

Regional disparities of hypertension prevalence and management within Germany

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Objective To investigate regional variations in the prevalence and management of hypertension in two communities in the north-east and the south-west of Germany.

Study setting Two population-based surveys of men and women aged 25–74 years, using a common standardized protocol: the Study of Health in Pomerania (SHIP; 3744 participants) and the Kooperative Gesundheitsforschung in der Region Augsburg (KORA; 4224 participants).

Main outcome measures Comparison of SHIP and KORA with regard to mean systolic (SBP) and diastolic blood pressure (DBP), prevalence of hypertension, percentage of awareness, treatment and control of hypertension in the community, by age and sex.

Results The overall age-standardized prevalence of hypertension for men was 60.1% in SHIP and 41.4% in KORA; the corresponding values for women were 38.5 and 28.6%. Mean blood pressure differences were present in each 10-year age group and sex. The overall SBP difference between SHIP and KORA was 8.2 mmHg (95% confidence interval 7.2–9.3) in men and 6.3 mmHg (5.3–7.3) in women, the respective DBP differences were 3.8 mmHg (3.2–4.5) and 3.6 mmHg (3.0–4.2). Nevertheless, the percentage of awareness, treatment and control of hypertension was strikingly similar in the two studies (women, $P = 0.858$; and men, $P = 0.564$).

Conclusions The entire distribution of diastolic and systolic blood pressure values was shifted upwards in the north-eastern as compared to the south-western German population samples and the prevalences of hypertension differed accordingly. Despite such substantial epidemiologic differences, the community management of hypertension was of almost identical quality. *J Hypertens* 24:293–299 © 2006 Lippincott Williams & Wilkins.

Journal of Hypertension 2006, 24:293–299

Keywords: epidemiology, Germany, hypertension, prevalence, regional disparities

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Sponsorship: SHIP is part of the Community Medicine Research net (CMR) of the University of Greifswald, Germany, which is funded by the Federal Ministry of Education and Research (grant no. ZZ9603), the Ministry of Cultural Affairs as well as the Social Ministry of the Federal State of Mecklenburg-West Pomerania. The KORA research platform was initiated and financed by the GSF-National Research Center for Environment and Health, which is funded by the German Federal Ministry of Education, Science, Research and Technology and by the State of Bavaria.

Received 19 July 2005 Revised 17 October 2005
Accepted 3 November 2005

Introduction

High blood pressure is one of the most prevalent risk factors for cardiovascular diseases (CVD) and it is a leading risk factor for overall mortality and global disease burden [1,2]. It has also been demonstrated convincingly that adequate management of individuals with hypertension can effectively reduce the morbidity and mortality due to stroke and myocardial infarction [3]. A recent study reported that age-specific mean blood pressure and hypertension prevalence differed substantially in population-based samples from six European countries and from Canada and the United States [4]. Moreover, at any age between 35 and 74 years, the proportion of hypertensives treated and controlled to target levels was much higher in the North American than the European

populations [5]. The highest blood pressure levels and hypertension prevalences, and a comparatively low degree of hypertension control, were found in Germany, which was represented by data from the 1998 National Health Survey. Additional analyses of this survey showed that hypertension levels in East Germany were significantly higher than in West Germany [6]. Partly due to the small numbers of subjects available for each of the 120 sampling points [7], more detailed analyses of these differences were not carried out by region. Therefore we analysed data from two large population-based surveys, the Study of Health in Pomerania (SHIP) in the north-east and the Kooperative Gesundheitsforschung in der Region Augsburg (KORA) Survey in the south-west of Germany. These studies, conducted in two selected

regions with great differences in mortality within Germany [8,9], were carried out almost concurrently using standardized examination methods. The purpose of the present study was to investigate regional variations in the prevalence, awareness, treatment and control of hypertension among 25–74-year-old men and women within Germany.

