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Temporal changes in predicted risk of type 2 diabetes in Germany: findings from the German Health Interview and Examination Surveys 1997–1999 and 2008–2011

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ABSTRACT

Objective Over time, prevalence changes in individual diabetes risk factors have been observed for Germany and other European countries. We aimed to investigate the temporal change of a summary measure of type 2 diabetes risk in Germany.

Design Comparison of data from two cross-sectional surveys that are about 12 years apart.

Setting Two nationwide health examination surveys representative for the non-institutionalised population aged 18–79 years in Germany.

Participants The study included participants without diagnosed diabetes from the national health examination surveys in 1997–1999 (n=6457) and 2008–2011 (n=6095).

Outcome measures Predicted 5-year type 2 diabetes risk was calculated using the German Diabetes Risk Score (GDRS), which considers information on age, anthropometry, lifestyle factors, hypertension and family history of diabetes.

Results Between the two survey periods, the overall age- and sex-standardised predicted 5-year risk of type 2 diabetes decreased by 27% from 1.5% (95% CI 1.4% to 1.6%) to 1.1% (1.0% to 1.2%). The decrease in red meat intake and waist circumference had the highest impact on the overall decrease in diabetes risk. In stratified analyses, diabetes risk decreased among both sexes and within strata of age and body mass index. Diabetes risk also decreased among highly educated persons, but remained unchanged among persons with a middle or low educational level.

Conclusions Monitoring type 2 diabetes risk by a summary measure such as the GDRS could essentially contribute to interpret the dynamics in diabetes epidemiology.

Strengths and limitations of this study

► The current study is based on two consecutive, nationwide health examination surveys representative for the non-institutionalised population.
► Several sensitivity analyses confirmed the main finding of a decrease in predicted type 2 diabetes risk.
► The assessment of some components of the German Diabetes Risk Score slightly differed between both surveys.
► Despite the carefully designed sampling procedure and the application of complex weighting factors, we cannot exclude the possibility of selection bias.

INTRODUCTION

Diabetes mellitus is a metabolic disease characterised by chronic hyperglycaemia. It may cause several long-term complications leading to disability, decreased life expectancy and increased healthcare expenditures.[1] Apart from non-modifiable risk factors such as age and family history of diabetes, the main modifiable risk factors for type 2 diabetes are overweight, a westernised diet, physical inactivity and smoking.[1 2] In recent years, prevalence changes in several risk factors for type 2 diabetes were observed for Germany and other European countries.[3–6] In Germany, for example, the prevalence of physical inactivity during leisure time and the prevalence of smoking decreased, whereas the prevalence of obesity increased during the past decade.[3 6–9]

Since these changes in risk factors differ in their direction and the strength of their influence on diabetes risk, monitoring a summary measure to estimate future diabetes risk could help to estimate net changes in diabetes risk[10] which in turn could help to understand the epidemiology of diabetes. Moreover, the monitoring of diabetes risk over time could support the evaluation of prevention programmes and enable evidence-informed policy advising.

Therefore, the objective of the present study was to investigate the temporal change in predicted type 2 diabetes risk among adults in Germany applying the German Diabetes Risk Score (GDRS). The GDRS was originally developed based on data of the European Prospective Investigation into Cancer and Nutrition (EPIC)-Potsdam study and contains information on age, lifestyle factors, anthropometry and history of hypertension.[11] Subsequently, it was extended by information on family history of diabetes.[12] Recently, the most updated version of the GDRS[13] has been successfully validated for predicting diabetes risk in the general German adult population.[14]

METHODS

Study population

The German National Health Interview and Examination Survey 1998 (GNHIES98; 1997–1999) encompasses a representative sample of the non-institutionalised population aged 18–79 years in Germany (n=7124; response: 61%).[15] For the German Health Interview and Examination Survey for Adults (DEGS1; 2008–2011), eligible participants of GNHIES98 were reinvited. The sample of reattendees (n=3959; response: 62%) was extended by a sample of first-time invitees (n=4192; response: 42%) to retain a representative cross-sectional sample of the population aged 18–79 years in Germany.[16] For both surveys, a two-stage cluster sampling procedure was applied which has been described in detail previously.[15–17] Both surveys were approved by the Federal Commissioner for Data Protection, and DEGS1 was approved by the ethics committee of the Charité-Universitätsmedizin Berlin (no EA2/047/08). All subjects provided written informed consent.[16]

