GBE KOMPAKT

ROBERT KOCH INSTITUT

Facts and Trends from Federal Health Reporting

Key messages

- Blood pressure in adults in Germany has fallen significantly in the period between 1997-1999 and 2008-2011. This positive trend is more pronounced among women than men.
- The porportions of adults who are aware of having hypertension, who are treated, and who are controlled, have increased.
- A third of adults are estimated to have hypertension. One in four adults in Germany take antihypertensive medication.
- Only one in three adults in Germany has an optimal blood pressure without treatment.
- Among women of low socioeconomic status mean systolic blood pressure (SBP) is higher than in women of high socioeconomic status. In men, the opposite is true. No difference is to be observed in the degrees of awareness, treatment or control depending on socioeconomic status.

Vol 6, No 4/2015

High blood pressure: A concern for everyone

Blood pressure is vital to blood flow and circulation and hence to supplying oxygen and nutrients to organs and the entire body. During physical exercise or excitement, blood pressure increases without being harmful to health. However, if blood pressure is elevated in the long term and even at rest this becomes harmful for the heart and blood vessels.

When is blood pressure considered to be elevated? According to current guidelines the threshold for hypertension is 140/90 mmHg (Mancia et al. 2013). Above this threshold, treatment is recommended; however, below this limit, blood pressure is not harmless. Observational studies have shown that the relationship between blood pressure and the occurrence of cardiovascular events such as stroke, coronary heart disease, heart failure, peripheral artery disease, and chronic kidney disease ranges a from high values down to relatively low values of 115 mmHg systolic and 75 mmHg diastolic (Stamler et al. 1993). Therefore only a blood pressure of under 120/80 mmHg is considered optimal whilst the range between 120/80 mHg to below 140/90 mmHg is subdivided in the European guidelines into "normal" and "high-normal".

Raised blood pressure can occur as a result of certain diseases or, much more frequently, via the interaction of genetic disposition, age, gender and various unfavourable nutritional and lifestyle conditions such as overweight, high consumption of table salt and alcohol, lack of exercise and stress (Carretero, Oparil 2000). Hypertension is a major risk factor for cardiovascular diseases such as stroke, coronary heart disease and heart failure, but also for chronic kidney disease and dementia. These diseases are widespread within the population and will become even more frequent due to demographic change both in Germany and worldwide (Mathers, Loncar 2006).

The World Health Organization (WHO) estimates that since 2010, elevated blood pressure has moved up to become the greatest global health risk (Lim et al. 2012). WHO calculations estimate that hypertension is involved in 13 % of all deaths, i. e. 9.4 million deaths per annum (Lim et al. 2012) and is responsible for more than half of all strokes as well as almost half of all cases of ischemic heart disease (Lawes et al. 2008). According to estimates in the 2010 Global Burden of Disease Study, hypertension had the second highest share of the total burden of disease in Germany (ranking equally alongside increased Body Mass Index and after unhealthy diet) (Plass et al. 2014). Small shifts in BP distribution among the entire population can have great effect.

With regard to population mean values for systolic blood pressure it has been shown that a decrease of 2 mmHg leads to a reduction in stroke mortality of around 10 % and 7 % in coronary heart disease mortality (Lewington et al. 2002). In children and adolescents on the one hand the focus – especially in the preschool age group, is on the detection of renal disorders and other rare causes of

Definition of hypertension

Clinical diagnosis - hypertension

Hypertension is defined as a permanent increase in resting "office blood pressure" systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg. It is recommended making a diagnosis based on two in-practice measurements of resting blood pressure per patient visit in at least two examinations (DGK 2014) and if required supplementing this by 24-hour ambulatory BP measurement independent of the doctor's surgery or by measuring BP in the home environment.

Definitions as per the German National Health Interview and Examination Survey (GNHIES) and the German Health Interview and Examination Survey for Adults (DEGS1)

Systolic blood pressure:	Standardised resting systolic blood pressure measures, two successive measurements, mean of the second and third measurements
Diastolic blood pressure:	Standardised resting diastolic blood pressure measures, two successive measurements, mean of the second and third measurements
Hypertensive reading:	Standardised measured BP ≥ 140 mmHg or diastolic ≥ 90 mmHg
Hypertension:	Standardised measured hypertensive reading or intake of antihypertensive medication in the past 7 days if they were aware of having hypertension
Hypertension awareness:	Hypertension in individuals who had reported that they had already been clinically diagnosed with elevated or too high blood pressure
Hypertensive reading without previous diagnosis of hypertension:	Hypertensive measurement in individuals who answered no to the question asking if they had ever been clinically diagnosed with elevated or high blood pressure.
Treated Hypertension:	Hypertension awareness and intake of medications with antihypertensive main effect: Diuretics (ATC code C03), beta blockers (C07), calcium channel blockers (C08), agents acting on the renin-angiotensin system (C09) and antihypertensive drugs (C02)
Controlled Hypertension:	Treated hypertension with systolic blood pressure of < 140 mmHg and diastolic blood pressure of < 90 mmHg

secondary hypertension (high BP due to another illness). On the other hand, elevated BP among children even of school age is in most cases associated with lifestyle factors. It is true that secondary diseases/complications such as strokes, heart attacks or chronic kidney disease typically do not occur until adulthood but elevated BP in childhood is correlated with hypertension in adulthood (Chen, Wang 2008) and is therefore part of a chain of risk. Furthermore, in children with elevated BP, thickening of the heart muscle wall and atherosclerotic changes in the arteries may already be seen in childhood or adolescence (Daniels et al. 1998, Pall et al. 2003, Litwin et al. 2006, Reinehr et al. 2006, Brady et al. 2008).

