ORIGINAL ARTICLE

Time Trends in Cardiometabolic Risk Factors in Adults

Results from Three Nationwide German Examination Surveys From 1990–2011

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SUMMARY

Background: Data from three representative health examination surveys in Germany were analyzed to examine secular trends in the prevalence and magnitude of cardiometabolic risk factors.

Methods: The target variables were the following cardiometabolic risk factors: lack of exercise, smoking, obesity, systolic blood pressure, total cholesterol, serum glucose, self-reported high blood pressure, hyperlipidemia, and diabetes, and the use of antihypertensive, cholesterol-lowering, and antidiabetic drugs. 9347 data sets from men and 10 068 from women were analyzed. The calculated means and prevalences were standardized to the age structure of the German population as of 31 December 2010 and compared across the three time periods of the surveys: 1990–1992, 1997–1999, and 2008–11.

Results: Over the entire period of observation (1990–2011), the mean systolic blood pressure fell from 137 to 128 mmHg in men and from 132 to 120 mmHg in women; the mean serum glucose concentration fell from 5.6 to 5.3 mmol/L in men and from 5.4 to 5.0 mmol/L in women; and the mean total cholesterol level fell from 6.2 to 5.3 mmol/L in both sexes. In men, smoking and lack of exercise became less common. On the other hand, the prevalence of use of antidiabetic, cholesterol-lowering, and antihypertensive drugs rose over the same time period, as did that of self-reported diabetes. The first of the three surveys (1990–1992) revealed differences between persons residing in the former East and West Germany in most of the health variables studied; these differences became less marked over time, up to the last survey in 2008–2011.

Conclusion: The cardiometabolic risk profile of the German adult population as a whole improved over a period of 20 years. Further in-depth analyses are now planned.

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Cardiovascular diseases and their underlying behavioral and metabolic risk factors cause an estimated 17.5 million deaths per year around the world, accounting for some 31% of all deaths (1, 2). In Germany, the nationwide, representative health examination surveys of the Robert Koch Institute (RKI) provide the opportunity to observe trends in cardiometabolic risk factors over a period of 20 years. In 1990, the last of three national examination surveys was carried out in the framework of the German Cardiovascular Prevention Study (*Deutsche Herz-Kreislauf Präventionsstudie*, DHP) (3). This survey, called NUST2, was representative for the western part of the country, i.e., the former West Germany and gained particular relevance as it was conducted just after the fall of the Berlin wall. A survey analogous to NUST2 was carried out in the former East Germany in 1991/92. The findings of these two surveys, collectively designated the East/West Health Survey 1991 (*Gesundheitssurvey Ost/West 1991*, OW91), yielded the earliest representative health data for Germany after national reunification. OW91 revealed differences in the health status, health-related behavior, and health care between the former East and West Germany (3): for example, lack of exercise, obesity, high blood pressure, and diabetes were much more common in the east than in the west, while the reverse was true for asthma and allergies (4, 5).

In 1998, a new representative health survey called the German National Health Interview and Examination 1998 was carried out (*Bundes-Gesundheitssurvey 1998*, BGS98). The third and latest nationwide examination study considered in this article was the German Health Interview and Examination Survey for Adults 2008–2011 (*Studie zur Gesundheit Erwachsener in Deutschland 2008–2011*, DEGS1) (7), carried out in the framework of the RKI's health monitoring program (6). The results of all three examination surveys were integrated in the federal German health reporting system, which was first mandated by law in 1998 (8).

In this article, we report the first threefold cross-sectional trend analysis of the results of the OW91, BGS98, and DEGS1. Secular trends in the prevalence

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TABLE 1

Description of the study samples*¹

	Period of study								
	1990–1992			1997–1999			2008–2011		
	Number of observations	%, unweighted	%, weighted	Number of observations	%, unweighted	%, weighted	Number of observations	%, unweighted	%, weighted
Total	7466			5825			6124		
Sex									
Men	3641	48.8	50.2	2831	48.6	50.3	2875	47.0	50.2
Women	3825	51.2	49.8	2994	51.4	49.7	3249	53.0	49.8
Region									
Eastern Germany	2038	27.3	16.2	1812	31.1	16.2	1716	28.0	16.7
Western Germany* ²	5428	72.7	83.8	4013	68.9	83.8	4408	72.0	83.3

*¹ men and women aged 25–69, three examination surveys carried out by the Robert Koch Institute, 1990–2011

*² Berlin was considered part of western Germany

of lack of exercise, smoking, obesity, high blood pressure, hyperlipidemia, diabetes, the use of anti-hypertensive, cholesterol-lowering, and antidiabetic drugs, and the mean values of systolic blood pressure, total cholesterol, and serum glucose among adults in Germany are described and evaluated, with attention to differences between the sexes and between persons living in the former East and West Germany.

Methods

Study population

The design and methods of the three surveys were described previously (3, 7, 9); the main facts are summarized in *eTable 1*. Two-staged cluster sampling was used to select 120 to 180 communities at random for each survey (*eTable 1*). The Resident Registration Offices of each community sent randomly selected addresses of adult residents to the Robert Koch Institute (RKI), which then invited these persons to participate in the survey. The subjects were examined and asked to fill out survey questions in temporary study centers located in each community; afterwards, their blood and urine samples were analyzed in a standardized fashion in an epidemiological laboratory of the RKI. In all three surveys except the NUST2, the study population consisted of adults aged 18–79 living in Germany. The NUST2 was designed in conformity to the DHP study, of which it was a component, and included only 25- to 69-year-old subjects of German nationality. We therefore restricted our comparative analysis to persons in this age range. The response rates were 70% for the OW91, 61% for the BGS98, and 62% / 42% for the DEGS1 (longitudinal and cross-sectional study participants, respectively). Separate questioning of non-responders revealed no major differences against responders with respect to basic health variables (10).

The distribution by sex and region of the participants whose data were analyzed is shown in *Table 1*.

Variables and methods of measurement

The criterion for including any particular cardiometabolic risk factor in the present comparative analysis was a (relative) consistency in the method of measurement across all three survey periods. Exercise, smoking, obesity, systolic blood pressure, total cholesterol level, serum glucose, use of a selection of drugs (antihypertensive, cholesterol-lowering, and antidiabetic drugs) and self-reported diabetes, high blood pressure, and hyperlipidemia were compared across the three surveys.