For the present analyses, participants aged 18–79 years who completed both the interview and examination part (GNHIES98: n=7124; DEGS1: n=7115) were eligible. Exclusion criteria comprised diagnosed diabetes (self-reported physician-diagnosed diabetes or use of antidiabetic medication[18] (n=374; n=591)) and missing information on diabetes status (n=25; n=36) or any GDRS component (n=268; n=393), yielding a final sample of 6457 GNHIES98 participants and 6095 DEGS1 participants.

Assessment of GDRS components

In our survey samples, the individual components of the GDRS were assessed as described in detail elsewhere.[14] In brief, information on smoking including the number of cigarettes smoked per day and regular sport activity was assessed through standardised self-administered questionnaires.[16] Regular sport activity was assessed as 'no sport', '<1 hour/week', '1–2 hours/week', '2–4 hours/week', '>4 hours/week' and was converted into a quasicontinuous variable by assigning the mean time of each category (ie, 0 hours/week,

0.5 hours/week, 1.5 hours/week, 3 hours/week and 4.5 hours/week).

Standardised measurements of body height and waist circumference were performed by trained health professionals with participants wearing no shoes. A small change in the protocol relates to measurement in underwear in DEGS1 but in light clothing in GNHIES98.[19]

Information on history of hypertension in GNHIES98 and DEGS1 and parental history of diabetes in DEGS1 was assessed by standardised physician-administered computer-assisted interviews.[16] In GNHIES98, information on parental history of diabetes was not assessed. Therefore, we assigned the observed prevalence of a history of diabetes in one parent (24.0%) or both parents (2.0%) from DEGS1 participants with available information to all GNHIES98 participants as a constant. The observed prevalences were calculated before the above-mentioned exclusion criteria were applied. These constants were also assigned to all DEGS1 participants with missing information on parental history of diabetes (n=382) to preclude their exclusion from analysis. Information on sibling history of diabetes was neither ascertained in GNHIES98 nor in DEGS1. Therefore, we assigned the prevalence of a history of diabetes in siblings in EPIC-Potsdam (5.0%) as a constant to all GNHIES98 and DEGS1 participants.[12]

In GNHIES98, a Food Frequency Questionnaire (FFQ) with seven categories of frequency was applied to assess the consumption of 'coffee with caffeine', 'whole grain bread', 'muesli, cornflakes and oatmeal' and 'meat (including poultry)'. Moreover, in the German Nutrition Survey module encompassing a subsample of 4030 GNHIES98 participants, a computer-aided personal interview was conducted by trained nutritionists to assess the usual frequencies and amounts of intake during the past 4 weeks.[20 21] From this subsample, we used the dietary history information stratified according to sex and age group to calculate the mean amount consumed per day for each category of the GNHIES98-FFQ for the above-mentioned foods. The obtained values were allocated to the respective categories of frequency for all GNHIES98 participants. In DEGS1, a semiquantitative FFQ was applied consisting of 11 categories of frequency and five categories of amounts. Categories of amounts were comparable between DEGS1 and EPIC-Potsdam. Consequently, we assigned the respective portion sizes as used in EPIC-Potsdam (ie, 150 g for red meat, 150 mL for coffee and 50 g for whole grain bread and muesli) to estimate the average intake in grams per day.[12]

