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Social Differences in Germany: Mortality and Life Expectancy

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Robert Koch Institute, Berlin

Thomas Lampert[1], Jens Hoebel[1],
Lars Eric Kroll[2]

[1] Robert Koch Institute, Berlin
Department of Epidemiology and Health Monitoring
[2] Formerly Robert Koch Institute, Berlin
Department of Epidemiology and Health Monitoring

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Social differences in mortality and life expectancy in Germany. Current situation and trends

Abstract

Social differences in mortality and life expectancy are a clear demonstration of the social and health-related inequalities that exist within a particular population. According to data from the Socio-Economic Panel (SOEP) for the period ranging from 1992 to 2016, 13% of women and 27% of men in the lowest income group died before the age of 65; the same can be said for just 8% of women and 14% of men in the highest income group. The difference between mean life expectancy at birth among the lowest and highest income groups is 4.4 years for women and 8.6 years for men. Substantial differences also exist between income groups regarding further life expectancy at the age of 65: women in the lowest income group have a 3.7-year shorter life expectancy than women in the highest income group. Similarly, men in the lowest income group have a 6.6-year shorter life expectancy than men in the highest income group. Finally, results from the trend analyses suggest that social differences in life expectancy have remained relatively stable over the last 25 years.

SOCIAL INEQUALITY · SOCIOECONOMIC STATUS · INCOME · MORTALITY · LIFE EXPECTANCY

1. Introduction

Germany is not only one of the wealthiest countries in the world, it also has well-developed social security and pension systems. However, significant inequalities continue to exist in terms of people's living conditions and the opportunities that people have to participate in society. These factors are reflected in a highly unequal distribution of income and wealth, poor prospects for low-skilled people in the labour market, growth in precarious employment and the continuing close links between social status and educational opportunities in Germany [1].

Social inequality is important from a public health and health policy perspective because it has an impact both on the population's health and life expectancy. People on low incomes or with a low occupational or educational status are at increased risk of developing chronic diseases and disorders. The same applies to illness-related functional limitations in everyday life and they also tend to have a lower general quality of life. Moreover, significant social differences also exist when it comes to individual health-related behaviour and behavioural risk factors such as smoking, physical inactivity, obesity and hypertension. Ultimately, these risks accumulate and are reflected in the higher premature mortality and shorter lifespans found among socially disadvantaged populations [2-4].

Analysis of social differences and their relation to mortality and life expectancy, therefore, is crucial. Importantly,

Social differences in life expectancy are an extreme indication of social inequality.

the Socio-Economic Panel (SOEP) provides a possible empirical basis for this type of research. The SOEP is an annual household survey conducted by the German Institute for Economic Research (DIW) aimed at providing a current assessment of political and social change in Germany. A mortality follow-up (an identification of the reasons why study participants who took part in previous survey waves no longer participate) can be used to identify deaths among former participants. Numerous analyses of social differences in mortality and life expectancy have already been conducted using SOEP data. Most of these studies have focused on differences between income groups, although some have also looked into differences linked to educational and occupational status. They all identified significant social differences in mortality and life expectancy which were to the detriment of people with a low level of income, education or occupational status [5-10].

In the following section, SOEP data [11] are used to analyse income-related differences in mortality and life expectancy for the period ranging from 1992 to 2016. In addition to mean life expectancy at birth, this study also considers further life expectancy at the age of 65 and provides results from trend analyses. The trend analyses indicate whether and, if so, the extent to which social differences in mortality and life expectancy have changed over the past 25 years.

2. Methodology

Income-related differences in mortality and life expectancy can be studied using SOEP data collected from 83,287 study participants between 1992 and 2016. Not all of the individuals who provided data were studied for the entire period. On average, the study participants were observed for 7.4 years, with the data consisting of 617,550 one-year study episodes. A total of 4,193 study participants died during the study period (5.0% of the participants).

This study uses 'net equivalised income' as an indicator of income. Net equivalised income takes the size and composition of a particular household into account. This helps ensure that the savings linked to the shared economy of multi-person households and the different income needs of adults and young people are considered, while also providing for a comparison of household incomes despite differences in household size and age structure. Calculations of net equivalised income are based on a household's net income, in other words, the total income of all household members after tax and social security contributions have been deducted. Equivalence balancing or needs weighting was undertaken in line with the new OECD equivalence scale, which is also used in official social and poverty monitoring. According to this scale, all persons aged 15 and over have an income need 0.5 times that of the head of the household and all children and adolescents under 15 have an income need 0.3 times that of the head of the household. Furthermore, the calculation uses a quotient based on the sum of the household members' needs weighting (e.g. 1 for a one-person household; 1.5 for a household with two adults; and 2.1 for a household consisting of either two adults and two children or adolescents under the age of 15).

Between 1992 and 2016, the median net equivalised income of the population in Germany was €1,495.00. This figure was used to define the following five income categories: an income of less than 60%, of between 60% and

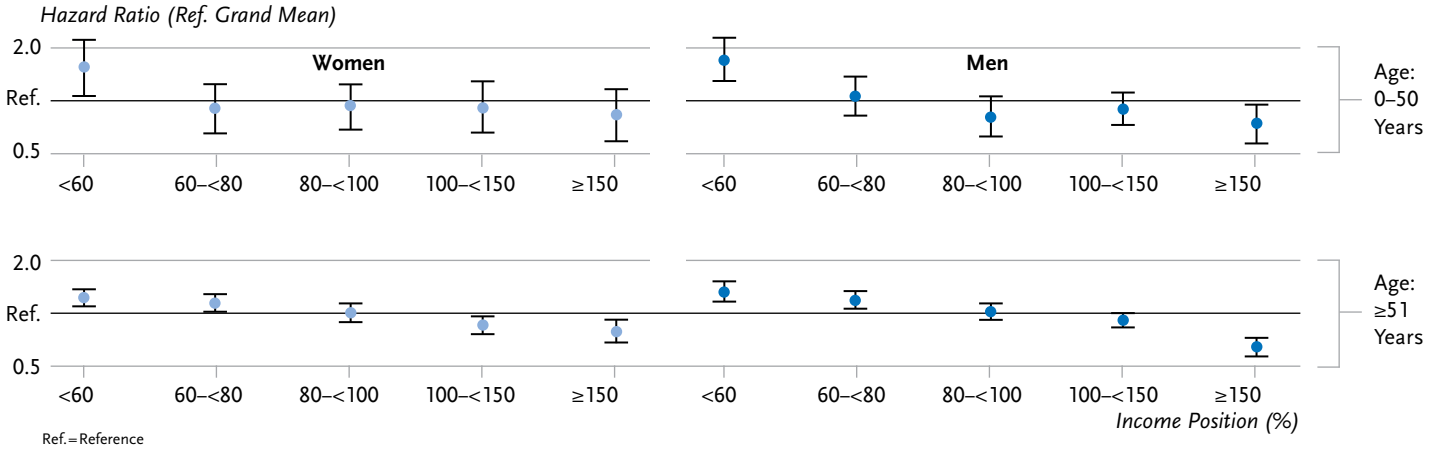
About 13% of women and 27% of men on low incomes die before the age of 65.

under 80%, of between 80% and under 100%, of between 100% and under 150%, and an income of 150% or more of this figure. In accordance with socio-political definitions, households with an income of less than 60% of the median income, in other words, less than €897.00 can be described as affected by or as at risk of poverty. In contrast, the 150% threshold (€2,243.00) can be used to delineate relative wealth.

Analyses of income-related differences in life expectancy tend to use a method that combines the figures on relative mortality risks gained from survey data with those on the general risk of mortality identified from official period life tables [12]. This study calculated the relative risk of mortality by applying Cox regression models to the SOEP data. The results are differentiated according to time period, age group and a participant's gender. In contrast to previous studies, instead of focusing on mortality risks for the entire range of ages reflected in the data, this study concentrated on specific age groups. This was done because the assumption that income remains constant during a person's entire life was considered inaccurate. However, the limited number of cases available only meant that two age groups could be compared (people aged up to 50; and those aged 51 and above). Finally, a semi-parametric Cox model was used to prevent a priori assumptions about the relationship between age and mortality risk from influencing the results.

In order to gain a figure for mean life expectancy, mortality risks were extracted from the official life tables for Germany as provided by the Federal Statistical Office's Genesis databank [13]. The databank provides annual figures that are structured according to age and gender. Until 2000, however, only abbreviated life tables are available with calculations based on a maximum age of 90 years. As calculations of life expectancy using mortality risks require complete life tables, mortality risks were extrapolated up to the age of 112, the age at which people were assumed to have a 100% mortality risk. In order to verify the results, these figures were then compared with the annual data available from the databank. The mean deviation between the figures used in this study and those provided by the Federal Statistical Office was less than 0.05 years for women and men at birth.

In order to gain baseline values for income group-specific survival rates and life expectancy, mean values for age- and gender-specific mortality risks were calculated using the official life tables for each respective study period. The relative mortality risks identified for the income groups in terms of the population average (calculated using SOEP data) were then applied to these baseline values while accounting for age and gender. Finally, the resulting income-specific rates were used to calculate survivor functions and life expectancy. In addition to average life expectancy at birth, this study also provides data on further life expectancy at the age of 65. Moreover, it also describes the proportion of women and men who died before reaching this age. All analyses were carried out using version 3.5 of the statistics package R [14]. Due to the complexity of the method applied, and to help ensure that the results could be reproduced, the procedure, the libraries and the functions developed for this study are documented in a 'jupyter' notebook [15]. Jupyter notebooks enable programs, results and comments to be saved in a single file. The relevant files have been made available on the online source code archive Github, which converts them into HTML



Ref. = Reference

Figure 1
Relative mortality risks (hazard ratios) in relation to the average risk in SOEP (effect coding) according to gender, age group and income
Source: SOEP 1992-2016

The difference in mean life expectancy at birth between the lowest and highest income group is 4.4 years for women and 8.6 years for men.

pages so that they can be viewed with any web browser. However, they can also be downloaded, run or modified after installing the necessary runtime environment (Project Jupyter).

3. Results

Women and men on an income that is below the poverty line had a significantly higher risk of mortality during the observation period than the population average. Income differences in mortality were somewhat more pronounced among women and men in the younger of the two age groups (people aged up to 50 years) than in the older group (51 years or above). Figure 1 shows the corresponding mortality risks in the 'effect coding' compared to the population average. However, instead of comparing the mortality risk faced by the lowest income group to the mean mortality risk of the population, these risks can also be compared

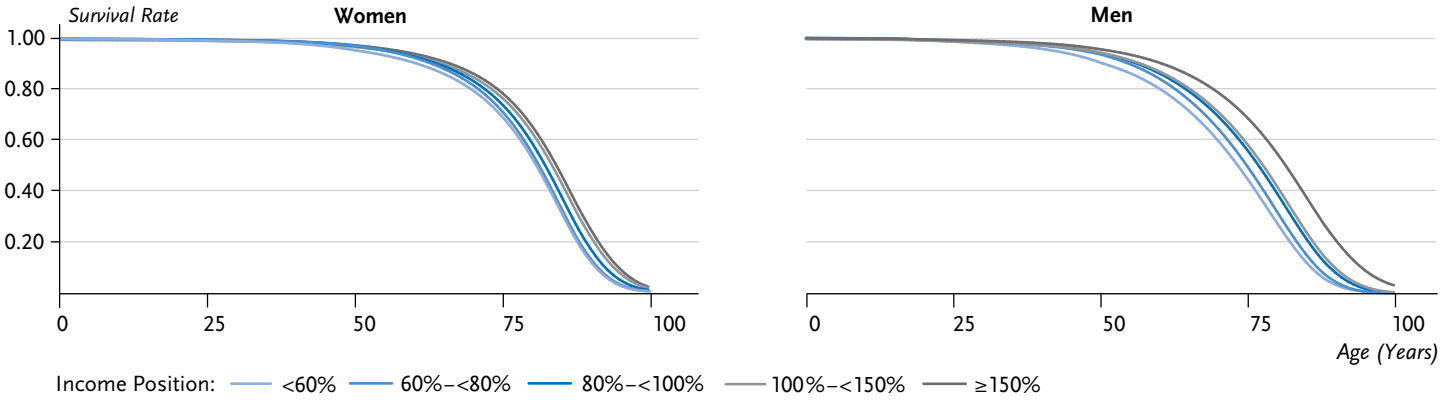
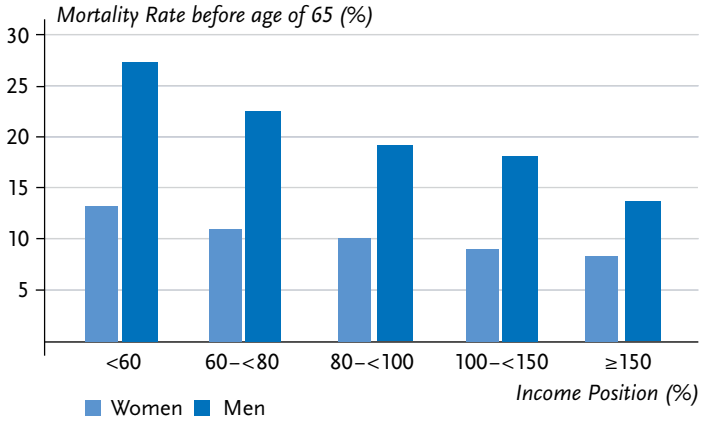


Figure 2
Survival rates according to gender and income
Source: SOEP, period life table 1992-2016

Figure 3
The proportion of women and men who die before the age of 65 according to income
Source: SOEP, period life table 1992-2016



to those faced by the highest income group. In this case, the mortality risk of women aged up to 50 in the low income group increases by a factor of 2.2, and it increases among men by a factor of 2.4. In the case of women and men aged 51 or above, the mortality risk increases by a factor of 1.5 and 1.9 respectively.

The figures set out in Figure 1 were then applied to the mortality rates derived from the life tables. Survival rates for women and men in the five income groups demonstrate the proportion of women and men in each group who survived up until a certain age (Figure 2). As Figure 2 contains probabilities, a value of 0.75 means that 75% of the group was still alive at this point. From the age of 40, the lines in the men's graph deviate, indicating that a larger proportion of men in the lower income groups had already died by this point compared to men in the higher income groups.

In order to emphasise this correlation more clearly, Figure 3 shows the proportion of women and men in each of the income groups that died prematurely (before the age of 65). The graph demonstrates that the lower the income, the higher the premature mortality. Whereas 13.2% of women in the lowest income group died before the age of 65, the same can be said of just 8.3% of women in the highest income group. Moreover, premature mortality among men is significantly higher across all income groups and the difference between the lowest and highest income groups is larger among men at 27.2% compared to 13.6%.

