ROBERT KOCH INSTITUT

SEPTEMBER 2017
ISSUE 3

FEDERAL HEALTH REPORTING
JOINT SERVICE BY RKI AND DESTATIS

Journal of Health Monitoring

ROBERT KOCH INSTITUT

SEPTEMBER 2017
ISSUE 3

FEDERAL HEALTH REPORTING
JOINT SERVICE BY RKI AND DESTATIS

Journal of **Health Monitoring**

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-061
Robert Koch Institute, Berlin

Authors:
Henriette Steppuhn*, Silke Buda*, Antje Wienecke*, Klaus Kraywinkel, Kristin Tolksdorf, Jörg Haberland, Detlef Laußmann, Christa Scheidt-Nave

*contributed equally

Time trends in incidence and mortality of respiratory diseases of high public health relevance in Germany

Abstract
Respiratory diseases are major causes of disease burden and mortality throughout the world. In Germany, alongside acute respiratory infections (ARI), chronic lung diseases – including lung cancer, chronic obstructive pulmonary disease (COPD), and asthma – are of particular socioeconomic importance. ARI incidence rates differ significantly according to age, season and year. They are recorded as weekly consultation rates as reported by selected outpatient and inpatient care facilities. Between 2009 and 2016, the highest incidence rates of severe acute respiratory infection (SARI) were recorded among young children in outpatient (9.4%) and inpatient (0.2%) care. Mortality rates for ARI are also subject to seasonal and annual fluctuations. However, the official statistics on causes of death, which lead to estimates of more than 17,000 annual deaths, provide an inadequate measure of death rates because chronic underlying illnesses are often recorded as the cause of death rather than a more recently acquired acute infection. Therefore, the excess mortality caused by ARI needs to be assessed in the context of influenza outbreaks. Regarding lung cancer, COPD and asthma, the long-term time trends in disease incidence and mortality rates are of particular interest from a health policy perspective. Analyses of data from the official statistics on causes of death for the years 1998 through 2015 show that mortality rates for lung cancer and COPD decreased on average by 1.8% and 1.1% per year respectively, among men, whereas among women they increased by 2.5% (lung cancer) and 2.3% (COPD) annually. Nevertheless, more men than women died of lung cancer or COPD in 2015 in Germany: 29,378 men and 15,881 women died from lung cancer, and 17,300 men and 13,773 women died from COPD. During the same period, the asthma mortality rates decreased on average by 8.3% annually among women and by 11.2% annually among men, and the absolute number of deaths came down to 659 among women and 393 among men. Lung cancer incidence rates have been at similar levels as lung cancer death rates since 1998. No such data are available on time trends in COPD or asthma incidence rates. Coordinated surveillance of respiratory diseases needs to be expanded within the framework of international action plans for disease prevention.

RESPIRATORY DISEASES · LUNG DISEASES · INCIDENCE · MORTALITY · SURVEILLANCE

1. Introduction

In Germany and throughout the world, diseases of the airways and lung are of significant socioeconomic importance [1-7]. Within the current framework of the international system of disease classification (10th revision of the International Statistical Classification of Diseases and Related Health Problems, ICD-10), this group of diseases not only covers a wide range of acute and chronic disorders of the respiratory system (J00-J99), but also malignant neoplasms (cancer) of the trachea, bronchus and lung (C33-C34) [2]. Recent data from Germany (2015) show that 12.3% of all deaths are caused by respiratory diseases (ICD-10: J00-J99 including C33-C34) [8]. The direct costs incurred from the treatment of respiratory disorders alone (including C33-C34) amount to EUR 14.7 billion (2008) [2]. Respiratory system disorders – alongside musculoskeletal disorders and connective tissue diseases – were the most common reason that patients sought treatment in a doctor's practice in 2016 [9]. They are also among the most important factors that cause people to take time off work [2, 10]. In Germany, alongside acute diseases of the respiratory tract (J00-J22), lung cancer (C33-C34), chronic obstructive pulmonary disease (COPD, J44), and asthma (J45-J46), in particular, are associated with a high burden of disease and mortality [1-7, 11, 12]. They are, therefore, of particular relevance to public health and are also the central focus of the World Health Organization's (WHO) surveillance and prevention strategies [1, 11-13].

Lung cancer (C33-C34) and COPD (J44) among both genders, and pneumonia (pneumonia, organism unspecified J18) among men, count among the ten most frequent causes of death in Germany [8]. The importance of these diseases is also reflected by the impact on the health care system. Every year, seasonal influenza is a major cause of extra visits in ambulatory care [14]. Depending on the season, influenza can cause up to 30,000 hospitalisations due to complications of primary influenza and secondary bacterial infection [14]. The number of pulmonary infections that occur outside of hospital (community-acquired pneumonia) is estimated at between 400,000 and 600,000. Approximately 30% to 50% of these cases lead to hospitalisation [15, 16]; community-acquired pneumonia should be treated in accordance with the S3 guideline [17]. Nevertheless, pneumonia is often the result of hospital-acquired (nosocomial) infections. According to a study of the burden of disease associated with nosocomial infections in Europe, the incidence of nosocomial pneumonia (healthcare-associated pneumonia – HAP) is 138 per 100,000 population [18]. Calculated in DALYs (disability-adjusted life years), which is an internationally established standard for measuring the burden of disease caused by an illness or pathogen, HAP (with a rate of 169 per 100,000 individuals) is the most important disease in terms of severity and case fatality among the six frequently occurring nosocomial infections examined in this study. However, only data from hospitals were taken into account in this case – data from nursing homes were not included [18]. In addition, COPD and asthma are not only common causes of outpatient care visits [19]. As chronic conditions that can be treated in an ambulatory care setting, both diseases are among the major causes of

The incidence rate of acute respiratory infections is highly dependent on age and fluctuates strongly according to the time of year and the severity of the influenza season.

Info box 1: Measures of disease frequency

Prevalence: The prevalence is the frequency of a certain disease within a defined population in a specific period of time. It is usually expressed as the percentage of the people who have had a certain disease, e.g., within the last 12 months (12-month prevalence) or during their life (lifetime prevalence).

Incidence: The incidence is the frequency of new cases of a certain disease within a defined population in a specific period of time. It is often expressed as a percentage of new cases within a specific period (cumulative incidence) or as the number of new cases per 1,000 person-years (incidence rate).

Cumulative incidence: The number of new cases is divided by the original number of people at risk. In other words, this is the proportion of a population that could develop the disease in a defined period of time (for example, at the beginning of a twelve-year study period). In order to calculate the cumulative incidence of a certain disease, new cases are counted only among people who did not have the disease at the start of the study (Annex Table 3).

Incidence rate: The incidence rate is the number of new cases divided by the so-called person-time at risk. The person-time at risk corresponds to the duration of time during which the people in a defined population are at risk of developing a disease. It can vary from person to person. For example, not everyone is at risk of developing a certain disease for the entire study duration because they may develop the disease before the study ends (Annex Table 3) [41]. According to international standards for cancer registration, the annual incidence rate of lung cancer is calculated as the proportion of the average total

Continued on next page

potentially avoidable hospital admissions with more than 270,000 hospitalisations in 2015 [20-23]. Around 190,000 cases of lung cancer were treated in hospitals in 2015, which provides an illustration of the considerable level of medical care associated with this disease [23, 24].

Continuous and timely disease monitoring including incidence and mortality rates is indispensable in infection control and also forms the basis of the WHO's Global Action Plan for the Prevention and Control of NCDs 2013-2020 [12, 13]. At the Robert Koch Institute (RKI), assessments of the rates of new cases and deaths (incidence and mortality, see Info box 1, 2, 3 and 4) associated with acute respiratory infections (ARI) and cancer, including lung cancer, are carried out continuously as part of the ongoing surveillance of infectious diseases and the pooled analyses of federal state-level epidemiological cancer registry data held by the German Centre for Cancer Registry Data (ZfKD). In addition, data on the epidemiology of respiratory diseases are available from the population-based, representative health surveys carried out at regular intervals by the RKI and from the official statistics on causes of death published by the Federal Statistical Office (Info box 3). All these data are integrated into the German Federal Health Monitoring information system [25]. Additional information on the prevalence (Info box 1) of lung cancer is published at regular intervals by the ZfKD [24]. Two Fact sheets published in this issue use data from the German Health Update (GEDA 2014/2015-EHIS) nationally health interview survey to provide current assessments of the prevalence of known COPD and asthma among adults. The current analyses are based on data available at the national level to describe time trends in the incidence and mortality due to acute respiratory infections and chronic lung diseases of high relevance to public health.

2. Methods

The current investigation relies on data sources available at the national level to analyse time trends in incidence (Info boxes 1 and 2) and mortality rates (Info boxes 3 and 4) of acute respiratory infections (ARI), lung cancer, COPD and asthma. It includes data on ARI from primary care practices and hospitals (syndromic surveillance), [26, 27] from the RKI's Centre for Cancer Registry Data (ZfKD) [28, 29], and from the official statistics on causes of death [8] (Info boxes 3, 5, 6 and 7). In addition, the incidence rate of asthma among adults during the observation period between 1997-1999 and 2008-2011 was estimated based on data from the nationwide interview and examination surveys regularly conducted by the RKI as part of the German Federal Health Monitoring system [30-33] (Info box 8).

2.1 Acute respiratory infection (ARI)

Case definition

In primary care practices, an acute respiratory infection (ARI) was counted if a doctor diagnosed a disease by entering at least one of the following ICD-10 codes into the medical information system: J00-J22 (J00-J06: acute upper respiratory infections; J09-J18: influenza and pneumonia; J20-J22: other acute lower respiratory infections) or an individual diagnosis of J44.0 (chronic obstructive

Info box 1 (continued)

population of the respective reference year that develops lung cancer in that year [24]. The number of people with previously diagnosed lung cancer among the total population is considered negligible. Thus, the average total population of the respective reference year is simplified and equated with the number of people at risk for that year. The incidence rate is presented as the number of new cases of lung cancer per 100,000 population.
Source: [24, 41, 129]

pulmonary disease with acute lower respiratory infection) or B34.9 (viral infection, unspecified). In order to assess the burden of severe acute respiratory infections (SARI) in inpatient care, cases with a discharge diagnosis of influenza, pneumonia or other acute lower respiratory infection (ICD-10 J09-J22, Table 1) were selected.

Incidence of acute respiratory infection (ARI)

A syndrome is a typical combination of several symptoms or diagnoses (or, in this case, the ICD-10 codes used to describe them) associated with a particular disease. The RKI conducts syndromic surveillance of acute respiratory infection (ARI) in both outpatient (general practitioners and paediatricians) and inpatient (hospital) care. It is particularly used to monitor the conditions resulting from influenza, as influenza viruses can cause acute respiratory diseases, and unlike many viruses causing the common cold, can account for serious illnesses and death. The RKI's Working Group Influenza (Arbeitsgemeinschaft Influenza, AGI) has provided data on outpatient care for many years (see Info box 5). Moreover, an ICD-10-code based, electronic reporting system was included in the syndromic routine surveillance since 2012/2013. This includes keeping electronic records of diagnostic codes [26]. The weekly ARI consultation rate (see Info box 2) is an important indicator for ARI activity. Due to its strong association with age, the consultation rate is estimated in five age groups separately [27]. For severe acute respiratory infections (SARI), the RKI has also developed a continuous syndromic sentinel

Table 1
Mortality due to respiratory diseases including lung cancer in 2015, Germany (≥0 years of age) by gender
Data source: Official statistics on causes of death [8]

ICD-10 codes		Gender	Number of deaths	Deaths per 100 thousand population (crude rate)
J00-J99	Diseases of the respiratory system	Women	31,700	76.4
		Men	36,600	91.1
J09-J22	Severe acute respiratory infections (SARI)[1]	Women	10,743	25.9
		Men	10,816	26.9
J40-J44, J47	COPD and other chronic lower respiratory diseases excluding asthma	Women	15,166	36.5
		Men	18,877	47.0
J44	Chronic obstructive pulmonary disease (COPD)	Women	13,773	33.2
		Men	17,300	43.1
J45-J46	Asthma	Women	659	1.6
		Men	393	1.0
C33-C34	Malignant neoplasms of the trachea, bronchus and lung	Women	15,881	38.3
		Men	29,378	73.1
C34	Malignant neoplasms of bronchus and lung	Women	15,870	38.2
		Men	29,354	73.1

[1] Severe acute respiratory infections (SARI): influenza, pneumonia and other acute infections of the lower respiratory tract.
ICD-10=10th revision of the International Statistical Classification of Diseases and Related Health Problems

Info box 2: The consultation and hospitalisation incidence

The consultation incidence of acute respiratory infection (ARI):
Visits to a doctor because of a medical condition in order to gain medical advice (and treatment) can also be called a consultation. The ARI consultation incidence refers to the number of people per 100,000 population who have visited (consulted) a general or paediatric practice due to a new acute respiratory infection in a given week. If the weekly ARI consultation incidence is assessed by age groups, the values are based on 100,000 population of the respective age group. Doing so demonstrates that children aged 4 years or below have the highest risk of developing a medically attended ARI. This indicator can also be expressed as a percentage (as a proportion of 100 population), resulting in a weekly ARI rate.

The hospitalisation incidence of severe acute respiratory infection (SARI):
If someone is treated for an acute respiratory infection in hospital, it can be termed that he or she was hospitalised due to the infection in question. The SARI hospitalisation incidence is the number of people per 100,000 population who have been hospitalised due to a severe acute respiratory infection (SARI) in a given week. If the weekly SARI hospitalisation incidence is assessed by age groups, the values are based on 100,000 population from the respective age group. Doing so demonstrates that children aged 4 years or below and elderly people aged 60 years or above have a higher risk of being treated in a hospital for severe respiratory infections than children older than 4 years of age or adults below the age of 60 years. This indicator can also be expressed as a percentage (as a proportion of 100 population), resulting in a weekly SARI rate.
Source: [27]

surveillance system in hospitals (the ICOSARI project) within a scientific cooperation with the HELIOS Kliniken GmbH (see Info box 6). An important indicator in this regard is the weekly SARI hospitalisation rate (see Info box 2). Just as the ARI consultation rate, these estimates are also reported stratified by five age groups (0-4, 5-14, 15-34, 35-59 and 60 years of age or older) [14 , 34].