The methods of measurement are described in detail in *eTable 2*. Exercise level was assessed with the question, “How often do you engage in physical exercise?” Smoking behavior was assessed with questions on current and previous smoking. On the basis of their replies to these questions, respondents were characterized as exercisers or non-exercisers, and as current smokers or current non-smokers. Height and weight were measured in standardized fashion, providing the basis for calculating the body-mass index (BMI); in accordance with the WHO guidelines (15), obesity was defined as a BMI of 30 kg/m² or above. Individual lifetime prevalences of high blood pressure, hyperlipidemia, and diabetes were determined by a written questionnaire in the OW91, and by an interview with a physician in the BGS98 and the DEGS1. These data were used to categorize the subjects into those who did or did not report ever having had high blood pressure, hyperlipidemia, and diabetes. Drugs and food supplements consumed in the last 7 days were determined in a standardized personal interview. Drugs were classified according to their anatomic-therapeutic-chemical

TABLE 2

Comparison of weighted and age-standardized prevalences and means*¹

	Men				Women			
	Survey period			p-value	Survey period			p-value
	1990–1992	1997–1999	2008–2011	p ²	1990–1992	1997–1999	2008–2011	p ²
Health-related behavior and BMI								
No exercise (%; 95% CI)	42.0 [39.4; 44.6]	46.7 [44.1; 49.4]	34.0 [31.6; 36.6]	<0.0001*	51.6 [49.1; 54.1]	50.5 [47.7; 53.3]	34.1 [31.8; 36.5]	<0.0001*
Smoking (%; 95% CI)	38.4 [36.4; 40.5]	37.9 [35.3; 40.5]	34.4 [31.8; 37.1]	0.0339*	26.4 [24.6; 28.3]	28.4 [26.3; 30.5]	29.3 [27.2; 31.6]	0.1648
BMI ≥ 30 (%; 95% CI)	18.9 [17.2; 20.8]	21.3 [19.5; 23.2]	24.5 [22.1; 27.0]	0.0023*	21.6 [19.8; 23.4]	23.9 [21.7; 26.3]	23.0 [20.9; 25.3]	0.3149
Blood pressure								
Systolic blood pressure, mmHg (mean; 95% CI)	137.2 [136.2; 138.2]	131.0 [130.2; 131.8]	127.8 [127.0; 128.6]	<0.0001*	132.3 [131.4; 133.2]	127.3 [126.5; 128.2]	120.5 [119.7; 121.2]	<0.0001*
Self-reported hypertension (%; 95% CI)	26.7 [25.1; 28.4]	22.1 [20.3; 24.0]	33.9 [31.7; 36.3]	<0.0001*	24.6 [23.1; 26.3]	22.5 [20.7; 24.4]	29.0 [27.2; 30.9]	<0.0001*
Use of antihypertensive drugs (%; 95% CI)	14.8 [13.4; 16.4]	14.1 [12.5; 15.8]	21.7 [19.8; 23.7]	<0.0001*	17.0 [15.8; 18.3]	18.4 [16.7; 20.4]	21.4 [19.6; 23.4]	0.0006*
Cholesterol								
Total cholesterol, mmol/L (mean; 95% CI)	6.16 [6.11; 6.21]	6.14 [6.08; 6.21]	5.30 [5.24; 5.36]	<0.0001*	6.19 [6.14; 6.24]	6.11 [6.05; 6.16]	5.32 [5.26; 5.39]	<0.0001*
Self-reported hyperlipidemia (%; 95% CI)	27.7 [25.7; 29.9]	27.3 [25.1; 29.5]	28.0 [26.1; 30.0]	0.8727	23.4 [21.7; 25.2]	23.0 [21.0; 25.0]	25.6 [23.8; 27.5]	0.0965
Use of lipid-lowering drugs (%; 95% CI)	4.67 [3.94; 5.52]	5.47 [4.58; 6.51]	8.99 [7.73; 10.4]	<0.0001*	4.32 [3.70; 5.03]	4.35 [3.58; 5.28]	6.71 [5.70; 7.88]	0.0002*
Blood sugar								
Serum glucose, mmol/L (mean; 95% CI)	5.61 [5.54; 5.68]	5.70 [5.61; 5.79]	5.30 [5.23; 5.38]	<0.0001*	5.44 [5.37; 5.50]	5.37 [5.32; 5.43]	5.01 [4.95; 5.07]	<0.0001*
Self-reported diabetes (%; 95% CI)	5.63 [4.70; 6.72]	4.91 [4.12; 5.84]	5.88 [4.88; 7.08]	0.2852	4.57 [3.92; 5.32]	4.36 [3.57; 5.32]	5.93 [4.99; 7.05]	0.0362*
Use of antidiabetic drugs (%; 95% CI)	2.60 [2.02; 3.34]	3.36 [2.65; 4.24]	4.12 [3.25; 5.22]	0.0295*	2.10 [1.61; 2.74]	2.69 [2.11; 3.43]	2.74 [2.13; 3.52]	0.3202

BMI, body-mass index; CI, confidence interval; OW91, East/West Health Survey (Germany) 1991; BGS98, German National Health Interview and Examination 1998; DEGS1, German Health Interview and Examination Survey for Adults 2008–2011

Significance level for p-values: * p<0.05

*¹ of: lack of exercise, smoking behavior, obesity, high blood pressure, total cholesterol, serum glucose, use of antihypertensive, lipid-lowering, and antidiabetic drugs, and self-reported hypertension, hyperlipidemia, and diabetes; comparison of secular trends in the survey periods of the OW91, BGS98, and DEGS1 in men vs. women in all of Germany, aged 25–69

*² Test for difference

(ATC) code numbers (16); the ones considered in the analysis included antidiabetic drugs (A10), cholesterol-lowering drugs (C10), and antihypertensive drugs (ATC-Code C02/C03/C07/C08/C09).

Study sample

The analysis included data sets from 7466 persons in the OW91, 5825 in the BGS98, and 6124 in the DEGS1. There were a total of 9347 data sets from men and 10068 from women (Table 1). The DEGS1

sample contained 3142 persons who had already participated in the BGS98. For some of the subjects in the surveys, only questionnaire responses and no data from physical examinations were available. The target variables were calculated on the basis of all the data available for each.

Statistical methods

All statistical analyses were performed with the survey procedures of Stata SE 14, with due attention

Trends in age-standardized means and prevalences of blood pressure, self-reported high blood pressure, and the use of antihypertensive drugs (reported separately for eastern and western Germany), among adults aged 25–69. Ref., reference category.

to weighting and the cluster design effect. Adaptive weighting by age, sex, region, and educational level was performed in all surveys in a methodologically consistent manner, and the results were age-standardized to the German population structure as of 31.12.2010 (17). Means, prevalences, and their 95% confidence intervals (CI) were calculated with weighting and standardization for age. Developments over time were tested for statistical significance by analysis of variance (for means) and logistic regression (for prevalences). Differences in trends across subgroups were tested by adding interaction terms in the models (sex and region $\times$ year of survey). Trends were expressed in terms of relative differences, i.e. (value in period 2 minus value in period 1) / (value in period 1) $\times$ 100%. The basis for comparison is always the relevant figure from the first survey (OW91). The criterion for statistical significance was set at $p < 0.05$.

Results

Weighted and age-standardized prevalences and means of cardiometabolic risk factors in the three survey periods 1990–1992, 1997–1999, 2008–2011, stratified by sex, are shown in Table 2.

Health-related behavior and obesity

The prevalence of lack of exercise dropped between the first and last periods (1990–1992 and 2008–2011) in both men and women (Table 2), but more in women than men, and more in the former East than in the former West Germany (eTable 3). Thus, by 2008–2011, the prevalence of lack of exercise was no longer higher in eastern Germany than in western Germany, as it had been in the period 1990–1992 (eTable 4), nor was it any higher in women than in men (Table 2). The prevalence of smoking fell

among men, but rose in eastern Germany, between the first and last periods (Table 2). In the period 2008–2011, the prevalence of smoking in eastern Germany was no longer lower than in western Germany, as it had been in the period 1990–1992 (eTable 4). The narrowing of the gap in smoking prevalence between eastern and western Germany is largely accounted for by a rise in smoking among women in the eastern part of the country (eTable 5 a, b). The overall prevalence of obesity rose between the first and last periods, but this was largely accounted for by a rise in the prevalence of obesity among men in western Germany (Table 2 and eTable 5 a, b).