Blood pressure is a concern for everyone: Everyday factors have a lifelong bearing on BP (diet, exercise, alcohol consumption, stress management), which we can help to shape both as individuals and as a society. There is significant potential here for preventing high blood pressure through careful analysis of the possible causes, providing advice and support for changing habits and creating favourable conditions for this kind of improvement in lifestyle habits, if possible throughout the entire population.

This edition of GBE kompakt presents current figures and trends regarding blood pressure in Germany and focusses on two topics: the distribution of blood pressure measurements in the general population and the treatment of hypertension.

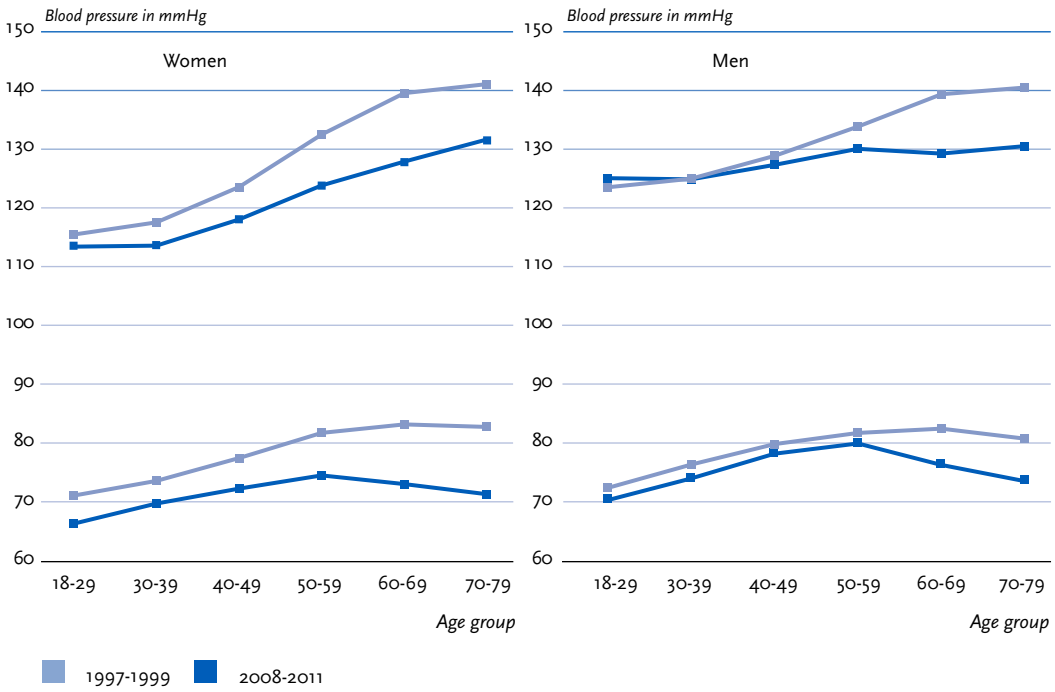
Blood pressure has decreased in Germany

The Robert Koch Institute examination surveys provide nationwide data on blood pressure in adults in Germany based on standardised resting blood pressure measurements. A comparison of the German National Health Interview and Examination Survey 1997-1999 (GNHIES98) and the German Health Interview and Examination Survey for Adults 2008-2011 (DEGS1) shows that blood pressure in Germany has decreased (Figure 1). For this and all subsequent comparative analyses GNHIES98 data has been standardised to the population as of 31/12/2010.

Since different measuring devices were used in the two studies, the blood pressure readings in GNHIES98 were calibrated to the new device, i. e. converted on the basis of measurements with both devices in a random sample of volunteers (Neuhauser et al. 2015). In 18 to 79-year-old age group mean systolic and diastolic blood pressure among women has fallen by 7 mmHg, in men systolic and diastolic blood pressure have fallen by 3 mmHg. In almost all age groups the percentages of men and women with optimal blood pressure has increased and the percentages with hypertensive blood pressure have fallen. There has been a shift in the overall blood pressure distribution within the population towards lower readings (Neuhauser et al. 2015).

Nevertheless, only 53 % of women and 29 % of men have optimal blood pressure (41 % overall, Table 1). At the same time, it should be borne in mind that blood pressure readings may also be within the optimal range in cases of hypertension, namely given drug treatment. Without taking antihypertensive medication only 47 % of women and 23 % of men have an optimal blood pressure, which equates to approximately one third of adults between the ages of 18 and 79.

Figure 1
Systolic and diastolic blood pressure in Germany 1997–1999 vs. 2008–2011
Data source: GNHIES98, DEGS1



An estimated one third of all adults have hypertension

One in three adults in Germany suffers from high blood pressure according to estimates of the DEGS1 Study (women 30 %, men 33 %). This includes both men and women who are aware of having hypertension as well as those who as part of the study were found to be above the hypertension threshold of 140/90 mmHg following three successive measurements and averaging of the second and third readings, although they stated they did not have high blood pressure (Figure 2).