Mortality of severe acute respiratory infections (SARI)
Age and gender-specific mortality rates for severe acute respiratory infections are based on data from the official statistics on causes of death provided by the Federal Statistical Office (Info box 3 and 4). Trends in mortality rates for severe acute respiratory infections were examined for the years 1998 through 2015 (see 2.5).

2.2 Lung cancer

Case definition
The definition of incident cases and deaths from lung cancer was made in accordance with the current international classification of diseases (10th revision of the International Statistical Classification of Diseases and Related Health Problems, ICD-10) and is based on the following ICD-10 codes: C33 for very rare malignant neoplasms of the trachea, and C34 for malignant neoplasms of the bronchus and lung (Table 1). In order to differentiate among the different types of lung cancer, the morphology codes recorded in the cancer registries were classified as follows (in accordance with the current International Classification of Diseases for Oncology – ICD-O-3): small cell lung carcinomas (8041-8045), adenocarcinomas (8140-8384), squamous cell carcinomas (8050-8080), unspecified lung tumours (8000-8005), and other malignant lung carcinomas (8010-8011) (Annex Figure 1).

Incidence of lung cancer
The analyses of lung cancer incidence rates are based on data from the epidemiological cancer registries of the federal states, which transmit data annually to the German Centre for Cancer Registry Data (ZfKD) in accordance with the Federal Cancer Registry Data Act (Info box 7). The nationwide incidence of lung cancer (Info box 1) was calculated using this data [29]. Trends in lung cancer incidence rates were examined for the years 1998 through 2013 (see 2.5).

Mortality of lung cancer
Age and gender-specific mortality rates for lung cancer are based on data from the official statistics on causes of death provided by the Federal Statistical Office (Info box 3 and 4). Trends in lung cancer mortality rates were examined for the years 1998 through 2015 (see 2.5).

2.3 Chronic obstructive pulmonary disease (COPD)

Case definition
The case definition of deaths from COPD was based on the ICD-10 code (Info box 3) J44 for other chronic obstructive pulmonary disease [2] (Table 1). In order to ensure comparability with previous analyses of COPD mortality, ICD-10 codes for COPD and other chronic lower respiratory diseases (ICD-10: J40-J44, J47) were con-

Info box 3: Causes of death

Causes of death: The official statistics on causes of death provide information about the most important causes of death and trends in death rates. From 1 January 1998 onwards, the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) has been in use to code the causes of death that occurred during the observation period. The statistics on causes of death are derived from an evaluation of death certificates. These are issued individually on the basis of the federal states' burial laws for all deaths as well as for stillborns with a birth weight of at least 500g and are pooled at the Federal Statistical Office.
Source: [129]

The mortality rate for severe acute respiratory infections is not recorded adequately by statistics on causes of death; therefore, additional estimates need to be made of the excess mortality associated with influenza outbreaks.

sidered in combination; only the ICD-10 codes for asthma (J45-J46) were excluded (Table 1) [35-37].

Mortality of COPD
Age and gender-specific mortality rates for COPD are based on data from the official statistics on causes of death provided by the Federal Statistical Office (Info box 3 and 4). Trends in COPD mortality rates were examined for the years 1998 through 2015 (see 2.5).

2.4 Asthma

Case definition
Based on data from the national health interview and examination surveys, incident cases of asthma (Info box 8) were defined as those participants who reported to have ever been diagnosed with asthma by a physician and having had asthma and/or having used asthma medication in the past 12 months. The case definition of death from asthma was based on the asthma-specific ICD-10 codes (Info box 3) J45-J46 [2] (Table 1).

Incidence of asthma among adults
The current analysis is based on data from the German Health Interview and Examination Survey for Adults (DEGS1) conducted by the RKI as part of the continuous health monitoring system in Germany [30-33]. DEGS1 has a mixed study design which allows for both cross-sectional and longitudinal analyses [30-32]. The study's concept and design is described in detail elsewhere [30-32]. Gender-specific estimates of the cumulative incidence of asthma (Info box 1) were calculated based on data from 3,959 participants of the DEGS1 study who participated in both the baseline survey (GNHIES98, 1997-1999) and the follow-up survey (DEGS1, 2008-2011) (see Info box 8). Participants (n=290) were excluded from the analyses because they reported to have ever been diagnosed with asthma by a physician at the time of the baseline survey (1997-1999) or because complete information about their asthma status was unavailable at baseline and/or follow-up survey. All results were reported by gender and further stratified by two age groups (18-44 and 45-79 years of age) (Table 4). Estimates on asthma incidence were calculated by using a specific weighting factor in order to correct not only for deviations of the baseline sample from the population structure at the time of data collection, but also to adjust for selective participation at follow-up [38]. For comparability with other studies, asthma incidence rates per 1,000 person-years were also estimated (Info box 1). Due to varying degrees of disease activity over time in individuals with asthma and resulting effects on self-reported information from those that are affected, different selection criteria of study participants for analyses on asthma incidence (population at risk, Info box 1) are found in the literature [39-42]. Therefore, incidence rates were additionally calculated after excluding specific participants who may have already had asthma before the baseline survey was conducted (see Annex Table 3).

Mortality of asthma
Age and gender-specific mortality rates for asthma are based on data from the official statistics on causes of death provided by the Federal Statistical Office (Info box 3

Info box 4: Mortality

Mortality: Mortality is the frequency of deaths within a given population during a specific period of time. It is usually expressed as a percentage of deaths within a certain period (cumulative mortality) or as the number of deaths per 1,000 person-years (mortality rate).

Cause-specific mortality rate: The cause-specific mortality rate is based on the annual number of deaths attributed to a specific underlying cause as recorded in the official statistics on causes of death (Info box 3). The average total population of the respective reference year is considered as the number of people at risk. Therefore, the annual number of deaths, for example, from lung cancer, is divided by the average total population of the respective reference year and is presented as the number of deaths from lung cancer per 100,000 population.
Source: [24, 129]

and 4). Trends in asthma mortality rates were examined for the years 1998 through 2015 (see 2.5).

2.5 Analysis of time trends

The Joinpoint Regression Program (version 4.4.0.0, [43]) was used to analyse time trends in incidence and mortality rates per 100,000 population. The average annual percentage change (AAPC) in the age-standardised rates (Info box 9) at the national level was estimated by performing joinpoint regression analyses [43, 44]. Trends in the incidence rates for lung cancer were examined for the years 1998 through 2013, whereas trends in mortality rates for each included respiratory disease were examined for the years 1998 through 2015. In each analysis, years ('joinpoints') were identified, in which statistically significant changes in trends occurred. Such joinpoints indicate, for example, points at which incidence rates begin increasing more noticeably or level out [44]. In order to account for the impact of changes to the population age structure, the rates were standardised according to age using the old European standard population (Info box 9). In addition, time trends in mortality rates for asthma and COPD were compared to time trends in mortality rates for all causes [37, 45]. For all outcomes of interest, the number of absolute cases as well as the number of cases per 100,000 population were presented by calendar year. Population estimates reflect the average total population of the respective reference year. For the years 1998 through 2010, these figures were based on projections of census data collected in the former FRG in 1987 and in the former GDR in 1990 [8]. From 2011 onwards, projections obtained from the 2011 census were used [8]. All results were reported by gender

Table 2
Trends in age-standardised mortality rates (deaths per 100,000 population) due to respiratory diseases of high public health relevance and for all causes of death between 1998 and 2015, Germany (old European standard population; ≥0 years of age) by gender
Data source: Official statistics on causes of death [8]

ICD-10 codes		Gender	Period	APC	(95% CI)	Period	APC	(95% CI)	AAPC	(95% CI)
J09-J22	(Severe acute respiratory infections – SARI)	Women	1998-2005	1.9	-1.4/5.2	2005-2015	-4.3	-6.2/-2.4	-1.8	-3.4/-0.2
		Men	1998-2007	0.0	-1.9/1.9	2007-2015	-3.9	-5.9/-1.9	-1.9	-3.1/-0.6
C33-C34	(Malignant neoplasms of the trachea, bronchus and lung)	Women	1998-2015	2.5	2.4/2.6					
		Men	1998-2006	-2.3	-2.7/-2.0	2006-2015	-1.4	-1.7/-1.1	-1.8	-2.0/-1.6
J40-J44, J47	(COPD and other chronic lower respiratory diseases excluding asthma)	Women	1998-2015	2.3	1.8/2.9					
		Men	1998-2007	-2.7	-3.8/-1.5	2007-2015	0.8	-0.5/2.1	-1.1	-1.8/-0.3
J45-J46	(Asthma)	Women	1998-2006	-10.3	-11.2/-9.3	2006-2015	-6.5	-7.7/-5.4	-8.3	-9.0/-7.6
		Men	1998-2008	-13.7	-14.5/-12.9	2008-2015	-7.6	-9.9/-5.2	-11.2	-12.2/-10.3
A00-T98	(All causes of death)	Women	1998-2015	-1.4	-1.6/-1.2					
		Men	1998-2008	-2.5	-2.9/-2.2	2008-2015	-0.8	-1.3/-0.2	-1.8	-2.1/-1.5

APC=annual percentage change, and 95% confidence interval (95% CI)
AAPC=average annual percentage change, and 95% confidence interval (95% CI) between 1998 and 2015
COPD=chronic obstructive pulmonary disease

Table 3
Trends in age-standardised incidence and mortality rates (per 100,000 population) for malignant neoplasms of the trachea, bronchus and lung (ICD-10 C33-C34) between 1998 and 2013, Germany (old European standard population; ≥0 years of age) by gender
Data Source: German Centre for Cancer Registry Data [28, 29]

ICD-10 codes		Gender	Period	APC	(95% CI)	Period	APC	(95% CI)	AAPC	(95% CI)
C33-C34	(Malignant neoplasms of the trachea, bronchus and lung)	Women	1998-2008	3.9	3.7/4.2	2008-2013	2.1	1.4/2.7	3.3	3.1/3.6
		Men	1998-2005	-1.8	-2.1/-1.5	2005-2011	-0.8	-1.3/-0.3	-1.5	-1.9/-1.2
			2011-2013	-2.7	-4.8/-0.5					

APC=annual percentage change, and 95% confidence interval (95% CI)
AAPC=average annual percentage change, and 95% confidence interval (95% CI) between 1998 and 2013

Long-term time trends in the incidence and mortality of chronic lung diseases, including lung cancer, are of particular interest from a health policy perspective.

(see Tables 2 and 3) and further stratified by age groups (0 to 54, 55 to 74, and 75 years of age or older, see Annex Tables 1 and 2). In contrast to the other age-associated chronic respiratory diseases considered here, asthma occurs frequently among people of all ages and may overlap with a COPD from mid- to late adulthood [2, 24, 46-50]. For international comparability, time trends in asthma mortality rates were thus additionally analysed for people aged 5 to 34 years [51].

3. Results

3.1 Acute respiratory infections

Figure 1 shows the weekly changes in the consultation incidence of acute respiratory infections that occurred between 2009 and 2016. Depending on the week and season, up to 2.6% of the population (at the peak of the 2012/2013 influenza season) visited a general or paediatric practice due to an acute respiratory infection. Large differences between age groups were identified year-round, whereas gender-specific differences hardly played a role (data not shown). Each week, between 1.5% and 9.4% of children aged 0 to 4 years visited a paediatrician. By contrast, no more than 1.3% of people aged 60 years or older visited their general practitioner due to an acute respiratory complaint – even in winter during weeks with high levels of influenza activity.

Only a small proportion of acute respiratory infections is severe enough to result in hospital treatment. Hospital admission due to severe acute respiratory infection (SARI) is also highly dependent on age. The weekly incidence of SARI (hospitalisation incidence, Info box 1) is highest among children aged 0 to 4 years. In the period of 2009 to 2016, it ranged from 0.001% to 0.19% depending on the season and level of influenza activity. Between 0.01% and 0.06% of adults aged 60 years or older were admitted to a hospital each week. The risk of a serious illness increases with age and with the presence of other risk factors, such as chronic pre-existing illnesses.