Calculation of GDRS points and predicted 5-year type 2 diabetes risk

In this study, the overall GDRS points were calculated according to the following previously published algorithm, which includes the multiplication of each GDRS

component by a weight that corresponds to the derived β coefficient from a Cox regression model[13]:

$$
\begin{aligned}
\text{GDRS points} = \;&5.1 \times \text{age (years)} + 7.6 \times \text{waist circumference (cm)} \\
&-2.7 \times \text{height (cm)} + 47 \times \text{history of hypertension (yes/no)} \\
&-2 \times \text{sport activity (h/week)} \\
&+15 \times \text{former smoking of less than 20 cigarettes/day (yes/no)} \\
&+45 \times \text{former smoking of at least 20 cigarettes/day (yes/no)} \\
&+23 \times \text{current smoking of less than 20 cigarettes/day (yes/no)} \\
&+77 \times \text{current smoking of at least 20 cigarettes/day (yes/no)} \\
&+55 \times \text{red meat intake (each portion of 150g/day)} \\
&-7 \times \text{whole grain intake (each portion of 50g/day)} \\
&-5 \times \text{coffee intake (each portion of 150ml/day)} \\
&+56 \times \text{only one parent with diabetes (yes/no)} \\
&+106 \times \text{both parents with diabetes (yes/no)} \\
&+48 \times \text{at least one sibling with diabetes (yes/no)}
\end{aligned} \tag{1}
$$

The corresponding predicted 5-year type 2 diabetes risk was calculated by inserting the obtained GDRS points into the following formula:

$$
P_{(5\ \text{years})} = 1 - 0.99061^{\exp\left(\left(\text{GDRS points} - 474.17096591\right)/100\right)} \tag{2}
$$

The derivation of this formula in EPIC-Potsdam has been described before.[12] In brief, the equation is based on three components: the baseline survival function for 5 years estimated in EPIC-Potsdam, the individual GDRS points calculated in the present study and the mean GDRS points estimated in EPIC-Potsdam.

Statistical analysis

For statistical analyses, means (95% CI) and frequencies (95% CI) were calculated with SAS V.9.4 (SAS Institute, Cary, North Carolina, USA). To account for the complex clustered sample design of the survey samples, we applied SAS survey procedures as well as a weighting factor to account for differences between the survey sample and the general population as previously described.[16 18] For comparisons between both surveys, data were weighted to the age and sex structure of the German population as of 31 December 2010. Several sensitivity analyses were conducted. For stratified analyses, stratification variables were used as previously defined.[18]

Results

Between 1997–1999 and 2008–2011, age- and sex-standardised predicted diabetes risk decreased from 1.5% to 1.1% among German adults (table 1). This development was largely explained by an increased proportion of adults with a low diabetes risk (<0.2%) and a decreased proportion with higher diabetes risk, that is, in the groups 1.2%–2.0% and 3.3%–24.4% as shown in figure 1. In several sensitivity analyses, findings remained essentially the same (table 2).

Several GDRS components, namely waist circumference, height, sport activity, current smoking of at least 20 cigarettes/day, coffee consumption and red meat intake, changed in a favourable way, whereas history of hypertension, former and current smoking of less than 20 cigarettes/day and whole grain intake changed

in an unfavourable way (table 1). When further considering each component's individual weighting factor for predicting diabetes risk, changes in red meat intake (equivalent to −13.4 GDRS points) and waist circumference (−11.6 points) had the highest impact on the overall decrease of predicted diabetes risk, while changes in current smoking of at least 20 cigarettes/day (−4.2 points), height (−3.4 points) and coffee consumption (−3.1 points) rather moderately decreased predicted diabetes risk. In contrast, the increase in history of hypertension (+4.1 points) moderately elevated predicted diabetes risk. Changes in the remaining observed GDRS components, that is, sport activity, former smoking of less than 20 cigarettes/day, former smoking of at least 20 cigarettes/day, current smoking of less than 20 cigarettes/day and whole grain intake, had a rather negligible influence (<2.0 points) (table 1).

At both survey periods, predicted diabetes risk was higher in men compared with women, in low educated adults compared with those with a middle or high educational level and in central-eastern compared with southern Germany. Diabetes risk consistently increased with increasing age and body mass index (BMI) (table 2). Between the two survey periods, predicted diabetes risk decreased in both sexes and within defined strata of age, BMI and region. Predicted diabetes risk decreased among highly educated adults, while it remained at a relatively low level among those with middle education and at a relatively high level among those with low education (table 2).