Methods

Study population

The Study of Health in Pomerania (SHIP)

SHIP was a cross-sectional population study in the north-eastern region of Germany, involving the three cities Greifswald, Stralsund and Anklam, and 29 surrounding communities (Fig. 1) [10]. From over 200 000 inhabitants with German citizenship living in the study area, a sample of 7008 persons aged between 20 and 79 years was selected from population registries, using a two-stage cluster sampling method adopted from the WHO MONICA Project, Augsburg, Germany [11]. Data were collected between October 1997 and May 2001. The net sample (i.e. without migrated or deceased persons) consisted of 6267 eligible subjects, of which 4310 participated (corresponding to a net response of 68.8%). Eleven participants with missing data on hypertension classification were excluded, as well as 555 subjects in the age groups 20–24 and 75–79 years, which were outside the range of the age distribution compatible with the KORA

Augsburg sample. Ultimately, data from 3744 individuals were analysed in the present study.

Kooperative Gesundheitsforschung in der Region Augsburg (KORA)

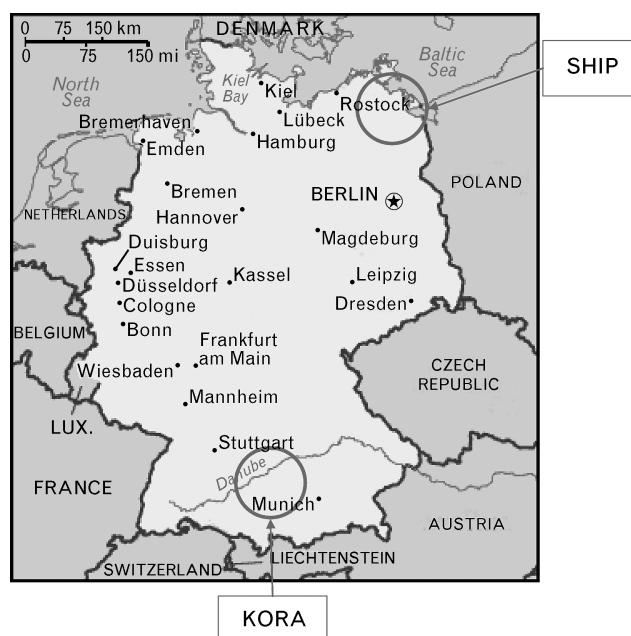
The KORA Survey 2000 was a cross-sectional study in the south-western region of Germany, encompassing the city of Augsburg and 16 towns and villages in the two surrounding rural districts from an area with about 600 000 inhabitants in 1999 (Fig. 1). A two-stage cluster sampling method, as previously applied within the WHO MONICA Augsburg project, was used [11]. The study was performed from October 1999 to April 2001. From a total sample of 6640 individuals randomly selected, 260 subjects were excluded due to migration, death or language problems. From the net sample of 6380 eligible individuals with German citizenship, 4261 participated in the study (net response 66.8%). Participants with missing data on blood pressure ($n = 20$) and with ages outside the range 25–74 years at the date of baseline examination ($n = 17$) were excluded. Thus, the present analyses comprised 4224 participants aged 25–74 years.

Interview and physical examination

In both studies, baseline information on sociodemographic variables, smoking habits, alcohol consumption and medical history were gathered by trained and certified staff during standardized personal interviews. These interviews also included questions related to the awareness, diagnosis and treatment of hypertension. In addition, all participants underwent an extensive standardized medical examination, including the collection of a blood sample. All measurement procedures have been described in detail elsewhere, for both studies [10,11]. Information concerning medical drug use was also obtained. All participants were asked to bring to the interview all medications taken in the 7 days (KORA Survey 2000) or 14 days (SHIP) preceding the examination. The drugs were categorized according to the Anatomical Therapeutic Chemical (ATC) classification index [12]. In both studies, medications were identically assigned as 'antihypertensive medication' only if the compounds taken were classified as antihypertensively effective by the most recent guidelines of the German Hypertension Society [13].

Blood pressure measurement techniques were very similar in SHIP and KORA. Systolic and diastolic blood pressure were measured three times at the right arm of seated subjects, after at least 5 min at rest, and by use of an oscillometric digital blood pressure monitor (HEM-705CP, Omron Corporation, Tokyo, Japan). The pause between readings was 3 min. One of two cuff sizes was applied, according to the circumference of the participant's arm. The mean of the second and third measurements was calculated and used for the present analyses.

Fig. 1



Regional location of the Study of Health in Pomerania (SHIP) and Kooperative Gesundheitsforschung in der Region Augsburg (KORA) study populations.