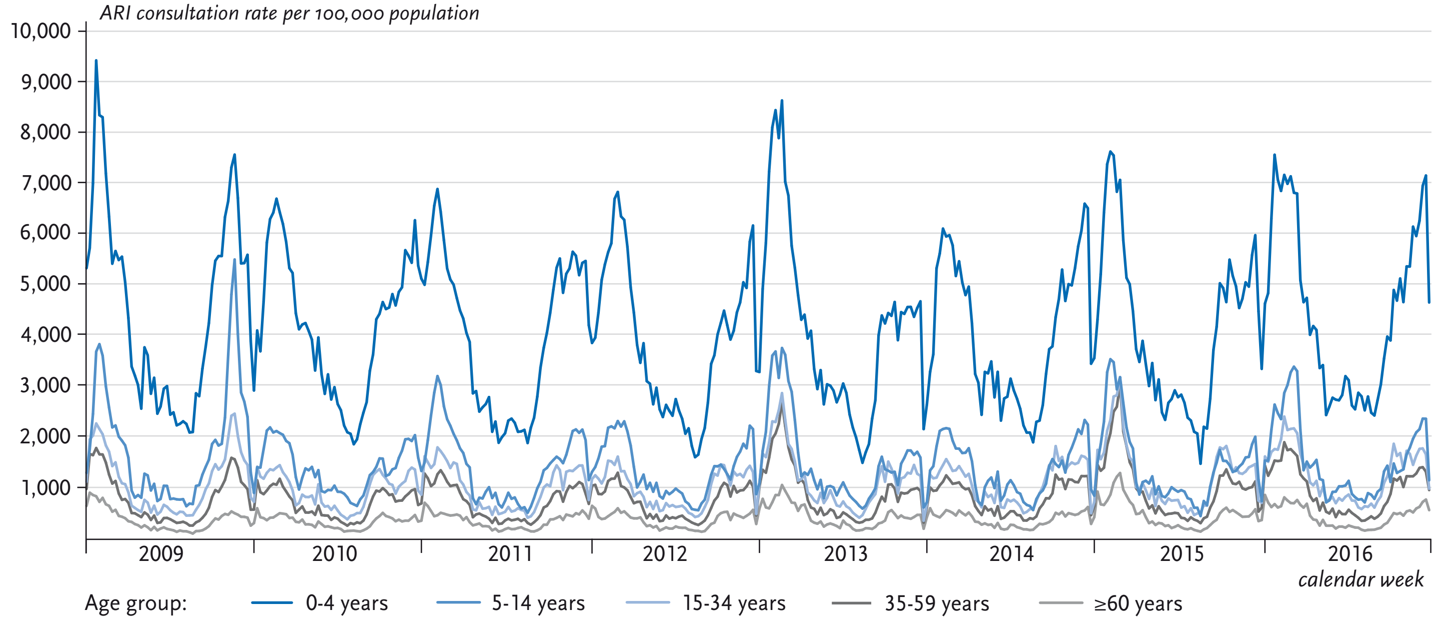
In 2015, a severe acute respiratory infection (ICD-10: J09-J22) was reported as the underlying cause of death (monocausal cause of death) for 10,743 women and 10,816 men in Germany (Table 1). The crude mor-

Table 4
Cumulative incidence of asthma among adults (18-79 years of age)
Data source: German Health Interview and Examination Survey for Adults 1997-1999 and 2008-2011 [30-32]

Gender	Age group	Cumulative incidence (95% CI)
Women	Total (18-79 years)	4.1 (2.8-5.7)
	18-44 years	3.6 (1.9-6.1)
	45-79 years	4.7 (2.8-7.3)
Men	Total (18-79 years)	1.6 (0.9-2.6)
	18-44 years	1.9 (1.0-3.5)
	45-79 years	1.2 (0.5-2.2)

CI=Confidence interval

Figure 1
Trends in the incidence of acute respiratory infections (ARI, ICD10: J00-J22, J44.0, B34.9) based on the weekly consultation rates (per 100,000 population) between 2009 and 2016, Germany (men and women) by age
Data source: Syndromic surveillance of acute respiratory infections (ARI) by the AGI (the RKI's working group on influenza) [26, 27]



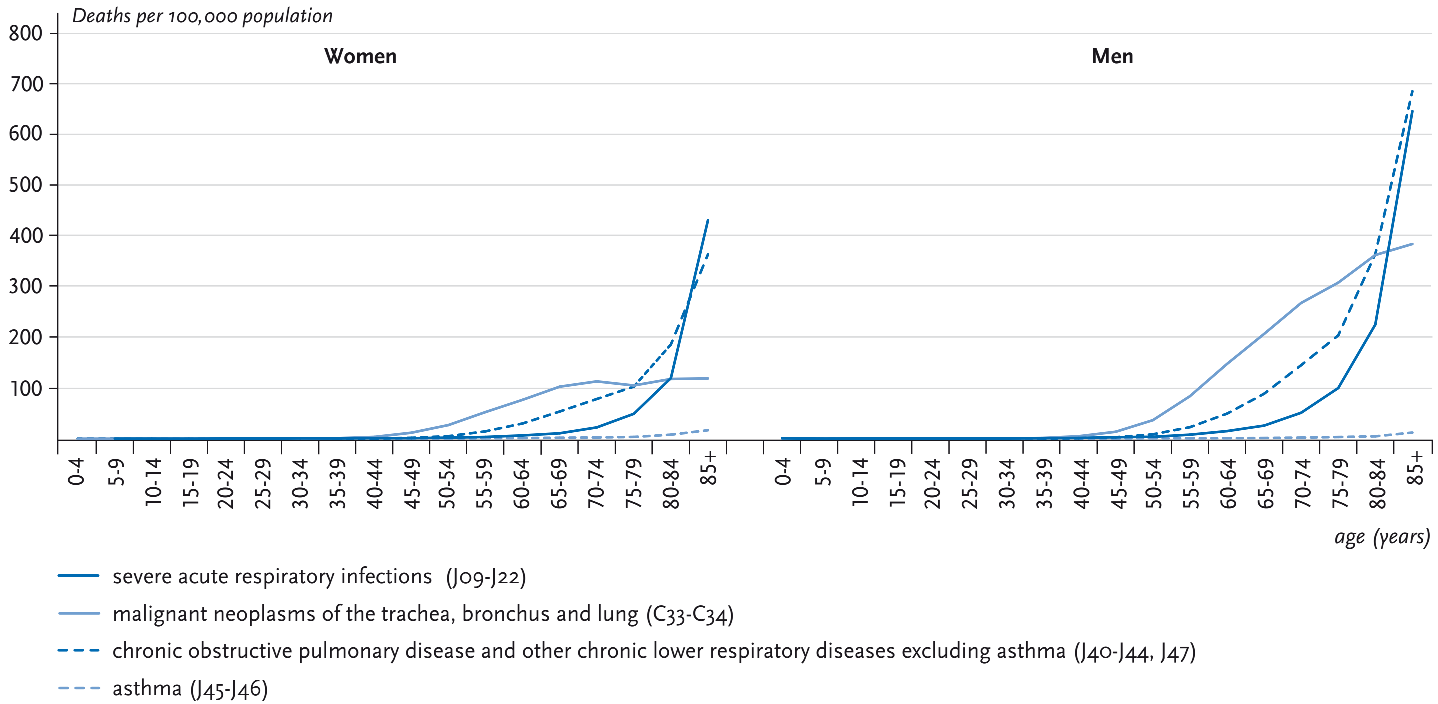
Lung cancer incidence and mortality rates decreased among men and increased among women.

tality rate was 25.9 per 100,000 among women, which is very similar to the rate found among men (26.9). However, mortality rates increased significantly with age for both genders (Figure 2). Between 1998 and 2015, age-standardised mortality rates due to severe acute respiratory infections significantly declined on average (AAPC) by 1.8% annually among women and by 1.9% annually among men (Figure 3, Table 2). Most recently, a similar annual drop in mortality rates (APC, from 2005 onwards) of 4.3% among men and 3.9% among women (see Table 2) has been observed. The overall decrease in mortality due to severe acute respiratory infection is mainly attributable to a marked decline among elderly (≥75 years) women and men (Annex Table 1).

3.2 Lung cancer

18,810 women and 34,693 men in Germany were diagnosed with lung cancer (ICD-10: C33-C34) in 2013 (see Figure 5). The average age at diagnosis was around 69 years. The crude incidence rate was substantially higher among men (87.9 per 100,000) than among women (45.7 per 100,000) (data not shown) and increased with age particularly among men (Figure 4). The absolute number of cases increased since 1998 among women but remained relatively constant among men. Correspondingly, sex-specific differences were found in the time trends of age-standardised incidence rates (Figure 6). Whereas among men the lung cancer incidence rate decreased on average (AAPC) by 1.5% annually between 1998 and 2013, women

Figure 2
Age-specific mortality rates (deaths per 100,000 population) due to respiratory diseases of high public health relevance in 2015, Germany (≥0 years of age) by age and gender
Data source: Official statistics on causes of death [8]



showed a contrasting trend with an average annual increase of 3.3% (Table 3). However, among women under 55 years of age, a 1.4% annual drop in the incidence of lung cancer can be observed from 2007 onwards (Annex Table 2). When lung cancer incidence among women is examined according to morphological type, a larger increase can be identified for adenocarcinomas compared to squamous cell carcinomas and small cell carcinomas. Adenocarcinomas also appear to be increasing among men despite the overall trend towards decreasing lung cancer incidence rates. However, it is important to recognise that the incidence rate of tumours classified as 'unspecified' also decreased during this period (Annex Figure 1) [24].

In 2015, lung cancer was reported as the underlying cause of death among more men (29,378) than women (15,881) (Table 1). The average age at death from lung cancer was 71 years. The crude mortality rate of 73.1 per 100,000 was considerably higher among men than among women (38.3 per 100,000) and substantially increased with age particularly among men (Figure 2). In a manner similar to the incidence, there has been a clear increase since 1998 in the absolute number of deaths among women, whereas deaths among men remained largely unchanged during the same period (Figure 3; Figure 5). Differences were also found between age-standardised death rates among women

Figure 3
Trends in the annual number of deaths (above) and age-standardised mortality rates (deaths per 100,000 population, below) due to respiratory diseases of high public health relevance between 1998 and 2015, Germany (old European standard population; ≥0 years of age) by gender
Data source: Official statistics on causes of death [8]

COPD mortality rates decreased among men and increased among women, whereas asthma mortality rates substantially declined for both genders.

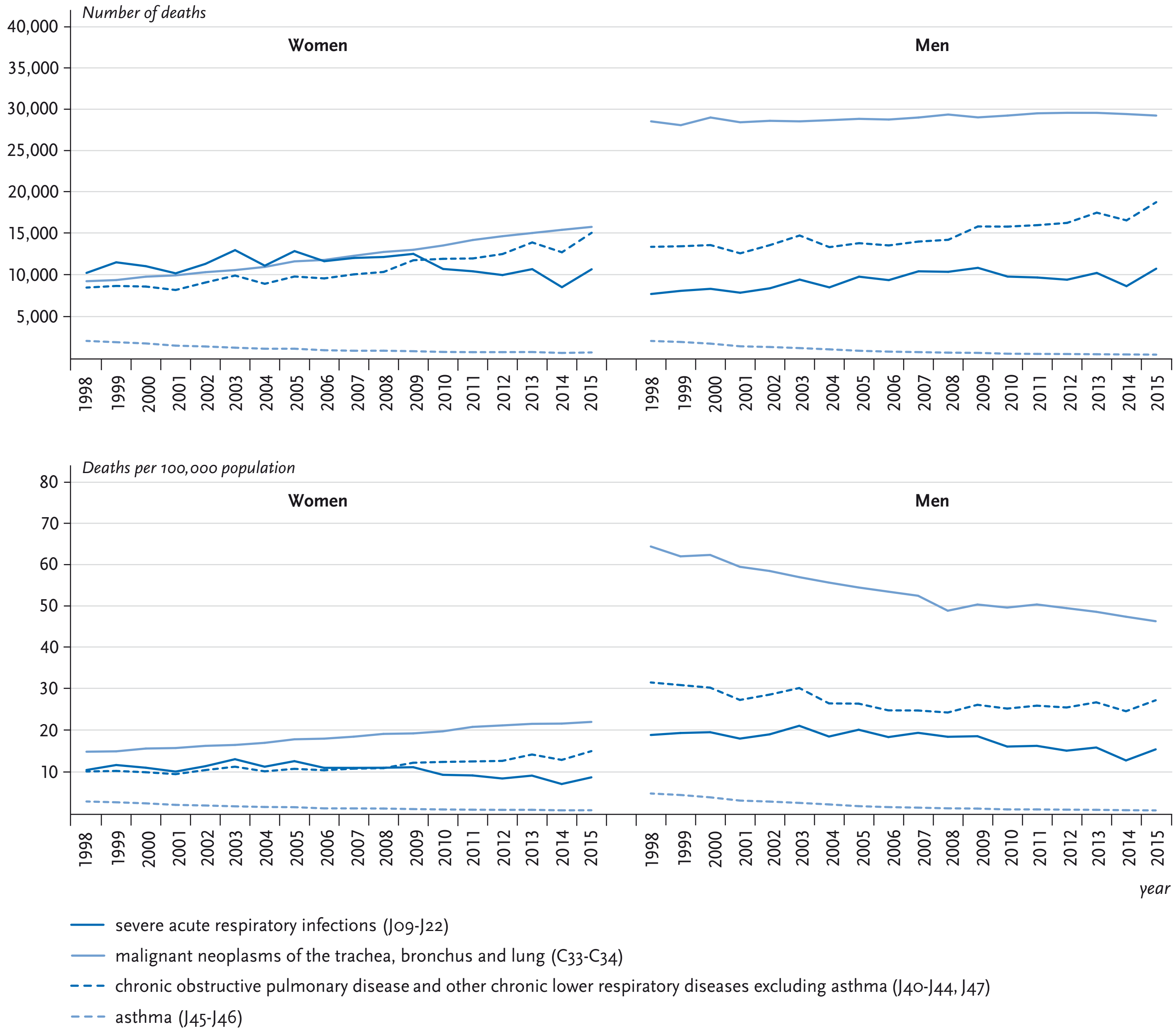
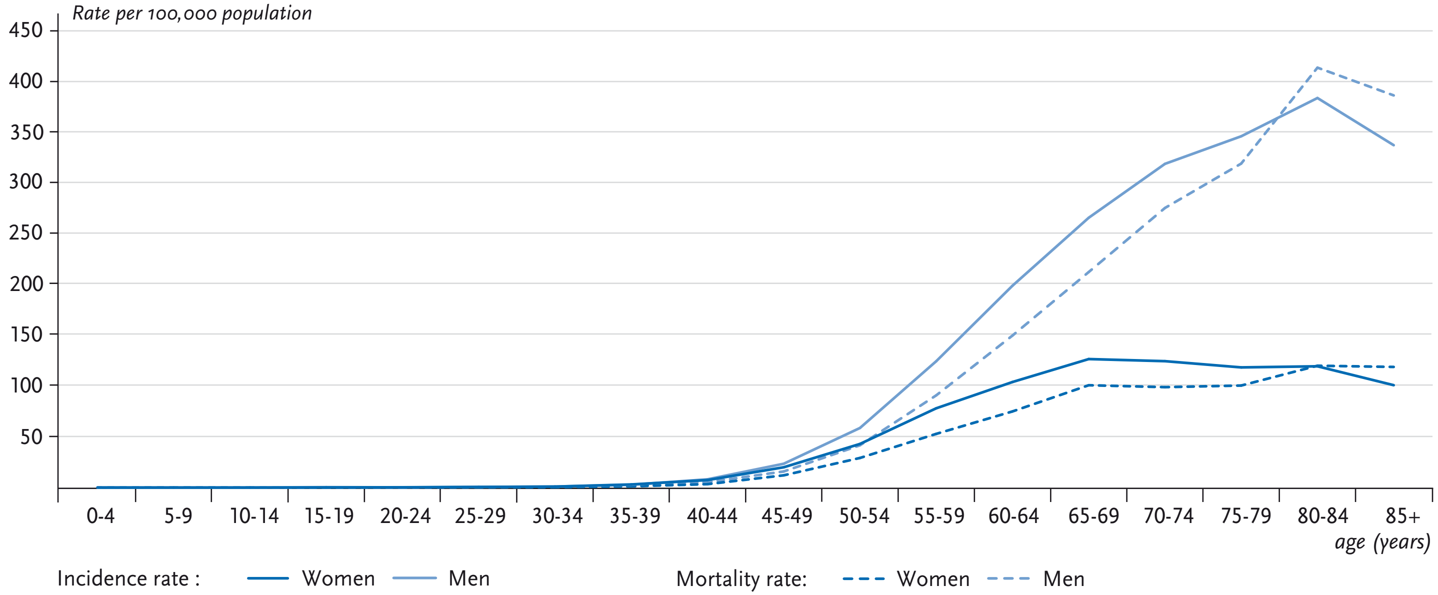


