classification of Diseases and Related Health Problems; WHO, World Health Organization

eFIGURE 1

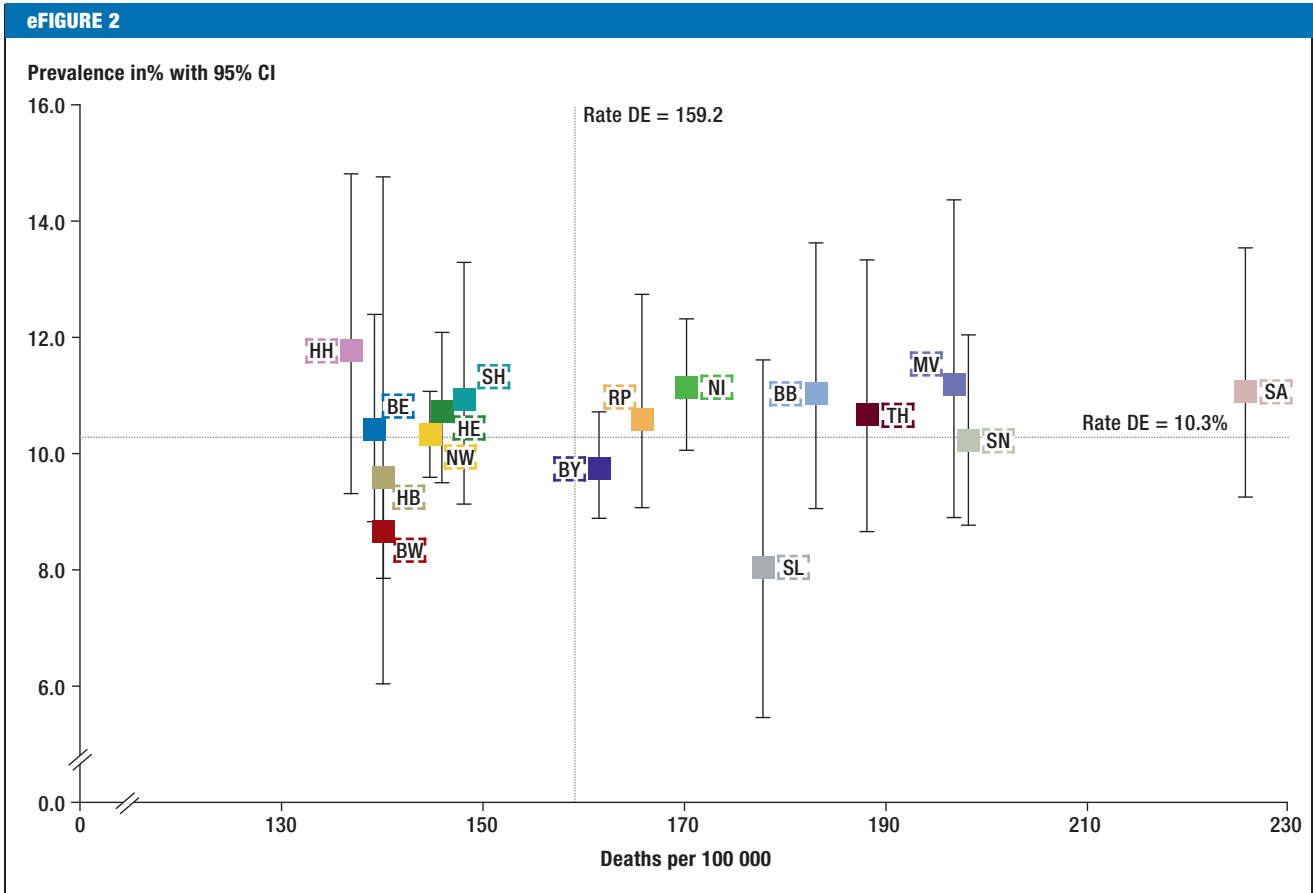


Standardized*1 lifetime prevalence of major cardiovascular disease2 by federal state and sex** (n = 62 214) (states arranged in order of official code number)

*1 Standard population: old European standard population (WHO 1976) (23)

**2 Myocardial infarction, other coronary heart disease, heart failure, or stroke

CI, confidence interval; WHO, World Health Organization; FRG, Federal Republic of Germany; GDR, German Democratic Republic