This is an internationally common method for estimating the prevalence of undiagnosed hypertension in the general population, but is not adequate for a clinical diagnosis of hypertension where blood pressure readings are required to be taken on at least two different appointments and if necessary, possibly supplemented via 24-hour ambulatory blood pressure measurement and self-measurement (cf. info box). The proportion of the group with hypertensive blood pressure values without a previous diagnosis of hypertension in the total group with hypertension has decreased significantly between the studies (1997-1999 and 2008-2011) because the degree of awareness with regard to hypertension has increased. The prevalence of hypertension increases constantly with age and is over 70 % among 65 to 79-year-olds.

Whilst in the younger age group(s) significantly more men have hypertension than women, age-specific prevalences become more equal with age. Overall the number of hypertensive men in Germany in the period 2008-2011 is estimated at 10.6 million and that of women at 9.6 million. These figures also include those who no longer have hypertensive blood pressure readings under medication for high blood pressure (controlled hypertension).

Systolic and diastolic blood pressure

The upper or systolic number (SBP) is the pressure in the arteries when the heart pumps blood. The lower or diastolic number (DBP) is the pressure in the arteries between two heartbeats when the heart is refilling with blood. Blood pressure is measured in millimetres of mercury (mmHg).

High blood pressure (Hypertension)

High blood pressure or hypertension is defined as the longterm increase in blood pressure to values equal to or above 140 mmHg systolic or 90 mmHg diastolic.

Classification of blood pressure levels in mmHg (European Society of Hypertension, 2013)

Optimal: SBP < 120 and DBP < 80
Normal: SBP 120–129 or DBP 80–84
High normal: SBP 130–139 oder DBP 85–89
Grade 1 hypertension: SBP 140–159 oder DBP 90–99
Grade 2 hypertension: SBP 160–179 oder DBP 100–109
Grade 3 hypertension: SBP ≥ 180 oder DBP ≥ 110

If systolic and diastolic fall into different categories, the higher category applies.

Table 1
Blood pressure among adults in Germany 2008-2011
Data source: DEGS1

	Age groups						Total
	18–29 Years	30–39 Years	40–49 Years	50–59 Years	60–69 Years	70–79 Years	18–79 Years
	% (95%–CI)	% (95%–CI)	% (95%–CI)	% (95%–CI)	% (95%–CI)	% (95%–CI)	% (95%–CI)
Women							
optimal	75.9 (71.3–80.0)	74.3 (68.9–79.0)	61.0 (56.1–65.7)	42.8 (37.7–48.0)	32.9 (27.9–38.4)	22.9 (18.5–28.0)	53.0 (50.7–55.2)
normal	19.2 (15.4–23.5)	17.1 (13.3–21.8)	21.1 (17.5–25.2)	23.1 (19.4–27.2)	22.8 (18.6–27.6)	23.9 (19.9–28.3)	21.1 (19.6–22.8)
high-normal	4.0 (2.4–6.5)	6.3 (4.2–9.5)	9.7 (7.4–12.5)	18.8 (15.1–23.2)	22.6 (18.6–27.1)	20.5 (16.5–25.1)	13.2 (11.9–14.6)
hypertensive	0.9 (0.4–2.1)	2.3 (1.0–5.2)	8.2 (6.1–11.0)	15.3 (12.5–18.7)	21.7 (17.8–26.3)	32.8 (28.1–37.7)	12.7 (11.3–14.3)
Grade 1	0.8 (0.3–1.9)	2.0 (0.9–4.5)	6.9 (5.0–9.6)	13.6 (10.9–16.9)	18.7 (15.2–22.9)	27.4 (23.2–32.1)	10.9 (9.5–12.3)
Grade 2 or 3	0.1 (0.0–1.0)	0.3 (0.0–2.1)	1.3 (0.6–2.8)	1.7 (0.9–3.2)	3.0 (1.5–6.0)	5.4 (3.4–8.4)	1.8 (1.3–2.5)
Men							
optimal	32.6 (28.5–36.9)	34.7 (29.3–40.6)	29.1 (24.8–33.9)	21.6 (18.2–25.4)	27.7 (23.2–32.7)	27.1 (22.4–32.3)	28.8 (26.8–31.0)
normal	36.6 (32.0–41.5)	34.4 (29.1–40.2)	29.5 (25.0–34.4)	26.9 (23.1–31.0)	25.6 (21.7–29.8)	22.5 (18.0–27.7)	29.8 (27.8–31.8)
high-normal	22.7 (18.6–27.5)	23.7 (18.8–29.4)	21.5 (17.7–25.9)	28.2 (23.7–33.0)	22.9 (18.9–27.6)	19.8 (16.1–24.1)	23.3 (21.5–25.2)
hypertensive	8.1 (5.6–11.5)	7.2 (4.6–11.0)	19.9 (16.1–24.3)	23.4 (19.8–27.4)	23.8 (19.4–28.8)	30.7 (25.6–36.3)	18.1 (16.2–20.2)
Grade 1	7.9 (5.5–11.4)	7.2 (4.6–11.0)	17.5 (13.8–21.9)	19.1 (15.9–22.9)	19.4 (15.6–23.9)	27.0 (22.1–32.6)	15.8 (14.0–17.7)
Grade 2 or 3	0.2 (0.0–0.7)	0	2.4 (1.4–4.1)	4.3 (2.6–6.9)	4.4 (2.9–6.6)	3.6 (2.1–6.3)	2.4 (1.8–3.0)
Total							
optimal	53.8 (50.4–57.2)	54.1 (49.7–58.5)	44.7 (41.3–48.2)	32.2 (29.0–35.6)	30.4 (26.8–34.2)	24.8 (21.4–28.6)	41.0 (39.3–42.7)
normal	28.1 (24.9–31.4)	25.9 (22.5–29.7)	25.4 (22.4–28.5)	25.0 (22.2–28.0)	24.1 (21.3–27.3)	23.2 (20.1–26.7)	25.4 (24.2–26.7)
high-normal	13.6 (11.3–16.2)	15.2 (12.3–18.6)	15.7 (13.4–18.3)	23.5 (20.6–26.7)	22.8 (19.8–26.0)	20.2 (17.4–23.2)	18.2 (17.1–19.4)
hypertensive	4.6 (3.3–6.4)	4.8 (3.3–7.0)	14.2 (11.8–17.0)	19.4 (16.8–22.2)	22.7 (19.6–26.2)	31.8 (28.2–35.7)	15.4 (14.1–16.8)
Grade 1	4.4 (3.1–6.2)	4.6 (3.2–6.7)	12.3 (10.0–15.1)	16.4 (14.1–18.9)	19.1 (16.4–22.0)	27.2 (23.8–31.0)	13.3 (12.1–14.6)
Grade 2 or 3	0.2 (0.0–0.5)	0.1 (0.0–1.1)	1.9 (1.2–2.9)	3.0 (2.0–4.4)	3.7 (2.5–5.4)	4.6 (3.2–6.5)	2.1 (1.7–2.6)