Subjects were defined as being hypertensive if they had a systolic blood pressure ≥ 140 mmHg and/or a mean diastolic blood pressure ≥ 90 mmHg, or if they were taking antihypertensive medication, given that the subjects were aware of having hypertension. All hypertensive persons were categorized into one of the following four subgroups: (1) unaware of hypertension; (2) aware of hypertension, but not antihypertensive treated; (3) aware of hypertension, but not reaching blood pressure values below target levels, that is, systolic blood pressure < 140 mmHg and diastolic blood pressure < 90 mmHg, with treatment of hypertension; (4) aware of hypertension and controlled antihypertensive treated, defined as reaching blood pressure values below target levels. Thus, 'awareness' of hypertension was given for subjects in category 2, 3 and 4, 'treatment' of hypertension for persons in category 3 and 4, and 'control' of hypertension for subjects in category 4.

Informed consent was obtained from every participant in the studies. For both studies the survey and study methods were approved by an institutional review board.

Statistical methods

We report age- and sex-specific means of systolic and diastolic blood pressure and prevalences of hypertension, as well as the percentages of awareness, treatment and control. Overall means and prevalences were standardized directly to the German standard population as of 31 December 2000. Results are given with 95% confidence interval (95% CI). Group results for continuous variables are compared using unpaired *t*-tests, and for categorized variables chi-squared tests were employed. All analyses were performed using the Statistical Analysis System (Version 8.2, SAS Institute Inc., Cary, North Carolina, USA).

Results

Some baseline characteristics of the SHIP and KORA populations are displayed in Table 1. SHIP participants showed a more unfavourable cardiovascular risk factor

profile with respect to regular smoking, history of diabetes, body mass index (men only) and total cholesterol/high-density lipoprotein cholesterol ratio (women only) than KORA participants. Furthermore, men and women in SHIP reported less frequently regular occupational activities and high educational levels, respectively, compared with men and women in KORA.

Blood pressure distributions in SHIP and KORA

In both populations the mean systolic blood pressure (SBP) increased consistently up to the age 65–74 years for men and women. By contrast, the mean diastolic blood pressure (DBP) increased only up to age 45–54 years and declined thereafter (Table 2). The mean blood pressure values in SHIP were significantly higher in each age and sex group as compared to the KORA participants. The means (SBP/DBP, mmHg) for 25–74-year-old men in SHIP were 141.3/86.7 and for men of the same age group in KORA 133.1/82.9. The respective values for women were 128.4/81.2 and 122.1/77.6. Figure 2 shows the age-standardized smoothed density estimation of distribution of SBP and DBP for both sexes together in SHIP and KORA. The overall distribution of SBP and DBP is shifted to higher values in the SHIP population.

The overall age-standardized SBP difference between SHIP and KORA was 8.2 mmHg (95% confidence interval: 7.2–9.3 mmHg) in men and 6.3 mmHg (95% CI: 5.3–7.3 mmHg) in women. The respective DBP differences were 3.8 mmHg (95% CI: 3.2–4.5 mmHg) and 3.6 mmHg (95% CI: 3.0–4.2 mmHg). These differences were highly significant (each $P < 0.0001$) (Table 2).

Prevalence of hypertension in SHIP and KORA

The prevalence of hypertension was also significantly higher in the SHIP population, both for men and women and in each age group (Table 3). The age-standardized prevalence of hypertension for 25–74-year-old men was 60.1% in SHIP and 41.4% in KORA; the corresponding values for women were 38.5 and 28.6%.

Table 1 Baseline characteristics of the SHIP and KORA study populations

Characteristics	Men			Women		
	SHIP	KORA	<i>P</i> value	SHIP	KORA	<i>P</i> value
Age (years)	50.7	49.6	0.0141	48.8	48.8	0.8408
Body mass index (kg/m ²)	27.9	27.5	0.0026	27.1	26.9	0.5290
Total cholesterol/HDL cholesterol ratio	4.8	4.8	0.9336	3.9	3.8	0.0297
Alcohol consumption (g/day)	21.9	23.5	0.0058	6.1	8.6	< 0.0001
Regular smoking (%)	31.7	26.8	0.0025	23.1	18.7	0.0006
History of diabetes (%)	7.9	4.3	< 0.0001	6.6	3.6	< 0.0001
Regular occupational activities (%)	49.5	66.2	< 0.0001	48.9	45.8	0.0491
Education						
low (%)	40.7	54.8	< 0.0001	35.9	53.4	< 0.0001
medium (%)	42.0	18.6		49.3	27.6	
high (%)	17.3	26.5		14.8	19.0	

SHIP, Study of Health in Pomerania; KORA, Kooperative Gesundheitsforschung in der Region Augsburg. HDL, high-density lipoprotein.