DISCUSSION

Overall predicted 5-year type 2 diabetes risk decreased among adults in Germany between 1997–1999 and 2008–2011. This finding was confirmed in several sensitivity analyses and also observed in analyses stratified by sex, age, BMI and region. However, temporal changes in predicted diabetes risk differed according to educational level.

Decreases in the mean intake of red meat and in mean waist circumference were identified as having the highest impact on the observed decline in predicted 5-year diabetes risk between 1997–1999 and 2008–2011. When interpreting the dietary changes, particularly the decrease in red meat intake, differences between the assessment methods of both surveys need to be considered. However, comparing overall meat intake in the German Nutrition Survey (1997–1999)[22] with meat and meat product intake in the German National Nutrition Survey II (2005–2006),[23] both applying the same assessment method (Diet Interview Software for Health Examination Studies (DISHES)), also showed a decrease. This is further in line with the marginal decrease in red meat intake found for Western Europe in another study.[5] Besides, in a sensitivity analysis applying a constant for red meat intake, the decrease in predicted diabetes risk remained statistically significant (table 2). With respect to abdominal obesity,

Table 1 Components of the GDRS, overall GDRS points and predicted 5-year type 2 diabetes risk in 1997–1999 (GNHIES98, n=6457) and 2008–2011 (DEGS1, n=6095) among participants aged 18–79 years

	Mean value or percentage (95% CI)		Equivalent GDRS points (95% CI)	
	1997–1999 (GNHIES98)	2008–2011 (DEGS1)	1997–1999 (GNHIES98)	2008–2011 (DEGS1)
Age (years)	46.4 (45.7 to 47.1)	46.0 (45.6 to 46.5)	236.7 (233.0 to 240.3)	234.8 (232.4 to 237.2)
Waist circumference (cm)	90.7 (90.1 to 91.2)¶	89.1 (88.5 to 89.7)	689.0 (684.8 to 693.2)¶	677.4 (672.8 to 682.0)
Height (cm)	169.4 (169.1 to 169.8)¶	170.7 (170.4 to 171.1)	−457.5 (−458.3 to −456.6)¶	−460.9 (−461.9 to −460.0)
Hypertension (%)	22.0 (20.7 to 23.4)¶	30.7 (29.3 to 32.1)	10.3 (9.7 to 11.0)¶	14.4 (13.8 to 15.1)
Sport activity (hours/day)	1.0 (1.0 to 1.1)¶	1.4 (1.4 to 1.5)	−2.1 (−2.2 to −2.0)¶	−2.8 (−2.9 to −2.7)
Former smoker (<20 cigarettes/day) (%)*	12.1 (11.1 to 13.1)¶	17.6 (16.3 to 19.0)	1.8 (1.7 to 2.0)¶	2.6 (2.4 to 2.8)
Former smoker (≥20 cigarettes/day) (%)	10.4 (9.5 to 11.3)	10.4 (9.5 to 11.4)	4.7 (4.2 to 5.1)	4.7 (4.2 to 5.1)
Current smoker (<20 cigarettes/day) (%)	19.4 (18.1 to 20.8)¶	22.0 (20.6 to 23.4)	4.5 (4.2 to 4.8)¶	5.1 (4.7 to 5.4)
Current smoker (≥20 cigarettes/day) (%)	13.4 (12.2 to 14.6)¶	8.0 (7.0 to 9.1)	10.3 (9.4 to 11.2)¶	6.1 (5.4 to 6.9)
Whole grain intake (each 50g/day)	1.3 (1.3 to 1.3)¶	1.2 (1.2 to 1.3)	−9.0 (−9.3 to −8.8)¶	−8.6 (−9.0 to −8.2)
Coffee consumption (each 150g/day)	2.6 (2.6 to 2.7)¶	3.3 (3.1 to 3.4)	−13.2 (−13.5 to −13.0)¶	−16.3 (−17.0 to −15.6)
Red meat intake (each 150g/day)	0.6 (0.6 to 0.6)¶	0.3 (0.3 to 0.3)	31.1 (30.7 to 31.4)¶	17.7 (16.9 to 18.5)
One parent with diabetes (%)†	24.0 (constant)	22.6 (21.2 to 24.1)	13.4 (constant)	12.7 (11.9 to 13.5)
Both parents with diabetes (%)‡	2.0 (constant)	1.8 (1.4 to 2.3)	2.1 (constant)	1.9 (1.5 to 2.3)
At least one sibling with diabetes (%)§	5.0 (constant)	5.0 (constant)	2.4 (constant)	2.4 (constant)
GDRS (points)	524.4 (517.4 to 531.4)¶	491.2 (484.3 to 498.1)	n/a	n/a
Predicted 5-year type 2 diabetes risk (%)	1.5 (1.4 to 1.6)¶	1.1 (1.0 to 1.2)	n/a	n/a