Figure 4
Age-specific incidence and mortality rates (per 100,000 population) for malignant neoplasms of the trachea, bronchus and lung (ICD-10 C33-C34) in 2013, Germany (≥0 years of age) by gender
Data Sources: German Centre for Cancer Registry Data [28, 29] and Official statistics on causes of death [8]



and men (Figure 3; Figure 6). Among men, there was a significant overall average annual decline of 1.8% (Table 2). Through 2006, this reduction was somewhat more marked (2.3%) before levelling out at 1.4% thereafter. The decrease in lung cancer mortality rates from 2007 onwards is more noticeable among younger men (<55 years old) compared to older men (≥55 years old) (Annex Table 1). Among women there was, by contrast, a significant increase in lung cancer mortality of 2.5% annually over the entire observation period. However, as with the incidence, a reduction in lung cancer mortality of 2.8% per year was observed among younger women (<55 years old).

3.3 COPD

In 2015, COPD (ICD-10: J44) was reported as the underlying cause of death among more men (17,300) than women (13,773) (Table 1). The crude death rate was substantially higher among men (43.1 per 100,000 population) than among women (33.2 per 100,000 population) and strongly increased with age particularly among men. Similar results were also seen when ICD-10 codes of COPD and other chronic lower respiratory diseases excluding asthma were considered (ICD-10: J40-J44, J47) (Table 1, Figure 2). This combination of ICD-10 codes is used internationally to enable comparability of long-term trends in COPD mortality over time, and is therefore also used below (see 2.3).

Figure 5
Trends in the annual number of incident cases and deaths, malignant neoplasms of the trachea, bronchus and lung (ICD-10 C33-C34) between 1998 and 2013, Germany (≥0 years of age) by gender
Data Sources: German Centre for Cancer Registry Data [28, 29] and Official statistics on causes of death [8]

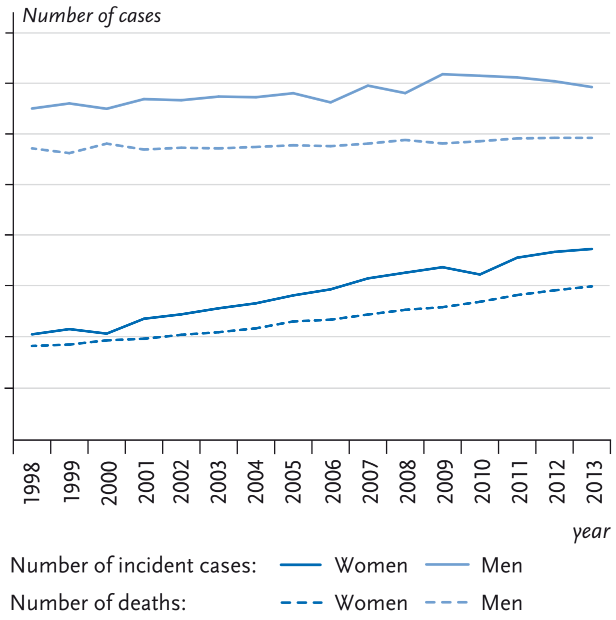


Figure 6
Trends in age-standardised incidence and mortality rates (per 100,000 population) for malignant neoplasms of the trachea, bronchus and lung (ICD-10 C33-C34) between 1998 and 2013, Germany (old European standard population; ≥0 years of age) by gender
Data Sources: German Centre for Cancer Registry Data [28, 29] and Official statistics on causes of death [8]

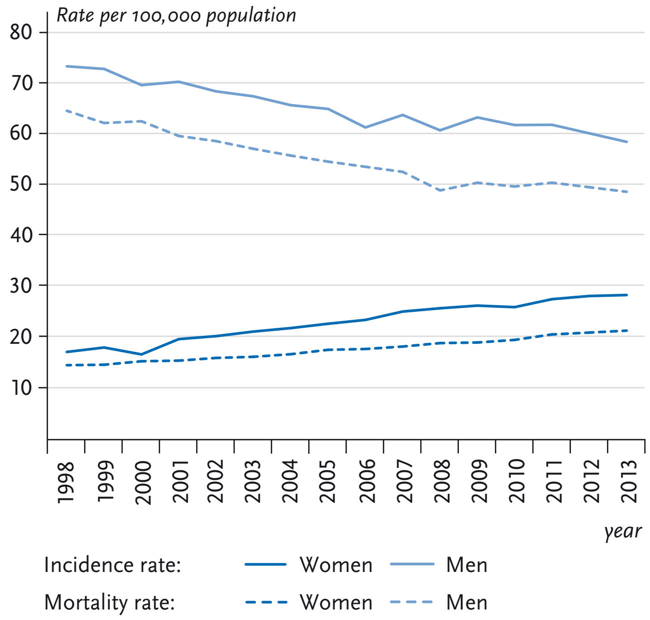


Figure 3 shows that the absolute number of deaths in 1998 was considerably lower among both women and men than in 2015. However, time trends in age-standardised death rates differed between women and men (Figure 3 and Table 2). Among women, there was a significant increase of 2.3% annually over the entire observation period (Table 2). At the same time, an average annual increase in COPD mortality rates was most noticeable among women aged 55 to 74 years (Annex Table 1). Among men, there was, by contrast, a significant overall average decline (AAPC) in COPD mortality rates of 1.1% annually (Table 2). However, this decrease came to a halt in 2007. A continuous decrease in mortality rates was only seen among men aged 75 years or older (Annex Table 1). Gender differences can also be observed when time trends in COPD mortality rates are compared to time trends in all-cause mortality (Table 2): between 1998 and 2015, a similar average decline in COPD and in all-cause mortality rates was observed among men (-1.1% and -1.8% annually). By contrast, time trends in COPD and all-cause mortality differed among women: COPD mortality rates rose by 2.3% annually as opposed to a significant decrease in all-cause mortality rates of 1.4% annually.

3.4 Asthma

During an average observation period of approximately 12 years, the cumulative incidence (Info box 1) of asthma was higher among women (4.1%) than among men (1.6%) (Table 4). This gender difference was observed both at a younger age (18 to 44 years) and among older

Info box 5: Data from the syndromic surveillance of acute respiratory infection (ARI) by the Working Group Influenza (Arbeitsgemeinschaft Influenza, AGI)

Data holder: Robert Koch Institute

Aims: Providing timely year-round surveillance data of acute respiratory infections (ARI) in primary care with a focus on influenza activity. This includes weekly reporting of the surveillance results.

Method used to estimate consultation incidence: Weekly number of cases with medically attended acute respiratory infection (ARI) in sentinel practices of RKI's Working Group Influenza

Population: Total population that sought a consultation with a general practitioner or paediatrician

Participants: Approximately 700 primary care physicians that regularly report to the RKI

Coverage: The participating sentinel practices provide medical care to about 1% of the total population

Study period: Cases identified between 1 Jan 2009 and 31 Dec 2016 have been included in the results presented here
Source: [26, 27]

More information in German is available at https://influenza.rki.de/Default.aspx

adults (45 to 79 years). To enable comparability with other studies, incidence rates were also calculated (Info box 1). Depending on the criteria considered for the selection of study participants in the analyses, asthma incidence rates ranged from 2.7 to 3.4 per 1,000 person-years among women and from 1.1 to 1.3 per 1,000 person-years among men (Annex Table 3).
Among women and men, asthma (ICD-10: J45-J46) was rarely documented as the underlying cause of death in 2015 (Table 1). The crude asthma mortality rate was similar in women (1.6 per 100,000 population) and men (1.0 per 100,000 population) and increased with age among both genders (Figure 2). Figure 3 shows that the number of deaths from asthma among women and men in 1998 was considerably higher than in 2015. Between 1998 and 2015, there was a strong decline in age-standardised asthma mortality rates, which was even more pronounced among men than among women (AAPC: -11.2% vs. -8.3%; Table 2). An annual decline in asthma mortality rates of 6.8% among women and of 7.5% among men was also observed in the age group 5 to 34 years (data not shown). Finally, among both genders, a much faster average annual decline in asthma mortality rates than in all-cause mortality rates was observed in all age groups (AAPC for women aged ≥0 years: -8.3% vs. -1.4%; AAPC for men aged ≥0 years: -11.2% vs. -1.8%; Table 2).

4. Discussion

4.1 Acute respiratory infection

Syndromic surveillance of acute respiratory infections with a focus on influenza is an internationally recognised and established practice [52]. Laboratory analyses are only conducted in a very small proportion of cases with an acute respiratory infection. Moreover, 75% of all patients who were treated in inpatient care for community acquired pneumonia left hospital with a diagnosis of J18 (pneumonia, unspecified organism) [53]. As such, assessing the individual diagnoses of influenza (instead of the fixed diagnostic groups used in syndromic surveillance) would probably provide an incomplete and distorted depiction of the situation. Nevertheless, the syndromic approach has a clear disadvantage: the burden of disease caused by individual pathogens such as influenza can only be estimated using relatively complex statistical procedures, which, at least in some cases, need to be accompanied by representative microbiological examinations [12, 54]. Influenza infections and subsequent pneumonia can also occur in hospitals. Such nosocomial pneumonia is often caused by pathogens that are already found in the respiratory tract ('commensals') which are normally harmless and only cause disease once the mucous membrane of the respiratory tract has been weakened, for example, due to an influenza infection [55].

The occurrence of acute respiratory infections is characterised by strong seasonal fluctuations. As such, a close (weekly) assessment of consultation rates is as relevant to health policy as analyses of long-term trends.

Info box 6: Data from syndromic surveillance of inpatient cases of severe acute respiratory infections (ICOSARI)

Data holder: Robert Koch Institute

Aims: Providing reliable and up-to-date information on serious acute respiratory infections (SARI), with the possibility of comparing different seasons and corresponding data from other countries.

Method used to estimate hospitalisation incidence: Weekly data on the number of patients with a main discharge diagnosis of SARI from one of the hospitals participating in the ICOSARI project (sentinel hospitals)

Population: The population in the catchment area of the sentinel hospitals, with the possibility of extrapolation to the total population in Germany

Participants: Sentinel hospitals belonging to HELIOS Kliniken GmbH (83 in 2014)

Coverage: In 2014, the participating sentinel hospitals in 13 out of 16 federal states provided care to about 6% of all hospital patients across Germany

Study period: Cases identified between 1 Jan 2009 and 31 Dec 2016 have been included in the results presented here
Source: [14, 34]

In general, acute respiratory illnesses during the winter are significantly more pronounced in both outpatient and inpatient care than during the summer months. Although efficient health care systems, such as the one in Germany, are designed with this in mind, seasonal influenza waves occur in various strengths. A particularly severe wave of influenza can tax the resources of outpatient and inpatient care for a few weeks. Furthermore, medical staff can also be affected by these outbreaks and may fall ill during periods that already require greater level of medical care. Finally, people with chronic diseases are at a higher risk during these periods, as an additional respiratory infection could lead to a severe or even fatal disease; this also increases the level of care needed during influenza outbreaks.

Even if respiratory infections contribute to or actually cause death, they are rarely recorded as the monocausal cause of death; instead, an underlying condition is usually documented in the statistics on causes of death. Therefore, mortality rates and absolute number of deaths due to severe acute respiratory infections are likely underestimated, despite the fact that the mortality rate for community acquired, hospital-treated pneumonia is already high (at approximately 13% depending on age) [53]. As such, it is an international standard practice to estimate the influenza-related deaths by utilising the total number of deaths by any cause (Info box 10). This method usually involves calculating a background mortality rate – the all-cause mortality rate that would have been expected at the time of the influenza season if there had been no influenza virus circulation. If the total mortality rate observed during the influenza season is markedly higher than the background mortality, the difference between expected and observed mortality rates can be attributed to the disease. This is referred to as excess mortality and can be estimated using statistical methods [56]. In the case of severe influenza seasons, such as those that occurred in 2012/2013 and 2014/2015, an excess mortality of 26 per 100,000 has been identified [14, 57]. This corresponds to 20,700 and 21,300 influenza-related deaths during the respective periods. Clearly, only a fraction of influenza-related deaths are stated as such in the annual statistics on causes of death due to severe respiratory infections. However, many respiratory infections that occur during an influenza season – including the majority of pneumonia cases – are not caused by influenza; this applies even more to respiratory-coded deaths that occurred outside the influenza season.