Table 2 Mean systolic (SBP) and diastolic blood pressure (DBP) in the SHIP and KORA surveys, by age and sex

Age (years)	SHIP		KORA	
	SBP, mean (SE)	DBP, mean (SE)	SBP, mean (SE)	DBP, mean (SE)
Men				
25–34	133.4 (0.76)	81.0 (0.49)	125.8 (0.60)	78.4 (0.39)
35–44	137.2 (0.81)	87.2 (0.56)	129.0 (0.67)	83.6 (0.48)
45–54	144.3 (1.04)	91.6 (0.61)	133.8 (0.81)	87.2 (0.51)
55–64	146.3 (0.98)	88.7 (0.53)	137.8 (0.94)	83.4 (0.53)
65–74	149.5 (1.04)	84.9 (0.56)	144.2 (1.02)	81.7 (0.52)
25–74*	141.3 (0.41)	86.7 (0.25)	133.1 (0.35)	82.9 (0.22)
Women				
25–34	115.8 (0.68)	75.9 (0.48)	110.1 (0.52)	73.1 (0.38)
35–44	120.1 (0.73)	79.8 (0.48)	115.1 (0.65)	76.7 (0.45)
45–54	130.9 (0.93)	84.3 (0.52)	126.4 (0.84)	81.9 (0.46)
55–64	137.1 (0.92)	84.2 (0.48)	129.1 (0.92)	78.8 (0.49)
65–74	146.8 (1.25)	83.5 (0.65)	136.7 (1.09)	78.3 (0.54)
25–74*	128.4 (0.39)	81.2 (0.23)	122.1 (0.35)	77.6 (0.21)

SHIP, Study of Health in Pomerania; KORA, Kooperative Gesundheitsforschung in der Region Augsburg; SE, standard error of the mean. *Age standardized according to the age distribution of the population of Germany, 31 December 2000.

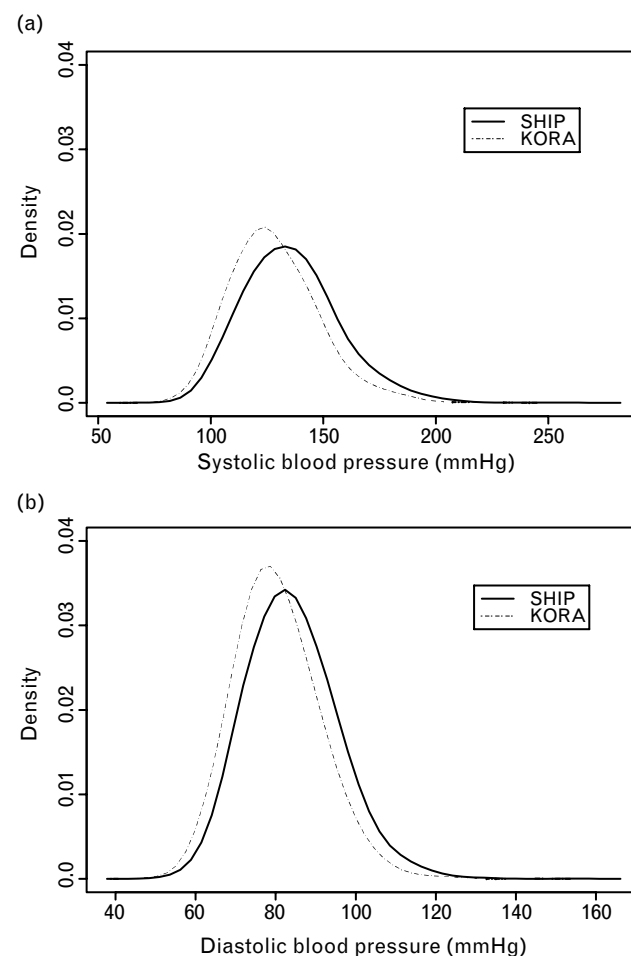
Awareness, treatment and control of hypertension in SHIP and KORA