Blood pressure, hypertension, and the use of antihypertensive drugs

The mean systolic blood pressure fell among both men and women between the first survey period (1990–1992) and the last (2008–2011) (Table 2), more in women than in men, and more in eastern than in western Germany (eTable 3). In the last period, the mean systolic blood pressure in eastern Germany was no longer higher than in western Germany, as it had been during the first period (Figure 1 and eTable 4). The prevalence of self-reported high blood pressure and use of antihypertensive drugs increased among both men and women over the same time period (Table 2), albeit to a greater extent in eastern German men than in eastern German women (eTable 5).

Cholesterol, hyperlipidemia, and the use of cholesterol-lowering drugs

From the first survey (1990–1992) to the last (2008–2011), the mean total cholesterol fell among both men and women (Table 2). The prevalence of self-reported hyperlipidemia remained unchanged, while

FIGURE 2

Trends in age-standardized means and prevalences of total cholesterol, self-reported hyperlipidemia, and the use of cholesterol-lowering drugs (reported separately for eastern and western Germany), among adults aged 25–69.

Ref., reference category.

the prevalence of use of cholesterol-lowering drugs rose over the same period in both men and women (Table 2), and to a greater extent in eastern than in western Germany (eTable 3). East-west differences in the prevalence of self-reported hyperlipidemia and the use of cholesterol-lowering drugs were smaller in 2008–2011 than in 1990–1992 (Figure 2 and eTable 4).

Blood sugar, diabetes, and the use of antidiabetic drugs

The mean serum glucose level fell between 1990–1992 and 2008–2011 in both men and women (Table 2), and to a greater extent in eastern than in western Germany (eTable 3). The mean serum glucose level in eastern Germany in 2008–2011 was no higher than that in western Germany in 1990–1992 (Figure 3 and eTable 4). The prevalences of self-reported diabetes and the use of antidiabetic drugs rose over the same interval, with two exceptions: self-reported diabetes in men and antidiabetic drug use in women (Table 2).

Discussion

In this study of nationwide trends, based on three representative cross-sectional surveys, we found that the prevalences and mean values of cardiometabolic risk factors decreased overall between 1990 and 2011, in both men and women. Differences between eastern and western Germany that were present in 1990–1992 became smaller by the time of the last survey in 2008–2011.

Health-related behavior and obesity

Two exceptions to the general statement above are smoking and obesity, whose prevalences did not decline in the age group that was analyzed. From 1990 to 2011, the prevalence of current smoking fell only among men

in western Germany. The marked decline of smoking since 2003 among 18-to-25-year-olds in Germany, which was documented by the Robert Koch Institute in a telephone survey as part of its regular health monitoring program (18), is not reflected in the findings of the present study because of the limited age range.

The increased prevalence of obesity is largely attributable to a markedly increased prevalence among men. Other studies, too, have revealed an increased prevalence of obesity among adults (19, 20). The observed decline in the prevalence of lack of physical exercise is in line with other studies. However, because of the simultaneously observed marked decline in occupational and daily physical activity, it could be that overall physical activity may actually have declined despite increased participation in sports and exercise (21, 22). There remains a large untapped potential for disease prevention with respect to all of the risk factors studied. In Germany, national health goals for the reduction of tobacco use, the prevention of obesity, the improvement of nutrition, and the encouragement of exercise have been incorporated into the federal Law for the Promotion of Health and Prevention of Disease (*Gesetz zur Stärkung der Gesundheitsförderung und der Prävention*, „Präventionsgesetz“) (23, 24).

Blood pressure, cholesterol, blood sugar, hypertension, hyperlipidemia, and diabetes

The observed decline in the mean measured values of systolic blood pressure and total cholesterol in the interval between the two periods 1990–1992 and 2008–2011 generally accords with comparable declines that have been reported in international meta-analyses for other high-income countries over the past two decades (25, 26). This does not hold for serum glucose,

Trends in age-standardized means and prevalences of serum glucose, self-reported diabetes, and the use of antidiabetic drugs (reported separately for eastern and western Germany), among adults aged 25–69.

Ref., reference category.

however, which has increased in most other countries (27). The simultaneously observed rise in the prevalence of self-reported high blood pressure and diabetes might be explicable with reference to the findings of other studies, which suggest that such apparent rises may reflect a higher detection rate of undiagnosed cases, rather than a true increase in incidence (28–30). Higher detection rates also lead to the more common prescribing, and use, of drugs (31), with resulting lower (i.e., better) mean values of blood pressure, cholesterol, and blood sugar. The increased prevalence of hypertension also partly reflects the lowering of blood pressure thresholds for the diagnosis and treatment of hypertension in recent medical guidelines (32, 33).

East-west differences

The differences between eastern and western Germany that were observed in 1990–1992 became much smaller, or even nonexistent, by 2008–2011, specifically with regard to (lack of) exercise, smoking, obesity, blood pressure, serum glucose, self-reported hyperlipidemia, and the use of cholesterol-lowering drugs. This evening out of differences was generally, but not always, in the direction of a more favorable cardiometabolic risk profile; the exceptions were the higher prevalences of obesity among men in western Germany and of increased smoking among women in eastern Germany. These developments were already pointed out in previous analyses based on only two periods of observation (34, 35); this is the first study with three periods of observation spanning a period of 20 years. The gradually more uniform living and working conditions in eastern and western Germany, along with increasingly similar patterns of health care, presumably account for the evening out of differences in

risk factors. Nonetheless, there are still regional differences in cardiovascular diseases (36, 37) that tend to be less intense as one proceeds from northeast to southwest, reflecting underlying differences in regional economies and in the socioeconomics of living and working conditions (35).

Strengths and weaknesses

The three representative examination surveys provide a unique database for the analysis of secular trends in health and health-related behavior among persons living in Germany over a period of more than 20 years. A particular strength of the present study is its ability to demonstrate the gradual evening out of differences in health between eastern and western Germany.

An inherent limitation of the database comes from differences between surveys with regard to method, particularly between the two surveys of 1990–1992 and 1997–1999, which were carried out before the health monitoring program of the Robert Koch Institute was established. Moreover, a long time interval such as the one spanned by the three surveys in the present study is inevitably accompanied by changes in laboratory analytical techniques, measuring methods, questionnaire instruments, care guidelines, and other standards, and these changes make all comparisons over time more difficult. We have paid due attention to these aspects and performed sensitivity analyses to estimate the effect of altered methods. Moreover, selection effects cannot be excluded (the survey participation rate declined over time), and the self-reported items may have been affected by reporting bias (social desirability and recall bias). The methodological differences and the ways we dealt with them are summarized in *eTable 2*. Because of the cross-sectional design of the study, we

cannot make any causal inferences from the findings. Further in-depth analyses are planned.

Overview

This study reveals an overall improvement in cardiovascular risk factors from 1990 to 2011 among men and women in Germany aged 25 to 69. The differences between eastern and western Germany observed in 1990–1992 were smaller or even nonexistent by 2008–2011. The need remains for health intervention and preventive measures in both eastern and western Germany.