Values are given as weighted arithmetic mean (95% CI) or weighted percentage (95% CI) and for predicted 5-year type 2 diabetes risk as weighted geometric mean (95% CI). All data are weighted to the German population as of 31 December 2010.

*The prevalence of never smoking was 44.8% (95% CI 43.1% to 46.5%) in GNHIES98 and 42.0% (95% CI 40.4% to 43.7%) in DEGS1.

†Information was not ascertained in 1997–1999 (GNHIES98) and is substituted by a constant reflecting the prevalence of history of diabetes in one parent among participants in 2008–2011 (DEGS1). Missing information in 2008–2011 (DEGS1, n=382) is replaced by a constant reflecting the prevalence of history of diabetes in one parent among participants with available information.

‡Information was not ascertained in 1997–1999 (GNHIES98) and is substituted by a constant reflecting the prevalence of history of diabetes in both parents among participants in 2008–2011 (DEGS1). Missing information in 2008–2011 (DEGS1, n=382) is replaced by a constant reflecting the prevalence of history of diabetes in both parents among participants with available information.

§Information was not ascertained in 1997–1999 (GNHIES98) and is substituted by a constant reflecting the prevalence of a sibling history of diabetes in EPIC-Potsdam.

¶Significant difference between 1997–1999 (GNHIES98) and in 2008–2011 (DEGS1) at a level of p<0.05.

DEGS1, German Health Interview and Examination Survey for Adults; GDRS, German Diabetes Risk Score; GNHIES98, German National Health Interview and Examination Survey 1998.
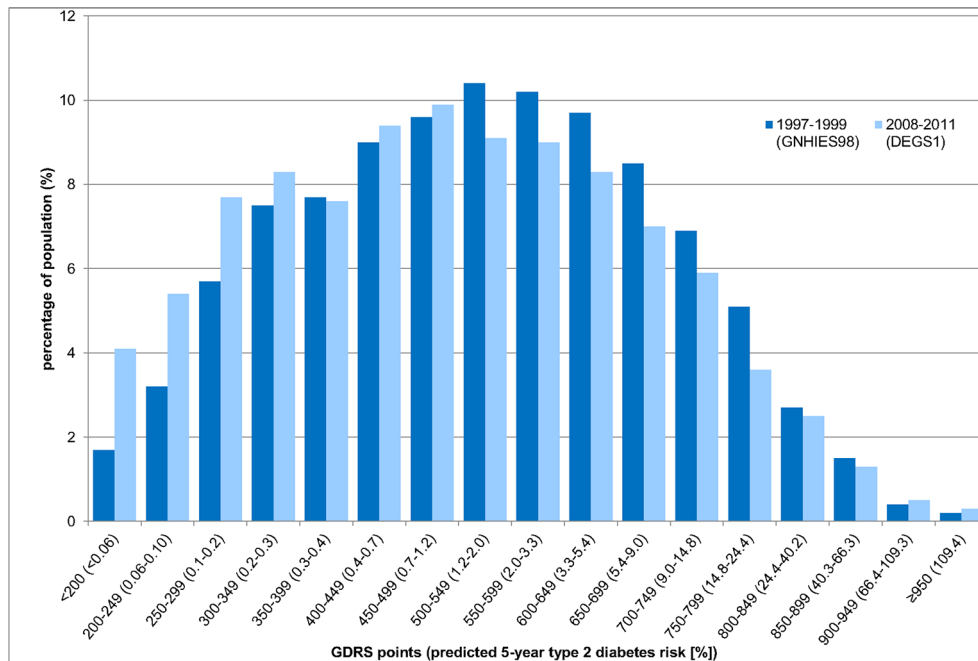
Figure 1 Distribution of GDRS points (predicted 5-year type 2 diabetes risk (%)) in 1997–1999 (GNHIES98, n=6457) and 2008–2011 (DEGS1, n=6095) among participants aged 18–79 years. All data are weighted to the German population as of 31 December 2010. DEGS1, German Health Interview and Examination Survey for Adults; GDRS, German Diabetes Risk Score; GNHIES98, German National Health Interview and Examination Survey 1998.