Classification of blood pressure levels (in mmHg)
optimal: SBP <120 and DBP <80
normal: SBP 120–129 or DBP 80–84
high-normal: SBP 130–139 or DBP 85–89
Grade 1 hypertension : SBP 140–159 or DBP 90–99
Grade 2 or 3 hypertension: SBP ≥160 or DBP ≥100

Only one in three adults has optimal blood pressure

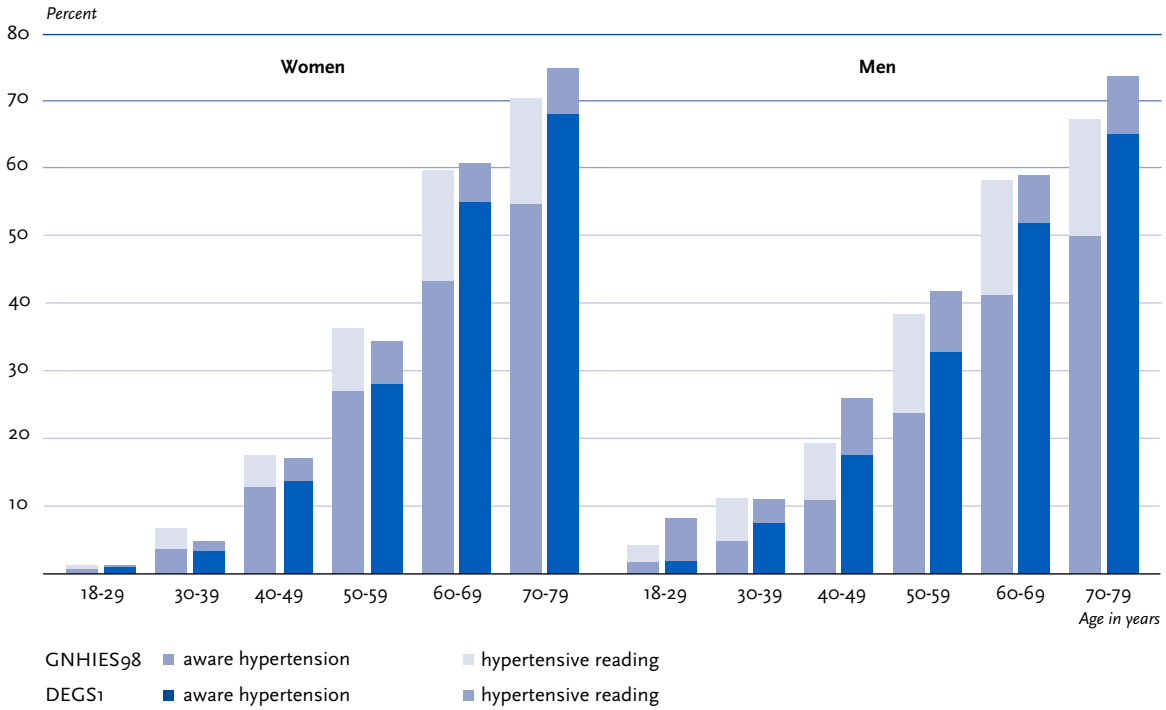
According to estimates from the DEGS1 Study, only one third of 18 to 79-year-olds in Germany (35 %) have an untreated optimal blood pressure, i. e. a blood pressure of under 120/80 mmHg without taking antihypertensive medication (Figure 3). A further third of 18 to 79-year-olds have hypertension - some of which is controlled (controlled under treatment) and some uncontrolled (Figure 3). Less attention has so far been paid to the fact that another third of adults admittedly are not yet deemed to be hypertensive yet do not have an optimal
blood pressure. Their systolic blood pressure is between 120 and 139 mmHg or their diastolic BP between 80 and 89 mmHg and falls into one of two groups - either normal or high-normal (Mancia et al. 2013).