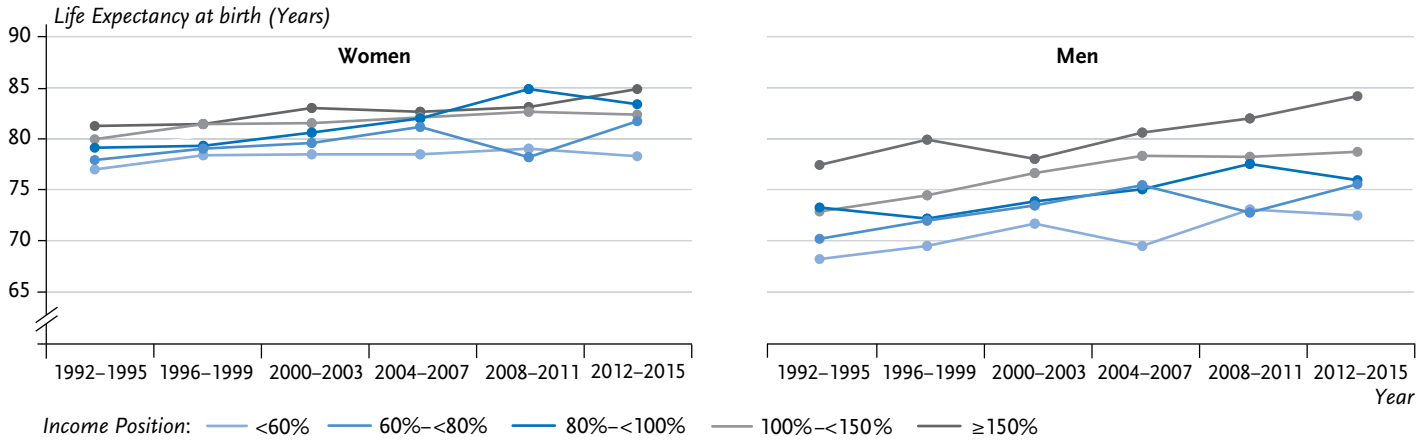
The mean life expectancy at birth for the period between 1992 and 2016 was 80.8 years among women and 75.0 years among men (Table 1). There was a 4.4-year and an 8.6-year difference between the lowest and highest income groups among women and men respectively. On average, women and men who reached the age of 65 could expect to live for 17.0 (women) and 12.5 (men) more years. A comparison of the lower and upper end of the income spectrum identified a 3.7-year difference in further life expectancy at the age of 65 among women, and a 6.6-year difference among men.

The results of the trend analysis show that mean life expectancy at birth during the 25-year observation period increased among women from 78.9 years to 82.2 years and among men from 72.3 years to 77.4 years. Increased life expectancy was observed among all income groups (Figure 4). However, life expectancy among women in the lowest income group rose by 1.4 years compared to 3.9 years

Table 1
Mean life expectancy at birth and further life expectancy from the age of 65 according to gender and income
Source: SOEP, period life table 1992-2016

	Mean life expectancy at birth (years)		Further life expectancy at the age of 65 (years)	
Income	Women	Men	Women	Men
<60%	78.4	71.0	15.2	9.8
60%–<80%	79.7	73.3	15.9	11.0
80%–<100%	80.7	75.2	16.9	12.4
100%–<150%	82.1	76.0	18.2	13.2
≥150%	82.8	79.6	18.9	16.4
Total	80.8	75.0	17.0	12.5

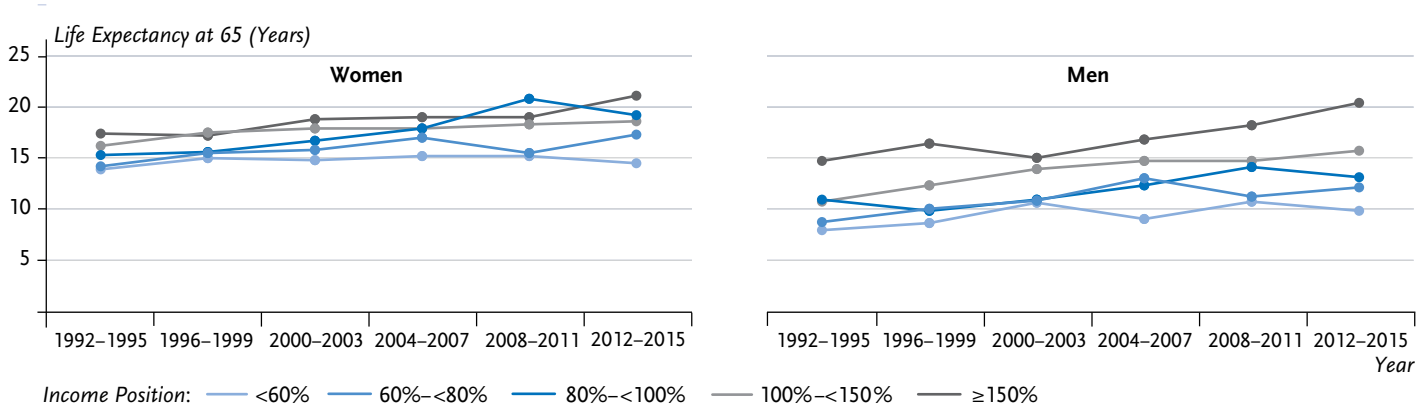
Figure 4
Trends in mean life expectancy at birth according to gender and income between 1992 and 2016
Source: SOEP, period life table 1992-2016



among women in the highest income group. Similarly, men in the lowest income group saw their life expectancy rise by 4.2 years, whereas those in the highest income group gained 6.9 years. The increase in life expectancy in the three middle income groups varies between 2.6 and 4.6 years among women and between 2.6 and 5.9 years among men.

During the observation period, further life expectancy at the age of 65 increased by 2.8 years among women and by 3.7 years among men. However, women in the lowest income group gained just 0.6 years compared to 3.7 years among women in the highest income group (Figure 5). Similarly, men in the lowest income group saw their life expectancy rise by 1.8 years, whereas life expectancy among men in the highest income group rose by 5.7 years. Women in the middle income groups gained an increase in further life expectancy at the age of 65 of between 2.4 and 3.9 years, men gained between 2.2 and 5.0 years of further life expectancy.

Figure 5
Trends in further life expectancy at the age of 65 according to gender and income between 1992 and 2016
Source: SOEP, period life table 1992-2016



4. Discussion

Significant income-related differences in mortality and life expectancy were identified among men and women from analyses of SOEP data covering 1992 to 2016. A 4.4-year difference in mean life expectancy at birth was identified between women in the lowest and highest income groups over the entire period. Among men, this difference was 8.6 years. Further life expectancy at the age of 65 also differs between the lowest and highest income groups with 3.7 years among women and 6.6 years among men. The trend analysis found no reduction in these differences during the past 25 years. Rather, the results indicate that the increase in life expectancy during this period was higher in the highest and middle income groups. As such, the gap between the lowest and highest income groups may have increased during the study period. However, it was impossible to test for this statistically, as case numbers were relatively low and estimator uncertainty is particularly high in analyses focused on short spaces of time rather than entire observation periods. As this still needs to be kept in mind when considering the otherwise considerable leaps in life expectancy at birth that some income groups have experienced and in further life expectancy at the age of 65, these findings need to be viewed with caution.

At the age of 65, women in the lowest income group have a 3.7-year and men have a 6.6-year lower further life expectancy than women and men in the highest income group.

The results of this study are broadly consistent with those of other studies of income-related differences in mortality and life expectancy. At the same time, they also apply to the results of previous studies that used data from the SOEP [6-9]; however, it is important to bear in mind that they are not always directly comparable with those of other studies. On the one hand, this study used a different observation period and a different methodology. Moreover, substantial changes have also been made to the data pool since these studies were conducted. The SOEP data is not derived from a static database; rather, each new data set can give rise to changes in the figures from previous years. This is due to missing values being entered at a later date, changes in imputation and weighting procedures and participant drop-out leading to fewer cases. In addition, this study made valid changes to the methodology, which could have influenced the results. Several of these changes were made to improve the stability of the results for trend analysis and to address limitations of the original approach [12]. Furthermore, this study provides estimates of age group-specific mortality risks, used Cox regression models, and relied on the information available on income at the beginning of each study period.

It is also important to note that no systematic follow-up is being undertaken in the SOEP as to reasons for non-participation. However, it is still possible to follow up and identify deaths that occurred before 2009 using a number of studies on attrition. No such studies have been carried out since then. As people in a poor state of health (who, therefore, also have a higher risk of death) drop out more frequently from studies like this, it is possible that mortality will be underestimated and life expectancy will be overestimated to a greater extent in the future [12]. Given that people on low incomes are more likely to be affected by ill health, this may also aggravate the uncertainty associated with estimates of income-related differences in life expectancy.

The results of this study are also consistent with studies that used other data sources. This includes the

MONICA/KORA studies undertaken for the Augsburg region [16, 17], the life expectancy survey conducted by the Federal Institute for Population Research [18] and the German Health Interview and Examination Survey for Adults (DEGS1) [19], which also follow-up on their study participants. Analyses that demonstrate trends in differences in life expectancy, but, for example, examine the further life expectancy of individuals after a heart attack or of people with diabetes [20], have also identified differences related to income and other social indicators such as education and occupational status.

Studies based on data from Germany's social insurers are also important, even though they face some additional limitations. For example, the validity of the data collected by statutory health insurers is limited due to the insurers' selective membership structure [21]. In addition, their data on income often lacks information or is missing entirely, meaning that in most cases the educational and occupational status or sometimes a person's type of insurance (compulsory versus voluntary insurance) are used instead. Be this as it may, there are some advantages in using data from statutory health insurers, such as the very large case numbers and the opportunity to carry out cause of death analyses. Findings from studies that used data from the AOK (Allgemeine Ortskrankenkasse) or the GEK (Gmünder Ersatzkasse) indicate significant social differences in mortality from heart attack, stroke and various cancers, including stomach, intestinal and lung cancer [21, 22].

A study based on data from the German Statutory Pension Insurance Scheme, which was restricted to male insurance holders, showed that a low income, as determined by earning points, was associated with a lower further life expectancy at the age of 65 years. In addition, the study indicated that income-related differences in further life expectancy continued to widen during the observation period (1995/1996 to 2007/2008). Although life expectancy increased among all income groups during this time, the increase was higher in high income groups than in lower income groups [23].

Comparable social differences in mortality and life expectancy have also been reported by studies using data from other countries, although most of them focused on education or occupational status; only very few concentrated on income. The results of a European research project that used data from nationwide health surveys and also undertook mortality follow-ups are particularly noteworthy. The results, which stem from 22 countries and are based on data from the 1990s and the 2000s, show that, on average, people with a low level of education have an approximately two-fold higher mortality risk across Europe than people with a high level of education. A study that took the various causes of death into account shows that these differences continue to exist in terms of cardiovascular and cancer-related deaths, as well as those caused by accidents and injuries. Moreover, a comparison of countries found that social differences in mortality were more pronounced in Eastern European countries than in Southern, Central and Northern European countries [24].

Studies have also been conducted of long-term developments for some other countries on social differences in mortality and life expectancy. In Europe, this particularly applies to the UK and Scandinavia. In the UK, data is available from the routine mortality follow-ups of the official census. A comparison of men and women in the lowest

and highest occupational status groups in England and Wales using data that was gathered between 1982 and 1986 found a difference in mean life expectancy at birth of 3.8 years among women and 4.9 years among men. In the 20 years that followed, life expectancy in all status groups increased, as did the gap between the groups. Between 2002 and 2006, the difference was 4.2 years among women and 5.8 years among men [25].

The data for Norway also show that social differences in life expectancy have increased over the last few decades. This is illustrated by a study using data from the Norwegian National Register as well as population-based studies and databases compiled between 1961 and 2009. At the beginning of the 1960s, people with a low level of education aged 35 and above had an average further life expectancy of 44.1 years (women) and 40.3 years (men). The figures for women and men with a high level of education were 45.6 years and 42.2 years, respectively. By 2009, further life expectancy in the low education group had increased by 2.9 (women) and 2.1 years (men). The increase in life expectancy in the high education group was much higher at 6.1 (women) and 6.4 years (men) [26].

The social differences that exist in mortality and life expectancy pose a major challenge for public health and health policy [27, 28]. Further improvements to the data should be sought as a basis for continuous monitoring, which, in turn, is essential for planning, implementing and evaluating measures aimed at reducing social differences in mortality and life expectancy. Data from mortality follow-ups carried out as part of social scientific or health-related studies, as well as routine data from social insurance institutions, are available for Germany. Both empirical approaches are promising; each has its own methodological limitations [21, 29, 30].

Countries that have national mortality registries have a head start over Germany. Data from these registries can be combined with other data sources, such as nationally representative social science and health-related studies. Even if a comparable combination of different data sources would, at best, only partially be possible due to the data protection regulations in Germany, the establishment of a national mortality register would provide additional opportunities for analysis [31]. Moreover, a mortality register that offered information about the social situation of the deceased or that could be linked to data sources containing this information would significantly improve the basis for analysis of social differences in mortality and life expectancy and their associated developments over time.

Corresponding author
PD Dr Thomas Lampert
Robert Koch Institute
Department of Epidemiology and Health Monitoring
General-Pape-Str. 62–66
D-12101 Berlin, Germany
E-mail: LampertT@rki.de

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Data protection and ethics

The data collected by the Socio-Economic Panel are subject to the provisions set out in the Federal Data Protection Act (BDSG). This means that the data collected through interviews are anonymised as part of the SOEP and individual respondents can no longer be identified.

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Conflicts of interest

The authors declared no conflicts of interest.

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Editors
Susanne Bartig, Johanna Gutsche, Dr Birte Hintzpeter,
Dr Franziska Prütz, Martina Rabenberg, Dr Alexander Rommel,
Dr Livia Ryl, Dr Anke-Christine Saß, Stefanie Seeling,
Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
Unit: Health Reporting
General-Pape-Str. 62–66
D-12101 Berlin
Phone: +49 (0)30-18 754-3400
E-mail: healthmonitoring@rki.de
www.rki.de/journalhealthmonitoring-en

Typesetting
Gisela Dugnus, Alexander Krönke, Kerstin Möllerke

Translation
Simon Phillips/Tim Jack

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Thomas Lampert, Jens Hoebel, Benjamin Kuntz, Jonas D. Finger, Heike Hölling, Michael Lange, Elvira Mauz, Gert B. M. Mensink, Christina Poethko-Müller, Anja Schienkiewitz, Anne Starker, Johannes Zeiher, Bärbel-Maria Kurth

Robert Koch Institute, Berlin
Department of Epidemiology and Health Monitoring

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Health inequalities among children and adolescents in Germany. Developments over time and trends from the KiGGS study

Abstract

This study examines the extent to which health inequalities among children and adolescents in Germany have developed over the past decade. The analyses are based on data from the German Health Interview and Examination Survey for Children and Adolescents (KiGGS), which are representative of the 0- to 17-year-old population in Germany. The KiGGS data were collected in three waves: the KiGGS baseline study (2003-2006), KiGGS Wave 1 (2009-2012) and KiGGS Wave 2 (2014-2017). Prevalences of five health outcomes are considered: general health, mental health problems, physical activity, the consumption of sugary soft drinks, and smoking. Moreover, it defines health inequalities in relation to differences in the socioeconomic status of the family (SES), an index derived from the parents' level of education, occupation and income, and considers both absolute and relative health inequalities. In order to do so, the Slope Index of Inequality (SII) and the Relative Index of Inequality (RII) were calculated using linear probability or log-binomial models. Significant inequalities were identified to the detriment of young people from families with a low SES. These inequalities were particularly pronounced in the KiGGS Wave 2 data with regard to general health and the consumption of sugary soft drinks. Additionally, evidence from trend analyses for these two outcomes suggests that relative inequalities have increased. However, absolute inequalities decreased during the same period, and this also applies to smoking. The persistently high and, in some cases, widened levels of health inequalities indicate that adolescents from families with a low SES do not benefit to the same extent from disease prevention and health promotion measures for children and adolescents as young people from families with a higher SES.