4.2 Lung cancer

In the case of lung cancer, continuous and nationwide estimates of incidence and mortality rates are made in accordance with the Federal Cancer Registry Data Act of 2009. Consistent with developments in the incidence rates, age-standardised mortality rates of lung cancer have been declining for decades among men and are still rising substantially among women. Due to the poor prognosis associated with lung cancer (about half of patients die within one year of being diagnosed) [24], the trends in mortality reflect the trends in incidence.

As the majority of lung cancer in Germany can be attributed to smoking, the different temporal trends found among women and men can be traced to changes

Info box 7: Data from the German Centre for Cancer Registry Data (ZfKD)

Data holder: German Centre for Cancer Registry Data at the Robert Koch Institute; epidemiological cancer registries of the German federal states

Aims: Aggregating data from the epidemiological registries of the federal states in order to estimate the nationwide number of new cancer cases as well as prevalence and survival rates in Germany, stratified by cancer diagnosis, age and gender.

Registration method: Registration of all new cancer cases using electronic or paper reports filed by the doctors who diagnosed the case

Population: The population with residency in Germany (all age groups)

Coverage: Since 2009, complete nationwide coverage; the year in which registration began varies by state and ranges from 1970 (Saarland) to 2009 (Baden-Württemberg). Currently, a registration completeness rate of 90-95% (nationwide) can be assumed for all types of cancer

Study period: Cases diagnosed between 1 Jan 1998 and 31 Dec 2013 have been included in the results presented here
Source: [28, 29]

More information in German is available at www.krebsdaten.de

in smoking habits that occurred towards the end of the 20th century. Whereas the proportion of smokers decreased among men, it rose among women until about 2000, although it never reached the same level as among men [58]. Women have now also begun reducing their tobacco consumption, and this will have a significant effect in the coming decades. The rate of new lung cancer cases among women below the age of 55 years has fallen by 1.4% per year since 2007, and the mortality rate in this age group has been decreasing by 2.8% per year since 2008. This trend has been observed in almost all Western industrialised countries. In fact, in the US and some Scandinavian countries, a reduction in lung cancer incidence and mortality has already been observed among women overall, although the peak rates in these countries were substantially higher than in Germany. There are clear regional differences in lung cancer mortality within the EU, and this is particularly the case among men: rates in some Eastern European countries are approximately three to four times higher than, for example, in Finland or Sweden [24].

Passive smoking, radon gas, other forms of environmental pollution (especially particulates) and exposure to asbestos can also increase the risk of lung cancer. Long-term exposure not only to particulates themselves [59] but also to the pollutants that they carry increases the likelihood of lung cancer [60, 61]. Whereas tobacco consumption is the major risk factor of lung cancer in Europe and North America, exposure to air pollution from open fires used for cooking and heating within households is an additional cause of lung cancer in large parts of sub-Saharan Africa and in some regions of Asia and Oceania [62]. The increase in the proportion of adenocarcinomas observed in Germany has also been observed in many other countries over the last few decades [63, 64]. Compared to the other two main forms of lung cancer (squamous cell carcinoma and small cell lung carcinoma), adenocarcinoma is less strongly associated with smoking and is the most common form of lung cancer in non-smokers [65]. In this respect, a growing influence of environmental risk factors, such as particulate air pollution, which are especially associated with adenocarcinomas, could play a role. However, the evidence in this regard is still limited [66], and particulate matter pollution (measured as PM10 values) seems to have declined in Germany since the mid-1990s, even if the values recommended by the WHO are still frequently exceeded in urban areas [67]. Other possible explanations for the increase in adenocarcinomas could be changes in the levels of tobacco consumption, the composition of tobacco products, the depth of inhalation and the age at which people begin to smoke.

4.3 COPD

Consistent with results on lung cancer mortality, in 2015, COPD was recorded as the underlying cause of death among more men than women. However, due to different time trends in COPD mortality between women and men a further narrowing of the gender gap in death rates for COPD can be observed as already reported in Germany and other European countries since 1994 [35]. As with lung cancer, smoking is the most important modifiable risk factor of COPD in Germany [48, 68]. The risk of devel-

Info box 8: Data from the panel component of the German Health Interview and Examination Survey for Adults (DEGS)

Data holder: Robert Koch Institute

Aims: Providing information on the incidence and course of major diseases and associated risk factors between 1997-1999 and 2008-2011

Methods: Paper-and-pencil self-administered questionnaire, physical examinations and laboratory tests, a physician-administered computer-assisted medical history taking, computer-assisted medication review

Population: People (aged 18 to 79 years at baseline) with permanent residency in Germany

Sampling: Stratified two-stage sample in which adults from 120 municipalities in Germany were randomly selected from population registries

Participants: 7,124 adults (18-79 years) for the baseline survey; 3,959 adults (28-91 years) for the follow-up

Response rate: 61% at baseline;
62% at follow-up

Study period: Baseline survey in 1997-1999 (GNHIES98); follow-up survey in 2008-2011 (DEGS1)
Source: [30-32]

More Information in German is available at www.degs-studie.de

oping COPD depends on the total amount of cigarette smoking over time ('pack years') [2, 7]. However, reliable data on time trends in COPD morbidity or survival rates are not available in Germany [2, 48, 69]. Since a high proportion of people with unknown or undiagnosed COPD within the population is to be expected, this would require a consideration of reliable data based on a pulmonary function test (spirometry) [70-73]. In the absence of such data, it cannot be determined to what extend differing time trends in COPD mortality between women and men can be attributed to gender differences in the development of COPD incidence – e.g., due to secular trends in smoking – or survival rates and resulting changes in prevalence (Info box 1) over time [74, 75]. In addition, COPD is a long-term chronic condition that may progress over decades accompanied by increasing health-related disability [2, 50]. Assessments of the burden of disease associated with COPD therefore highly depend on the availability of reliable data permitting analyses on time trends in the number of years spent with health-related disability [4, 5, 7]. In turn, this requires a reliable database for the analysis of trends in the prevalence of COPD and COPD-related disability over time [4, 5, 7].

In international comparison, such as with data from Hannover (2006), there is a regional association between the local average amount of cigarette smoking over the time ('pack years') and the prevalence of COPD [76]. In Spain, moreover, a decline in COPD prevalence estimates based on spirometry testing was observed among adults aged 40 to 69 years between 1997 and 2007. This decline in prevalence was recorded across all age groups among men and in particular among women under 50 years of age [77]. The authors discussed that in addition to changes in smoking habits, prenatal and early-childhood influences may be contributing to COPD morbidity in later life [77]. Impaired growth and functional development of the lungs also relates to COPD risk [50, 78, 79]. In addition to a genetic predisposition and prenatal influences (e.g., maternal smoking during pregnancy), repeated respiratory infections in early childhood, exposure to airborne pollutants, or childhood asthma may contribute to developing COPD in later adulthood [48, 50, 68, 78-80]. Further work-related factors (such as exposure to coal dust) are also important modifiable risk factors of COPD [48, 68, 81]. Moreover, exposure to high levels of air pollution in households that, for example, result from burning biomass (such as wood or animal dung) in open fires or leaky stoves is also a known cause of COPD [2, 3, 50, 82, 83]. This is particularly the case in low and middle income countries [3, 82, 83]. The survival prospects of people with COPD are further influenced by the quality of medical care, including prevention and treatment of concurrent conditions and sequelae (such as cardiovascular disease, but also respiratory infections and lung cancer) [50].

4.4 Asthma

Consistent with results observed at the global level, age-standardised asthma mortality rates and annual number of asthma deaths have both substantially decreased among women and men in Germany [51, 84]. The considerable faster decline in asthma mortality when compared with all-cause mortality indicates that sur-

Info box 9: Age-standardised incidence and mortality rates

Age standardisation: Age standardisation is used to compare measures of disease frequency or mortality rates (Info box 1 and 2) of populations with different age structures. It is used when investigating trends within a geographically defined population to account for age structure changes over time. To calculate an age standardisation, 'crude' incidence or mortality rates for individual age groups are determined and applied to a standard population with a fixed age distribution. In the current analyses of time trends in incidence and mortality rates, the 'old' European standard population is used as the standard population. This statistical method enables analyses of incidence and mortality rates that are independent of changes and differences in age structure of the population.

Age-standardised incidence and mortality rates: This can be illustrated with the example of lung cancer among men (Figure 5 and 6). In 2013 in Germany, 34,693 incident cases of lung cancer (ICD-10: C33-C34) were recorded within the framework of nationwide cancer registration – more than the 32,589 that were recorded fifteen years earlier in 1998. Does this mean that men now more frequently develop lung cancer? This question can be examined using the age-standardised incidence rate: the age-standardised incidence rate for lung cancer in 1998 was 73.4 per 100,000 population, whereas in 2013 it was 58.6 – a substantially lower rate. When age-standardisation is employed to take the ageing population into account, it becomes clear that the rate of incident cases of lung cancer among men has in fact decreased considerably during the period in question.

Continued on next page

vival prospects of asthma patients may have improved. This development has been related particularly to improvements in drug therapy of asthma patients [51, 84]. However, low asthma mortality rates could probably be reduced even further, particular through the implementation of appropriate medical care, including adequate management of the condition by patients themselves [51, 85]. In the current analyses, the incidence rate of asthma during the observation period between 1997-1999 and 2008-2011 among women was higher than among men. Results from other epidemiological studies also point to an increased asthma risk for women compared to men, whereby this difference is already evident in adolescence, and besides hormonal factors, differences in lung development or in the vulnerability (susceptibility) to environmental factors have been related to the observed gender differences in asthma incidence [42, 86-90]. Further, no nationwide studies are available on long-term trends in asthma incidence or survival rates in Germany [2, 91, 92].

Repeated population-based surveys have, however, demonstrated that the prevalence (Info box 1) of asthma increased during the second half of the last century not only in Germany, but also in other parts of the world [46, 93-102]. This increase has been linked to changes in lifestyle and environmental factors (such as infections, exposure to microbes, allergens and airborne pollutants, or diet) possibly resulting in an increment in asthma incidence particularly among children and young adults [46, 94-96, 99, 103]. Most recently, a further rise in the lifetime prevalence of physician-diagnosed asthma among both genders was recorded from national interview and examination surveys among adults (1997-1999 and 2008-2011) as well as among children and adolescents (2003-2006 and 2009-2012) [47, 49, 104]. At the same time, an increase in the 12-month prevalence was also observed, which, among adults, was attributable mainly to an increase in prevalence among women [49, 105]. In addition to changes in asthma incidence, improved survival of asthma patients could have contributed to the observed changes in prevalence. In large population-based epidemiological studies, data on asthma prevalence and incidence is based on self-reported information and particularly relies on the assessment of self-reported physician-diagnosed asthma [46, 98, 106-111]. Thus, secular trends in degrees of asthma awareness or changes in the way patients perceive symptoms and seek medical care over time may all affect levels of self-reported asthma prevalence and incidence [94, 95, 106, 112].

4.5 Summary overview and conclusions

Both the burden of acute respiratory infections and the resulting need for medical care are subject to strong seasonal fluctuations. A close (weekly) surveillance of short-term trends in incidence is thus as relevant to health policy as the analysis of long-term trends over time. A large proportion of influenza-related deaths are attributed to existing chronic underlying diseases or to complications frequently associated with bacteria-related pneumonia instead of the acute influenza infections themselves. Therefore, evaluations of mortality using the official statistics on causes of death are inadequate and additional

Info box 9 (continued)

The average annual percentage change (AAPC) was -1.5%, which was statistically significant. Therefore, the rate of incident cases of lung cancer has actually decreased by 1.5% per year. The absolute number of incident cases rose because the number of people in older age groups increased. The observed time trends in the annual number of incident cases and age-standardised incidence rates for lung cancer among men were comparable to the corresponding time trends in the annual number of deaths and age-standardised mortality rates. Age standardisation enables evaluation of time trends in incidence and mortality rates, preventing an increasing number of older people within a given population from influencing the results.
Source: [129]

assessments of the excess mortality associated with influenza are necessary. For that purpose, the method of estimating influenza-related excess mortality has been implemented in Germany (Info box 10) [56]. However, compared to other countries, timely data that could provide an up-to-date assessment of time trends in the influenza-attributable mortality in Germany are lacking [113].

Regarding chronic lung diseases including lung cancer, long-term trends in incidence and mortality rates are of particular relevance. A decline in asthma mortality rates is observed among both genders. However, mortality rates for COPD and lung cancer are decreasing among men, whereas they are increasing among women. Incidence trends for longer periods of time are only available for lung cancer and remain at a very similar level to mortality rates. The contrasting developments in lung cancer incidence and mortality among women and men can be attributed to sex differences in smoking habits that occurred in the second half of the 20th century – the proportion of men who smoked was already declining during this time, whereas it was still increasing among women [58]. Overall, the proportion of smokers in Germany has decreased in recent years, but still around one quarter of adults is currently smoking (women: 20.8%, men: 27.0%, see also fact sheet on Smoking among adults in Germany in issue 2/2017). The sustainable reduction of tobacco consumption is therefore an important goal in terms of preventing lung cancer and COPD as well as other chronic diseases. In addition, some of the burden of disease and premature mortality associated with acute respiratory infections could be avoided by vaccination (influenza and pneumococcal vaccination) [114, 115]. This is particularly the case among elderly patients with multiple chronic diseases, as they are significantly more likely to suffer from a severe illness which could even have a fatal outcome [114].

The results of the present investigation illustrate a number of aspects that are of particular relevance for the continuous analysis of time trends in morbidity and mortality of respiratory diseases. Detailed analyses of gender and age-specific trends enables conclusions to be drawn about changes in underlying behavioural or environmental determinants of disease that may explain these trends (for example, temporal changes in tobacco consumption and the incidence rates for lung cancer). At the same time, trends in morbidity and mortality for age-associated diseases such as COPD and lung cancer are also influenced by changes to the population age structure. This can be seen, for example, in the difference in time trends between the absolute number of incident cases and age-standardised incidence rates for lung cancer among men (Info box 9). Clearly, temporal changes in mortality rates can also be influenced by changes in survival, such as through improved treatments. Regarding lung cancer, survival rates are estimated regularly in Germany as part of national cancer surveillance activities in accordance with the Federal Cancer Registry Data Act [24, 116, 117]. For COPD and asthma, mortality follow-up of national health survey participants could help to close this gap in the future [74, 118, 119]. Additional information can be derived by considering process data of in- and outpatient care [75, 120].