The trends in cardiometabolic risk factors that were detected by analyzing data from the RKI's health monitoring program are consistent with the reported downward trend in mortality due to cardiometabolic risk factors and heart disease in Germany since 1990, a trend which is stronger in eastern than in western Germany (35, 37, 38). This welcome development is presumably due in part to better health care, with improved detection and treatment of cardiometabolic disorders, as suggested by the observed increases in the self-reported prevalence of high blood pressure and diabetes and the use of drugs to treat these conditions. Yet it is presumably also due in part to improved health-related behavior, e.g., more exercise, healthier nutrition, and decreased smoking. This has come about through general changes in lifestyle as well as through changes in the societal framework conditions by deliberate political intervention, e.g., national action plans and legislative initiatives to combat smoking (and protect nonsmokers), promote exercise, and lessen overweight and obesity. It is to be hoped that the health-promoting lifestyle changes taken as targets in the federal Law for the Promotion of Health and Prevention of Disease (24) will help sustain and prolong the favorable secular trends in cardiometabolic risk factors that we have observed over the past two decades.

Conflict of interest statement

The authors state that they have no conflict of interest.

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KEY MESSAGES

- The three representative examination surveys (OW1991, BGS98 und DEGS1) provide a unique data-base for the analysis of secular trends in health and health-related behavior among persons living in Germany over a period of more than 20 years.
- The present study reveals an overall improvement in cardiovascular risk factors from 1990 to 2011 among men and women in Germany aged 25 to 69.
- This is presumably due in part to better health care, with improved detection and treatment of cardiometabolic disorders, and in part to improved health-related behavior, including more exercise and less smoking.
- The differences between eastern and western Germany observed in 1990–1992 were smaller or even nonexistent by 2008–2011.
- The need remains for health intervention and preventive measures in both eastern and western Germany.

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Supplementary material

eTables:

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Supplementary material to:

Time Trends in Cardiometabolic Risk Factors in Adults

Results from Three Nationwide Examination Surveys in Germany, 1990–2011

by Jonas D. Finger, Markus A. Busch, Yong Du, Christin Heidemann, Hildtraud Knopf, Ronny Kuhnert, Thomas Lampert, Gert B. M. Mensink, Hannelore K. Neuhauser, Angelika Schaffrath Rosario, Christa Scheidt-Nave, Anja Schienkiewitz, Julia Truthmann, and Bärbel-Maria Kurth

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eTABLE 1

The three examination surveys, for adults, by the Robert Koch Institute (1990–2011)

Name of study	Time period (month/year)	Total number of observations	Observations: men	Observations: women	Age range (years)	Response rate (%)	Study locations
NUST2 (DHP)	04/1990–05/1991	5311 (west)	2623	2688	25–69	69	104
Survey Ost	09/1991–06/1992	2617 (east)	1223	1394	18–79	70	46
OW91 (NUST2+Survey Ost)	04/1990–06/1992	7466 (overall)	3641	3825	25–69	70	150
BGS98	10/1997–03/1999	7124	3450	3674	18–79	61	120
DEGS1	11/2008–11/2011	7238	3473	3765	18–79	62 ^{*1} , 42 ^{*2}	180

BGS98, German National Health Interview and Examination 1998; DEGS1, German Health Interview and Examination Survey for Adults, 2008–2011; DHP, German Cardiovascular Prevention Study; NUST2, National Examination Survey 1990; OW91, East/West Health Survey 1991

^{*1} longitudinal subject

^{*2} cross-sectional subject

eTABLE 2

Overview of measurement and data acquisition methods and quantitative variables used, by period of data acquisition

		Time periods of studies		
		1990–1992 (OW91)	1997–1999 (BGS98)	2008–2011 (DEGS1)
Measurement of biomarkers				
Blood pressure				
Sphygmomanometer		Hawksley random-zero sphygmomanometer	mercury sphygmomanometer (Erkameter 3000)	Dalaspac Acculorr Plus
Cuffs		12 × 23 cm (arm circumference < 20 cm); 12 × 28 cm (arm circumference 20–40 cm); 14 × 40 cm (arm circumference > 40 cm)	8 × 20 cm (arm circumference < 20 cm); 12 × 28 cm (arm circumference 20–40 cm); 14 × 40 cm (arm circumference > 40 cm)	10.5 × 23.9 cm (arm circ. 21.0–27.9 cm); 13.5 × 30.7 cm (arm circ. 28.0–35.9 cm); 17.0 × 38.6 cm (arm circ. 36.0–46.0 cm)
Number of measurements		2	3	3
Measurement used to compare 1990–1992, 1997–1999 and 2008–2011		systolic blood pressure (mm Hg), second measurement	systolic blood pressure (mm Hg), second measurement	systolic blood pressure (mm Hg), second measurement
Measurement used in publications to date		mean of the first and second measurements	mean of the second and third measurements	mean of the second and third measurements
Sphygmomanometer- and cuff-related bias		underestimation of the systolic blood pressure by up to 3 mmHg with the random-zero method, but overestimation of the blood pressure through use of the medium cuff with arm circumferences up to 40 cm, of the order of 3 mmHg (mean) according to sensitivity analyses of the population mean	obsolete cuff rule for large arm circumferences; calibration of values for comparison with Dalaspac in order to take sphygmomanometer- and cuff-related differences into account	the cuffs meet the criteria of current guidelines; the sphygmomanometer meets the validation criteria of international specialty societies
Serum cholesterol, total				
Measuring device		SMAC (Technicon Corporation, Tarrytown, NY, USA)	MEGA (Merck, Germany)	Architect ci2800 (Abbott, Germany)
Method of analysis (parameter)		cholesterinoxidase-peroxidase-4-aminophenazone-phenol	cholesterinoxidase-peroxidase-4-aminophenazone-phenol	cholesterinoxidase-peroxidase-4-aminophenazone-phenol
Parameter used to compare 1990–1992, 1997–1999 and 2008–2011		mean serum total cholesterol level in mmol/L	mean serum total cholesterol level in mmol/L	mean serum total cholesterol level in mmol/L
Biases due to device and method of analysis		- same method of analysis; the two changes of measuring instrument probably had little effect on the measured values (11) - the varying percentage of fasting subjects across surveys probably had a negligible effect (conclusion from adjusted and stratified analyses)		
Serum glucose				
Measuring device		SMAC (Technicon Corporation, Tarrytown, NY, USA)	MEGA (Merck, Germany)	Architect ci2800 (Abbott, Germany)
Method of analysis (parameter)		glucose-oxidase-peroxidase-4-aminophenazone-phenol	glucose-oxidase-peroxidase-4-aminophenazone-phenol	hexokinase
Parameter used to compare 1990–1992, 1997–1999 and 2008–2011		mean serum glucose in mmol/L	mean serum glucose in mmol/L	mean serum glucose in mmol/L
Biases due to device and method of analysis		The percentage of fasting subjects (≥ 8 hours before blood drawing) rose from each survey to the next, from 9.5% in the OW91 to 26.6% in the BGS98 and 49.0% in the DEGS1. This may have led to an overestimation of the mean serum glucose concentration in the OW91 compared to the DEGS1.		
		Sensitivity analysis: consideration of the fasting time as an independent categorical variable (< 4 hr, ≥ 4 to < 8 hr, ≥ 8 to < 10 hr, ≥ 10 hr) in the models for estimating differences in trends yielded similar trends to those obtained when fasting time was not considered. This was true of all serum glucose trends presented here, except among men in western Germany: in this subgroup, consideration of the fasting time altered the p-value for differences in trends between the two periods 1990–1992 and 2008–2011 from significant (p < 0.001; unadjusted mean glucose values of 5.56 mmol/L with 95% CI [5.48; 5.63] in the OW91 vs. 5.30 mmol/L [5.21; 5.39] in the DEGS1) to insignificant (p = 0.188; adjusted mean glucose values of 5.38 mmol/L [5.29; 5.46] in the OW91 vs. 5.29 mmol/L [5.18; 5.39] in the DEGS1).		