the age-standardised prevalence marginally decreased among men (waist circumference ≥94 cm) in a regionally confined German study, whereas it slightly increased among women (waist circumference ≥80 cm).[24] We cannot exclude that the overall decrease in mean waist circumference observed in the current study was partly based on differences in measurement methods between both surveys. Still, in a sensitivity analysis applying a constant for waist circumference for both survey periods the decrease in predicted diabetes risk remained statistically significant (table 2).

Further, the decrease in current smoking of at least 20 cigarettes/day and the increase in hypertension diagnosis had a moderate, though in case of hypertension opposing influence on the change in predicted diabetes risk. A decreased prevalence of current heavy smoking was also seen in another German study,[25] which is probably largely attributable to measures targeted at decreasing the smoking prevalence, for example, increased tobacco taxes and smoking bans.[25 26] The increased prevalence of a self-reported history of hypertension found in the present study, however, was difficult to compare to the findings of other studies as the definition of hypertension usually further includes use of antihypertensive agents and hypertensive blood pressure. When applying such an extended definition of hypertension, the prevalence of hypertension no longer differed between the two survey periods as previously shown.[27] Nevertheless, the overall change in predicted diabetes risk remained statistically significant (table 1).

The decrease in predicted diabetes risk observed over time in the overall population was also seen in all

examined strata of sex, age, BMI and residential region, but in terms of educational level was only evident among highly educated adults. An additional analysis revealed that the latter was mainly due to differences in the temporal development of waist circumference, which significantly decreased only among highly educated adults (data not shown).

The favourable changes in some diabetes risk factors and the resulting decrease in predicted diabetes risk observed in the current study are in line with the previously observed decreased prevalence of pre-diabetes and undiagnosed diabetes among German adults.[18] As previously suggested, the increased prevalence of diagnosed diabetes in Germany during the same period of time might, therefore, be largely attributable to a somewhat earlier diabetes diagnosis, that is, a shift from undiagnosed to diagnosed diabetes and improvements in diabetes care potentially leading to a longer life span in persons with diabetes.[18 28]

In other countries, temporal changes in predicted risk for coronary heart or cardiovascular disease based on risk factors partly overlapping with those of the GDRS have been examined. Similar to the current finding, 10-year risk of coronary heart disease significantly declined between 1999 and 2010 in the USA[10] and 10-year risk of cardiovascular disease significantly declined between 2007 and 2012 in France.[29]

Limitations of the current study include that the assessment of some GDRS components differed between both surveys. In addition, we had no information on parental history of diabetes in the earlier survey and no information on sibling history of diabetes at

Table 2 Predicted 5-year type 2 diabetes risk (%, 95% CI) in 1997–1999 (GNHIES98, n=6457) and 2008–2011 (DEGS1, n=6095) according to sensitivity and stratified analyses among participants aged 18–79 years