Based on data from the official statistics on causes of death, the present analysis investigated time trends

Info box 10: Excess mortality of influenza [6]

Influenza-related excess mortality: Excess mortality refers to an increased rate of death among a particular population compared to the population's average rate, or an increased number of deaths over a certain period of time compared to the normally expected death rate at that time of year. In order to calculate influenza-related excess mortality, the background mortality rate is usually calculated – this is the mortality rate that would be expected during the respective period (month, week) if no influenza activity were present. If the level of mortality present during the influenza season is – to a greater or lesser extent – higher than the background level, this excess mortality can be attributed to influenza [6].

More information in German is available at
http://www.rki.de/DE/Content/Infekt/EpidBull/Archiv/2015/Ausgaben/03_15.pdf

in mortality of severe acute respiratory infections and chronic lung diseases, including lung cancer with a high relevance to public health. Compared to lung cancer, which represents a clearly defined underlying disease, there is a far higher risk of misclassification for COPD or asthma as the underlying cause of death, not least because of the possible overlap of both diseases in middle and older age [50, 121-123]. However, a decline in asthma mortality was evident also among younger people aged 5 to 34 years. The fact that patients with COPD often suffer from other chronic diseases, such as cardiovascular disease or lung cancer, can also affect the risk of death [123, 124]. Furthermore, it is particularly difficult to identify the single cause of death in COPD patients with severe acute respiratory infections [123, 124]. Besides, the analysis of time trends in mortality based on data from the official statistics on causes of death faces a limitation due to the fact that coding practices can change over long periods of time. For example, since the death certificates are processed electronically in England and Spain using the IRIS software, dementia is now documented more frequently as an underlying cause of death instead of aspiration pneumonia (pneumonia due to substances entering the lungs, such as after swallowing food). In these cases, by contrast, manual coding would more likely have resulted in an acute respiratory illness being documented as the underlying cause of death [125, 126]. In Germany, the electronic coding of causes of death using IRIS software has been piloted at the regional level since 2007; some federal states now use the system to process all of their death certificates electronically [127]. Improving the statistics on causes of death through quality control in death registration and the implementation of multi-causal coding of the underlying diseases that led to the death represents a major challenge for the future [127, 128].

4.6 Conclusion

This article underlines the need for continuous and coordinated surveillance of morbidity and mortality related to acute respiratory infections as well as lung cancer, COPD and asthma as chronic lung diseases of high public health relevance. In doing so, it is essential that the association between respiratory diseases and the concurrence of other, mainly age-related, diseases is taken into account. The analysis of existing data – also with regard to their limitations and the potential for future development – is a particularly important step in establishing sustainable surveillance structures in Germany within the framework of international public health strategies aimed at the prevention and control of communicable and non-communicable diseases.

5. Annex

Annex Table 1
Trends in age-standardised mortality rates (deaths per 100,000 population) due to respiratory diseases of high public health relevance and for all causes of death between 1998 and 2015, Germany (old European standard population; ≥0 years of age) by gender and age
Data source: Official statistics on causes of death [8]

ICD-10 codes	Period	APC	(95% CI)	Period	APC	(95% CI)	AAPC	(95% CI)
J09-J22 (Severe acute respiratory infections)								
Women								
0-54 years	1998-2015	-1.0	-2.5/0.5					
55-74 years	1998-2015	-0.7	-1.6/0.2					
≥75 years	1998-2005	2.0	-1.3/5.5	2005-2015	-4.9	-6.8/-3.1	-2.1	-3.7/-0.5
Men								
0-54 years	1998-2015	-1.6	-2.4/-0.7					
55-74 years	1998-2015	-1.2	-1.9/-0.4					
≥75 years	1998-2005	0.8	-2.0/3.8	2005-2015	-3.7	-5.1/-2.2	-1.8	-3.2/-0.5
C33-C34 (Malignant neoplasms of the trachea, bronchus and lung)								
Women								
0-54 years	1998-2008	1.6	0.8/2.4	2008-2015	-2.8	-4.0/-1.6	-0.2	-0.8/0.4
55-74 years	1998-2003	2.7	1.4/4.0	2003-2015	3.9	3.6/4.2	3.6	3.2/3.9
≥75 years	1998-2015	1.6	1.5/1.8					
Men								
0-54 years	1998-2007	-2.6	-3.1/-2.0	2007-2015	-4.4	-5.2/-3.7	-3.5	-3.9/-3.0
55-74 years	1998-2007	-2.7	-3.0/-2.4	2007-2015	-0.8	-1.2/-0.4	-1.8	-2.1/-1.6
≥75 years	1998-2012	-1.0	-1.2/-0.7	2012-2015	-2.7	-5.1/-0.4	-1.3	-1.7/-0.9
J40-J44, J47 (COPD and other chronic lower respiratory diseases excluding asthma)								
Women								
0-54 years	1998-2015	1.5	0.6/2.5					
55-74 years	1998-2006	0.0	-1.7/1.6	2006-2015	6.4	5.2/7.7	3.3	2.4/4.3
≥75 years	1998-2015	1.5	1.0/2.0					
Men								
0-54 years	1998-2015	-0.6	-1.3/0.1					
55-74 years	1998-2008	-2.9	-4.1/-1.8	2008-2015	3.2	1.2/5.3	-0.4	-1.4/0.5
≥75 years	1998-2015	-1.4	-1.8/-1.0					

ICD-10=10th revision of the International Statistical Classification of Diseases and Related Health Problems

Continued on next page

Annex Table 1 *(continued)*

ICD-10 codes	Period	APC	(95% CI)	Period	APC	(95% CI)	AAPC	(95% CI)
J45-J46 (Asthma)								
Women								
0-54 years	1998-2015	-7.5	-8.2/-6.8					
55-74 years	1998-2015	-9.6	-10.2/-8.9					
≥75 years	1998-2007	-10.4	-11.7/-9.1	2007-2015	-4.2	-6.3/-1.9	-7.5	-8.6/-6.4
Men								
0-54 years	1998-2008	-9.0	-10.7/-7.2	2008-2015	-2.7	-6.8/1.6	-6.4	-8.2/-4.6
55-74 years	1998-2008	-14.6	-15.6/-13.6	2008-2015	-8.1	-11.4/-4.6	-12.0	-13.3/-10.6
≥75 years	1998-2010	-14.1	-15.1/-13.1	2010-2015	-8.0	-14.1/-1.5	-12.3	-14.0/-10.6
A00-T98 (All causes of death)								
Women								
0-54 years	1998-2007	-2.5	-2.8/-2.2	2007-2015	-1.6	-2.0/-1.2	-2.1	-2.3/-1.8
55-74 years	1998-2007	-2.5	-2.8/-2.2	2007-2015	-0.2	-0.6/0.2	-1.4	-1.7/-1.2
≥75 years	1998-2015	-1.3	-1.5/-1.1					
Men								
0-54 years	1998-2003	-2.2	-2.8/-1.6	2003-2006	-3.8	-6.5/-1.1	-2.6	-3.0/2.1
	2006-2015	-2.3	-2.6/-2.1					
55-74 years	1998-2008	-2.9	-3.1/-2.6	2008-2015	-0.6	-1.1/-0.1	-1.9	-2.2/-1.7
≥75 years	1998-2008	-2.2	-2.7/-1.7	2008-2015	-0.4	-1.2/0.3	-1.5	-1.9/-1.1

APC=annual percentage change, and 95% confidence interval (95% CI)
AAPC=average annual percentage change, and 95% confidence interval (95% CI) between 1998 and 2015
COPD=chronic obstructive pulmonary disease
ICD-10=10th revision of the International Statistical Classification of Diseases and Related Health Problems

Annex Table 2
Trends in age-standardised incidence rates (incident cases per 100,000 population) for malignant neoplasms of the trachea, bronchus and lung (ICD-10 C33-C34) between 1998 and 2013, Germany (old European standard population; ≥0 years of age) by age and gender
Data Source: German Centre for Cancer Registry Data [28, 29]

ICD-10 codes	Period	APC	(95% CI)	Period	APC	(95% CI)	AAPC	(95% CI)
C33-C34 (Malignant neoplasms of the trachea, bronchus and lung)								
Women								
0-54 years	1998-2000	9.9	1.0/19.6	2000-2007	2.4	1.1/3.6	1.8	0.7/3.0
	2007-2013	-1.4	-2.5/-0.2					
55-74 years	1998-2005	4.2	3.9/4.5	2005-2008	5.7	3.8/7.6	4.3	4.0/4.7
	2008-2013	3.6	3.2/4.0					
≥75 years	1998-2004	2.2	1.4/2.9	2004-2008	4.5	2.5/6.5	2.1	1.5/2.7
	2008-2013	0.1	-0.7/0.9					
Men								
0-54 years	1998-2010	-2.0	-2.2/-1.8	2010-2013	-4.9	-6.4/-3.3	-2.6	-2.9/-2.3
55-74 years	1998-2000	-0.4	-2.9/2.2	2000-2005	-2.4	-3.2/-1.6	-1.3	-1.7/-0.9
	2005-2013	-0.8	-1.1/-0.5					
≥75 years	1998-2002	-2.3	-3.6/-1.0	2002-2011	-0.2	-0.6/0.2	-1.4	-2.0/-0.9
	2011-2013	-5.2	-8.5/-1.9					

APC=annual percentage change, and 95% confidence interval (95% CI)
AAPC=average annual percentage change, and 95% confidence interval (95% CI) between 1998 and 2013

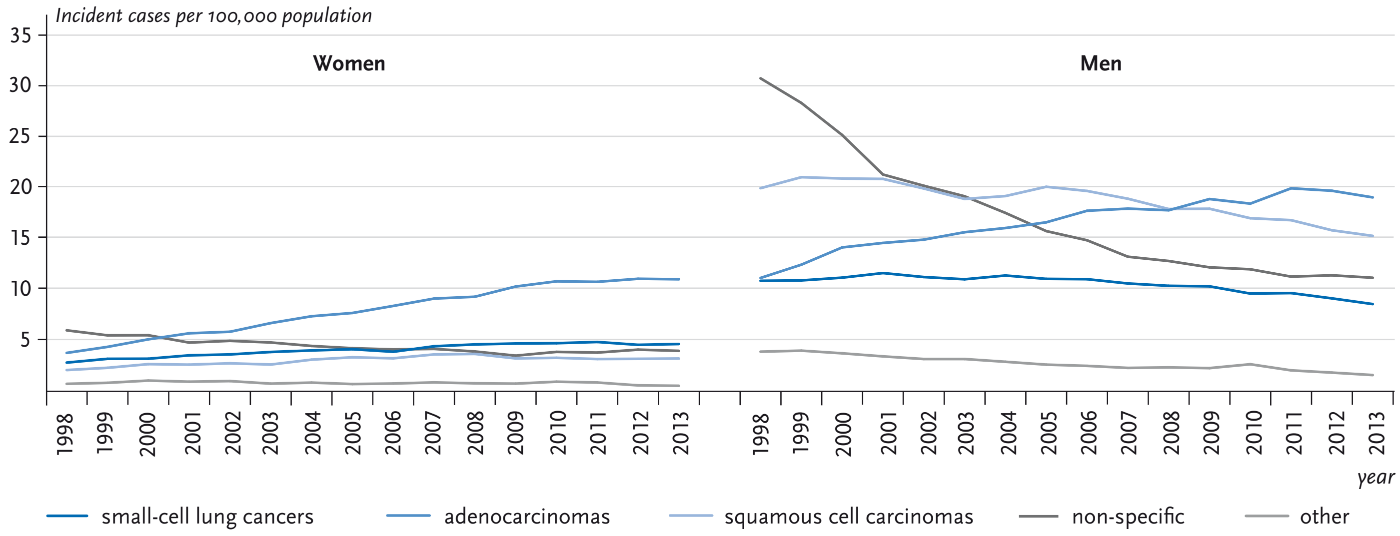
Annex Table 3
Cumulative incidence and incidence rates (per 1,000 person-years, PY) for asthma among adults (18-79 years of age)
Data source: German Health Interview and Examination Survey for Adults 1997-1999 and 2008-2011 [30-32]

	Cumulative incidence (95% CI)	Incidence rate per 1,000 PY (95% CI)	Incidence rate* per 1,000 PY (95% CI)
Women			
Total (18-79 years)	4.1 (2.8-5.7)	3.4 (2.2-4.6)	2.7 (1.7-3.6)
18-44 years	3.6 (1.9-6.1)	3.0 (1.3-4.6)	1.8 (0.8-2.8)
45-79 years	4.7 (2.8-7.3)	4.0 (2.2-5.8)	3.7 (2.0-5.5)
Men			
Total (18-79 years)	1.6 (0.9-2.6)	1.3 (0.7-2.0)	1.1 (0.5-1.7)
18-44 years	1.9 (1.0-3.5)	1.6 (0.7-2.6)	1.4 (0.5-2.3)
45-79 years	1.2 (0.5-2.2)	1.0 (0.3-1.6)	0.6 (0.2-1.0)

* in addition, participants of the follow-up survey in 2008-2011 (n=18) reporting a year of asthma diagnosis ≥5 years before the baseline survey (1997-1999) were excluded [41]
CI=Confidence intervall
PY=person years

Annex Figure 1
Trends in age-standardised incidence rates (incident cases per 100,000 population) for malignant neoplasms of the bronchus and lung (ICD-10 C34) between 1998 and 2013, Germany (selected registries; old European standard population; ≥0 years of age) by gender and type of lung cancer

histology:
In accordance with the current International Classification of Diseases for Oncology (ICD-O-3), the figures were divided into small-cell lung cancers (8041-8045), adenocarcinomas (8140-8384), squamous cell carcinomas (8050-8080), non-specific lung carcinomas (8000-8005), and other malignant lung carcinomas (8010-8011)
Data Source: German Centre for Cancer Registry Data [24, 28-29]