CHILD AND ADOLESCENT HEALTH · SOCIOECONOMIC STATUS · HEALTH INEQUALITIES · TREND ANALYSES

1. Introduction

The vast majority of children and adolescents in Germany grow up healthy. Although acute diseases such as upper respiratory tract infections and diarrhoeal diseases are common, these can usually be treated successfully and can even be partly prevented through vaccination [1-3]. Chronic diseases and functional limitations are much less common during childhood and adolescence than in later life. Allergic diseases, however, are widespread among children and adolescents [4-6]. In addition, developmental delays and disorders, e.g. related to motor, psychosocial, and cognitive development, and mental health problems and disorders, such as attention deficit/hyperactivity

The KiGGS study

The German Health Interview and Examination Survey for Children and Adolescents

Data owner: Robert Koch Institute

Aim: Providing reliable information on health status, health-related behaviour, living conditions, protective and risk factors, and health care among children, adolescents and young adults living in Germany, with the possibility of trend and longitudinal analyses

Study design: Combined cross-sectional and cohort study

KiGGS survey waves

- KiGGS baseline study (2003-2006), examination and interview survey
- KiGGS Wave 1 (2009-2012), interview survey
- KiGGS Wave 2 (2014-2017), examination and interview survey

KiGGS cross-sectional study

Population: Children and adolescents with permanent residence in Germany
Age range: 0-17 years

KiGGS cohort study

Sampling: Re-invitation of everyone who took part in the KiGGS baseline study (n=17,641) and who was willing to participate in a follow-up
Age range KiGGS Wave 1: 6-24 years (n=11,992)
Age range KiGGS Wave 2: 10-31 years (n=10,853)

More information is available at www.kiggs-studie.de/english

disorder (ADHD), eating disorders and anxiety disorders, need to be taken into account [7-10].

Health development in childhood and adolescence considerably influences people's health-related opportunities in later life [11, 12]. Studies that demonstrate the association between pre- and perinatal risk factors such as maternal smoking in pregnancy and diseases in later life clearly show that the foundations for health-related behaviour are set early on [13-15]. Empirical evidence also points to a correlation between low birth weight and a risk of cardiovascular disease and type 2 diabetes mellitus in middle age and among the elderly [16, 17]. Additional risk factors in childhood and adolescence have also been shown to increase the long-term risk of chronic disease and disorders; these factors include preterm birth, environmental pollution, exposure to violence [18, 19], an unhealthy diet, unhealthy patterns of exercise, overweight and obesity [20], as well as the consumption of psychoactive substances such as tobacco and alcohol at a young age [21].

The current literature indicates that children and adolescents from socioeconomically disadvantaged families are significantly more likely to face health disadvantages than their peers from families in a better socioeconomic situation [22-26]. These are less pronounced with regard to physical health and infectious diseases, but are particularly evident in the case of developmental disorders in early childhood [27], as well as in mental and psychosocial health [28, 29]. Significant socioeconomic inequalities have also been observed for health-related behaviour and behavioural risk factors such as diet, physical activity and obesity, and for the perinatal risk factors mentioned above [30, 31].

Efforts to improve the health status of children and adolescents have increased in recent years through disease prevention, health promotion measures and health care provision. Children and young people from socioeconomically disadvantaged families are a special target group, not merely because they have greater needs for support and care, but also because existing services fail to reach them in the same way as their peers from families in better social positions [32]. Data that enable a wide-ranging description and analysis of the health situation and unequal socioeconomic distribution of health-related opportunities among children and adolescents are therefore essential for the planning, implementation and evaluation of measures and programmes aimed at promoting child and adolescent health. The Robert Koch Institute's German Health Interview and Examination Survey for Children and Adolescents (KiGGS) provides an important contribution to making this possible, as, in contrast to many other studies, it covers the majority of relevant health-related areas for the entire period ranging from childhood to adolescence. Moreover, as data is available from the first survey wave, which took place between 2003 and 2006 (KiGGS baseline study), the first follow-up survey, which was conducted between 2009 and 2012 (KiGGS Wave 1), and the latest wave, undertaken between 2014 and 2017 (KiGGS Wave 2), KiGGS can be used to analyse temporal developments and trends over the last ten years.

This work uses data from the KiGGS study to investigate the following three questions, based on selected indicators, about child and adolescent health:

- Which developments have occurred in the health of children and adolescents in Germany over the last ten years?
- Have socioeconomic inequalities in children's and adolescents' health widened, narrowed or remained constant?
- How should these inequalities be interpreted in light of the measures and programmes implemented in Germany aimed at promoting child and adolescent health?

Children and adolescents from families with a low socioeconomic status are more likely to have health disadvantages than their peers from families with a higher socioeconomic status.

2. Methodology

2.1 Study design

The KiGGS study is part of the health monitoring programme undertaken at the Robert Koch Institute [33]. The following analyses are based on the three cross-sectional surveys conducted as part of the KiGGS study, all of which are representative of 0- to 17-year-old children and adolescents living in Germany. The first cross-sectional survey (KiGGS baseline study) was carried out between 2003 and 2006. It was undertaken as a combined examination and interview survey in a total of 167 communities (sample points) that were representative of Germany's settlement structure. The addresses of the children and adolescents were selected at random (stratified according to age) from the population registers held by the registry offices in the sample points. In order to attract sufficient numbers of participants with a migration background, the sample was broadened to include more children and adolescents not holding German citizenship. A total of 17,641 children and adolescents (8,656 girls, 8,985 boys) aged between 0 and 17 participated in the study (response rate: 66.6%). In addition to the physical examinations, medical interviews, and various tests and laboratory analyses that were undertaken for the study, parents and participants aged eleven or above were asked to complete a written questionnaire [34].

The second cross-sectional survey (KiGGS Wave 1) was conducted between 2009 and 2012 via telephone interviews. The interviews were based on the questionnaire used for the KiGGS baseline study, but the questions were limited to topics and aspects that could be spoken about in a telephone interview. A total of 12,368 children and adolescents (6,093 girls, 6,275 boys) aged between 0 and 17 took part in the study; parents and participants aged eleven or above were once again provided with a questionnaire. The sample included 7,913 children and adolescents who had already participated in the KiGGS baseline study and who were now aged between 7 and 17 (response rate: 72.9%). In addition, 4,455 children aged between 0 and 6 were newly selected from the population registers from the same sample points and invited to take part (response rate: 38.8%). The aim was to ensure that results from KiGGS Wave 1 were representative of the 0- to 17-year-old population in Germany [35].

The third representative cross-sectional survey (KiGGS Wave 2) was carried out between 2014 and 2017, once again as an examination and interview survey. The survey programme included physical examinations, tests and laboratory analyses as well as a written-postal questionnaire for the parents and for participants aged eleven or above [36]. A new sample stratified according to age was drawn from the registers held by the registry offices in the 167 sample points where the KiGGS baseline study was undertaken.

A randomly selected sub-sample of young people aged between 3 and 17 was invited for an examination and an interview; a further sub-sample consisting of children and adolescents aged between 0 and 17 was only invited for an interview. A total of 15,023 children and adolescents (7,538 girls, 7,485 boys) participated in the KiGGS Wave 2 study programme (response rate: 40.1%); 3,567 children and adolescents participated in the additional examination programme (1,801 girls, 1,766 boys) (response rate: 41.5%) [37].

The extent of the socio-economic inequalities in mental health problems that occur in childhood and adolescence has remained largely stable over time.

2.2 Indicators

This article analyses the following health outcomes: general health, mental health problems, physical activity, the consumption of sugary soft drinks, and smoking. Most of these outcomes focus on children and adolescents aged between 3 and 17. One exception is smoking, where data was collected from children and adolescents aged between 11 and 17. All three surveys provide comparable data for general health, mental health problems and smoking. The analyses of the consumption of sugary soft drinks and physical activity are based on data collected only in two surveys. In the case of physical activity, findings are only based on a period of five (not ten) years.

The analysis of the overall health of children and adolescents is based on data from parental assessments. In the KiGGS study the following question, which is also recommended by the World Health Organization (WHO), was asked: 'How would you describe the general health of your child?' (Response categories: 'Very good', 'Good', 'Fair', 'Poor', 'Very poor') [38]. The responses for 'Very good' and 'Good', as well as 'Fair', 'Poor' and 'Very poor' were combined to establish two new categories [39].

The data collected on mental health problems as part of the Strengths and Difficulties Questionnaire (SDQ) are also based on information provided by parents [40]. The KiGGS study concentrates on the following four problem areas set out in the questionnaire: emotional symptoms, conduct problems, hyperactivity/inattention and peer relationship problems. 20 statements made by the parents about their children were scored according to the answers provided: 'Not true' (0), 'Somewhat true' (1) or 'Certainly true' (2). The points from each of the areas were then summed. In line with a German standardization [41], children and adolescents with up to 12 points were classified as having no mental health problems, whereas scores of 13 or more points were interpreted as existing mental health problems [42].

In KiGGS Wave 1 and 2, data on physical activity in childhood and adolescence was collected by asking, 'In a normal week, on how many days are you/is your child physically active for at least 60 minutes per day?' The answers were provided by parents in the case of children aged between 3 and 10, whereas children and adolescents aged between 11 and 17 were expected to answer the question themselves. The eight response categories ranged from 'None' to 'On seven days'. In the following, a low level of physical activity is assumed for children or adolescents who are physically active for at least 60 minutes per day on less than two days per week [43].

Conclusions about the consumption of sugary soft drinks can be made from data collected with the food frequency questionnaire used for the KiGGS baseline study

A more marked decline in the consumption of sugary soft drinks was identified in percentage terms over the course of time in the high status group than in the low status group. Relative inequalities have increased accordingly.

and KiGGS Wave 2. The questionnaire was filled out by parents of 3- to 10-year-old children and by 11- to 17-year-old children and adolescents themselves [44]. KiGGS Wave 2 posed the following question about sugary soft drinks: 'How often during the past four weeks did your child/did you drink sugary soft drinks (such as cola, lemonade, ice tea, malt beer or energy drinks)? This does not include diet beverages.' The following answer categories were provided: 'Never', 'Once per month', '2-3 times per month', '1-2 times per week', '3-4 times per week', '5-6 times per week', 'Once per day', '2 times per day', '3 times per day', '4-5 times per day' and 'More than 5 times per day'. In addition, data on the mean portion size was collected using the following question: 'When your child/you drink sugary soft drinks, how much does your child/do you usually drink?' The answer categories provided were: '½ a glass (or less)', '1 glass (200 ml)', '2 glasses', '3 glasses', '4 glasses (or more)'. In the KiGGS baseline study the note 'This does not include diet beverages' was not added when asking about the consumption of sugary soft drinks. Instead, data on diet beverages were collected using an additional question. Furthermore, rather than providing the separate answer options '2 times per day' and '3 times per day', the baseline study provided the category '2-3 times per day'. In addition, participants were asked to choose from the following portion sizes: '¼ a glass (or less)', '½ a glass', '1 glass (200 ml)', '2 glasses' and '3 glasses (or more)'. Estimated mean daily portion sizes were calculated using the information provided about consumption frequency (consumption frequency per 28 days x portion size (g)/28 days). The following analysis distinguishes between children and adolescents who consume less than 500 ml of sugary soft drinks per day and those who consume 500 ml or more per day [45].

In order to collect data on smoking behaviour among adolescents, the KiGGS baseline study and KiGGS Wave 2 asked the written question: 'Do you currently smoke?' The following answer categories were provided: 'No', 'Daily', 'Several times a week', 'Once a week' and 'Less [than once a week]'. KiGGS Wave 1 began by asking participants 'Have you ever smoked?' (Answer categories were 'Yes' and 'No'.) If this question was answered affirmatively, it was followed by 'How often do you currently smoke?' The answer categories provided were very similar to those used in the other two survey waves: 'Daily', 'Several times a week', 'Once a week', 'Less than once a week' and 'Not at all'. In this article, adolescents who used tobacco at all, including only occasionally, are referred to as current smokers [46].

In the following section, social differences in the health of children and adolescents (also referred to hereafter as 'health inequalities') are analysed in terms of the socioeconomic status (SES) of the family. SES was calculated consistently across the three survey waves using information provided by parents about their education, occupational qualifications, occupational status, and needs-weighted net household income. An index developed as a sum of point scores, in which the three indicators were included equally, was used to draw a distribution-based demarcation that established three groups: 20% of the children and adolescents were placed in the low (first quintile), 60% in the medium (second to fourth quintile) and 20% in the high status group (fifth quintile) [47].

Info box: Calculation and interpretation of the Slope Index of Inequality (SII) and the Relative Index of Inequality (RII)

The SII and the RII are regression-based measures that take into account the overall distribution of socioeconomic variables and the size of socioeconomic groups [48, 49]. Linear probability models were used to compute the SII and log-binomial models were used to calculate the RII. This involved converting the SES variable into a metric scale ranging from 0 (highest SES) to 1 (lowest SES) by means of a ridit analysis [53]. SES was then included as an independent variable in the regression models [52]. The resulting regression coefficients indicate the SII or RII, depending on the respective model. The models included statistical controls for age, gender and a recent history of migration.

SII is to be interpreted as the difference in prevalence (absolute inequality), whereas RII is the prevalence ratio (relative inequality) between adolescents from families with the lowest SES and those from families with the highest SES. For example, an SII of 0.15 would indicate that a 15 percentage-point prevalence difference exists between people at the very bottom and at the very top of the SES scale. An SII value of 0.00 would signify no difference in prevalence between these individuals. An RII of 2.00, for example, indicates that people at the very bottom of the SES scale are twice as likely to have a particular health outcome compared to those at the very top of the SES scale. An RII value of 1.00, in contrast, would indicate that no differences were identified in risk between these individuals.

2.3 Statistical methods

Depending on the indicator used, a differing number of participants had to be excluded from the study as they lacked certain information. Prevalences with 95% confidence intervals (CI) were calculated for each health indicator, stratified according to survey period, gender and SES. Trends over time were analysed using logistic regression models with the respective health indicator as the dependent and the survey year as the independent variable. The survey year was included in the model as a linear term. The extent of health inequalities in relation to family SES was analysed using the Slope Index of Inequality (SII) and the Relative Index of Inequality (RII) [48, 49]. Whereas the SII quantifies the extent of absolute inequality, the RII provides a measure of the degree of relative inequality (see Info box). Moreover, since the results of trend analyses of health inequalities and the conclusions that they lead to can be significantly dependent on whether relative or absolute inequalities are considered, it is important that analyses take both dimensions into account [50-52]. Trends over time in terms of absolute and relative health inequalities were analysed using the interaction term between SES and the survey year.

Weighting factors were used to ensure that the samples reflect the official population statistics of the respective survey period in terms of age, gender, federal state, citizenship and parental education. All analyses were performed using Stata 15.1 (StataCorp LP, College Station, TX) survey procedures and took weighting and cluster design effects into account (using cluster-robust standard error estimation). A statistically significant difference between groups is assumed when p-values were less than 0.05 once weighting and the survey design had been taken into account.

3. Results

Table 1 describes the sample compositions in relation to gender, age and socioeconomic status (SES). Table 2 depicts developments in the prevalence of selected indicators over the past ten years. In addition to the total values, the prevalences for girls and boys are shown separately. Table 3 sets out prevalences according to SES. The SII and RII shown in Table 4 demonstrate the extent to which absolute and relative inequalities changed over the survey period. Tables 5 to 8 describe the results on developments in prevalence among the socioeconomic status groups and in terms of absolute and relative inequalities, displayed again separately for girls and boys.