Both for men and women and in each age group there was a striking similarity between the two populations with regard to the proportions of awareness, treatment and control among all hypertensives (Tables 4 and 5). The overall age-standardized comparison demonstrated no statistically significant variation in the percentages of aware, treated and controlled hypertensives, either in men ($P = 0.564$) or in women ($P = 0.858$; Tables 4 and 5). In both populations, men were less aware of hypertension than women, and the proportion of those who were aware but untreated despite high blood pressure values on examination was also higher in men. In both studies, women were more frequently treated and the proportion reaching target levels with antihypertensive medication was more than

Table 3 Prevalence of hypertension in the SHIP and KORA surveys, by age and sex

Age (years)	SHIP			KORA		
	n	(%)	95% CI	n	(%)	95% CI
Men						
25–34	311	35.4	30.1–40.7	407	16.0	12.4–19.5
35–44	359	51.5	46.4–56.7	410	31.0	26.5–35.5
45–54	347	69.5	64.6–74.3	424	46.2	41.5–51.0
55–64	412	73.3	69.0–77.6	441	54.7	50.0–59.3
65–74	394	81.2	77.4–85.1	391	70.8	66.3–75.4
25–74*	1823	60.1	57.9–62.3	2073	41.4	39.1–43.1
Women						
25–34	378	10.9	7.7–14.0	433	4.2	2.3–6.0
35–44	402	20.7	16.7–24.6	462	13.4	10.3–16.5
45–54	394	43.2	38.3–48.0	458	36.7	32.3–41.1
55–64	445	60.7	56.1–65.2	434	42.9	38.2–47.5
65–74	302	74.5	69.6–79.4	364	61.5	56.5–66.5
25–74*	1921	38.5	36.6–40.4	2151	28.6	26.9–30.3

SHIP, Study of Health in Pomerania; KORA, Kooperative Gesundheitsforschung in der Region Augsburg; CI, confidence interval. *Age standardized according to the age distribution of the population of Germany, 31 December 2000.

Fig. 2

(a) Smoothed density estimation of the distribution of systolic blood pressure in the Study of Health in Pomerania (SHIP) and Kooperative Gesundheitsforschung in der Region Augsburg (KORA) study populations. (b) Smoothed density estimation of the distribution of diastolic blood pressure in the SHIP and KORA study populations.

twice that in men Tables 4 and 5). Generally, in SHIP and KORA awareness and treatment of hypertension increased with age in both sexes and was highest in the age group 65–74 years.

Among the persons with antihypertensive medication in SHIP, 43, 34 and 22% were receiving 1, 2 and 3 classes of antihypertensive drugs, respectively. The corresponding percentages in KORA were 45, 34 and 21%. The most often used antihypertensive drug classes were beta-blockers, diuretics, angiotensin-converting enzyme (ACE) inhibitors and calcium antagonists, with a frequency of 54, 29, 48 and 38% in SHIP and a frequency of 50, 47, 34 and 29% in KORA, respectively.

Discussion

This comparison of two recent population-based surveys performed almost concurrently in Germany demonstrates

Table 4 Comparison of hypertension awareness, treatment and control in men between KORA and SHIP, by age group