		Time periods of studies		
		1990–1992 (OW91)	1997–1999 (BGS98)	2008–2011 (DEGS1)
Weight and height				
Measuring device		weight without shoes, lightly dressed: measurement accuracy 0.1 kg height: measurement accuracy 0.5 cm	weight without shoes, lightly dressed: SECA electronic scale, measurement accuracy 0.1 kg height: yardstick built into SECA scale, measurement accuracy 0.1 cm	weight without shoes, in underwear: SECA electronic column scale 930, measurement accuracy 0.1 kg height: portable stadiometer (Holtain Ltd./UK), measurement accuracy 0.1 cm
Method of analysis (parameter)		BMI: weight/height ² (in kg and m, respectively)	BMI: weight/height ² (in kg and m, respectively)	BMI: weight/height ² (in kg and m, respectively)
Parameter used to compare 1990–1992, 1997–1999 and 2008–2011		BMI ≥ 30 kg/m ² (WHO obesity threshold)	BMI ≥ 30 kg/m ² (WHO obesity threshold)	BMI ≥ 30 kg/m ² (WHO obesity threshold)
Biases due to device and method of analysis				change in instruction to subjects (from lightly clothed to underwear only)
Questioning methods				
Self-reported high blood pressure				
Questions		<ul style="list-style-type: none"> self-administered questionnaire of the NUST2: Do you now have, or have you ever had, any of the following diseases? (I have it now / I don't have it any more / I don't know whether I still have it / I have never had it) self-administered questionnaire of the East-West Survey: Which of the following diseases have you ever had? (if yes, then: only in the past 12 months / in the past 12 months and previously / treated with drugs) 	<p>(1) self-administered questionnaire: Which of the following diseases have you ever had? (yes / no / I don't know)</p> <p>(2) CAPI</p> <p>Was the subject ever given a diagnosis of any of the following diseases or health disturbances by a physician? (yes/no)</p>	<p>CAPI</p> <p>Was your blood pressure ever found to be elevated or too high? (yes / no / I don't know)</p> <p>Subjects were told only if they asked that a systolic blood pressure above 140 mmHg or a diastolic blood pressure above 90 mmHg is considered to be elevated.</p>
Variables used to compare 1990–1992, 1997–1999, and 2008–2011		high blood pressure (ever): yes/no	high blood pressure (ever): yes/no (CAPI)	high blood pressure (ever): yes/no (CAPI)
Reporting bias		<p>The mode of questioning changed from a self-administered questionnaire (OW91, BGS98) to a CAPI (BGS98, DEGS). Any ensuing reporting bias was probably small, as there was no significant difference between the self-reported and CAPI-derived prevalences in the BGS98.</p> <p>Sensitivity analysis: comparison of self-reported and CAPI-derived prevalences (weighted and age-standardized) in the BGS98 (complete-case sample, 5385 subjects):</p> <p>(1) CAPI: overall 22.7 [21.2; 24.2]; men 22.5 [20.6; 24.6]; women 22.8 [20.9; 24.8]</p> <p>(2) Self-reported: overall 22.6 [21.3; 24.0]; men 22.0 [20.2; 24.0]; women 23.1 [21.4; 25.0]</p>		
Self-reported hyperlipidemia				
Questions		<ul style="list-style-type: none"> self-administered questionnaire of the NUST2: Do you now have, or have you ever had, any of the following diseases? (I have it now / I don't have it any more / I don't know whether I still have it / I have never had it) self-administered questionnaire of the East-West Health Survey: Which of the following diseases have you ever had? (if yes, then: only in the past 12 months / in the past 12 months and previously / treated with drugs) 	<p>(1) self-administered questionnaire: Which of the following diseases have you ever had? (yes / no / I don't know)</p> <p>(2) CAPI</p> <p>Was the subject ever given a diagnosis of any of the following diseases or health disturbances by a physician? (yes/no)</p>	<p>CAPI</p> <p>Did a doctor ever tell you that you had a disorder of lipid metabolism? This term refers to high levels of fatty substances such as cholesterol or triglycerides. (yes / no / I don't know)</p>
Variables used to compare 1990–1992, 1997–1999, and 2008–2011		hyperlipidemia (ever): yes/no	hyperlipidemia (ever): yes/no (CAPI)	hyperlipidemia (ever): yes/no (CAPI)

Time periods of studies			
	1990–1992 (OW91)	1997–1999 (BGS98)	2008–2011 (DEGS1)
Reporting bias	The mode of questioning changed from a self-administered questionnaire (OW91, BGS98) to a CAPI (BGS98, DEGS). Any ensuing reporting bias was probably small, as the self-reported prevalence in the BGS98 was not significantly higher than the CAPI-derived prevalence. If a correction were to be made for the observed difference, the prevalence for 1990–1992 would have to be adjusted downward, and this would only reinforce the observed trend. Sensitivity analysis: comparison of self-reported and CAPI-derived prevalences (weighted and age-standardized) in the BGS98 (complete-case sample, 4775 subjects): (1) CAPI: overall 27.6 [25.8; 29.4]; men 30.1 [27.8; 32.5]; women 25.1 [22.8; 27.6] (2) Self-reported: overall 28.6 [26.9; 30.3]; men 31.4 [29.0; 33.9]; women 25.8 [23.6; 28.1]		
Self-reported diabetes mellitus			
Questions	<ul style="list-style-type: none">self-administered questionnaire of the NUST2: Do you now have, or have you ever had, any of the following diseases? (I have it now / I don't have it any more / I don't know whether I still have it / I have never had it) high blood sugar, diabetesself-administered questionnaire of the East/West Health Survey: Which of the following diseases have you ever had? (if yes, then: only in the past 12 months / in the past 12 months and previously / treated with drugs) high blood sugar, diabetes	(1) self-administered questionnaire: Which of the following diseases have you ever had? (yes / no / I don't know) high blood sugar (diabetes mellitus) treated with insulin high blood sugar (diabetes mellitus) not treated with insulin (2) CAPI Was the subject ever given a diagnosis of any of the following diseases or health disturbances by a physician? (yes/no) high blood sugar (diabetes mellitus) treated with insulin high blood sugar (diabetes mellitus) not treated with insulin	CAPI Did a doctor ever tell you that you had high blood sugar or diabetes? . (yes / no / I don't know)
Variables used to compare 1990–1992, 1997–1999, and 2008–2011	diabetes (ever): yes/no	diabetes (ever): yes/no (CAPI)	diabetes (ever): yes/no (CAPI)
Reporting bias	The mode of questioning changed from a self-administered questionnaire (OW91, BGS98) to a CAPI (BGS98, DEGS). Any ensuing reporting bias was probably small, as the self-reported prevalence in the BGS98 was not significantly higher than the CAPI-derived prevalence. If a correction were to be made for the observed difference, the prevalence for 1990–1992 would have to be adjusted downward, and this would only reinforce the observed trend. Sensitivity analysis: comparison of self-reported and CAPI-derived prevalences (weighted and age-standardized) in the BGS98 (complete-case sample, 5638 subjects): (1) CAPI: overall, 4.58 [3.94; 5.33]; men 4.86 [4.03; 5.84]; women 4.31 [3.50; 5.29] (2) Self-reported: overall 4.93 [4.24; 5.75]; men 5.39 [4.46; 6.50]; women 4.48 [3.68; 5.45]		
Lack of exercise			
Questions	How often do you engage in physical exercise? - regularly, more than 2 hours per week - regularly, 1 to 2 hours per week - less than one hour per week - not at all	How often do you engage in physical exercise? - regularly, more than 4 hours per week - regularly, 2 to 4 hours per week - regularly, 1 to 2 hours per week - less than one hour per week - not at all	How often do you engage in physical exercise? - not at all - less than one hour per week - regularly, 1 to 2 hours per week - regularly, 2 to 4 hours per week - regularly, more than 4 hours per week
Variables used to compare 1990–1992, 1997–1999, and 2008–2011	no exercise: yes/no	no exercise: yes/no	no exercise: yes/no
Reporting bias	The social desirability of exercise may have led to an underestimation of the prevalence of lack of exercise. Analyses have shown that self-reported information about exercise overestimates the amount of exercise taken in comparison to objective measures (accelerometry or the doubly-labeled water technique) (12, 13). It is hard to estimate the effect, if any, of the change in the number and order of answer categories on the comparability of data across surveys.		