3.1 General health

In the years 2003-2006, 7.7% of the 3- to 17-year-old children and adolescents in Germany had fair, poor or very poor general health. Between 2003-2006 and 2014-2017, this proportion decreased to 4.3%. The proportion of boys with fair or poor general health was slightly above the corresponding proportion of girls – both at the beginning and end of the observation period. However, the decline in prevalence occurred in a similar way among girls and boys (Table 2). Moreover, it is striking that significant differences were identified throughout the entire observation period to the detriment of the low compared to the medium and in particular to the high socioeconomic status

Table 1
Characteristics of the KiGGS study populations
Source: KiGGS baseline study (2003-2006), KiGGS Wave 1 (2009-2012), KiGGS Wave 2 (2014-2017)

	KiGGS baseline study (2003-2006)		KiGGS Wave 1 (2009-2012)		KiGGS Wave 2 (2014-2017)			
	IS/ES		IS		IS		ES	
	%	n	%	n	%	n	%	n
Gender								
Girls	48.7	7,265	48.7	5,154	48.5	6,810	48.5	1,801
Boys	51.3	7,570	51.3	5,272	51.5	6,758	51.5	1,766
Age group								
3-10 Years	49.5	8,023	50.5	5,168	51.3	6,969	51.3	1,796
11-17 Years	50.5	6,812	49.5	5,258	48.7	6,599	48.7	1,771
Socioeconomic status								
Low	19.9	2,297	20.7	1,074	20.2	1,671	21.6	532
Medium	60.5	8,745	59.7	6,524	60.5	8,257	59.0	2,113
High	19.6	3,492	19.6	2,753	19.4	3,425	19.4	798
Total	**100.0**	**14,835**	**100.0**	**10,426**	**100.0**	**13,568**	**100.0**	**3,567**

IS=interview survey, ES=examination survey, n=absolute frequency in the sample (unweighted), %=relative frequency in the population (weighted)

group (Table 3). Prevalence decreased over time in all three status groups. However, as a percentage – in other words, in relative terms – the decline in prevalence was weaker in the low status group than in the medium and high status groups. As such, relative inequalities have widened for general health, and this has occurred equally among girls and boys. By contrast, no significant change was identified in absolute inequalities during the observation period (Table 4).

3.2 Mental health problems

The prevalence of mental health problems has decreased over the past decade from 19.8% to 16.9% among 3- to 17-year-old children and adolescents. This is due to the development in boys. No reduction was identified among girls, who are less affected by mental health problems than boys (Table 2). As in general health, a clear social gradient was identified with the highest prevalence in the low status group and the lowest prevalence in the high status group (Table 3). Despite this, absolute inequalities in the prevalence of mental health problems are still significantly higher than in general health. If girls and boys are grouped together, a decline in the prevalence of mental health problems is observed for all three status groups, although no significant change occurs to either relative or absolute inequalities (Table 4). When viewed by gender, only the decline in prevalence among boys in the medium status group is significant.

3.3 Low level of physical activity

In contrast to most of the other indicators considered in this work, the proportion of 3- to 17-year-old children and

Table 2
Prevalence of health outcomes in 3- to 17-year-olds (smoking among 11- to 17-year-olds) according to gender*
Source: KiGGS baseline study (2003-2006), KiGGS Wave 1 (2009-2012), KiGGS Wave 2 (2014-2017)

	KiGGS baseline study (2003-2006)		KiGGS Wave 1 (2009-2012)		KiGGS Wave 2 (2014-2017)		
	%	(95% CI)	%	(95% CI)	%	(95% CI)	*p*-trend
General health (fair to very poor)							
Total	7.7	(7.1-8.4)	6.4	(5.7-7.1)	4.3	(3.8-4.9)	<0.001
Girls	7.3	(6.4-8.2)	6.6	(5.6-7.6)	4.0	(3.4-4.7)	<0.001
Boys	8.1	(7.3-9.0)	6.2	(5.2-7.2)	4.6	(3.8-5.5)	<0.001
Mental health problems							
Total	19.8	(18.9-20.7)	20.2	(18.9-21.6)	16.9	(15.9-17.9)	<0.001
Girls	15.9	(14.8-16.9)	16.9	(15.2-18.7)	14.5	(13.2-15.9)	0.204
Boys	23.6	(22.3-24.9)	23.4	(21.5-25.4)	19.1	(17.7-20.6)	<0.001
Low level of physical activity							
Total	–	–	6.3	(5.5-7.3)	9.0	(8.3-9.8)	<0.001
Girls	–	–	8.0	(6.7-9.5)	11.1	(9.9-12.4)	0.001
Boys	–	–	4.7	(3.8-5.9)	7.0	(6.2-8.0)	0.001
Consumption of sugary soft drinks							
Total	19.7	(18.6-20.8)	–	–	10.2	(9.4-11.1)	<0.001
Girls	16.3	(15.2-17.6)	–	–	8.1	(7.1-9.1)	<0.001
Boys	22.8	(21.4-24.4)	–	–	12.3	(11.1-13.5)	<0.001
Smoking							
Total	21.6	(20.4-22.9)	12.0	(10.8-13.3)	7.2	(6.3-8.2)	<0.001
Girls	22.0	(20.3-23.7)	11.9	(10.2-13.8)	7.4	(6.2-8.9)	<0.001
Boys	21.3	(19.6-23.1)	12.1	(10.5-14.0)	7.0	(5.9-8.2)	<0.001

* weighted by the population structure in the respective study period, CI=confidence interval

adolescents who were found to have a low level of physical activity has actually risen. Between 2009-2012 and 2014-2017, the prevalence increased from 6.3% to 9.0%. Girls are more likely to show a low level of physical activity than boys, but there are no differences in time trends by gender (Table 2). In addition, the association between low socioeconomic status and a higher proportion of children and adolescents with a low level of physical activity applies to girls just as much as to boys (Table 3). A reduction in relative inequalities was observed during the observation period, which was five years in the case of physical activity (Table 4). This is due to the development in boys, where the increase in prevalence in the medium and high status group was higher than in the low status group. Relative inequalities have remained constant among girls. No significant changes were found among girls or boys in terms of absolute inequalities during the observation period.

Table 3
Prevalence of health outcomes among 3- to 17-year-olds (smoking among 11- to 17-year-olds) according to socioeconomic status*
Source: KiGGS baseline study (2003-2006), KiGGS Wave 1 (2009-2012), KiGGS Wave 2 (2014-2017)

	KiGGS baseline study (2003-2006)		KiGGS Wave 1 (2009-2012)		KiGGS Wave 2 (2014-2017)		
	%	(95% CI)	%	(95% CI)	%	(95% CI)	*p*-trend
General health (fair to very poor)							
Low SES	11.4	(9.7-13.4)	10.6	(8.3-13.6)	7.7	(6.1-9.6)	0.003
Medium SES	7.5	(6.8-8.3)	5.9	(5.1-6.7)	4.1	(3.5-4.6)	<0.001
High SES	4.4	(3.7-5.3)	3.2	(2.5-4.1)	1.4	(1.0-1.9)	<0.001
Mental health problems							
Low SES	30.6	(28.3-33.1)	33.5	(29.6-37.6)	26.0	(23.3-28.9)	0.031
Medium SES	19.0	(17.9-20.1)	19.0	(17.5-20.6)	16.1	(15.0-17.4)	0.002
High SES	11.2	(10.3-12.2)	9.8	(8.6-11.3)	9.7	(8.7-10.8)	0.028
Low level of physical activity							
Low SES	–	–	11.9	(9.2-15.3)	15.4	(12.9-18.2)	0.094
Medium SES	–	–	5.8	(5.1-6.7)	7.9	(7.1-8.8)	<0.001
High SES	–	–	2.3	(1.7-3.1)	5.9	(5.0-6.9)	<0.001
Consumption of sugary soft drinks							
Low SES	28.9	(26.4-31.5)	–	–	17.9	(15.7-20.3)	<0.001
Medium SES	20.3	(19.0-21.6)	–	–	10.3	(9.3-11.4)	<0.001
High SES	9.0	(7.9-10.3)	–	–	2.6	(1.9-3.4)	<0.001
Smoking							
Low SES	25.2	(22.4-28.3)	14.4	(11.1-18.5)	8.0	(5.6-11.4)	<0.001
Medium SES	21.5	(19.8-23.2)	11.8	(10.4-13.4)	7.9	(6.8-9.2)	<0.001
High SES	16.3	(14.2-18.7)	8.9	(7.1-11.1)	4.0	(2.8-5.6)	<0.001

* weighted by the population structure in the respective study period, SES=socioeconomic status, CI=confidence interval

3.4 Consumption of sugary soft drinks

The proportion of 3- to 17-year-olds that consume 500ml or more of sugary soft drinks per day decreased significantly between 2003-2006 and 2014-2017 from 19.7% to 10.2%. Boys drink sugary soft drinks more often than girls, but the reduction is similar in both genders (Table 2). The relative inequalities to the detriment of the low status group were already very pronounced in 2003-2006 and have widened again until 2014-2017 (Table 4). This increase is due to the fact that the consumption of sugary soft drinks in the medium and especially in the high status group has fallen even more sharply than in the low status group. This trend was identified among girls and boys. At the same time, however, absolute inequalities have decreased, especially among girls.

Table 4
Absolute and relative inequalities (SII and RII) of different health outcomes among 3- to 17-year-olds (smoking among 11- to 17-year-olds)*
Source: KiGGS baseline study (2003-2006), KiGGS Wave 1 (2009-2012), KiGGS Wave 2 (2014-2017)

	KiGGS baseline study (2003-2006)		KiGGS Wave 1 (2009-2012)		KiGGS Wave 2 (2014-2017)		
		(95% CI)		(95% CI)		(95% CI)	*p*-trend
General health (fair to very poor)							
SII	0.06	(0.04-0.09)	0.07	(0.04-0.11)	0.07	(0.05-0.10)	0.399
RII	2.26	(1.64-3.12)	3.26	(1.88-5.66)	6.04	(3.81-9.58)	0.001
Mental health problems							
SII	0.22	(0.19-0.26)	0.28	(0.23-0.34)	0.21	(0.17-0.25)	0.899
RII	3.11	(2.62-3.67)	4.15	(3.19-5.39)	3.63	(2.90-4.54)	0.128
Low level of physical activity							
SII	–	–	0.09	(0.06-0.13)	0.09	(0.06-0.12)	0.907
RII	–	–	4.21	(2.60-6.82)	2.95	(2.10-4.12)	0.215
Consumption of sugary soft drinks							
SII	0.25	(0.22-0.29)	–	–	0.20	(0.17-0.23)	0.009
RII	3.35	(2.86-3.94)	–	–	6.78	(5.04-9.10)	<0.001
Smoking							
SII	0.16	(0.12-0.20)	0.07	(0.01-0.12)	0.04	(0.004-0.08)	<0.001
RII	2.04	(1.70-2.47)	1.58	(1.05-2.37)	1.78	(1.06-2.99)	0.388

SII=Slope Index of Inequality, RII=Relative Index of Inequality, CI=confidence interval
* adjusted for age, gender, age × gender and migration background

3.5 Smoking

Smoking has declined sharply: whereas in 2003-2006, 21.6% of 11- to 17-year-olds smoked, until 2014-2017 the proportion dropped to just 7.2%. No significant differences as to prevalence or trends were identified between girls and boys (Table 2). However, social differences were observed with regard to tobacco consumption. Girls and boys from families with a low or medium socioeconomic status smoke more often than their peers from families with a high socioeconomic status (Table 3). Nevertheless, the trend analysis shows that the prevalence decreased significantly in all status groups during the observation period. Relative inequalities among girls have remained constant. Absolute inequalities, on the other hand, are significantly reduced (Table 4), which applies to boys and girls.

4. Discussion

The data from the KiGGS study indicates that the health of children and adolescents in Germany has improved over the last ten years. There has been, for example, a reduction in the proportion of adolescents with fair, poor or very poor health [39]. The same applies to the proportion of children and adolescents with mental health problems [42]. Further positive developments are that fewer sugary soft drinks are being consumed and that smoking is declining [45, 46]. However, these results stand in contrast to the findings

Table 5
Trends in the prevalence of health outcomes for 3- to 17-year-old girls (smoking among 11- to 17-year-olds) according to socioeconomic status*
Source: KiGGS baseline study (2003-2006), KiGGS Wave 1 (2009-2012), KiGGS Wave 2 (2014-2017)

	KiGGS baseline study (2003-2006)		KiGGS Wave 1 (2009-2012)		KiGGS Wave 2 (2014-2017)		
	%	(95% CI)	%	(95% CI)	%	(95% CI)	*p*-trend
General health (fair to very poor)							
Low SES	11.0	(8.8-13.7)	10.0	(6.9-14.3)	6.8	(5.1-9.0)	0.004
Medium SES	6.8	(5.9-7.9)	6.5	(5.4-7.8)	3.9	(3.2-4.6)	<0.001
High SES	4.7	(3.6-6.1)	3.2	(2.3-4.4)	1.0	(0.6-1.7)	<0.001
Mental health problems							
Low SES	26.5	(23.5-29.9)	29.4	(23.9-35.6)	22.7	(19.3-26.4)	0.157
Medium SES	14.7	(13.4-16.2)	15.7	(14.0-17.7)	14.3	(12.8-16.0)	0.816
High SES	8.3	(7.0-9.8)	8.0	(6.6-9.6)	6.4	(5.2-7.9)	0.117
Low level of physical activity							
Low SES	–	–	13.1	(9.4-18.1)	19.4	(15.8-23.6)	0.040
Medium SES	–	–	8.0	(6.7-9.4)	9.6	(8.3-11.1)	0.093
High SES	–	–	3.3	(2.3-4.7)	7.6	(6.2-9.4)	<0.001
Consumption of sugary soft drinks							
Low SES	25.1	(21.9-28.6)	–	–	13.5	(11.0-16.5)	<0.001
Medium SES	16.9	(15.5-18.4)	–	–	8.4	(7.2-9.9)	<0.001
High SES	6.2	(4.9-7.9)	–	–	1.5	(1.0-2.3)	<0.001
Smoking							
Low SES	27.2	(22.8-32.0)	13.9	(9.2-20.5)	9.2	(6.0-13.9)	<0.001
Medium SES	21.9	(19.6-24.3)	12.3	(10.1-15.0)	7.6	(6.2-9.4)	<0.001
High SES	15.2	(12.8-18.0)	7.5	(5.2-10.5)	4.3	(2.6-7.0)	<0.001

* weighted by the population structure in the respective study period, SES=socioeconomic status, CI=confidence interval

that the proportion of children and adolescents who are physically active for at least 60 minutes per day on less than two days per week increased over the last five years [43]. The developments in the health outcomes described here are similar among girls and boys; the only exception being mental health problems, where a reduction was only observed among boys. Moreover, although the prevalence of mental health problems is lower in girls than boys, the prevalence did not decrease further during the observation period [42].