Men					
Age (years)	<i>n</i>	Aware, controlled, treated, % (95% CI)	Aware, not controlled, treated, % (95% CI)	Aware, not treated, % (95% CI)	Unaware, % (95% CI)
SHIP					
25–34	110	3.6 (–)	3.6 (–)	36.4 (27.3–45.4)	56.4 (47.1–65.7)
35–44	185	7.0 (3.3–10.7)	16.8 (11.4–22.2)	35.1 (28.2–42.0)	41.1 (34.0–48.2)
45–54	239	5.4 (2.6–8.3)	25.1 (19.6–30.6)	26.4 (20.8–32.0)	43.1 (36.8–49.4)
55–64	299	9.7 (6.3–13.1)	34.1 (28.7–39.5)	14.7 (10.7–18.7)	41.5 (35.9–47.1)
65–74	318	15.1 (11.2–19.0)	42.8 (37.3–48.2)	7.2 (4.4–10.1)	34.9 (29.7–40.2)
25–74*	1151	8.4 (6.9–10.0)	26.2 (23.7–28.6)	23.0 (20.5–25.6)	42.4 (39.4–45.3)
KORA					
25–34	64	3.1 (–)	1.6 (–)	34.4 (22.6–46.1)	60.9 (48.9–73.0)
35–44	127	2.4 (–)	4.7 (1.0–8.4)	36.2 (27.8–44.6)	56.7 (48.0–65.3)
45–54	195	7.2 (3.5–10.8)	14.4 (9.4–19.3)	27.2 (20.9–33.4)	51.3 (44.2–58.3)
55–64	241	16.6 (11.9–21.3)	29.9 (24.1–35.7)	22.4 (17.1–27.7)	31.1 (25.3–37.0)
65–74	276	19.2 (14.5–23.9)	33.0 (27.4–38.5)	16.3 (11.9–20.7)	31.5 (26.0–37.0)
25–74*	903	10.2 (8.4–12.0)	18.0 (15.7–20.2)	26.8 (23.7–29.9)	45.0 (41.7–48.4)

SHIP, Study of Health in Pomerania; KORA, Kooperative Gesundheitsforschung in der Region Augsburg; CI, confidence interval. *Age standardized according to the age distribution of the population of Germany, 31 December 2000.

that blood pressure mean values and hypertension prevalences in all age and sex groups are significantly higher in the north-eastern as compared to the south-western part of the country. Despite the large prevalence differences, the percentage of awareness, treatment and control of hypertension was quite similar in the two populations.

In a recent international comparison [4] the German population stood out from six European and two North American populations as having the highest hypertension prevalences. Data from the German National Health Survey indicated that blood pressure was higher in the East as compared to the West of Germany [6]. Our analyses of the SHIP and KORA surveys permit a regionally more detailed and precise analysis of this issue. The results of this comparison indicate that the variation of blood pressure and hypertension within the population of Germany is as pronounced as the variation reported

between countries in Europe by Wolf-Maier *et al.* [4]. Transposed into the framework of the international comparison, average blood pressure levels and hypertension prevalence in KORA are among the lowest, and those in SHIP are among the highest in Europe. Regionalized official mortality data from Germany seem to support our findings by showing that the mortality rates due to ischaemic heart disease and cerebrovascular disease persisted at higher levels in East Germany despite the substantial declines that occurred after the reunification [8,9]. In the year 2000 cardiovascular disease mortality in the 25–74-year-old German population was 321.5/100 000 in men and 141.8/100 000 in women in the study region of SHIP; the corresponding values for the study region of KORA were 278.4/100 000 in men and 116.0/100 000 in women.

We show here that the entire distribution of blood pressure is shifted to higher values in the SHIP

Table 5 Comparison of hypertension awareness, treatment and control in women between KORA and SHIP, by age group

Women					
Age (years)	<i>n</i>	Aware, controlled, treated, % (95% CI)	Aware, not controlled, treated, % (95% CI)	Aware, not treated, % (95% CI)	Unaware, % (95% CI)
SHIP					
25–34	40	15.0 (3.8–26.2)	–	47.5 (31.8–63.2)	37.5 (22.3–52.7)
35–44	83	15.7 (7.8–23.5)	14.5 (6.8–22.1)	33.7 (23.5–44.0)	36.1 (25.7–46.5)
45–54	170	21.2 (15.0–27.3)	21.8 (15.5–28.0)	28.8 (22.0–35.7)	28.2 (21.4–35.0)
55–64	270	25.2 (20.0–30.4)	35.9 (30.2–41.7)	12.2 (8.3–16.1)	26.7 (21.4–32.0)
65–74	222	19.4 (14.2–24.6)	44.6 (38.0–51.1)	10.4 (6.3–14.4)	25.7 (19.9–31.4)
25–74*	785	20.8 (18.0–23.6)	30.1 (27.1–33.2)	20.4 (17.6–23.2)	28.7 (25.5–31.9)
KORA					
25–34	18	–	–	–	–
35–44	62	9.7 (2.3–17.1)	19.4 (9.4–29.3)	35.5 (23.5–47.5)	35.5 (23.5–47.5)
45–54	166	21.1 (14.9–27.3)	16.9 (11.2–22.6)	21.1 (14.9–27.3)	41.0 (33.5–48.5)
55–64	185	30.3 (23.6–36.9)	27.0 (20.6–33.4)	21.6 (15.7–27.6)	21.1 (15.2–27.0)
65–74	222	30.6 (24.6–36.7)	41.9 (35.4–48.4)	12.6 (8.2–17.0)	14.9 (10.2–19.6)
25–74*	653	24.7 (21.4–28.1)	26.6 (23.3–29.9)	22.3 (18.9–25.6)	26.4 (22.9–29.9)