Awareness, treatment and control of hypertension have increased

The degree of awareness, treatment and control of hypertension in Germany have all increased significantly between the 1997-1999 study and that of 2008-2011 (Neuhauser et al. 2015) (Table 2). Awareness of hypertension among women has increased from 74 % to 87 % and among men from 65 % to 78 %.

The percentage of women with hypertension receiving treatment increased from 62 % to 79 % and the percentage of men increased from 48 % to 65 % (the percentages are correspondingly higher if they only relate to those that are aware of having hypertension, Table 2). The percentage of controlled hypertension (BP under 140/90 mmHg) among hypertensive women increased from 25 % to 58 % and in hypertensive men from 20 % to 45 %. Of treated hypertensive women in 2008-2011 study period, 73 % had blood pressure measurements below the hypertension threshold of 140/90 mmHg, in hypertensive men the figure was 70 %.

Figure 2
Aware hypertension and hypertensive readings without diagnosis of hypertension according to age and gender, 1997-1999 and 2008-2011
Data source: GNHIES98, DEGS1



The intake of anti-hypertensive medication has increased

The percentage of men and women taking medication with an anti-hypertensive main effect has significantly increased between 1997-1999 and 2008-2011 (women from 22.1% to 26.5%, men from 17.3% to 24.9%, overall from 19.7% to 25.7%). The intake of these groups of medications was recorded in GNHIES98 and in DEGS1 with respect to the past seven days and coded according to the WHO Anatomical Therapeutic Chemical Classification System (ATC-Code). The groups of drugs with anti-hypertensive main effects are diuretics (ATC-Code C03), beta blockers (C07), calcium-channel blockers (C08), agents acting on the renin-angiotensin system (C09) and antihypertensive drugs (C02).

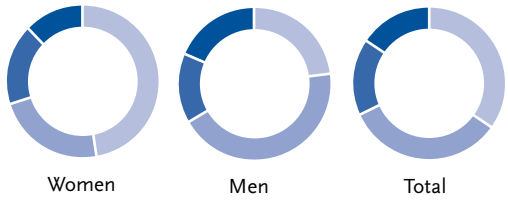
Since the indication for taking these medicines may also be another than elevated blood pressure, these drugs were only counted as hypertensive medication if the participants were aware of having hypertension. Accordingly the proportion of the population taking medication for hypertension increased among women from 18.5% to 23.6%, among men from 14.1% to 21.7% (overall from 16.3% to 22.7%). The proportion taking polytherapy (medication comprising at least two groups of medicines either as separate drugs or

Table 2
Management of hypertension among 18-79-year-old adults 1997-1999 and 2008-2011
Data source: GNHIES98, DEGS1

	Aware hypertension	Treated hypertension	Controlled hypertension	Treatment	Control
	% of adults with hypertension			% of adults with aware hypertension	% of adults with treated hypertension
DEGS1 2008-2011					
Women	86.8	79.1	57.5	91.5	73.0
Men	78.3	65.3	45.4	83.9	69.8
Total	82.3	71.8	51.2	87.7	71.5
GNHIES98* 1997-1999					
Women	73.8	62.0	25.1	84.0	40.6
Men	65.0	47.5	20.3	73.0	43.0
Total	69.4	54.8	22.7	78.8	41.6

* Blood pressure values calibrated based on meter comparison study (Neuhauser et al. 2015)

Figure 3
Proportion of persons with hypertension*, normal to high-normal BP and optimal BP***2008-2011**
Data source: DEGS1



optimal, untreated
normal to high-normal, untreated
hypertension, controlled
hypertension, uncontrolled

* hypertension: blood pressure ≥140/90 mmHg or antihypertensive medication in cases of diagnosed hypertension

** normal to high-normal, untreated: blood pressure 120–139 / 80–89 mmHg without treatment for hypertension

*** optimal, untreated: blood pressure <120 / 80 mmHg without treatment for hypertension

as combined drug products) compared to monotherapy has increased (Figure 4). Altogether, two-thirds of those treated were taking polytherapy (Sarganas et al. 2015).

Changes have also taken place with regard to the classes of drugs used (Figure 5): primarily a significant increase is to be seen in the proportion of hypertensive men and women taking beta blockers, angiotensin receptor blockers and thiazide diuretics but also a reduction among persons who take calcium-channel blockers and antihypertensives (ATC C02) (Sarganas et al. 2015).

Differences according to gender, region and social status

The gender differences in blood pressure and blood pressure management are considerable. From around puberty onward, girls have a lower blood pressure on average than boys. This difference, however, decreases increasingly in adulthood to the extent that women have approximately the same blood pressure as men from around the sixth decade of their lives onward (Neuhauser et al. 2013). In both the 1997-1999 and the 2008-2011 study, women had lower mean systolic and diastolic blood pressure readings than men. Even the trends are not equally pronounced: The mean blood pressure readings among women have fallen to a greater extent than among men. The prevalence of hypertension in the whole group of 18 to 79-year-olds is, on the other hand, only slightly lower in women than among men (30 % vs. 33 % in 2008-2011). In younger age groups, however, the differences in prevalence are large. Women still have higher rates of hypertension awareness, treatment and control (cf. Table 2, Neuhauser et al. 2015, Sarganas, Neuhauser 2015). Among young men mean SBP has increased slightly (in 18 to 29-year-olds by 1.5 mmHg between 1997-1999 and 2008-2011) and the prevalence of hypertension has increased.