The KiGGS data point to significant socioeconomic inequalities in young people's health. The results for all of the health outcomes considered in this article show that children and adolescents from families with a low socioeconomic status are more likely to face disadvantages than their peers in a better socioeconomic situation. In addition, inequalities often exist between children and adolescents from the medium socioeconomic status group compared to those from the high status group. The KiGGS baseline study [54] and KiGGS Wave 1 [28] also identified

Table 6
Trends in the prevalence of health outcomes for 3- to 17-year-old boys (smoking among 11- to 17-year-olds) according to socioeconomic status*
Source: KiGGS baseline study (2003-2006), KiGGS Wave 1 (2009-2012), KiGGS Wave 2 (2014-2017)

	KiGGS baseline study (2003-2006)		KiGGS Wave 1 (2009-2012)		KiGGS Wave 2 (2014-2017)		
	%	(95% CI)	%	(95% CI)	%	(95% CI)	*p*-trend
General health (fair to very poor)							
Low SES	11.8	(9.6-14.5)	11.2	(8.1-15.2)	8.5	(6.2-11.6)	0.092
Medium SES	8.1	(7.1-9.2)	5.2	(4.3-6.4)	4.2	(3.4-5.2)	<0.001
High SES	4.1	(3.3-5.2)	3.2	(2.4-4.4)	1.6	(1.0-2.5)	<0.001
Mental health problems							
Low SES	34.5	(31.0-38.2)	37.0	(31.2-43.3)	29.0	(24.8-33.7)	0.094
Medium SES	23.1	(21.5-24.7)	22.1	(20.1-24.3)	17.9	(16.1-19.8)	<0.001
High SES	14.0	(12.6-15.6)	11.6	(9.6-14.0)	12.7	(10.9-14.7)	0.193
Low level of physical activity							
Low SES	–	–	10.9	(7.4-15.7)	11.6	(8.6-15.5)	0.791
Medium SES	–	–	3.7	(3.0-4.7)	6.3	(5.3-7.4)	0.001
High SES	–	–	1.3	(0.8-2.1)	4.4	(3.3-5.8)	<0.001
Consumption of sugary soft drinks							
Low SES	32.5	(28.7-36.4)	–	–	21.9	(18.5-25.8)	<0.001
Medium SES	23.5	(21.8-25.3)	–	–	12.2	(10.8-13.7)	<0.001
High SES	11.7	(9.9-13.7)	–	–	3.5	(2.5-4.8)	<0.001
Smoking							
Low SES	23.2	(19.0-28.1)	14.8	(10.2-20.9)	6.7	(4.2-10.4)	<0.001
Medium SES	21.1	(19.0-23.4)	11.3	(9.6-13.3)	8.2	(6.7-10.1)	<0.001
High SES	17.4	(14.3-21.1)	10.3	(7.9-13.2)	3.7	(2.3-5.9)	<0.001

* weighted by the population structure in the respective study period, SES=socioeconomic status, CI=confidence interval

inequalities according to the socioeconomic status of the family and these results are confirmed by the latest data from KiGGS Wave 2 [31, 55].

The answer to the question raised at the outset – whether socioeconomic inequalities in the health of children and adolescents have changed over the past ten years – depends on the particular health outcome. Moreover, the answer also depends on whether absolute or relative health inequalities are considered. Relative inequalities have widened in general health and the consumption of sugary soft drinks. This is due to the fact that although positive developments were identified among all socioeconomic status groups, they were more pronounced in the medium and high status group than in the low status group. In contrast, relative inequalities in mental health problems and smoking have remained constant over time, and they have even decreased in the case of physical activity. However, the latter reduction is due to the development among boys: during the five-year period, a significantly higher increase in low levels of

Table 7
Trends in absolute and relative inequalities (SII and RII) for different health outcomes among 3- to 17-year-old girls (smoking among 11- to 17-year-olds)*
Source: KiGGS baseline study (2003-2006), KiGGS Wave 1 (2009-2012), KiGGS Wave 2 (2014-2017)

	KiGGS baseline study (2003-2006)		KiGGS Wave 1 (2009-2012)		KiGGS Wave 2 (2014-2017)		
		(95% CI)		(95% CI)		(95% CI)	*p*-trend
General health (fair to very poor)							
SII	0.05	(0.02-0.09)	0.07	(0.02-0.13)	0.07	(0.04-0.10)	0.426
RII	2.17	(1.31-3.61)	3.10	(1.42-6.76)	6.13	(3.43-10.94)	0.010
Mental health problems							
SII	0.21	(0.16-0.25)	0.26	(0.18-0.33)	0.21	(0.16-0.26)	0.883
RII	3.79	(2.86-5.01)	4.70	(3.10-7.13)	4.22	(3.07-5.80)	0.525
Low level of physical activity							
SII	–	–	0.08	(0.03-0.12)	0.11	(0.06-0.16)	0.373
RII	–	–	2.53	(1.49-4.29)	2.67	(1.69-4.22)	0.871
Consumption of sugary soft drinks							
SII	0.24	(0.20-0.28)	–	–	0.15	(0.12-0.19)	0.002
RII	4.19	(3.26-5.38)	–	–	7.04	(4.44-11.16)	0.039
Smoking							
SII	0.20	(0.13-0.26)	0.07	(-0.01-0.15)	0.05	(-0.002-0.11)	<0.001
RII	2.47	(1.88-3.26)	1.85	(1.003-3.40)	2.03	(0.95-4.33)	0.372

SII=Slope Index of Inequality, RII=Relative Index of Inequality, CI=confidence interval
* adjusted for age and migration background

physical activity was observed for the medium and high status group than for the low status group [56].

No changes were identified in absolute health inequalities over time for general health, mental health problems or physical activity. The results on sugary soft drinks are interesting because they indicate that absolute inequalities narrowed at the same time as relative inequalities significantly widened. The results on smoking demonstrate a significant decline in absolute inequalities with relative inequalities remaining constant. This is understandable given the sharp decline in smoking among all status groups and its current low prevalence.

Discussion in relation to the current state of research

A number of studies provide information about developments over time regarding the health of children and adolescents in Germany for some but not all of the indicators examined here. Comparable information is available for subjective health, smoking and the consumption of sugary soft drinks. The international Health Behaviour in School-aged Children (HBSC) study provides, for example, data on the health and health-related behaviour of 11- to 15-year-old school children every four years. According to HBSC data for Germany, the proportion of adolescents that view their overall health as 'fair' or 'poor' (rather than 'very good' or 'good') decreased slightly between 2002 and 2010 from 14.8% to 13.0% [57]. The decline in smoking, which is clear

Table 8
Trends in absolute and relative inequalities (SII and RII) for different health outcomes among 3- to 17-year-old boys (smoking among 11-17 year-olds)*
Source: KiGGS baseline study (2003-2006), KiGGS Wave 1 (2009-2012), KiGGS Wave 2 (2014-2017)

	KiGGS baseline study (2003-2006)		KiGGS Wave 1 (2009-2012)		KiGGS Wave 2 (2014-2017)		
		(95% CI)		(95% CI)		(95% CI)	*p*-trend
General health (fair to very poor)							
SII	0.07	(0.04-0.10)	0.07	(0.03-0.12)	0.08	(0.05-0.11)	0.657
RII	2.34	(1.62-3.39)	3.46	(1.70-7.04)	5.93	(3.12-11.26)	0.013
Mental health problems							
SII	0.24	(0.19-0.29)	0.31	(0.22-0.40)	0.22	(0.16-0.28)	0.735
RII	2.78	(2.22-3.48)	3.84	(2.67-5.53)	3.30	(2.43-4.47)	0.231
Low level of physical activity							
SII	–	–	0.10	(0.05-0.16)	0.08	(0.04-0.13)	0.549
RII	–	–	10.35	(4.14-25.84)	3.43	(1.93-6.12)	0.058
Consumption of sugary soft drinks							
SII	0.27	(0.22-0.32)	–	–	0.24	(0.20-0.29)	0.436
RII	2.96	(2.39-3.66)	–	–	6.68	(4.67-9.57)	<0.001
Smoking							
SII	0.12	(0.06-0.19)	0.06	(-0.02-0.14)	0.03	(-0.01-0.08)	0.021
RII	1.70	(1.28-2.25)	1.40	(0.78-2.51)	1.61	(0.86-3.01)	0.679

SII=Slope Index of Inequality, RII=Relative Index of Inequality, CI=confidence interval
* adjusted for age and migration background

from the KiGGS data, is supported by results from representative surveys conducted by the Federal Centre for Health Education (BZgA) [58], the European School Survey Project on Alcohol and Other Drugs (ESPAD) [59] and the HBSC study [60, 61]. The BZgA study found that the proportion of 12- to 17-year-olds who smoke fell from around 22% to around 7% between 2003 and 2016 [58]. On the basis of the HBSC data, analyses also can be made about developments in the consumption of sugary soft drinks. The data shows that the proportion of 11- to 15-year-olds who consume sugary soft drinks every day decreased between 2002 and 2014 in Germany as in many other countries [62].

Only a few other studies have investigated developments of socioeconomic inequalities over time in health and health-related behaviour among children and adolescents in Germany. Trend analyses conducted for the HBSC study show that adolescents with low family affluence and a rather poor financial status are more likely to report their health as 'fair' or 'poor' for all three study years (2002, 2006 and 2010) than their socially better-off peers [57]. The extent of social inequalities in subjective health remained largely constant for both genders over the observation period from 2002 to 2010. In Germany, most studies have focused on developments of social inequalities over time regarding tobacco consumption among adolescents. The studies consistently show that the proportion of girls and boys who smoke has not only decreased significantly since the beginning of the 2000s, and particularly among

socioeconomically better-off population groups, but also that considerably fewer young people smoke than 10 to 15 years ago. This even applies to socioeconomically disadvantaged groups [63]. A recent study that determined social status according to the type of secondary school a participant attended, showed that in various surveys (KiGGS, BZgA representative surveys, HBSC, ESPAD), as a result of the reduction in smoking prevalence, absolute inequalities in smoking-related behaviour have mostly decreased, whereas relative inequalities have tended to remain constant or even increase. Students in middle and lower secondary school tracks still smoke more often than those of the same age in higher ones [61].

The proportion of adolescents who smoke has fallen sharply in all status groups; this has also led to a decline in absolute inequalities.

The majority of international studies on time trends in socioeconomic inequalities in health and health-related behaviour of children and adolescents also use data from the HBSC study [64-67]. Elgar et al. report trends in health inequalities for five indicators using pooled HBSC data from 34 countries [65]. Their findings on physical activity, mental and physical symptoms, body mass index and general satisfaction with life are based entirely on self-reported data collected from the 11- to 15-year-old participants. Between 2002 and 2010, socioeconomic inequalities in health widened in four out of five areas to the disadvantage of socioeconomically deprived young people; general satisfaction with life was the only area in which the extent of social inequalities – the lower the family affluence, the lower the level of satisfaction with life – decreased. A further trend study that focused on physical activity and diet among 15-year-old girls and boys and included data from the latest HBSC wave (2013/2014), concluded that socioeconomic inequalities in physical activity and fruit and vegetable consumption have remained stable or even increased over time [67]. On the other hand, regular consumption of sweets and soft drinks, both summarised in an index as 'unhealthy diet', is less associated with family affluence: in 2013/2014, there were no significant differences in this area of nutritional behaviour between adolescents of various social backgrounds in the majority of the countries covered by the HBSC study. Finally, a recent study that evaluated Danish HBSC data also confirmed the finding that physical inactivity among children and adolescents is more widespread in socially disadvantaged families [66]. However, absolute and relative inequalities in physical inactivity remained largely unchanged between 1991 and 2014.

Although a direct, causal attribution cannot be established, it is important to view and interpret changes in health and in socioeconomic inequalities in the health of young people against the background of the measures of health promotion implemented in recent years aimed at promoting child and adolescent health. Correlations may be identified between particular measures and some of the health outcomes considered here; however, this is not always possible, and sometimes only applies to a very limited extent. This was particularly the case for general health because the decline in the proportion of children and adolescents with fair, poor or very poor health could be associated with a variety of causes and can hardly be attributed to the implementation of one particular measure. However, the association is much clearer for other health outcomes such as smoking. Since 2003, efforts to curb smoking and to protect non-smokers from exposure to passive smoking have been stepped up in Germany; for example, tobacco taxes have been raised significantly, smoking bans have

been implemented in public places and the sale and marketing of tobacco products is strictly regulated [63]. Many of these measures are aimed at children and adolescents and are intended to prevent or at least complicate the path to taking up smoking [68]. Given the significant decline in smoking and absolute inequalities among adolescents, it is likely that these measures, which are largely attributable to successful structural prevention, have also reached adolescents from families with low socioeconomic status. With this in mind, it seems even more important to continue, extend and adapt these measures to the new products currently being offered by the tobacco industry [69].

At best, the decline in the consumption of sugary soft drinks could be partially associated with a variety of preventive measures. For example, these include measures that have improved the range of drinks on offer and the attractiveness of drinking water and other unsweetened beverages in schools and day-care centres [70, 71]. However, young people continue to consume large amounts of sugary soft drinks, and, as the KiGGS results show, children and adolescents from the low socioeconomic status group do not benefit equally from these measures. In addition to expanding the range of unsweetened drinks on offer in schools and day-care centres, additional preventive measures are currently being discussed with the aim of securing a sharper decline in the consumption of sugary soft drinks. They include the introduction of a sugary soft drinks tax and restrictions on advertising aimed at children and adolescents [72].

The results on physical activity should not only be considered within the context of the National Recommendations for Physical Activity and Physical Activity Promotion [73], but also in terms of the national health target 'Growing up healthy' [74], which also promotes exercise. A large proportion of children and adolescents across all status groups were found to undertake a significantly low level of physical activity and this proportion has increased in recent years [43]. The promotion of physical activity in childhood and adolescence should follow a settings-based approach and include measures to ensure that nurseries, schools and the home environment of children and young people become more exercise-friendly. This also includes health-oriented urban planning, the reduction of dangers linked to road traffic and environmental pollution, the expansion of networks of paths for pedestrians and bicycle lanes, and ensuring that green areas and leisure facilities are designed to be child and youth-friendly [73]. These structural preventive measures would also benefit children from socially disadvantaged families, which are proportionally more often physically inactive or only active to a limited extent.

The measures mentioned in connection with the consumption of sugary soft drinks and low levels of physical activity are also relevant with regard to the prevention of overweight. Measures aimed at promoting a healthy diet also need to be taken into account, and these are also addressed as part of the national health target 'Growing up healthy' [74] and the National Action Plan 'IN FORM – Germany's National Initiative to Promote Healthy Diets and Physical Activity' [75]. The promotion of a healthy diet and an active lifestyle can influence habits that are otherwise difficult to change in later life [76, 77]. Therefore, efforts to improve the diets of children and adolescents should begin at an early age and be undertaken in environments that are important to children. In addition to

the family, this primarily means educational institutions such as day-care centres and schools.

The decline in the prevalence of mental health problems can also be related to specific health-policy measures. In addition to numerous projects conducted in day-care centres and schools, the increased uptake of early detection examinations for children (called U-Untersuchungen in Germany) [78] may have led to better prevention and, therefore, improved mental health. In addition, improved health care may have also contributed to the decline in the prevalence of mental health problems. During the period covered by the KiGGS baseline study, 70% of children and adolescents who displayed symptoms of a mental health problem did not seek psychiatric-psychotherapeutic treatment [79]. Since then, however, the number of child and adolescent psychiatrists taking part in contracted medical care has almost doubled [80]. This increase in specific measures aimed at children and adolescents was partly due to the statutory minimum rate, which was put in place in 2009 and stipulates that 20% of new medical and psychotherapeutic licenses should be reserved for child and adolescent psychotherapy [81].

Strengths and limitations

One particular strength of the analyses presented here is that developments and trends in the health of children and adolescents and health inequalities are considered using nationwide representative data. The broad samples enable reliable estimates of prevalences, and SII and RII as a measure of absolute or relative health inequalities, over all three observation periods. No other comparable analysis is available for Germany at this time.

However, this study faces a number of limitations that, for example, arise from the fact that KiGGS Wave 1 was conducted as a telephone interview, and the KiGGS baseline study and KiGGS Wave 2 were undertaken as combined examination and interview surveys. In addition, the instruments used to collect data for some health outcomes changed between survey waves. This means that only KiGGS Wave 1 and KiGGS Wave 2 provide comparable data on physical activity, which, in turn, shortens the respective observation period to five years. Changes were also made to the instruments used to study other health outcomes, and this should be taken into consideration when interpreting the results about certain health outcomes in the context of other studies; these changes could have also potentially influenced the results of the trend analyses. This particularly applies to the consumption of sugary soft drinks, since the questionnaires used for this health outcome were not identical. Furthermore, the aim of this article was to analyse health developments and changes to health inequalities in childhood and adolescence using a number of specific health outcomes, and this was done using one indicator in each case. It seems sensible, therefore, that a next step would entail a more differentiated, in-depth analysis using several indicators at the same time.