SHIP, Study of Health in Pomerania; KORA, Kooperative Gesundheitsforschung in der Region Augsburg; CI, confidence interval. *Age standardized according to the age distribution of the population of Germany, 31 December 2000.

population. This is demonstrated by the substantially and consistently higher blood pressure values in any age and sex group. The observed differences in hypertension prevalence between SHIP and KORA might be related to differences in both biological and lifestyle components [14,15]. However, the detailed investigation of possible factors responsible for such a shift of the blood pressure distribution of the population of Pomerania is beyond the scope of this analysis.

Commonly applied quality indicators of hypertension management in the community, that is, the percentage of awareness, treatment and control of hypertension, were very similar in SHIP and KORA. Their overall level, as outlined in Tables 4 and 5, corresponds well with findings from other studies conducted concurrently in Europe [16,17]. Likewise, the German National Health Interview and Examination Survey 1998 documented almost identical relative proportion of awareness, treatment and control of hypertension in 18–79-year-old men and women [6].

We emphasize with our finding that the much higher burden of hypertension in SHIP apparently did not adversely affect the quality of hypertension management at the community level. However, the present situation still leaves ample room for considerable improvement in both German regions, in particular in comparison with North America. Furthermore, despite regional homogeneity of health care delivery in Germany, differences in standard of care between SHIP and KORA cannot entirely be excluded.

A critical point in any comparison of results from independent surveys is a potential measurement bias that may arise from the fact that different personnel use different techniques and/or devices. It should be noted, therefore, that the measurement techniques employed in SHIP and KORA were highly standardized and almost identical. Specifically, automated oscillometric blood pressure measurement devices of the same type and manufacturer (OMRON HEM-705CP) were employed in both surveys. This device has successfully passed the evaluation against a standard mercury device according to the British Hypertension Society protocol [18]. Furthermore, the intra-individual blood pressure variability, as an important component of measurement error, was reduced by averaging the last two of three recordings taken from individuals who had rested in a sitting position for at least 5 min. Moreover, all technicians were centrally trained, an elaborate quality assurance program was employed, and all questions related to blood pressure awareness and treatment were identical in SHIP and KORA. We believe, therefore, that the comparability of the survey results is extraordinarily high and that the comparisons are essentially unbiased.

In summary, we found marked differences in average blood pressure and hypertension prevalence between population samples from the north-east and the south-west of Germany. Despite these differences in epidemiology, the quality indicators of hypertension management in the community, that is, awareness, treatment and control of hypertension were very similar. Because there were no differences in sampling protocols, response proportions, measurement procedures, and in the degree of medical care between both studies, it could be assumed that the risk of hypertension is really higher in the north-east. Thus, the present findings provide a possible explanation of the regional differences in mortality from cardiovascular disease. Further research may help to elucidate the causal role of different risk factor patterns that are correlated with blood pressure and hypertension in Germany.

Acknowledgement

SHIP is part of the Community Medicine Research net (CMR) of the University of Greifswald, Germany, which encompasses several research projects that share data of the population-based Study of Health in Pomerania (SHIP; <http://www.medizin.uni-greifswald.de/cm>). The KORA research platform was initiated by the GSF-National Research Center for Environment and Health. We thank all members of the GSF Institute of Epidemiology and the field staff in Augsburg who were involved in the planning and realization of the study.

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