There has been no improvement in the degree of hypertension awareness, treatment or control (Neuhauser et al. 2015). Differences according to socioeconomic status were to be observed 2008-2011, especially among women. Mean systolic blood pressure for 2008-2011 in women of high socioeconomic status was around 3.2 mmHg lower than in women of low socioeconomic status. In men the difference was reversed and less pronounced (men of high socioeconomic status had a mean systolic blood pressure around 1.7 mmHg higher compared with men of low socioeconomic status). With regard to the prevalence of hypertension, no differences due to socioeconomic status were observed for 2008-2011 among men. In women however, hypertension prevalence was only half as high in the

Figure 4
Drug treatment of women and men with diagnosed hypertension 1997-1999 and 2008-2011
Data source: GNHIES98, DEGS1

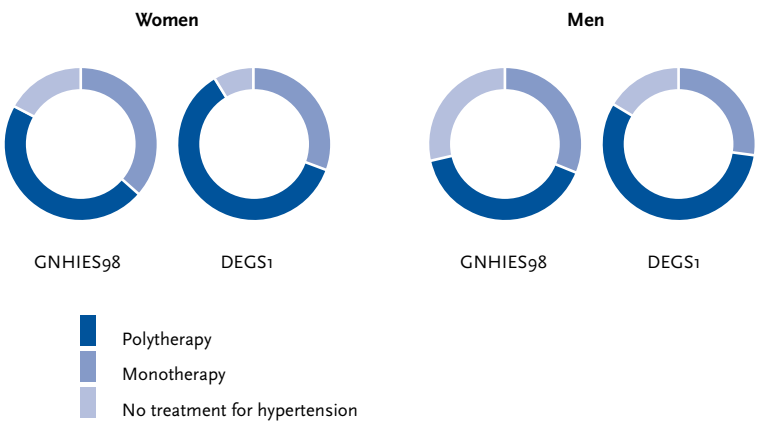
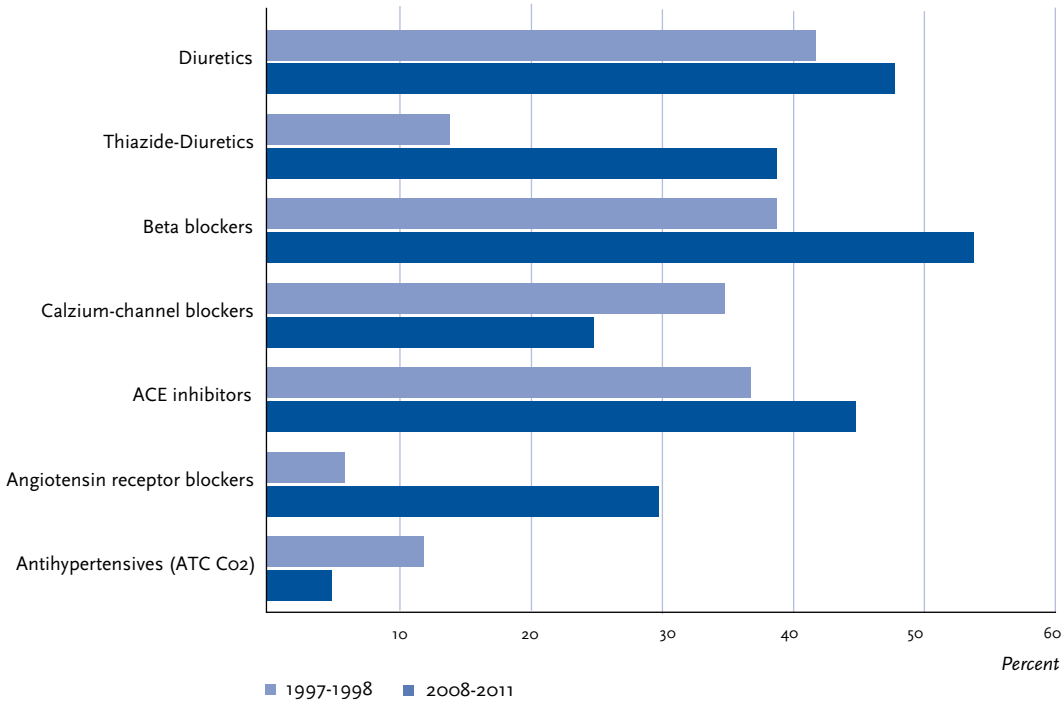


Figure 5
Drug classes used in the treatment of hypertension among 18 to 79-year olds, 1997-1999 and 2008-2011
Data source: GNHIES98, DEGS1



group of high socioeconomic status compared to women of low socioeconomic status (Neuhauser et al. 2013).

No differences related to socioeconomic status were found for the degree of awareness, treatment or control. Among 18 to 79-year-olds with hypertension, antihypertensive medication was taken more often in the group with low (72 %) and medium socioeconomic status (74 %) compared to the group of high socioeconomic status (64 %). The differences no longer existed once other factors, especially age, gender and comorbidities were taken into account (Sarganas et al. 2015). Regional differences in blood pressure in Germany have been reported previously (Thamm 1999, Meisinger et al. 2006).

However, there is only little data available to analyse reginal differences in a differentiated manner. GNHIES98 showed higher blood pressure levels in East compared to West Germany - as had already been indicated in the East-West Health Survey of 1991 (Hoffmeister, Bellach 1995, Bellach 1996). Any further regional differentiation however is not possible using this data. In the DEGS1 Study it was possible to differentiate between five major regions in Germany (Figure 6).