The question can be raised as to whether three observation periods within ten years are sufficient to provide reliable conclusions about temporal developments and trends. For some of these issues, a longer observation period and a closer sequencing of the surveys would certainly have been desirable. For example, a longer observation period would be valuable for analyses of changes to health inequalities as such changes can often only be

identified after a particular time delay. In addition, repeating surveys at shorter intervals would provide a better basis with which to conduct up-to-date assessments of the impact and success of public health policies. Moreover, shortening the interval between surveys would generate a larger number of data points over time. This would mean that non-linear trends could also be analysed, such as whether a decline in prevalence or a rise in health inequalities has continued to increase or begun to decrease over time. As a maximum of three data points were available, the regression models applied in this study only provide for estimates of linear trends.

Nevertheless, it is important to note that the data that was previously available for Germany meant that it was impossible to make any representative conclusions about developments over time and on trends for many health outcomes. In addition, the results of this study clearly show that analyses of temporal developments and trends over the past ten years provide numerous indications about new and changing challenges. The discussion about the associations between developments in health and health inequalities in childhood and adolescence, on the one hand, and health policy measures, on the other, should be approached with caution. For example, the decline in smoking or in the consumption of sugary soft drinks cannot be directly attributed to the policy measures that have been implemented; therefore, it is impossible to confirm how successful they have actually been. At best, it is possible to suggest a temporal coincidence. Be this as it may, the results point to a particularly promising association with regard to the measures implemented in tobacco prevention and control, and the subsequent decline in smoking – all the more so, since smoking has also declined significantly among adolescents from families with low socioeconomic status.

Corresponding author
PD Dr Thomas Lampert
Robert Koch Institute
Department of Epidemiology and Health Monitoring
General-Pape-Str. 62–66
D-12101 Berlin, Germany
E-mail: LampertT@rki.de

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Data protection and ethics

All of the Robert Koch Institute's studies are subject to strict compliance with the data protection provisions set out in the EU General Data Protection Regulation (GDPR) and the Federal Data Protection Act (BDSG). Charité – Universitätsmedizin Berlin's ethics committee assessed the ethics of the KiGGS baseline study (No. 101/2000) and KiGGS Wave 1 (No. EA2/058/09), and Hannover Medical School's ethics committee assessed KiGGS Wave 2 (No. 2275-2014); both committees provided their approval for the respective studies. Participation in the studies was voluntary. The participants and/or their parents/legal guardians were also informed about the aims and contents of

the study, and about data protection. Informed consent was obtained in writing.

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Conflicts of interest

The authors declared no conflicts of interest.

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Editors
Susanne Bartig, Johanna Gutsche, Dr Birte Hintzpeter,
Dr Franziska Prütz, Martina Rabenberg, Dr Alexander Rommel,
Dr Livia Ryl, Dr Anke-Christine Saß, Stefanie Seeling,
Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
Unit: Health Reporting
General-Pape-Str. 62–66
D-12101 Berlin
Phone: +49 (0)30-18 754-3400
E-mail: healthmonitoring@rki.de
www.rki.de/journalhealthmonitoring-en

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Gisela Dugnus, Alexander Krönke, Kerstin Möllerke

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Enno Nowossadeck, Elena von der Lippe, Thomas Lampert

Robert Koch Institute, Berlin
Department of Epidemiology and Health Monitoring

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Developments in life expectancy in Germany. Current trends

Abstract

Since the beginning of the 1990s, life expectancy in Germany has increased by 4.2 years among women (to 83.2 years), and by 5.9 years among men (to 78.4 years). This rise is related to the increasing convergence of life expectancy in Germany's new and old federal states. Recently, life expectancy among women in the new federal states has even risen slightly above the level found in the old federal states. In addition, differences between socioeconomic groups continue to be observed in Germany. Women in the highest income group have a 4.4-year longer life expectancy than women in the lowest income group. Similarly, an 8.6-year difference exists between men in the highest income group and men in the lowest income group. Influenza waves can adversely affect the development of life expectancy in certain calendar years. In comparison to other European countries, Germany has a mid-range life expectancy: the current difference between life expectancy in Germany and Switzerland (the European country with the highest life expectancy) is 2.7 years.

LIFE EXPECTANCY · GENDER · SOCIAL DIFFERENCES · REGIONAL DIFFERENCES · EUROPEAN COMPARISON

Introduction

Mortality has a strong impact on demographic change. As an example, a decline in mortality can contribute to population growth. In recent decades, mortality has fallen most sharply among people of high and highest age groups. In fact, this decline in mortality in higher ages is one of the causes behind population ageing, in other words, an increased proportion of elderly and very old people in a population. This is also referred to as 'ageing from above', i.e. ageing from the upper end of the age structure. Declining mortality is reflected in increased life expectancy. Since about 1840, record life expectancy, in other words, the highest level of life expectancy in the world in a given year, has grown linearly [1]. But it is not only record life expectancy that is rising; life expectancy is also increasing in various regions and countries throughout the world [2]. This Fact sheet focuses on and describes the current trends in mortality and life expectancy in Germany.

Indicator

Mean life expectancy at birth is an important summary measure that describes the health state of a population. Mean life expectancy refers to the average number of years of life that a new-born child can be expected to live under the mortality rates of the respective year. In addition, it is also possible to calculate life expectancy for a particular age group (such as people aged 65). The measure of further life expectancy indicates the average number of additional years of life that a person of a particular age can be expected to live (e.g. at the age of 65).

The life expectancy estimates used in this Fact sheet were calculated by the Federal Statistical Office using life

tables. Each estimate of life expectancy is based on mortality data from three calendar years and uses a moving average to smooth out short-term fluctuations in the data. The last available life table refers to the three-year period 2015/2017 [3]. These data were taken from Germany's Information System of the Federal Health Monitoring.

The life expectancy of women in the new federal states is now higher than that of women in the old federal states.

Results and discussion

Life expectancy has increased significantly in Germany in recent decades [4]. Until the middle of the 20th century, this increase was mainly due to declining mortality among infants, children and young adults. Since then, increasing life expectancy has mainly been driven by declining mortality among older people [5, 6]. Life expectancy has continued to rise over the last 25 years. In the beginning of the 1990s (1991/1993), the average life expectancy among women was 79.0 years and 72.5 years among men; in 2015/2017 it had increased to 83.2 years among women and to 78.4 years among men. This corresponds to an increase of 4.2 years for women and 5.9 years for men. However, small interruptions in the continuous increase in life expectancy can be observed, for example, in the 2013/2015 period. Most recently, women faced a very small decline in life expectancy of 0.02 years (2015/2017). For men, life expectancy increased by 0.05 years during the same period.

Life expectancy is rising faster among men than among women.

The latest life table (which covers the period 2015/2017) shows that life expectancy among women is 4.8 years higher than among men. The phenomenon of women's longer life expectancy, however, is repeated throughout the world [7] and seems to be partly related to biology. The 'cloister study' demonstrated that nuns had a survival advantage of approximately one year over monks despite similar health-related behaviour and living conditions [8]. Consequently, biological causes are assumed to account for about one year of the difference between life expectancies among women and men. Non-biological factors, therefore, can be considered as the main cause of the differences in life expectancy among the general population.

Non-biological factors include aspects such as health-related behaviour and people's living conditions. The most important factors that need to be considered in terms of health-related behaviour are differences in tobacco and alcohol consumption, physical inactivity, diet, and accident-causing behaviour. With regard to living conditions, differences between women and men in labour force participation, working conditions and income distribution are likely to be of particular significance [9].

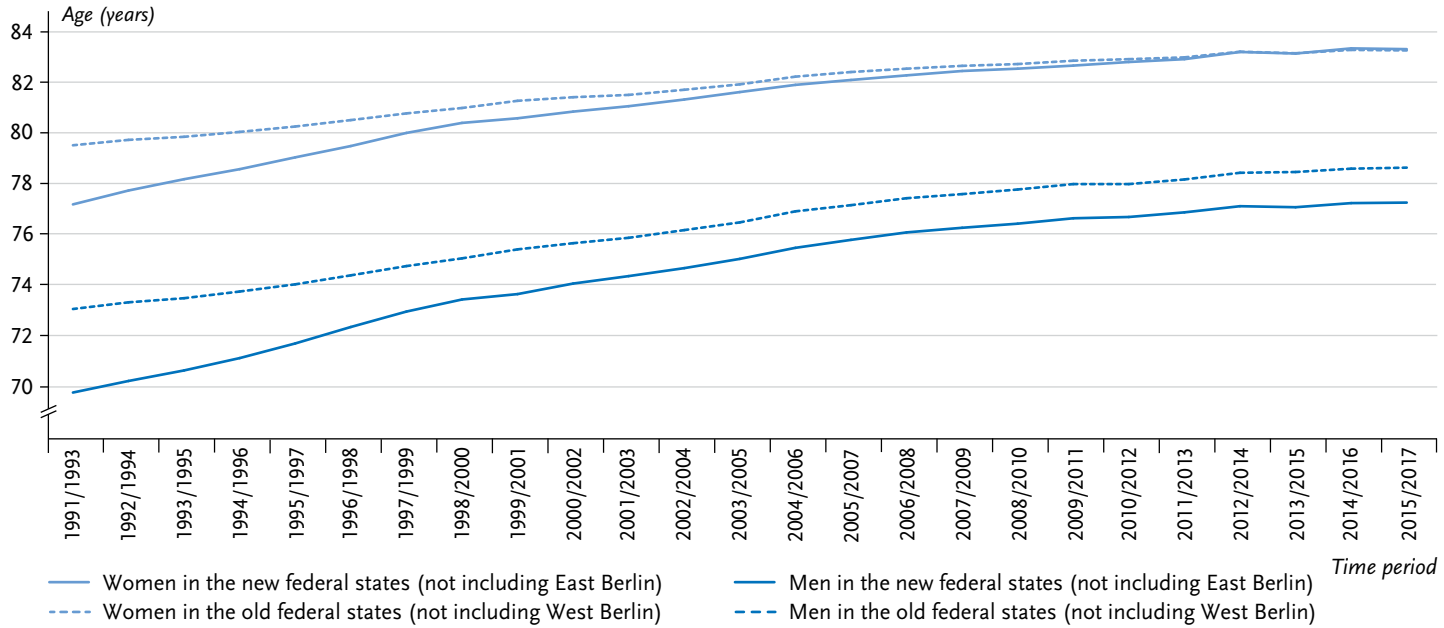
Differences in life expectancy have also been observed with regard to social status [9, 10]. Women in the highest income group have a 4.4-year longer life expectancy than women in the lowest income group [11]. Similarly, men in the highest income group have an 8.6-year longer life expectancy than men in the lowest income group. The higher rate of mortality among men may be due to the fact that certain subpopulations have particularly high mortality rates that are associated with their lower socioeconomic status [10, 12].

These social differences in life expectancy are also reflected in differences at the regional level. For example, socioeconomic differences in life expectancy were also identified using an analysis conducted at the district and city level. The life expectancy of women in poorer districts and cities is 1.5-years lower than that of women in the most affluent districts; the difference between men in poorer and affluent districts and cities is even greater at 2.9 years [13].

In the 2014/2016 period, women in the new federal states (former East Germany; excluding East Berlin) had a life expectancy of 83.25 years. This is the first time that women's life expectancy has been higher in the new federal states than in the old federal states (former West Germany; excluding West Berlin) (83.19 years; Figure 1). This difference also persisted one year later. However, the differences are so small that they could also be due to coincidence.

As early as 2013, a study reported that mortality among women of several age groups in former East and West Germany converged between 2000 and 2009. In the years that followed, mortality in the new federal states in the respective age groups fell below that of the old federal states [15]. It is possible that this process is also reflected in the data on average life expectancy as of the 2014/2016 period.

The 2013 study discussed tobacco consumption as a possible explanation of women's advantage in mortality in the new federal states. Once causes of deaths that are largely related to tobacco consumption, such as lung cancer, are excluded from the analysis, a higher mortality rate remains in the new federal states. In the beginning of the 1990s, the proportion of female smokers in the old federal states (29%) was higher than in the new federal states (22%). The delay in the onset of tobacco-related diseases can explain the slower increase in women's life expectancy in the old federal states. However, in recent years, the proportion of smokers in the new federal states has reached a similar



[1] Until 1998/2000 including East Berlin
[2] Until 1998/2000 including West Berlin

Figure 1
The life expectancy of women and men in the new[1] and old[2] German federal states between 1991/1993 and 2015/2017
Source: Federal Statistical Office (2017)
Statistics on the natural population change [14]

level to that in the old federal states [16, 17]. As such, women from the new federal states are expected to lose their advantage in mortality in the future [18].

As pointed out above, the rise in life expectancy has slowed down in Germany in certain years. Influenza waves provide a possible explanation. A number of strong influenza waves have occurred in recent years, such as during the 2012/2013, 2014/2015 and 2016/2017 winters [19]. As influenza outbreaks occur in the first quarter of a year, they are recorded in the second calendar year of a particular winter. Influenza outbreaks often lead to a higher number of deaths than what would normally be expected, a situation known as 'excess mortality' [19, 20]. The figures on excess mortality for the winter seasons mentioned above were 20,700 for 2012/2013; 21,300 for 2014/2015, and 22,900 for 2016/2017 [19]. These additional deaths correspond to between 2.3% and 2.5% of the annual deaths that occurred in Germany in 2013, 2015 and 2017, which were precisely the calendar years in which the increase in life expectancy slowed down.

The increase in life expectancy has slowed down recently in some calendar years, and a slight drop in life expectancy was observed in 2015/2017.

Two influenza waves occurred between 2015 and 2017 – one in 2015, and one in 2017. Therefore, the calculations undertaken for the 2015/2017 life table will have been influenced by the higher excess mortality. The preceding table, which covers 2014 to 2016, only includes one year with an influenza wave (2015). Thus, the impact of influenza outbreaks is likely to be strongest on the 2015/2017 life table. As such, the use of a moving average may have had an impact on the results and slowed down the increase in life expectancy.

Influenza waves could help explain the recent slowdown in life expectancy.

The fact that influenza waves can influence mortality in certain calendar years is not a new phenomenon and has already been discussed in population research elsewhere [cf. 21]. In general, however, changes in life expectancy are influenced by many factors. Influenza waves are just one such factor and their effects are of a short-term nature. Other factors, such as medical care, disease prevention, health promotion, rehabilitation and health-related behaviour tend to have a longer term impact.

An international comparison with other European countries shows that Germany has a mid-range life expectancy (Table 1). Switzerland currently has the highest life expectancy in Europe (83.7 years), followed by Spain (83.5) and Italy (83.4). Georgia has the lowest life expectancy in Europe (74.2 years). This places life expectancy in Germany 2.7 years behind the highest level in Europe. In 1991, this difference was 2.3 years. The difference between women's life expectancy in Germany and in Spain (where women have the highest life expectancy) is 2.8 years; the difference between men's life expectancy in Germany and Switzerland (where men have the highest life expectancy) is 3.1 years. Since the beginning of the 1990s, Germany has been unable to make up for this gap. Moreover, this difference has even increased somewhat since then, but the reasons for this remain unclear. However, other countries, such as the United Kingdom, the Netherlands, Sweden, Spain and France have also experienced a less pronounced increase in life expectancy in recent years compared to Switzerland [22].

In summary, the increase in life expectancy in Germany is certainly a success. This particularly applies to the situation in Germany's new federal states. Nevertheless, when the figures are compared to those of other European countries, it is clear that Germany continues to face certain challenges.