References

1. World Health Organization (WHO) (2007) Global surveillance, prevention and control of chronic respiratory diseases: a comprehensive approach. J. Bousquet, N. Khaltaev (eds) WHO, Genf

2. Gillissen A, Welte T (eds) (2014) Weißbuch Lunge 2014 – Herausforderungen, Zukunftsperspektiven, Forschungsansätze – Zur Lage und Zukunft der Pneumologie in Deutschland. Frisch Texte Verlag, Herne

3. Ferkol T, Schraufnagel D (2014) The global burden of respiratory disease. Ann Am Thorac Soc 11(3):404-406

4. Global Burden of Disease 2015 Disease and Injury Incidence and Prevalence Collaborators (2016) Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 388(10053):1545-1602

5. Global Burden of Disease 2015 DALYs and HALE Collaborators (2016) Global, regional, and national disability-adjusted life-years (DALYs) for 315 diseases and injuries and healthy life expectancy (HALE), 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 388(10053):1603-1658

6. Global Burden of Disease 2015 Mortality and Causes of Death Collaborators (2016) Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 388(10053):1459-1544

7. Plass D, Vos T, Hornberg C et al. (2014) Entwicklung der Krankheitslast in Deutschland. Ergebnisse, Potenziale und Grenzen der Global Burden of Disease Study. Dtsch Arztebl Int 111(38):629-638

8. Statistisches Bundesamt (2017) Sterbefälle, Sterbeziffern (je 100.000 Einwohner, altersstandardisiert) (ab 1998). Gliederungsmerkmale: Jahre, Region, Alter, Geschlecht, Nationalität, ICD-10, Art der Standardisierung.
www.gbe-bund.de (As at 03.08.2017)

9. Kassenärztliche Bundesvereinigung (2016) Die häufigsten Krankheiten in deutschen Arztpraxen.
http://www.kbv.de/media/sp/Infografik_KBV_Krankheiten.jpg (As at 03.08.2017)

10. Marschall J, Hildebrandt S, Sydow S et al. (2017) Gesundheitsreport 2017. Beiträge zur Gesundheitsökonomie und Versorgungsforschung (Band 16). medhochzwei Verlag, Heidelberg

11. World Health Organization (WHO) (2014) Global status report on noncommunicable diseases 2014. WHO, Genf

12. World Health Organization (WHO) Global Influenza Programme (2015) A Manual for Estimating Disease Burden Associated With Seasonal Influenza. WHO, Genf

13. World Health Organization (WHO) (2013) Global Action Plan for the Prevention and Control of NCDs 2013-2020. WHO, Genf

14. Buda S, Prahm K, Preuß U et al. (2016) Bericht zur Epidemiologie der Influenza in Deutschland Saison 2015/16. RKI, Berlin

15. Hoffken G, Lorenz J, Kern W et al. (2009) Epidemiologie, Diagnostik, antimikrobielle Therapie und Management von erwachsenen Patienten mit ambulant erworbenen unteren Atemwegsinfektionen sowie ambulant erworbener Pneumonie - Update 2009. S3-Leitlinie der Paul-Ehrlich-Gesellschaft für Chemotherapie, der Deutschen Gesellschaft für Pneumologie und Beatmungsmedizin, der Deutschen Gesellschaft für Infektiologie und vom Kompetenznetzwerk CAPNETZ. Pneumologie 63(10):e1-68

16. Schnoor M, Hedicke J, Dalhoff K et al. (2007) Approaches to estimate the population-based incidence of community acquired pneumonia. J Infect 55(3):233-239

17. Ewig S, Hoffken G, Kern WV et al. (2016) [Behandlung von erwachsenen Patienten mit ambulant erworbener Pneumonie und Prävention - Update 2016. Pneumologie 70(3):151-200

18. Cassini A, Plachouras D, Eckmanns T et al. (2016) Burden of Six Healthcare-Associated Infections on European Population Health: Estimating Incidence-Based Disability-Adjusted Life Years through a Population Prevalence-Based Modelling Study. PLoS Med 13(10):e1002150

19. Zentralinstitut für die kassenärztliche Versorgung (Zi) (2016) Die 50 häufigsten ICD-10-Schlüsselnummern nach Fachgruppe aus dem ADT-Panel des Zentralinstituts Jahr 2015.
https://www.zi.de/cms/fileadmin/images/content/PDFs_alle/Die_50_häufigsten_ICD-2015.pdf (As at 03.08.2017)

20. Albrecht M (2015) Regionale Unterschiede von Krankenhaushäufigkeiten bei ambulant-sensitiven Konditionen. Vortrag beim 14. Deutschen Kongress für Versorgungsforschung, Berlin, 9.10.2016.
http://www.netzwerk-versorgungsforschung.de/uploads/DKVF%202015/Vortraege/Albrecht_Martin_Regionale%20Unterschiede%20von%20Krankenhaushaeufigkeiten%20bei%20ASK.pdf (As at 03.08.2017)

21. Pollmanns J, Romano PS, Weyermann M et al. (2017) Impact of Disease Prevalence Adjustment on Hospitalization Rates for

Chronic Ambulatory Care-Sensitive Conditions in Germany. Health Serv Res. Doi: 10.1111/1475-6773.12680

22. Freund T, Heller G, Szecsenyi J (2014) [Hospitalisations for ambulatory care sensitive conditions in Germany]. Z Evid Fortbild Qual Gesundhwes 108(5-6):251-257
23. Statistisches Bundesamt (2017) Diagnosedaten der Krankenhäuser ab 2000 (Fälle/Sterbefälle, Fälle je 100.000 Einwohner (altersstandardisiert), Berechnungs- und Belegungstage, durchschnittliche Verweildauer) (ab 2000). Gliederungsmerkmale: Jahre, Wohnsitz, Alter, Geschlecht, Verweildauer, ICD10-3-Steller, Art der Standardisierung.
http://www.gbe-bund.de (As at 03.08.2017)
24. Robert Koch-Institut (eds) (2016) Bericht zum Krebsgeschehen in Deutschland 2016. RKI, Berlin
25. Robert Koch-Institut, Statistisches Bundesamt. Das Informationssystem der Gesundheitsberichterstattung des Bundes www.gbe-bund.de (As at 03.08.2017)
26. Kopke K, Prahm K, Buda S et al. (2016) Evaluation einer ICD-10-basierten elektronischen Surveillance akuter respiratorischer Erkrankungen (SEEDARE) in Deutschland. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 59(11):1484-1491
27. Uphoff H, Stalleicken I, Bartelds A et al. (2004) Are influenza surveillance data useful for mapping presentations? Virus Res 103(1-2):35-46
28. Robert Koch-Institut (2017) Zentrum für Krebsregisterdaten. Datenabfrage.
www.krebsdaten.de (As at 03.08.2017)
29. Wolf U, Barnes B, Bertz J et al. (2011) Das Zentrum für Krebsregisterdaten (ZfKD) im Robert Koch-Institut. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 54(11):1229-1234
30. Gößwald A, Lange M, Kamtsiuris P et al. (2012) DEGS: Studie zur Gesundheit Erwachsener in Deutschland. Bundesweite Quer- und Längsschnittstudie im Rahmen des Gesundheitsmonitorings des Robert Koch-Instituts. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 55(6-7):775-780
31. Kamtsiuris P, Lange M, Hoffmann R et al. (2013) Die erste Welle der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1): Stichprobendesign, Response, Gewichtung und Respräsentativität. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 56(5-6):620-630
http://edoc.rki.de/oa/articles/reOjvEr9ooQ1Q/PDF/22VmD7JrO6CNg.pdf (As at 03.08.2017)
32. Scheidt-Nave C, Kamtsiuris P, Gößwald A et al. (2012) German health interview and examination survey for adults (DEGS) - design, objectives and implementation of the first data collection wave. BMC Public Health 12:730
33. Kurth BM, Lange C, Kamtsiuris P et al. (2009) Gesundheitsmonitoring am Robert Koch-Institut. Sachstand und Perspektiven. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 52(5):557-570
34. Buda S, Tolksdorf K, Schuler E et al. (2017) Establishing an ICD-10 code based SARI-surveillance in Germany - description of the system and first results from five recent influenza seasons. BMC Public Health 17(1):612
35. Lopez-Campos JL, Ruiz-Ramos M, Soriano JB (2014) Mortality trends in chronic obstructive pulmonary disease in Europe, 1994-2010: a joinpoint regression analysis. Lancet Respir Med 2(1):54-62
36. Adair T, Hoy D, Dettrick Z et al. (2012) 100 years of mortality due to chronic obstructive pulmonary disease in Australia: the role of tobacco consumption. Int J Tuberc Lung Dis 16(12):1699-1705
37. Burney PG, Patel J, Newson R et al. (2015) Global and regional trends in COPD mortality, 1990-2010. Eur Respir J 45(5):1239-1247
38. Li L, Shen C, Li X et al. (2013) On weighting approaches for missing data. Stat Methods Med Res 22(1):14-30
39. Upham JW, James AL (2011) Remission of asthma: The next therapeutic frontier? Pharmacol Ther 130(1):38-45
40. Aaron SD, Vandemheen KL, FitzGerald JM et al. (2017) Reevaluation of Diagnosis in Adults With Physician-Diagnosed Asthma. JAMA 317(3):269-279
41. Basagana X, Sunyer J, Zock JP et al. (2001) Incidence of asthma and its determinants among adults in Spain. Am J Respir Crit Care Med 164(7):1133-1137
42. Eagan TM, Brogger JC, Eide GE et al. (2005) The incidence of adult asthma: a review. Int J Tuberc Lung Dis 9(6):603-612
43. National Cancer Institute (2015) Software „Joinpoint Regression Programm“, Version 4.4.0.0.
44. Kim HJ, Fay MP, Feuer EJ et al. (2000) Permutation tests for joinpoint regression with applications to cancer rates. Stat Med 19(3):335-351
45. Burney P, Jarvis D, Perez-Padilla R (2015) The global burden of chronic respiratory disease in adults. Int J Tuberc Lung Dis 19(1):10-20.

46. Jarvis D (2014) Asthma and rhinitis. In: Annesi-Maesano I, Lundbäck B, Viegi G et al. (eds) Respiratory epidemiology. European Respiratory Society, Sheffield

47. Langen U, Schmitz R, Steppuhn H (2013) Häufigkeit allergischer Erkrankungen in Deutschland. Ergebnisse der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1). Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 56 (5-6):698-706
http://edoc.rki.de/oa/articles/reSp8JYqnpVo/PDF/20xkoi9EoFU4w.pdf (As at 03.08.2017)

48. Lundbäck B, Bakke P, Ingebrigtsen T et al. (2014) Chronic obstructive pulmonary disease. In: Annesi-Maesano I, Lundbäck B, Viegi G et al. (eds) Respiratory epidemiology. European Respiratory Society, Sheffield

49. Schmitz R, Thamm M, Ellert U et al. (2014) Verbreitung häufiger Allergien bei Kindern und Jugendlichen in Deutschland. Ergebnisse der KiGGS-Studie - Erste Folgebefragung (KiGGS Welle 1). Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 57(7):771-778
http://edoc.rki.de/oa/articles/reanlTxmpPiBk/PDF/27CDfhKBFstMs.pdf (As at 03.08.2017)

50. Global Initiative for Chronic Obstructive Lung Disease (2017) Global Strategy for the Diagnosis, Management and Prevention of COPD.
http://goldcopd.org/gold-2017-global-strategy-diagnosis-management-prevention-copd/ (As at 27.07.2017)

51. The Global Asthma Network (2014) The Global Asthma Report 2014. Auckland, New Zealand

52. World Health Organisation (WHO) (2014) Global Epidemiological Surveillance Standards for Influenza. WHO, Genf

53. Institut für Qualitätssicherung und Transparenz im Gesundheitswesen (IQTiG) (2016) Bundesauswertung zum Erfassungsjahr 2015. Ambulant erworbene Pneumonie. Qualitätsindikatoren.
https://iqtig.org/downloads/ergebnisse/qidb/2015/2016-05-25/QIDB_2015_INDIREKT_PDF/QIDB_2015_indirekte_Leistungsbereiche/BuAw_2015_INDIREKT/bu_Gesamt_PNEU_2015.pdf
(As at 03.08.2017)

54. An der Heiden M, Buchholz U (2017) Estimation of influenza-attributable medically attended acute respiratory illness by influenza type/subtype and age, Germany, 2001/02-2014/15. Influenza Other Respir Viruses 11(2):110-121

55. McCullers JA (2014) The co-pathogenesis of influenza viruses with bacteria in the lung. Nat Rev Microbiol 12(4):252-262

56. Zucs P, Buchholz U, Haas W et al. (2005) Influenza associated excess mortality in Germany, 1985-2001. Emerg Themes Epidemiol 2:6

57. Buchholz U (2015) Aktualisierung der der Influenza zugeschriebenen Mortalität, bis einschließlich der Saison 2012/2013. Epidemiologisches Bulletin (03):17-20

58. Kuntz B, Zeiher J, Lampert T (2016) Tabak – Zahlen und Fakten zum Konsum. In: Deutsche Hauptstelle für Suchtfragen e.V. (eds) Jahrbuch Sucht 2016. Pabst, Lengerich, S. 55-87

59. Eikmann T, Dopp E, Herr C (2010) Die Wirkung von Fein- und Feinststäuben auf die menschliche Gesundheit. In: Gemeinschafts-Arbeitsausschuss »Feinstäube« der Gesellschaft Deutscher Chemiker e.V. (GDCh), Gesellschaft für Chemische Technik und Biotechnologie e.V. (DECHEMA), Kommission Reinhaltung der Luft (KRdL) im VDI und DIN-Normenausschuss, ProcessNet (eds) Statuspapier Feinstaub DECHEMA e.V., Frankfurt am Main, P. 153-170