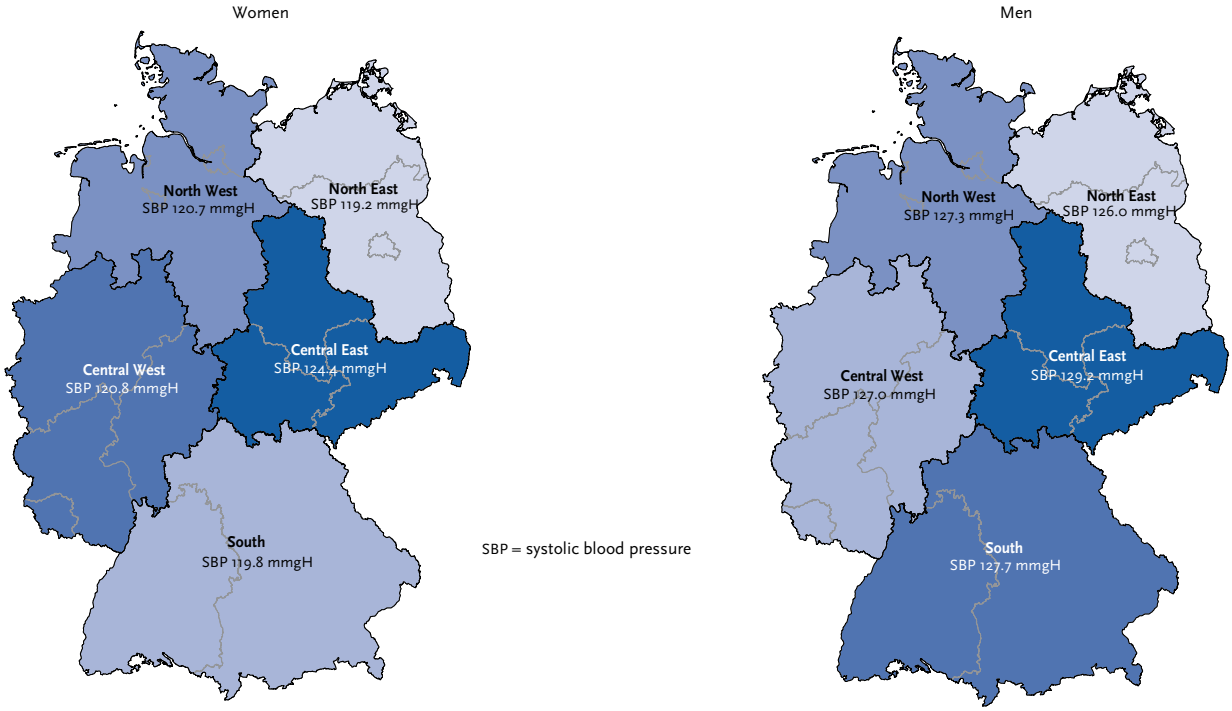
The most pronounced differences were to be seen within two neighboring regions of the former East Germany and not generally between East and West (Diederichs, Neuhauser 2014). The difference in systolic blood pressure between the region with the highest BP levels "Central-East" (Saxony-Anhalt, Saxony, Thuringia) and the region with the lowest blood pressure "North-East" (Mecklenburg-Vorpommern, Brandenburg, Berlin) was 5.2 mmHg in women and 3.2 mmHg in men. The diastolic differences were less pronounced but followed a similar regional pattern. Regional differences in hypertension management were only to be observed among men with a significantly higher rate of hypertension awareness, treatment and control among men in the "North-East" region compared to the "South" (Bavaria, Baden-Wurttemberg).

The influence of demographic change

Since blood pressure increases with age, demographic change is a factor that causes an increase in mean blood pressure and in the prevalence of hypertension in the population. The comparison presented here of the blood pressure situation in Germany between the years 1997-1999 (GNHIES98) and 2008-2011 (DEGS1) shows the development independent of any demographic change since both studies have been standardised to the same population distribution as of 31/12/2010. The prevalence of hypertension in this comparison, which does not take ageing of the population into account, has not increased significantly between the 1997-1999 and 2008-2011 studies.

The impact of demographic change becomes obvious however, if the estimated number of case for adults with hypertension are compared for the periods 1997-1999 (GNHIES98) and 2008-2011 (DEGS1) based on actual age distribution of the population in the aforementioned

Figure 6
Mean systolic blood pressure of men and women according to regions 2008-2011
Data source: DEGS1



periods: For 1997-1999 an estimated 17 million adults had hypertension, for 2008-2011 the figure was 20 million adults.

Blood pressure among children

Blood pressure in children is lower than in adults. There are distribution-based limits although internationally the discussion with regard to the limits and the reference population is still ongoing (Lurbe et al. 2009). Mostly those blood pressure readings are defined as hypertensive which - based on age, gender and height - are above the 95th percentile (above the values for 95 % of the children in a reference population) (Lurbe et al. 2009).

As part of the German Health Interview and Examination Survey for Children and Adolescents (KiGGS 2003-2006) it was possible for the first time to examine blood pressure among children on a nationwide basis using standardised measurements. Percentiles were developed for blood pressure in children and adolescents with relation to age, gender and body height based on a non-overweight KiGGS reference population (Neuhauser et al. 2011). The results show that the mean systolic blood pressure for average height, non-overweight boys between 3 and 17 years increases from 96 to 123 mmHg and for girls from 97 to 114 mmHg.