Table 1
Life expectancy at birth in selected* European countries according to gender in 1991, 2006 and 2016
Source: Eurostat (2018) [23]

	Life expectancy at birth (years)								
	Total			Women			Men		
	1991	2006	2016	1991	2006	2016	1991	2006	2016
European Union (EU 28)	–	78.9	81.0	–	82.0	83.6	–	75.8	78.2
Austria	75.9	80.1	81.8	79.1	82.8	84.1	72.3	77.1	79.3
Belgium	76.3	79.5	81.5	79.7	82.3	84.0	72.9	76.6	79.0
Bulgaria	71.1	72.7	74.9	74.4	76.3	78.5	68.0	69.2	71.3
Croatia	–	75.9	78.2	–	79.3	81.3	–	72.4	75.0
Cyprus	–	80.1	82.7	–	82.0	84.9	–	78.1	80.5
Czechia	72.0	76.7	79.1	75.8	79.9	82.1	68.2	73.5	76.1
Denmark	75.3	78.4	80.9	78.1	80.7	82.8	72.5	76.1	79.0
Estonia	69.8	73.2	78.0	75.0	78.6	82.2	64.4	67.6	73.3
Finland	75.5	79.5	81.5	79.5	83.1	84.4	71.4	75.9	78.6
France	77.2	80.9	82.7	81.4	84.5	85.7	73.0	77.3	79.5
Germany	75.7	79.9	81.0	78.8	82.4	83.5	72.2	77.2	78.6
Greece	77.3	79.9	81.5	79.8	82.7	84.0	74.8	77.1	78.9
Hungary	69.4	73.5	76.2	74.0	77.8	79.7	65.1	69.2	72.6
Ireland	75.0	79.3	81.8	77.9	81.7	83.6	72.3	76.9	79.9
Italy	77.1	81.4	83.4	80.4	84.1	85.6	73.8	78.6	81.0
Latvia	–	70.6	74.9	–	76.1	79.6	–	65.0	69.8
Lithuania	70.6	71.0	74.9	76.0	77.1	80.1	65.1	65.0	69.5
Luxembourg	75.7	79.4	82.7	79.3	81.9	85.4	72.0	76.8	80.1
Malta	–	79.5	82.6	–	82.0	84.4	–	77.0	80.6
Netherlands	77.2	80.0	81.7	80.3	82.0	83.2	74.1	77.7	80.0
Poland	70.4	75.3	78.0	75.1	79.7	82.0	65.9	70.9	73.9
Portugal	74.1	79.0	81.3	77.7	82.5	84.3	70.5	75.5	78.1
Romania	70.1	72.5	75.3	73.5	76.1	79.1	66.8	69.0	71.7
Slovakia	71.1	74.5	77.3	75.5	78.4	80.7	66.9	70.4	73.8
Slovenia	73.6	78.3	81.2	77.5	82.0	84.3	69.5	74.5	78.2
Spain	77.1	81.1	83.5	80.7	84.4	86.3	73.4	77.8	80.5
Sweden	77.8	81.0	82.4	80.7	83.1	84.1	75.0	78.8	80.6
United Kingdom	–	79.5	81.2	–	81.6	83.0	–	77.3	79.4
Albania	–	–	78.5	–	–	80.1	–	–	77.1
Armenia	–	72.9	75.1	–	76.0	78.4	–	69.7	71.5
Belarus	–	–	74.2	–	–	79.2	–	–	69.0
Georgia	–	74.2	72.7	–	78.4	77.2	–	69.7	68.3

Continued on next page

Table 1 *Continued*
Life expectancy at birth in selected* **European countries according to gender in 1991, 2006 and 2016**
Source: Eurostat (2018) [23]

	Life expectancy at birth (years)								
	Total			Women			Men		
	1991	2006	2016	1991	2006	2016	1991	2006	2016
Iceland	78.0	81.2	82.2	81.3	82.9	84.1	74.9	79.5	80.4
Kosovo+	–	–	78.6	–	–	81.6	–	–	75.9
Liechtenstein	–	81.0	82.3	–	83.1	84.0	–	78.9	80.6
The former Yugoslav Republic of Macedonia	–	73.9	75.4	–	76.2	77.5	–	71.7	73.4
Montenegro	–	73.9	76.5	–	76.4	78.9	–	71.4	74.1
Norway	77.1	80.6	82.5	80.2	82.9	84.2	74.0	78.2	80.7
Serbia	–	73.4	75.7	–	76.1	78.3	–	70.8	73.2
Switzerland	77.8	81.8	83.7	81.4	84.2	85.6	74.2	79.2	81.7
Turkey	–	–	78.1	–	–	81.0	–	–	75.4

* Only countries with data for 2016
+ In accordance with United Nations Security Council Resolution 1244/99

Corresponding author
Enno Nowossadeck
Robert Koch Institute
Department of Epidemiology and Health Monitoring
General-Pape-Str. 62–66
D-12101 Berlin, Germany
E-mail: NowossadeckE@rki.de

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Editors
Susanne Bartig, Johanna Gutsche, Dr Birte Hintzpeter,
Dr Franziska Prütz, Martina Rabenberg, Dr Alexander Rommel,
Dr Livia Ryl, Dr Anke-Christine Saß, Stefanie Seeling,
Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
Unit: Health Reporting
General-Pape-Str. 62–66
D-12101 Berlin
Phone: +49 (0)30-18 754-3400
E-mail: healthmonitoring@rki.de
www.rki.de/journalhealthmonitoring-en

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Robert Koch Institute, Berlin

Claudia Santos-Hövener, Maria Schumann, Patrick Schmich, Antje Gößwald, Alexander Rommel, Thomas Ziese, Thomas Lampert

Robert Koch Institute, Berlin
Department of Epidemiology and Health Monitoring

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Improving the information base regarding the health of people with a migration background. Project description and initial findings from IMIRA

Abstract

Germany is an immigration country and nearly a quarter of its population has a migration background. Thus, there is increasingly a need for reliable information on the health situation of people with a migration background. The Robert Koch Institute is in charge of expanding its health monitoring to improve the representation of people with a migration background in interview and examination surveys. Studies adequately need to reflect the health status of people with a migration background and currently the Robert Koch Institute's representative interview and examination surveys for adults do not fully achieve this. At the end of 2016, therefore, the Improving Health Monitoring in Migrant Populations (IMIRA) project was initiated aiming to expand the Robert Koch Institute's health monitoring to people with migration background and improve their involvement in health surveys in the long-term. This includes carrying out two feasibility studies to test strategies to reach and recruit people with migration background for interview surveys and develop measures to overcome language barriers in examination surveys. In order to expand health reporting on migration and health, a reporting concept and a core indicator set will be developed and the potential of (secondary) data sources will be tested. Furthermore, plans foresee the testing and further development of relevant specific migration sensitive survey instruments and indicators, as well as increasing networking with relevant stakeholders.

MIGRATION · MIGRATION BACKGROUND · HEALTH MONITORING · HEALTH REPORTING

1. Introduction

The Federal Republic of Germany is an immigration country. Nearly a quarter of the population has a migration background (23.6%), which means that either they themselves or at least one of their parents were born with a non-German citizenship [1]. Around half of the 19.3 million people with a migration background hold German citizenship (51.1%) and over two thirds (68.4%) have themselves migrated to Germany. The most common countries of birth of all people with a migration background in Germany are Turkey (2.8 million), Poland (2.1 million), the Russian Federation (1.4 million), Kazakhstan (1.2 million) and Romania (0.9 million) [1, 2]. In the group of migrants who do not hold German citizenship, the five most represented nationalities are Turkish, Polish, Syrian, Italian and Romanian [3].

People who migrate to Germany tend not to be sick more often, but their health resources and issues are

Info box

Health monitoring at the Robert Koch Institute aims to continuously monitor disease incidence as well as health and risk behaviour in Germany. Moreover, the aim is to identify trends and changes in the health status and analyse these with regard to current or planned prevention measures. Health monitoring is conducted on behalf of the Federal Ministry of Health. Key elements of health monitoring at the Robert Koch Institute are the three health studies (1) German Health Interview and Examination Survey for Children and Adolescents (KiGGS), (2) German Health Interview and Examination Survey for Adults (DEGS1) and (3) German Health Update (GEDA). Starting in 2020, the next Germany-wide interview and examination survey for adults, the Health and Nutrition Survey in Germany (gern), will be conducted in co-operation with the Max Rubner-Institute.

Federal health reporting (GBE) regularly reports on the health of the German population. Federal health reporting provides a sound basis for political decision-making and offers a data-supported information base to all interested parties. It also serves to assess the success of measures and contributes to developing and evaluating health targets.

different. These may vary greatly depending on region of origin and their experiences prior to, during and after migration. The heterogeneity of migrant groups with regard to factors such as culture and language, and also the causes of migration, as well as healthcare needs represent new challenges for the healthcare system [4, 5]. This makes it particularly important to gain information on the health status of current migrant groups and contribute to an analysis of health-related needs for integration [5, 6]. It will be equally important to improve the data basis on the health of people with a migration background who have already been in Germany for a longer time or were born here. Here too differences regarding protective factors are evident, for example lower levels of alcohol and tobacco consumption [7], and risk factors such as a less frequent utilization of health services [8]. Attempts to improve the data and information basis should therefore target the entire population with migration background. For the Robert Koch Institute the task will therefore consist of expanding the health monitoring the institute has developed over the past years, as well as expanding its health reporting which has become well established over the years to reach people with a migration background in national health surveys commensurate with their share of the German population and delivering representative statements on their health. The great challenge here lies in taking into account the diversity of people with a migration background, while at the same time ensuring data comparability.

This article describes the Improving Health Monitoring in Migrant Populations (IMIRA) project that aims to expand health monitoring at the Robert Koch Institute to include people with a migration background and to improve their participation in health surveys in the long-term. The article also considers the measures and strategies applied in the context of previous German interview and examination surveys.

1.1 Including people with a migration background in health monitoring at the Robert Koch Institute so far

National-level health surveys of the adult population at the Robert Koch Institute have so far not satisfactorily taken people with a migration background into account. Regular surveys such as the German Health Update (GEDA) did not apply special measures to factor in this group. Based on this survey, there is therefore no robust data for people with a migration background. Furthermore, the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) took considerable measures to include families with a migration background. With the aim of compensating for the low level of willingness to participate by families with a migration background, sampling in the KiGGS baseline study (2003-2006) was conducted by applying an oversampling factor of 1.5. Children and adolescents without German citizenship were therefore considered 1.5 as frequently in the unadjusted gross sample relative to their proportion of the population. Furthermore, using a computer-aided system of name categorisation (onomastic procedure) [9], participants with German citizenship were assigned to a particular language and therefore a possible migration background according to their names and surnames. People detected through onomastic sampling received translated invitation letters and survey materials in Turkish, Russian, Bosnian/Croatian/

Interview and examination surveys of the Robert Koch Institute so far do not represent people with a migration background proportional to their share of the population.

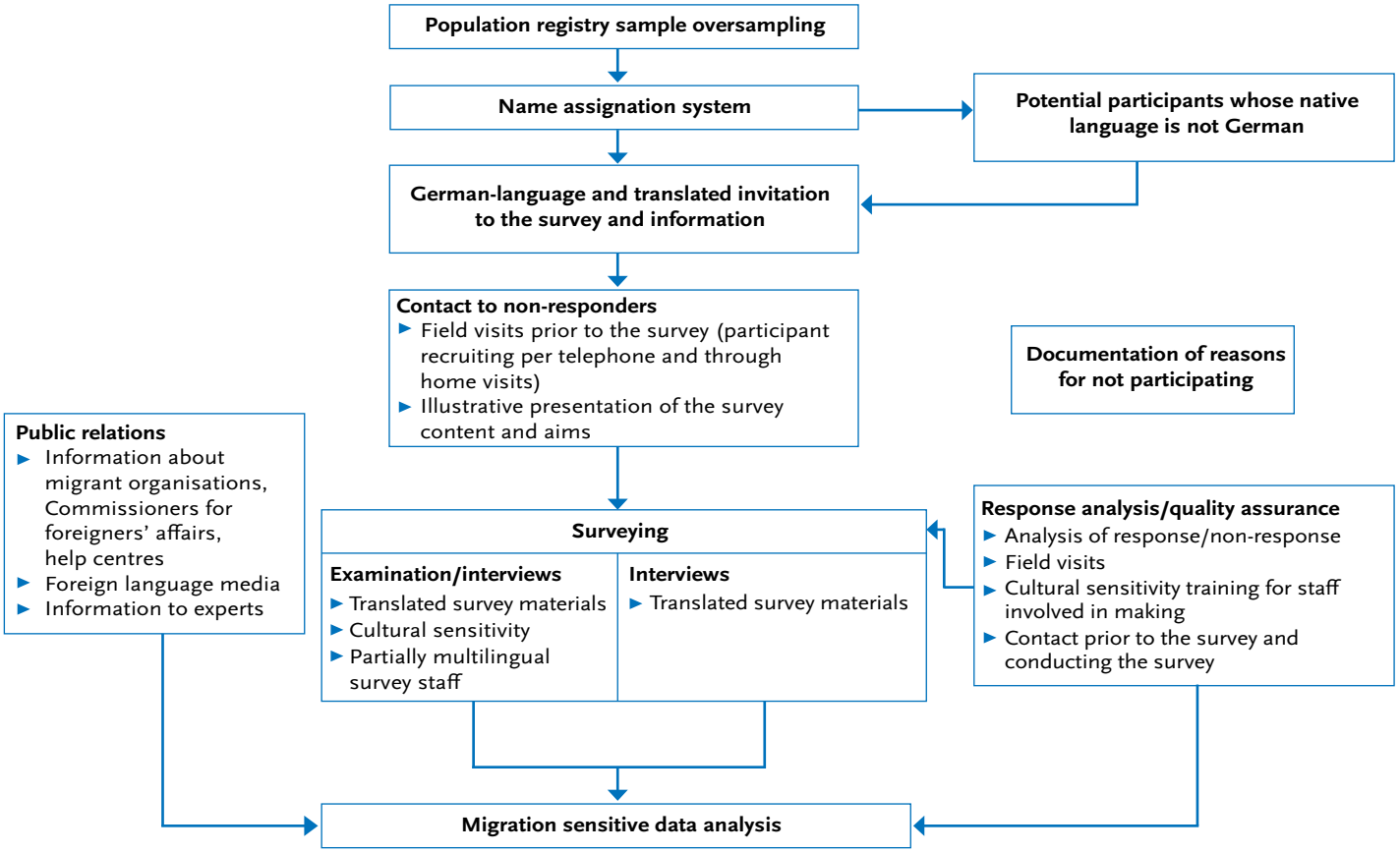
Serbian (Serbo-Croatian), Arabic, English and Vietnamese. Furthermore, field teams at the examination centres as well as the staff visiting the field prior to the survey received intercultural training. Specific public relations efforts for people with a migration background were implemented by using national and local level media published in these languages for example. Moreover, migrant organisations, integration commissioners (also for resettlers – ethnic Germans from Eastern Europe), counselling centres as well as the Working Group Migration and Public Health (Arbeitskreis Migration und öffentliche Gesundheit) at the Federal Commissioner for Migration, Refugees and Integration were informed in advance about the project and the initial findings [10]. The proportion of participants with a migration background in the unweighted sample was 17.0% (weighted 25.4%), although this proportion for 0- to 18-year-old children and adolescents with a migration background was lower than according to the 2005 Microcensus data (28.6%) [7, 11, 12].