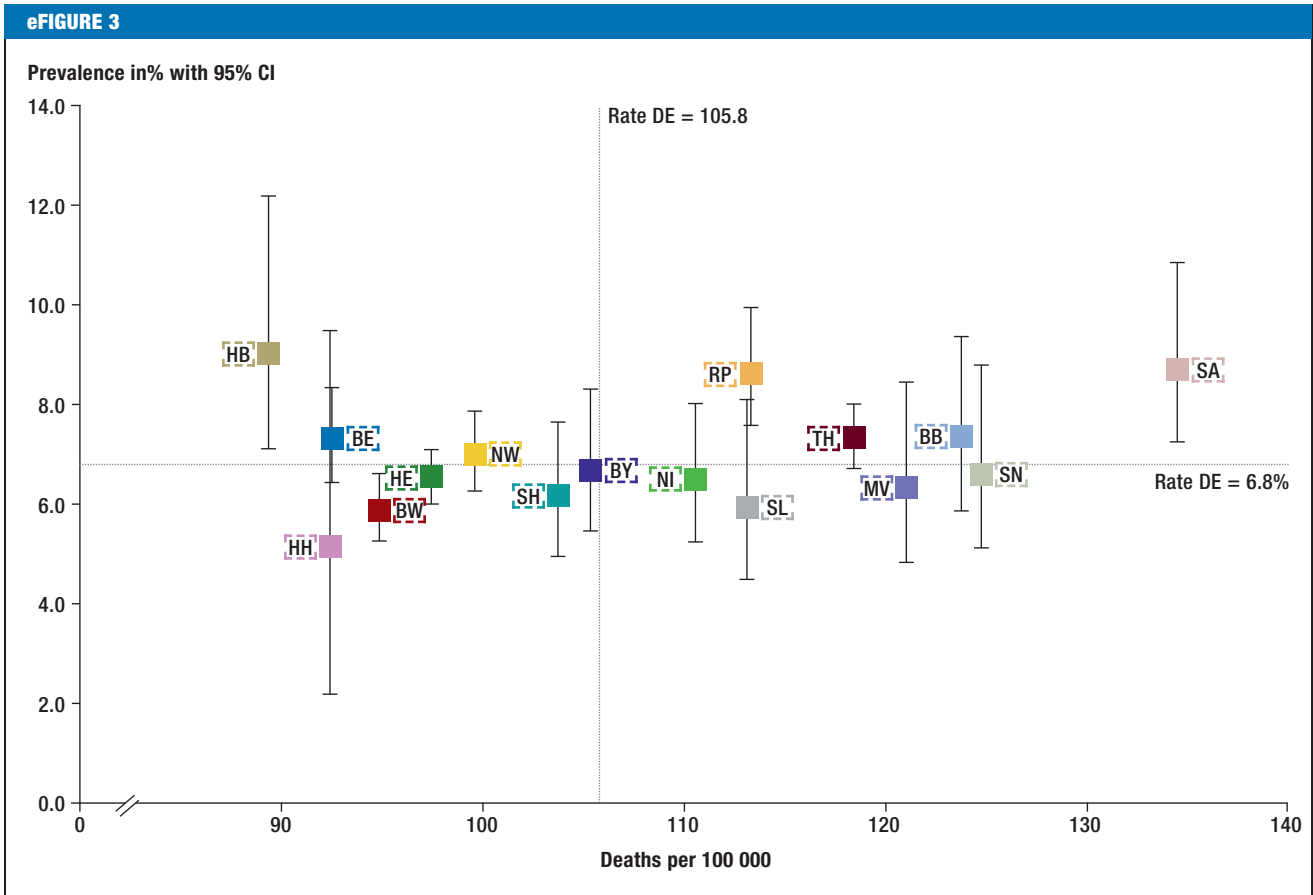


Comparison of standardized mortality rates*¹ and lifetime prevalence of major cardiovascular disease*² by federal state – men

*¹ ICD-10 codes I20–25; I50; I60–69

*² Myocardial infarction, other coronary heart disease, heart failure, or stroke

CI, Confidence interval; ICD, International Statistical Classification of Diseases and Related Health Problems; HH, Hamburg; BE, Berlin; HB Bremen; BW, Baden-Württemberg; SH, Schleswig-Holstein; HE, Hesse; NW, North Rhine-Westphalia; BY, Bavaria; RP, Rhineland-Palatinate; NI, Lower Saxony; SL, Saarland; MV, Mecklenburg-West Pomerania; TH, Thuringia; SN, Saxony; SA, Saxony-Anhalt; DE, Germany



Comparison of standardized mortality rates*¹ and lifetime prevalence of major cardiovascular disease*² by federal state – women

*¹ ICD-10 codes I20–25; I50; I60–69

*² Myocardial infarction, other coronary heart disease, heart failure, or stroke

CI, Confidence interval; ICD, International Statistical Classification of Diseases and Related Health Problems; HB, Bremen; HH, Hamburg; BE, Berlin; HE, Hesse; BW, Baden-Württemberg; NW, North Rhine-Westphalia; SH, Schleswig-Holstein; BY, Bavaria; NI, Lower Saxony; RP, Rhineland-Palatinate; SL, Saarland; TH, Thuringia; MV, Mecklenburg-West Pomerania; BB, Brandenburg; SN, Saxony; SA, Saxony-Anhalt; DE, Germany