	1997–1999 (GNHIES98)	2008–2011 (DEGS1)	p Value for trend
Sensitivity analyses			
Exclusion of participants with hemoglobin A1c (HbA1c) levels =48 mmol/mol (6.5%)*	1.4 (1.3 to 1.5)	1.0 (1.0 to 1.1)	<0.01
History of hypertension defined as use of antihypertensive agents and self-reported physician diagnosis or systolic blood pressure =140 mm Hg or diastolic blood pressure =90 mm Hg†	1.5 (1.4 to 1.7)	1.1 (1.0 to 1.2)	<0.01
Mean whole grain intake in DEGS1 assigned as a constant to all GNHIES98 participants	1.5 (1.4 to 1.6)	1.1 (1.0 to 1.2)	<0.01
Mean red meat intake in DEGS1 assigned as a constant to all GNHIES98 participants	1.3 (1.2 to 1.4)	1.1 (1.0 to 1.2)	<0.01
Mean coffee intake in DEGS1 assigned as a constant to all GNHIES98 participants	1.5 (1.4 to 1.6)	1.1 (1.0 to 1.2)	<0.01
Mean waist circumference in DEGS1 assigned as a constant to all GNHIES98 participants	1.4 (1.3 to 1.4)	1.1 (1.1 to 1.1)	<0.01
Stratified analyses			
Sex			
Women	1.1 (1.0 to 1.2)	0.8 (0.7 to 0.9)	<0.01
Men	2.2 (2.0 to 2.3)	1.5 (1.3 to 1.6)	<0.01
Age			
18–44 years	0.5 (0.4 to 0.5)	0.3 (0.3 to 0.3)	<0.01
45–64 years	2.9 (2.7 to 3.1)	2.2 (2.1 to 2.4)	<0.01
65–79 years	9.9 (9.1 to 10.7)	7.7 (7.2 to 8.3)	<0.01
Education‡			
Low	2.7 (2.5 to 2.9)	2.5 (2.2 to 2.7)	0.12
Middle	0.7 (0.7 to 0.8)	0.7 (0.6 to 0.8)	0.29
High	1.3 (1.1 to 1.4)	0.8 (0.7 to 1.0)	<0.01
BMI (kg/m²)§			
<25.0	0.4 (0.4 to 0.5)	0.3 (0.3 to 0.3)	<0.01
25.0–29.9	2.4 (2.2 to 2.5)	1.7 (1.6 to 1.8)	<0.01
=30.0	7.2 (6.7 to 7.8)	6.4 (5.8 to 7.0)	0.03
Region			
North-East	1.6 (1.2 to 2.1)	1.0 (0.9 to 1.3)	<0.01
Central-East	1.7 (1.5 to 2.0)	1.4 (1.2 to 1.6)	0.02
North-West	1.4 (1.2 to 1.7)	1.0 (0.8 to 1.3)	<0.01
Central-West	1.6 (1.4 to 1.8)	1.1 (1.0 to 1.2)	<0.01
South	1.4 (1.3 to 1.6)	1.0 (0.9 to 1.1)	<0.01

All data are weighted to the German population as of 31 December 2010.
*Exclusion of 240 participants in 1997–1999 (GNHIES98) and 128 participants in 2008–2011 (DEGS1).
†Information was missing for 15 participants in 1997–1999 (GNHIES98) and 22 participants in 2008–2011 (DEGS1).
‡Information was missing for 18 participants in 1997–1999 (GNHIES98) and 11 participants in 2008–2011 (DEGS1).
§Information was missing for nine participants in 2008–2011 (DEGS1).
BMI, body mass index; DEGS1, German Health Interview and Examination Survey for Adults; GNHIES98, German National Health Interview and Examination Survey 1998.

all. However, from a genetic point of view, we would not expect a considerable change in this component during the relatively short period of about 12 years.

Finally, despite the application of complex weighting factors, we cannot exclude the possibility of selection bias.[18]

In summary, between 1997–1999 and 2008–2011, overall predicted risk for future type 2 diabetes decreased among adults in Germany. Public health monitoring of diabetes risk factors and of overall diabetes risk in the general population could essentially contribute to understand the complex dynamics of diabetes epidemiology and to guide health policy decisions for diabetes prevention.

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These include:

Notes