		Time periods of studies		
		1990–1992 (OW91)	1997–1999 (BGS98)	2008–2011 (DEGS1)
Smoking status				
Questions	Have you ever smoked, or do you smoke now? - I used to smoke but don't any more. - I smoke now. - I have never smoked.	Have you ever smoked, or do you smoke now? - I have never smoked. - I smoke now. - Yes, every day. - Yes, occasionally. - I used to smoke. - I have quit smoking in the past 12 months (...).	Have you ever smoked, or do you smoke now? - I have never smoked. - I smoke now. - Yes, every day. - Yes, occasionally. - No, not any more. - I have never smoked.	
Variables used to compare 1990–1992, 1997–1999, and 2008–2011	current smoker: yes/no	current smoker: yes/no	current smoker: yes/no	current smoker: yes/no
Reporting bias	The social underestability of smoking may have led to an underestimation of its prevalence. Analyses have shown that self-reported information about smoking underestimates the amount of smoking in comparison to objective measures (urine cotinine concentration). Current smokers sometimes say they are ex-smokers and are misclassified as such (14). It is hard to estimate the effect, if any, of the changes in the questions and answer categories on the comparability of data across surveys.			
Determination of drug use				
Antihypertensive drugs				
Data acquisition	standardized interview to determine drug use in the past 7 days	standardized interview to determine drug use in the past 7 days	standardized interview to determine drug use in the past 7 days	standardized interview to determine drug use in the past 7 days
Drug coding ATC code ATC code of the WHO for BGS98 ATC code of the WiDo for DEGS1 Recoding of the EPhMIRA code in the ATC code for the OW91	antihypertensive drugs (ATC codes C02) or diuretics (ATC code C03) or β -adrenoreceptor antagonists (ATC code C07) or calcium-channel blockers (ATC code C08) or drugs affecting the renin-angiotensin system (ATC code C09)	antihypertensive drugs (ATC codes C02) or diuretics (ATC code C03) or β -adrenoreceptor antagonists (ATC code C07) or calcium-channel blockers (ATC code C08) or drugs affecting the renin-angiotensin system (ATC code C09)	antihypertensive drugs (ATC codes C02) or diuretics (ATC code C03) or β -adrenoreceptor antagonists (ATC code C07) or calcium-channel blockers (ATC code C08) or drugs affecting the renin-angiotensin system (ATC code C09)	antihypertensive drugs (ATC codes C02) or diuretics (ATC code C03) or β -adrenoreceptor antagonists (ATC code C07) or calcium-channel blockers (ATC code C08) or drugs affecting the renin-angiotensin system (ATC code C09)
Indicator used to compare 1990–1992, 1997–1999 and 2008–2011	use of antihypertensive drugs: yes/no	use of antihypertensive drugs: yes/no	use of antihypertensive drugs: yes/no	use of antihypertensive drugs: yes/no
Recall bias	Underestimation of the prevalence of drug use because of recall bias cannot be ruled out.			
Cholesterol-lowering drugs				
Data acquisition	standardized interview to determine drug use in the past 7 days	standardized interview to determine drug use in the past 7 days	standardized interview to determine drug use in the past 7 days	standardized interview to determine drug use in the past 7 days
Drug coding ATC code ATC code of the WHO for BGS98 ATC code of the WiDo for DEGS1 Recoding of the EPhMIRA code in the ATC code for the OW91	drugs affecting lipid metabolism (ATC code C10)	drugs affecting lipid metabolism (ATC code C10)	drugs affecting lipid metabolism (ATC code C10)	drugs affecting lipid metabolism (ATC code C10)
Indicator used to compare 1990–1992, 1997–1999 and 2008–2011	use of lipid-lowering drugs: yes/no	use of lipid-lowering drugs: yes/no	use of lipid-lowering drugs: yes/no	use of lipid-lowering drugs: yes/no
Recall bias	Underestimation of the prevalence of drug use because of recall bias cannot be ruled out.			
Antidiabetic drugs				
Data acquisition	standardized interview to determine drug use in the past 7 days	standardized interview to determine drug use in the past 7 days	standardized interview to determine drug use in the past 7 days	standardized interview to determine drug use in the past 7 days

	Time periods of studies		
	1990–1992 (OW91)	1997–1999 (BGS98)	2008–2011 (DEGS1)
Drug coding ATC code ATC code of the WHO for BGS98 ATC code of the WHO for DEGS1 Recoding of the EPhMRA code in the ATC code for the OW91	antidiabetic drugs (ATC code A10)	antidiabetic drugs (ATC code A10)	antidiabetic drugs (ATC code A10)
Indicator used to compare 1990–1992, 1997–1999 and 2008–2011	use of antidiabetic drugs: yes/no	use of antidiabetic drugs: yes/no	use of antidiabetic drugs: yes/no
Recall bias	Underestimation of the prevalence of drug use because of recall bias cannot be ruled out.		

ATC code, anatomic-therapeutic-chemical code; BMI, body-mass index; BGS98, German National Health Interview and Examination 1998; CAPI, computer-assisted telephone interview; DEGS1, German Health Interview and Examination Survey for Adults 2008–2011; EPhMRA, European Pharmaceutical Market Research Association; NUST2, German National Examination Survey 1990; OW91, East/West (German) Health Survey 1991; WHO, World Health Organization; WHO, Research Institute of the Local Health Insurers in Germany.

eTABLE 3

Differences in trends by sex, in eastern vs. western Germany, by sex in eastern Germany, and by sex in western Germany (effect modifications/interactions)

	Male vs. female	Eastern vs. western Germany	Male vs. female in eastern Germany	Male vs. female in western Germany
Interaction terms (sex or region × year of survey)	p-value ^{*1}	p-value ^{*1}	p-value ^{*1}	p-value ^{*1}
Health-related behavior and BMI				
No exercise (%)	0.0011*	0.0094*	<0.0001*	0.0091*
Smoking (%)	0.0025*	0.0106*	<0.0001*	0.0504*
BMI ≥ 30 (%)	0.0669	0.1464	0.4303	0.0772
Blood pressure				
Mean systolic blood pressure, mmHg	<0.0001*	0.0014*	0.0166*	<0.0001*
Self-reported hypertension (%)	0.0448*	0.8852	0.0244*	0.1341
Use of antihypertensive drugs (%)	0.0165*	0.5600	0.0279*	0.0597
Cholesterol				
Mean total cholesterol, mmol/L	0.3430	0.8320	0.0862	0.5496
Self-reported hyperlipidemia (%)	0.4288	<0.0001*	0.6923	0.3662
Use of lipid-lowering drugs (%)	0.3350	0.0003	0.5131	0.3030
Blood sugar				
Mean serum glucose, mmol/L	0.0443	<0.0002*	0.2329	0.1105
Self-reported diabetes (%)	0.4843	0.1217	0.2509	0.3326
Use of antidiabetic drugs (%)	0.5849	0.2447	0.5970	0.3969