Similar to international studies, the KiGGS Study shows the interrelation of elevated blood pressure with other life-style related risk factors such as obesity, abnormal cholesterol levels and tobacco consumption at a young age (Neuhauser et al. 2009). The development of blood pressure among children and adolescents in Germany is currently being examined in KiGGS wave 2 (survey period 2014-2016).

Discussion

The DEGS1 Study shows a significant improvement in the blood pressure situation in Germany albeit there is still great preventive potential. The German National Health Interview and Examination Survey 1997-1999 (GNHIES98) had - in international comparison - revealed high mean systolic and diastolic blood pressure among adults in Germany along with a lower degree of hypertension awareness, treatment and control (Wolf- Maier et al. 2003, Wolf-Maier et al. 2004). These findings appeared plausible since Germany at that point in time also had one of the highest stroke mortality rates compared with other western industrialised nations (Wolf-Maier et al. 2003) and elevated blood pressure is strongly correlated with stroke mortality.

Approximately ten years later, as part of the German Health Interview and Examination Survey for Adults (DEGS1) 2008-2011 it was again possible to take standardised blood pressure readings from a nationwide random sample of 18 to 79-year-olds and collect data with regard to awareness, treatment and control of blood pressure (Neuhauser et al. 2013). For the purpose of comparing the two studies, the blood pressure readings from GNHIES98 were calibrated to reflect the change of measurement device and

the improved choice of cuffs (Neuhauser et al. 2015).

The population-wide reduction in systolic blood pressure by on average 5 mmHg represents a significant decrease in blood pressure, especially if one considers that according to studies, a drop of 2 mmHg leads to a fall in stroke mortality of around 10 %, as well as 7 % in coronary heart disease mortality (Lewington et al. 2002). The marked increase in hypertension treatment may well have played the greatest role in mean blood pressure reduction in Germany.

Due to the amendment of the international guidelines in 1997 and 1999, i. e. the lowering of the hypertension threshold from 160 / 95 mmHg to 140 / 90 mmHg (1997, 1999), significantly more people with elevated blood pressure were treated with medication. The fall in blood pressure and improvement in blood pressure management in Germany in the last fifteen years is confirmed by some regional studies (Lacruz et al. 2015, Ruckert et al. 2015). Regional differences here (Diederichs, Neuhauser 2014) point to the great preventive potential.

In addition to the increase in antihypertensive therapy, changes in life-style factors may also have contributed to blood pressure reduction. For example, the comparison between GNHIES98 and DEGS1 shows an increase in physical activity (Krug et al. 2013) and a higher level of fruit and vegetable consumption (Mensink et al. 2013). Additionally, estimated per capita alcohol consumption has fallen (http://dhs.de/datenfakten/alkohol.html). Unfortunately, current data does not allow reliable statements on the development of salt intake in Germany, even though international estimates suggest that there have been no significant changes (Powles et al. 2013). The increased prevalence of obesity among women and men overall and especially in young adults (Mensink et al. 2013) may have countered the falling blood pressure trend to some extent.

Medication treatment of hypertension is one of the major advances in medicine that have contributed to the reduction in cardiovascular diseases in recent decades. Compared internationally, hypertension awareness, treatment and control levels in Germany 2008-2011 were shown to be at a high level (Gu et al. 2012, Joffres et al. 2013, Falaschetti et al. 2014). Nevertheless, preventive potential remains very high, since hypertension is not always diagnosed and treated. Further improvements are possible as Canada's example shows (Onysko et al. 2006). However, the burden of disease can only be partially reduced through treatment of elevated blood pressure. A considerable portion of blood pressure-associated risk originates from increases in blood pressure that still remain below the hypertension threshold and thus fall short of the levels indicating medical treatment. In other words, even given optimal treatment, blood pressure as a public health problem remains unsolved and a considerable preventive potential remains. There is good evidence to support this (Stamler et al. 1993), but it is not a well-known fact.

Consequently, population-wide improvement in lifestyle habits is highly relevant. Healthy diet - including avoiding high alcohol consumption, increased physical exercise, reduction of overweight and obesity and stress management may all lead to a reduction in blood pressure. The DEGS1 Study showed that only approximately one in six 40 to 79-year-olds in Germany met the recommended threshold value for five important life-style factors (the study examined physical exercise, obesity, smoking, fruit intake and alcohol consumption) (Truthmann et al. 2015) and the KiGGS-Study confirmed that these lifestyle factors already correlate with blood pressure among adolescents.

There is a need to stop seeing blood pressure in the limited medical context of hypertension but instead to view it in the broader context of an important health characteristic that is of significance from childhood onward and is considerably influenced by lifestyle. Successes of prevention will be determined by both individual and societal measures.

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Imprint
GBE kompakt

Publisher
Robert Koch Institute
Nordufer 20
13353 Berlin

Editor
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How to quote this publication
Neuhauser H, Sarganas G (2015)
High Blood Pressure: A concern for everyone.
Publ. Robert Koch Institute, Berlin
GBE kompakt 6(4)
www.rki.de/gbe-kompakt (Last accessed: 10.03.2016)

ISSN 2191-4974
DOI 10.17886/RKI-GBE-2016-004

The Robert Koch Institute is a Federal Institute within the portfolio of the German Federal Ministry of Health