In the second follow-up to KiGGS (KiGGS Wave 2, 2014-2017), the migration specific approach of the KiGGS baseline study was further pursued and optimised (Figure 1). A total of 2,994 0- to 17-year-old children and adolescents with a migration background took part in KiGGS Wave 2. This corresponds to a proportion of 20.2% in the unweighted sample (weighted 28.8%), which was less than their proportion according to the 2013 Microcensus data (31.2%) [13].

In the context of the German Health Interview and Examination Survey for Adults (DEGS1) conducted between 2008 and 2011, some measures were implemented to include people with migration background. Thus, an oversampling by a factor of 1.5 of people with non-German citizenship, the translation of invitation letters and questionnaires into selected languages as well as specific public relations activities were implemented. However, due to limited resources, it was not possible to include all measures that proved successful in KiGGS. A total of 1,107 participants with a migration background were reached. This corresponds to an unweighted proportion of 14.2% of the net sample, which is below their share of 20.5% according to Microcensus data (2009). In DEGS1 specific subgroups with a migration background are underrepresented. Among them are migrants (first generation), women and men who hold Turkish citizenship, as well as people with low levels of education. A deeper analysis moreover shows distortions regarding length of stay and further sociodemographic and migration-specific variables in the context of DEGS1 [14].

Overall, it is evident that the response rates of children and adolescents and in particular adults of non-German nationality are lower compared to those of German nationals. This makes it particularly important to implement migration-specific measures to improve reach and participation and represent people with a migration background proportionate to their share of the population in the data. This is particularly true for hard-to-reach subpopulations, such as people with insufficient knowledge of German, first-generation immigrants, as well as people with low levels of education. Beyond translated invitation letters and survey materials, migration sensitive public relations efforts, visits to the field ahead of the survey have proven to be highly effective. Making personal contact and clarifying the aims and content of surveys appears to reduce barriers and fears and increase willingness to participate [10, 13, 15].

Figure 1
Improving the inclusion and participation of people with a migration background in KiGGS Wave 2
Source: Modified from Schenk et al. 2007 [15]



1.2 Heterogeneous data for describing the health status of people with a migration background

Beyond low response rates and possible barriers to participation, further challenges need to be addressed to improve the available data on the health of people with a migration background in the long term. More and more epidemiological studies provide data on the health of people with a migration background and numerous official statistics (Microcensus) and social science surveys such as the Socio-Economic Panel (SOEP) can be drawn upon for analyses to varying degrees. However, the different studies do not uniformly operationalise migration background, some rely on citizenship, others on country of birth, others consider parental country of birth. Comparing such data is therefore difficult. Moreover, it is often impossible to make

Table 1
Subprojects of the IMIRA project
Own table

Subproject	Inhalte
TP1	Taking stock of current research
TP2	Adaptation and further development of concepts
TP3	Feasibility study 'interview survey'
TP4	Feasibility study 'examination survey'
TP5	Further development of health reporting
TP6	Utilization of secondary data
TP7	Utilization of SOEP data
TP8	Networking and co-operation

TP = subproject, SOEP = Socio-Economic Panel

statements on groups from specific regions or take into account variables such as length of stay, because the corresponding subsamples are too small. Simply differentiating by migration background (yes/no) however cannot do justice to the heterogeneity of people with a migration background. Ultimately, the situation calls for an established form of health reporting that regularly addresses the question of the health of people with a migration background and uses different data sources to gain a more complete picture.

2. The IMIRA project and initial results

In order to meet the challenges described above, in 2016 the Robert Koch Institute began the three-year Improving Health Monitoring in Migrant Populations (IMIRA) project that aims to expand health monitoring to also reach people with a migration background and increase their participation in health surveys in the long term. Results relevant to health monitoring are to be implemented during the next adult survey, the field phase of which is scheduled to begin in 2020. The survey can rely on the experiences and findings especially from the KiGGS studies. Beyond identifying relevant migration-specific concepts and indicators, an additional aim will be to expand health reporting. This will include a review and evaluation of the feasibility of using further sources of data, such as secondary data and SOEP data. Intensifying networking and co-operation with important national and international actors are also planned.

The IMIRA project consists of a total of eight subprojects (Table 1), which we describe below.

2.1 Taking stock of current research and adaptation of concepts (TP1 and TP2)

Subproject 1 took stock on the literature of 'Migration and Health' and provided an overview of current research at the national and international level. A review of the relevant literature identified publications dealing with ways of defining and operationalising migration background. Further studies that were included were those reflecting on forms of accessing and recruiting migrant populations through migration-specific surveying instruments and content. In addition, 26 experts such as researchers and stakeholders from the realms of academia and healthcare were interviewed to identify the challenges for epidemiological research in Germany as well as possible solutions for reaching people with a migration background. The results of these expert interviews showed several different challenges and strategies when approaching people with a migration background. Besides language and cultural barriers, a clear lack of trust in research exists, which can be met by including key migrant representatives and by using migration-sensitive translations [16].

The IMIRA project was initiated to include people with a migration background in health monitoring at the Robert Koch Institute in the long term.

Subproject 2 dealt with reviewing, developing and adapting the existing surveying instruments and concepts that can have an impact on the health of people with migration background. Within this context, the current operationalisation of a migration background in the adult surveys at the Robert Koch Institute was reviewed and harmonised. Additionally, the relevant literature regarding the application of the concept of acculturation in epidemiologic research was systematically reviewed. Acculturation describes a multi-dimensional process during which cultural practices, norms and values of the country of origin merge with those of the host country. Research has shown that this concept has an impact on the health of people with migration background [17-19]. Based on the results of the review, the aim is therefore to develop a short survey instrument for acculturation for the health surveys at the Robert Koch Institute. Further concepts relevant to migration were also identified and their collection and operationalisation discussed. Among them were subjectively perceived experiences with discrimination, surveying religious affiliation and subjective social status. In order to validate the concepts and tools people with a migration background were involved through focus groups and cognitive interviews.

2.2 Implementation of feasibility studies (TP3 and TP4)

Two feasibility studies were conducted in order to understand how to better reach people with a migration background in Robert Koch Institute surveys and therefore acquire comprehensive data on their health. The feasibility study entitled 'interview survey' (subproject 3) tested methodology with regard to their potential to increase the reachability of people with a migration background and increase this group's response rates in health surveys. Data collection took place between January and May 2018. Using a population registry sample, people with a migration background in Berlin and Brandenburg were drawn for five groups based on the criterion of nationality (Croatian, Polish, Romanian, Syrian and Turkish) and subsequently received an invitation letter. In a sequential study design, different interview formats (online questionnaire, telephone interview and face-to-face interview) were offered to assess their acceptance. Prior to the study, the invitation letters and study information were developed with the help of people with migration backgrounds from the corresponding countries to verify the cultural sensitivity of all materials. Target persons received bilingual invitation letters and information brochures together with an invitation to participate in the study in the form of a bilingual online interview. Questionnaires were made available in German and participants' mother tongues. For questions, or to cancel participation, target persons could call a multilingual study hotline. A first reminder letter offered the possibility of taking part in a telephone interview in addition to participating online. A final reminder letter sent to a random sample of the Turkish, Syrian and Romanian target persons notified home visits. During these visits, telephone numbers were collected to conduct a telephone interview, or a face-to-face interview was conducted on the spot. 1,090 participants filled out the questionnaires. The initial results show great differences in levels of willingness to participate, from 8.6% in the Turkish group to 24.3% in the Syrian group. All groups made use of the

Overcoming language barriers, applying different interview formats and culturally sensitive invitation letters are key to reaching the target group.

foreign language questionnaires, albeit with clear differences of preference. Around a quarter of people of Croatian nationality (23.6%), 41.0% of Turkish nationality, around half of the Polish people (51.1%) and Romanians (54.1%) as well as 80.9% of Syrian nationals used the non-German version. The feasibility study moreover showed that face-to-face interviews make it easier to reach people with low levels of education and at an older stage in life [20].

The feasibility study entitled 'examination survey' (subproject 4) aimed to test new methods for overcoming language barriers between the people being examined and those carrying out the examinations. The participation in examination surveys requires the written consent of participants, which is obtained after providing detailed information. So far, people without sufficient knowledge of German were excluded from examination surveys as it was not possible to provide them with adequate information on the content, counter indications of examinations and questions concerning data protection, due to their lack of or insufficient knowledge of German.

From October to December 2017, different measures to overcome language barriers were tested and evaluated for their application in the forthcoming adult survey in 2020. Around 90 participants respectively with a Polish, Syrian and Turkish migration background were recruited in a non-random sampling procedure (convenience sampling). Participants with low levels of German, based on the European Council reference framework for languages (B1 or less), were explicitly selected for the examination survey. The feasibility study here relied on information videos in German and the person's mother tongue as well as multilingual information materials. A video interpreting service was available to provide information on the content of the study prior to participants providing their written consent and for any additional questions during the examination. Information letters and questionnaires were offered in German, Arabic, Polish and Turkish. A final evaluation of the measures applied by participants was also available whenever this was necessary with a video interpreting service. Following the feasibility study 'examination survey', focus groups in the corresponding languages were conducted with selected participants, to speak about the use of methods and overcoming barriers during the participation in surveys. The initial results indicate a high level of acceptance in particular of the multilingual information videos and video interpreting service. The examination and interview survey for adults due to begin in 2020 will therefore use translations, a video interpreting service as well as information videos in selected languages. In future, this will allow also people with low levels of German to participate in Robert Koch Institute health surveys. Due to the positive experiences made in the context of the IMIRA project, videos will also be used for the German language population and therefore provide a standardised tool of information provision.

2.3 Expanding health reporting (TP5 – TP7)

Federal health reporting regularly reports on the health of the German population. Health monitoring data here provide an important basis. Many further sources of data are also used to provide a report as complete as possible on the questions at hand. Within the context of the IMIRA project, a reporting concept is being developed that supports

regular reporting on the health of people with a migration background (subproject 5). One question being analysed is, for example, the format future reports on the health of people with a migration background should have (stand-alone health report versus migration as a cross-sectional issue within broader reporting formats). To develop a relevant reporting concept for migration, international best practice examples are being identified. Beyond systematic research online, an online survey targeting national public health institutes and further relevant institutions in EU and OECD countries was conducted. Within the context of the subproject, a set of core indicators for describing the health of people with a migration background is being developed. Further data beyond health monitoring that could be used in an expanded health reporting is being reviewed. In addition to defining thematic focuses, stock has been taken of the national surveys in Germany that adequately collect information relating to health and migration background.

Within the context of the project, the question, as to what extent secondary data (e.g. data from statutory health insurances) can be used and the explanatory power and reliability such data has regarding the health of people with migration background (subproject 6). Secondary data is not collected primarily for scientific, rather for administrative purposes, but is, however, frequently used for scientific purposes. To get an overview, stock was broadly taken of the available data sources and the options for analysis they offer. In a second step, two sources of data that were considered as particularly relevant were looked at more closely and evaluated (asylum-seeker benefits statistics and cause-of-death statistics). Furthermore, data from the Socio-Economic Panel (SOEP) is being used for an evaluation project (subproject 7). SOEP is a representative longitudinal study to collect data on political and social change in Germany. While health is not a focus within SOEP, health-related questions have increasingly become part of the surveying programme over the course of the last five years. Within the context of SOEP, different populations with migration background have explicitly been taken into account since 1984. In 2016, for example a new and comprehensive sample of refugees in Germany was drawn up and initial interviews conducted [21].

Consulting with people with a migration background improves the quality of materials such as invitation letters or survey information.

2.4 Networking with relevant stakeholders (TP8)

A further subproject across the entire duration of the project has aimed to network and create co-operation with important stakeholders in Germany and Europe (subproject 8). The aim is to network with university institutes and public health practice. This includes a joint presence at congresses and conferences, scientific supervision of other migrant and/or refugee and health-related projects, as well as involving public health services and migrant organisations. An advisory board accompanies the project and provides guidance.

3. Conclusion

The IMIRA project followed the aim of establishing migration-sensitive health monitoring at the Robert Koch Institute that does justice to the heterogeneity of the population with migration background in Germany. This is essential for providing reliable data on the health situation and behaviour of people with migration background in the

future. To provide up-to-date and robust data in the context of health monitoring that provide meaningful information on people with migration backgrounds in its full diversity, it is crucial to representatively include these populations. In future, the aim is to be able not only to account for migration background or generation, but also to reflect aspects such length of stay, residency status, level of German or region of origin and ensure a differentiated analysis of the health situation of people with migration background.

Analyses of the health status of people with a migration background should cover several aspects such as length of stay, residency status, German language competency or region of origin.

Based on the experiences made in previous interview and examination surveys and the initial results from the IMIRA project, the following elements are essential for reaching and representing people with migration backgrounds within the context of health monitoring:

- further developing the survey content, indicators and concepts to do justice to the heterogeneity of people with migration backgrounds
- offering greater flexibility in the choice of different interview formats
- ensuring personal contact in data collection, in particular face-to-face interviews to include groups which are particularly hard-to-reach
- focusing on overcoming language barriers by using multilingual services, materials and offering (video) interpretation services in examinations
- taking into account concepts such as 'diversity' and intercultural competency and therefore the use of migration-sensitive materials, as well as offering training sessions for the survey and research staff
- involving people with migration backgrounds in the planning, implementation and dissemination of results and promoting participation
- further developing health reporting and a reflected presentation of migration-specific statements

The coming national interview and examination survey for adults, the Health and Nutrition Survey in Germany (gern), that the Robert Koch Institute will conduct in cooperation with the Max Rubner Institute, will implement the conclusions from IMIRA regarding improving the reachability of people with migration background. The aims will therefore be (1) to reach adults with migration background commensurate with their share of the population; (2) to enable differentiated statements on the health situation of different migrant groups. The gern study applies established measures to increase response (visiting the field prior to the survey and public relations). Language barriers during examinations are to be addressed by using multilingual materials and information videos and making video interpretation services available. To provide findings on the health status of specific groups depending on their region of origin, the aim is to achieve a sample of non-German nationals for interviews from five select countries of origin (1,000 to 1,500 people per group). Interviews will be based on multilingual online and paper questionnaires, as well as face-to-face interviews.

Corresponding author
Dr Claudia Santos-Hövener
Robert Koch Institute
Department of Epidemiology and Health Monitoring
General-Pape-Str. 62–66
D-12101 Berlin, Germany
E-mail: Santos-HoevenerC@rki.de

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Data protection and ethics

All of the Robert Koch Institute's studies are subject to strict compliance with the data protection provisions set out in the EU General Data Protection Regulation (GDPR) and the Federal Data Protection Act (BDSG). Charité – Universitätsmedizin Berlin's ethics committee assessed and approved the ethics of the IMIRA feasibility study 'interview survey' (EA1/210/17). The Ethics Committee of the Berlin Chamber of Physicians assessed and approved the ethics of the IMIRA feasibility study 'examination survey' (Eth 21/17). Both study protocols were also assessed by the Federal Commissioner for Data Protection and Freedom of Information (13-401/008#0085). Participation in the studies was voluntary. The participants were also informed about the aims and contents of the study, and about data protection. Informed consent was obtained in writing.

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Conflicts of interest

The authors declared no conflicts of interest.

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Editors
Susanne Bartig, Johanna Gutsche, Dr Birte Hintzpeter,
Dr Franziska Prütz, Martina Rabenberg, Dr Alexander Rommel,
Dr Livia Ryl, Dr Anke-Christine Saß, Stefanie Seeling,
Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
Unit: Health Reporting
General-Pape-Str. 62–66
D-12101 Berlin
Phone: +49 (0)30-18 754-3400
E-mail: healthmonitoring@rki.de
www.rki.de/journalhealthmonitoring-en

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