BMI, body-mass index

Significance level for p-values: * p<0.05

^{*1} Test for difference

eTABLE 4

Comparison of weighted and age-standardized prevalences and means*¹

	Eastern Germany				Western Germany			
	Survey period			p-value	Survey period			p-value
	1990–1992	1997–1999	2008–2011	p ²	1990–1992	1997–1999	2008–2011	p ²
Health-related behavior and BMI								
No exercise (%; 95% CI)	53.9 [50.8; 57.0]	54.2 [51.3; 57.0]	35.2 [32.2; 38.4]	<0.0001*	45.7 [43.3; 48.0]	47.5 [45.0; 50.0]	33.9 [32.0; 36.0]	<0.0001*
Smoking (%; 95% CI)	28.2 [26.4; 30.1]	32.5 [29.7; 35.5]	33.5 [30.7; 36.3]	0.0026*	33.4 [31.6; 35.2]	33.2 [31.2; 35.3]	31.6 [29.4; 33.8]	0.3247
BMI ≥ 30 (%; 95% CI)	24.9 [22.4; 27.7]	25.3 [22.2; 28.7]	24.5 [21.0; 28.4]	0.9431	19.4 [18.0; 20.9]	22.0 [20.1; 24.0]	23.6 [27.8; 25.5]	0.0024*
Blood pressure								
Systolic blood pressure, mmHg (mean, 95% CI)	140.0 [138.2; 141.7]	131.7 [130.4; 133.0]	125.9 [124.7; 127.2]	<0.0001*	133.8 [133.0; 134.6]	128.7 [127.9; 129.4]	123.8 [123.1; 124.4]	<0.0001*
Self-reported hypertension (%; 95% CI)	30.5 [28.1; 32.9]	27.1 [24.5; 29.8]	36.9 [34.4; 39.5]	<0.0001*	24.8 [23.5; 26.0]	21.3 [19.9; 22.8]	30.4 [28.8; 32.0]	<0.0001*
Use of antihypertensive drugs (%; 95% CI)	21.2 [19.6; 22.9]	21.7 [19.5; 24.0]	26.4 [23.9; 29.1]	0.0010*	14.8 [13.8; 15.9]	15.2 [13.8; 16.6]	20.6 [19.2; 22.0]	<0.0001*
Cholesterol								
Total cholesterol, mmol/L (mean, 95% CI)	6.24 [6.16; 6.31]	6.16 [6.10; 6.23]	5.40 [5.28; 5.52]	<0.0001*	6.16 [6.12; 6.21]	6.11 [6.06; 6.16]	5.30 [5.23; 5.36]	<0.0001*
Self-reported hyperlipidemia (%; 95% CI)	9.51 [7.89; 11.3]	18.6 [16.5; 20.7]	22.1 [19.6; 24.8]	<0.0001*	28.7 [27.2; 30.3]	26.3 [24.6; 28.1]	27.9 [26.4; 29.3]	0.1023
Use of lipid-lowering drugs (%; 95% CI)	2.82 [2.12; 3.75]	6.19 [5.17; 7.39]	9.20 [7.81; 10.8]	<0.0001*	4.86 [4.24; 5.56]	4.62 [3.94; 5.41]	7.61 [6.68; 8.66]	<0.0001*
Blood sugar								
Ser. glucose, mmol/L (mean, 95% CI)	5.83 [5.72; 5.94]	5.66 [5.55; 5.77]	5.18 [5.08; 5.27]	<0.0001*	5.47 [5.42; 5.52]	5.51 [5.45; 5.58]	5.16 [5.09; 5.22]	<0.0001*
Self-reported diabetes (%; 95% CI)	5.33 [4.44; 6.38]	6.00 [4.92; 7.29]	6.22 [4.97; 7.76]	0.5369	5.08 [4.46; 5.78]	4.31 [3.63; 5.11]	5.88 [5.06; 6.82]	0.0278*
Use of antidiabetic drugs (%; 95% CI)	3.46 [2.68; 4.44]	4.51 [3.59; 5.65]	3.94 [2.94; 5.26]	0.2986	2.15 [1.73; 2.66]	2.69 [2.13; 3.40]	3.34 [2.69; 4.13]	0.0152*

BMI, body-mass index; CI, confidence interval; OW91, East/West Health Survey (Germany) 1991; BGS98, German National Health Interview and Examination Survey for Adults 1998; DEGS1, German Health Interview and Examination Survey for Adults 2008–2011

Significance level for p-values: * p<0.05

*¹ of: lack of exercise, smoking behavior, obesity, high blood pressure, total cholesterol, serum glucose, use of antihypertensive, lipid-lowering, and antidiabetic drugs, and self-reported hypertension, hyperlipidemia, and diabetes; comparison of secular trends in the survey periods of the OW91, BGS98, and DEGS1 in eastern vs. western Germany; the subjects were men and women aged 25–69

*² Test for difference

eTABLE 5a

Comparison of weighted and age-standardized prevalences and means*¹

	Men in eastern Germany				Women in eastern Germany			
	Survey period			p-value	Survey period			p-value
	1990–1992	1997–1999	2008–2011	p ²	1990–1992	1997–1999	2008–2011	p ²
Health-related behavior and BMI								
No exercise (%; 95% CI)	49.2 [45.4; 53.1]	56.4 [52.1; 60.6]	35.5 [31.3; 40.0]	<0.0001*	58.7 [55.0; 62.3]	51.9 [48.2; 55.5]	34.9 [30.4; 39.6]	<0.0001*
Smoking (%; 95% CI)	38.3 [35.7; 41.0]	37.5 [33.7; 41.5]	35.8 [31.2; 40.7]	0.6411	18.0 [15.4; 20.9]	21.4 [24.3; 30.8]	31.1 [27.8; 34.7]	<0.0001*
BMI ≥ 30 (%; 95% CI)	22.3 [18.6; 24.5]	24.8 [20.4; 29.7]	23.6 [19.0; 29.7]	0.7208	27.6 [24.8; 30.5]	25.8 [22.4; 29.5]	25.4 [21.2; 30.1]	0.6719
Blood pressure								
Systolic blood pressure, mmHg (mean; 95% CI)	143.3 [141.1; 145.5]	133.8 [132.3; 135.4]	129.4 [127.9; 130.9]	<0.0001*	136.6 [134.7; 138.5]	129.6 [128.2; 131.0]	122.4 [120.8; 124.0]	<0.0001*
Self-reported hypertension (%; 95% CI)	29.2 [26.2; 32.4]	25.9 [22.7; 29.4]	39.1 [34.9; 43.5]	<0.0001*	31.7 [28.6; 35.1]	28.3 [25.4; 31.4]	34.8 [31.9; 37.8]	0.0070*
Use of antihypertensive drugs (%; 95% CI)	19.0 [16.5; 21.6]	19.8 [19.4; 22.5]	27.7 [24.0; 31.8]	<0.0001*	23.6 [21.4; 25.9]	23.5 [20.7; 26.5]	25.1 [22.1; 28.4]	0.6674
Cholesterol								
Total cholesterol, mmol/L (mean; 95% CI)	6.29 [6.21; 6.38]	6.25 [6.18; 6.33]	5.41 [5.30; 5.51]	<0.0001*	6.18 [6.09; 6.27]	6.07 [5.99; 6.15]	5.39 [5.25; 5.54]	<0.0001*
Self-reported hyperlipidemia (%; 95% CI)	9.90 [8.00; 12.2]	20.2 [17.7; 23.0]	23.6 [20.3; 27.2]	<0.0001*	9.13 [7.37; 11.2]	16.9 [14.2; 19.9]	20.6 [17.5; 24.0]	<0.0001*
Use of lipid-lowering drugs (%; 95% CI)	2.83 [1.88; 4.23]	5.91 [4.49; 7.75]	10.0 [7.90; 12.7]	<0.0001*	2.82 [1.98; 4.01]	6.46 [5.12; 8.13]	8.35 [6.74; 10.3]	<0.0001*
Blood sugar								
Serum glucose, mmol/L (mean; 95% CI)	5.88 [5.76; 6.00]	5.82 [5.66; 5.98]	5.32 [5.18; 5.47]	<0.0001*	5.77 [5.61; 5.93]	5.50 [5.40; 5.60]	5.03 [4.93; 5.13]	<0.0001*
Self-reported diabetes (%; 95% CI)	5.00 [3.82; 6.51]	7.13 [5.74; 8.83]	6.41 [4.57; 8.92]	0.1296	5.66 [4.27; 7.46]	4.86 [3.49; 6.74]	6.03 [4.35; 8.30]	0.6230
Use of antidiabetic drugs (%; 95% CI)	3.29 [2.34; 4.62]	5.26 [3.95; 6.97]	3.98 [2.53; 6.22]	0.1075	3.62 [2.43; 5.36]	3.76 [2.55; 5.51]	3.89 [2.57; 5.84]	0.9700

BMI, body-mass index; CI, confidence interval; OW91, East/West Health Survey (Germany) 1991; BGS98, German National Health Interview and Examination 1998; DEGS1, German Health Interview and Examination Survey for Adults 2008–2011

Significance level for p-values: * p<0.05

*¹ of: lack of exercise, smoking behavior, obesity, high blood pressure, total cholesterol, serum glucose, use of antihypertensive, lipid-lowering, and antidiabetic drugs, and self-reported hypertension, hyperlipidemia, and diabetes; comparison of secular trends in the survey periods of the OW91, BGS98, and DEGS1 in men vs. women in eastern Germany, aged 25–69

*² Test for difference

eTABLE 5b

Comparison of weighted and age-standardized prevalences and means*¹

	Men in western Germany				Women in western Germany			
	Survey period			p-value	Survey period			p-value
	1990–1992	1997–1999	2008–2011	p* ²	1990–1992	1997–1999	2008–2011	p* ²
Health-related behavior and BMI								
No exercise (%; 95% CI)	41.0 [38.1; 44.1]	44.7 [41.8; 47.6]	33.8 [31.0; 36.7]	<0.0001*	50.3 [47.5; 53.2]	50.2 [47.0; 53.5]	34.1 [31.4; 36.8]	<0.0001*
Smoking (%; 95% CI)	38.6 [36.3; 41.0]	37.8 [34.8; 41.0]	34.0 [31.1; 37.1]	0.0353	28.0 [26.1; 30.1]	28.6 [26.3; 31.0]	29.1 [26.6; 31.7]	0.8366
BMI ≥ 30 (%; 95% CI)	18.3 [16.5; 20.4]	20.6 [18.6; 22.7]	24.6 [22.0; 27.5]	0.0018*	20.5 [18.5; 22.5]	23.5 [20.9; 26.2]	22.6 [20.3; 25.2]	0.2080
Blood pressure								
Systolic blood pressure, mmHg (mean, 95% CI)	136.0 [135.0; 137.0]	130.5 [129.6; 131.3]	127.4 [126.6; 128.3]	<0.0001*	131.6 [130.7; 132.5]	126.9 [125.9; 127.8]	120.1 [119.2; 120.9]	<0.0001*
Self-reported hypertension (%; 95% CI)	26.2 [24.4; 28.1]	21.3 [19.2; 23.4]	32.9 [30.3; 35.6]	0.0000*	23.3 [21.7; 25.0]	21.4 [19.4; 23.5]	27.9 [25.9; 30.0]	<0.0001*
Use of antihypertensive drugs (%; 95% CI)	14.0 [12.4; 15.8]	12.9 [11.2; 14.8]	20.5 [18.4; 22.7]	<0.0001*	15.7 [14.4; 17.1]	14.5 [15.4; 19.7]	20.7 [18.6; 22.9]	0.0006*
Cholesterol								
Total cholesterol, mmol/L (mean, 95% CI)	6.14 [6.08; 6.19]	6.11 [6.04; 6.18]	5.28 [5.21; 5.35]	<0.0001*	6.19 [6.13; 6.25]	6.11 [6.05; 6.18]	5.31 [5.24; 5.38]	<0.0001*
Self-reported hyperlipidemia (%; 95% CI)	31.2 [29.2; 33.4]	28.5 [26.1; 31.1]	29.0 [26.9; 31.2]	0.1741	26.2 [24.4; 28.0]	24.1 [21.9; 26.5]	26.7 [24.6; 27.1]	0.2120
Use of lipid-lowering drugs (%; 95% CI)	5.07 [4.21; 6.10]	5.36 [4.35; 6.58]	8.82 [7.37; 10.5]	<0.0001*	4.64 [3.92; 5.50]	3.87 [3.02; 4.94]	6.40 [5.24; 7.79]	0.0059*
Blood sugar								
Serum glucose, mmol/L (mean, 95% CI)	5.56 [5.48; 5.63]	5.68 [5.58; 5.77]	5.30 [5.21; 5.39]	0.0001*	5.37 [5.30; 5.44]	5.35 [5.28; 5.41]	5.01 [4.94; 5.08]	<0.0001*
Self-reported diabetes (%; 95% CI)	5.74 [4.64; 7.08]	4.43 [3.57; 5.48]	5.84 [4.70; 7.23]	0.1037	4.41 [3.70; 5.25]	4.19 [3.32; 5.29]	5.92 [4.85; 7.20]	0.0426*
Use of antidiabetic drugs (%; 95% CI)	2.47 [1.80; 3.36]	2.95 [2.19; 3.96]	4.17 [3.18; 5.45]	0.0267*	1.83 [1.32; 2.54]	2.44 [1.81; 3.27]	2.50 [1.84; 3.38]	0.3416

BMI, body-mass index; CI, confidence interval; OW91, East/West Health Survey (Germany) 1991; BGS98, German National Health Interview and Examination 1998; DEGS1, German Health Interview and Examination Survey for Adults 2008–2011

Significance level for p-values: * p<0.05

*¹ of: lack of exercise, smoking behavior, obesity, high blood pressure, total cholesterol, serum glucose, use of antihypertensive, lipid-lowering, and antidiabetic drugs, and self-reported hypertension, hyperlipidemia, and diabetes; comparison of secular trends in the survey periods of the OW91, BGS98, and DEGS1 in men vs. women in western Germany, aged 25–69

*² Test for difference