60. Böckelmann I (2014) Die ESCAPE-Studie. Prospektive Analysen zur Assoziation der Feinstaubexposition mit Lungenkrebs. Der Pneumologe 11(3):252-254

61. Valavanidis A, Vlachogianni T, Fiotakis K et al. (2013) Pulmonary oxidative stress, inflammation and cancer: respirable particulate matter, fibrous dusts and ozone as major causes of lung carcinogenesis through reactive oxygen species mechanisms. Int J Environ Res Public Health 10(9):3886-3907

62. Lim SS, Vos T, Flaxman AD et al. (2012) A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 380(9859):2224-2260

63. Devesa SS, Bray F, Vizcaino AP et al. (2005) International lung cancer trends by histologic type: male:female differences diminishing and adenocarcinoma rates rising. Int J Cancer 117(2):294-299

64. Lewis DR, Check DP, Caporaso NE et al. (2014) US lung cancer trends by histologic type. Cancer 120(18):2883-2892

65. Pesch B, Kendzia B, Gustavsson P et al. (2012) Cigarette smoking and lung cancer – relative risk estimates for the major histological types from a pooled analysis of case-control studies. Int J Cancer 131(5):1210-1219

66. Samet JM, Avila-Tang E, Boffetta P et al. (2009) Lung cancer in never smokers: clinical epidemiology and environmental risk factors. Clin Cancer Res 15(18):5626-5645

67. Umweltbundesamt (2017) Entwicklung der Luftqualität. http://www.umweltbundesamt.de/themen/luft/daten-karten/entwicklung-der-luftqualitaet#textpart-1 (As at 03.08.2017)

68. European Respiratory Society (2013) Major respiratory diseases - chronic obstructive pulmonary disease. In: Gibson J, Loddenkemper R, Sibille Y et al. (eds) The European Lung White Book - Respiratory Health and Disease in Europe. European Respiratory Society, Sheffield

69. Aumann I, Prenzler A (2013) Epidemiologie und Kosten der COPD in Deutschland - Eine Literaturrecherche zu Prävalenz, Inzidenz und Krankheitskosten. Klinikarzt 42(4):168-172

70. Karrasch S, Bruske I, Smith MP et al. (2016) What is the impact of different spirometric criteria on the prevalence of spirometrically defined COPD and its comorbidities? Results from the population-based KORA study. Int J Chron Obstruct Pulmon Dis 11:1881-1894

71. Lamprecht B, Soriano JB, Studnicka M et al. (2015) Determinants of underdiagnosis of COPD in national and international surveys. Chest 148(4):971-985

72. Geldmacher H, Biller H, Herbst A et al. (2008) Die Prävalenz der chronisch obstruktiven Lungenerkrankung (COPD) in Deutschland. Ergebnisse der BOLD-Studie. Dtsch Med Wochenschr 133(50):2609-2614

73. Colak Y, Afzal S, Nordestgaard BG et al. (2017) Prognosis of asymptomatic and symptomatic, undiagnosed COPD in the general population in Denmark: a prospective cohort study. Lancet Respir Med 5(5):426-434

74. Ford ES, Mannino DM, Zhao G et al. (2012) Changes in mortality among US adults with COPD in two national cohorts recruited from 1971-1975 and 1988-1994. Chest 141(1):101-110

75. Doucet M, Rochette L, Hamel D (2016) Incidence, Prevalence, and Mortality Trends in Chronic Obstructive Pulmonary Disease over 2001 to 2011: A Public Health Point of View of the Burden. Can Respir J 2016:7518287

76. Burney P, Jithoo A, Kato B et al. (2014) Chronic obstructive pulmonary disease mortality and prevalence: the associations with smoking and poverty--a BOLD analysis. Thorax 69(5):465-473

77. Soriano JB, Ancochea J, Miravitlles M et al. (2010) Recent trends in COPD prevalence in Spain: a repeated cross-sectional survey 1997-2007. Eur Respir J 36(4):758-765

78. Lange P, Celli B, Agusti A et al. (2015) Lung-Function Trajectories Leading to Chronic Obstructive Pulmonary Disease. N Engl J Med 373(2):111-122

79. Martinez FD (2016) Early-Life Origins of Chronic Obstructive Pulmonary Disease. N Engl J Med 375(9):871-878

80. Gauderman WJ, Urman R, Avol E et al. (2015) Association of improved air quality with lung development in children. N Engl J Med 372(10):905-913

81. Baur X (2011) Obstruktive Atemwegserkrankungen als Berufskrankheiten. Pneumologie 65(11):654-661

82. GBD 2015 Risk Factors Collaborators (2016) Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 388(10053):1659-1724

83. World health Organisation (WHO) (2016) Household air pollution and health. Fact sheet N°292. Updated February 2016. http://www.who.int/mediacentre/factsheets/fs292/en/ (As at 03.08.2017)

84. Burney P (2013) Death and disability due to asthma. In: Akdis CA, Agache I (eds) Global Atlas of Asthma. European Academy of Allergy and Clinical Immunology, Zürich, P. 14-17

85. Levy ML (2014) National Review of Asthma Deaths (NRAD). Br J Gen Pract 64(628):564

86. Zemp E, Hansen S, Schneider C et al. (2014) Sex, gender and respiratory health. In: Annesi-Maesano I, Lundbäck B, Viegi G et al. (eds) Respiratory epidemiology. European Respiratory Society, Sheffield

87. Zein JG, Erzurum SC (2015) Asthma is Different in Women. Curr Allergy Asthma Rep 15(6):28

88. Fuchs O, Bahmer T, Rabe KF et al. (2017) Asthma transition from childhood into adulthood. Lancet Respir Med 5(3):224-234

89. Winer RA, Qin X, Harrington T et al. (2012) Asthma incidence among children and adults: findings from the Behavioral Risk Factor Surveillance system asthma call-back survey – United States, 2006-2008. J Asthma 49(1):16-22

90. Vink NM, Postma DS, Schouten JP et al. (2010) Gender differences in asthma development and remission during transition through puberty: the TRacking Adolescents' Individual Lives Survey (TRAILS) study. J Allergy Clin Immunol 126(3):498-504 e491-496

91. Aumann I, Prenzler A, Welte T et al. (2014) Epidemiologie und Kosten von Asthma bronchiale in Deutschland - eine systematische Literaturrecherche. Pneumologie 68(8):557-567

92. Genuneit J, Grabenhenrich L, Kämer U et al. (2012) Epidemiologische Forschung zu allergischen Erkrankungen in Deutschland: eine Chronologie. Allergologie 35(1):3-10

93. Anandan C, Nurmatov U, van Schayck OC et al. (2010) Is the prevalence of asthma declining? Systematic review of epidemiological studies. Allergy 65(2):152-167

94. Eder W, Ege MJ, von Mutius E (2006) The asthma epidemic. N Engl J Med 355(21):2226-2235

95. Kramer U, Schmitz R, Ring J et al. (2015) What can reunification of East and West Germany tell us about the cause of the allergy epidemic? Clin Exp Allergy 45(1):94-107

96. Sunyer J, Anto JM, Tobias A et al. (1999) Generational increase of self-reported first attack of asthma in fifteen industrialized countries. European Community Respiratory Health Study (ECRHS). Eur Respir J 14(4):885-891

97. Landesamt für Verbraucherschutz Sachsen-Anhalt (2014) Auswirkungen der Umwelt auf die Gesundheit von Kindern. Schulanfängerstudie 1991-2014. Landesamt für Verbraucherschutz Sachsen-Anhalt, Magdeburg

98. Bergmann KC, Heinrich J, Niemann H (2016) Current status of allergy prevalence in Germany: Position paper of the Environmental Medicine Commission of the Robert Koch Institute. Allergo J Int 25:6-10

99. Kramer U, Link E, Oppermann H et al. (2002) Die Schulanfängerstudie in West- und Ostdeutschland (SAWO): Trends von Allergien und Sensibilisierungen 1991-2000. Gesundheitswesen 64(12):657-663

100. Heinrich J, Hoelscher B, Frye C et al. (2002) Trends in prevalence of atopic diseases and allergic sensitization in children in Eastern Germany. Eur Respir J 19(6):1040-1046

101. Krämer U, Möllemann A, Behrendt J (2001) Epidemiologie allergischer Erkrankungen bei Kindern. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 44:633–642

102. Maziak W, Behrens T, Brasky TM et al. (2003) Are asthma and allergies in children and adolescents increasing? Results from ISAAC phase I and phase III surveys in Munster, Germany. Allergy 58(7):572-579

103. Yunginger JW, Reed CE, O'Connell EJ et al. (1992) A community-based study of the epidemiology of asthma. Incidence rates, 1964-1983. Am Rev Respir Dis 146(4):888-894

104. Schlaud M, Atzpodien K, Thierfelder W (2007) Allergische Erkrankungen. Ergebnisse aus dem Kinder- und Jugendgesundheitssurvey (KiGGS). Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 50(5-6):701-710 http://edoc.rki.de/oa/articles/reRhnrND9xOGA/PDF/27KpokRUqJI.pdf (As at 03.08.2017)

105. Schmitz R (2015) Trends in der Prävalenz von Asthma bronchiale und allergischer Rhinitis bei Erwachsenen in Deutschland 1997-99 und 2008-11. Fortbildungsveranstaltung für den Öffentlichen Gesundheitsdienst. Berlin. http://www.bfr.bund.de/cm/343/trends-in-der-praevalenz-von-asthma-bronchiale-und-allergischer-rhinitis.pdf (As at 01.03.2017)

106. Bjerg A, Ekerljung L, Middelveld R et al. (2011) Increased prevalence of symptoms of rhinitis but not of asthma between 1990 and 2008 in Swedish adults: comparisons of the ECRHS and GA(2)LEN surveys. PLoS One 6(2):e16082

107. de Marco R, Cappa V, Accordini S et al. (2012) Trends in the prevalence of asthma and allergic rhinitis in Italy between 1991 and 2010. Eur Respir J 39(4):883-892

108. Jarvis D, Newson R, Lotvall J et al. (2012) Asthma in adults and its association with chronic rhinosinusitis: the GA2LEN survey in Europe. Allergy 67(1):91-98

109. Kainu A, Pallasaho P, Piirila P et al. (2013) Increase in prevalence of physician-diagnosed asthma in Helsinki during the Finnish Asthma Programme: improved recognition of asthma in primary care? A cross-sectional cohort study. Prim Care Respir J 22(1):64-71

110. Kilpelainen M, Terho EO, Helenius H et al. (2001) Validation of a new questionnaire on asthma, allergic rhinitis, and conjunctivitis in young adults. Allergy 56(5):377-384

111. Sembajwe G, Cifuentes M, Tak SW et al. (2010) National income, self-reported wheezing and asthma diagnosis from the World Health Survey. Eur Respir J 35(2):279-286

112. Ellsasser G, Diepgen TL (2002) Atopische Erkrankungen und soziale Lage bei Einschulungskindern im Land Brandenburg. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 45(3):267-276

113. Vestergaard LS, Nielsen J, Krause TG et al. (2017) Excess all-cause and influenza-attributable mortality in Europe, December 2016 to February 2017. Euro Surveill 22(14):30506

114. Remschmidt C, Harder T, Wichmann O et al. (2016) Hintergrundpapier der STIKO: Evaluation der bestehenden Influenzaimpfempfehlung fur Indikationsgruppen und fur Senioren

(Standardimpfung ab 60 Jahren). Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 59(12):1606-1622

115. Falkenhorst G, Remschmidt C, Harder T et al. (2016) Background paper to the updated pneumococcal vaccination recommendation for older adults in Germany. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 59(12):1623-1657

116. Kraywinkel K, Barnes B, Dahm S et al. (2014) Von regionalen Daten zu bundesweiten Aussagen. Die Methoden im Zentrum für Krebsregisterdaten. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 57(1):13-21

117. Robert Koch-Institut, Gesellschaft der epidemiologischen Krebsregister in Deutschland e.V., (eds) (2015) Krebs in Deutschland 2011/2012. 10. Ausgabe. RKI, Berlin

118. Cheng YJ, Gregg EW, Rolka DB et al. (2016) Using multi-year national survey cohorts for period estimates: an application of weighted discrete Poisson regression for assessing annual national mortality in US adults with and without diabetes, 2000-2006. Popul Health Metr 14:48

119. Paprott R, Schaffrath Rosario A, Busch MA et al. (2015) Association between hemoglobin A1c and all-cause mortality: results of the mortality follow-up of the German National Health Interview and Examination Survey 1998. Diabetes Care 38(2):249-256

120. Afonso AS, Verhamme KM, Sturkenboom MC et al. (2011) COPD in the general population: prevalence, incidence and survival. Respir Med 105(12):1872-1884

121. Jensen HH, Godtfredsen NS, Lange P et al. (2006) Potential misclassification of causes of death from COPD. Eur Respir J 28(4):781-785

122. Bopp M, Spoerri A, Zwahlen M et al. (2009) Cohort Profile: the Swiss National Cohort--a longitudinal study of 6.8 million people. Int J Epidemiol 38(2):379-384

123. McGarvey LP, John M, Anderson JA et al. (2007) Ascertainment of cause-specific mortality in COPD: operations of the TORCH Clinical Endpoint Committee. Thorax 62(5):411-415

124. McGarvey LP, Magder S, Burkhart D et al. (2012) Cause-specific mortality adjudication in the UPLIFT(R) COPD trial: findings and recommendations. Respir Med 106(4):515-521

125. Floristan Floristan Y, Delfrade Osinaga J, Carrillo Prieto J et al. (2016) Coding Causes of Death with IRIS Software. Impact in Navarre Mortality Statistic. Rev Esp Salud Publica 90:e1-9

126. Wells C (2014) Impact of the Implementation of IRIS Software for ICD-10 Cause of Death Coding on Mortality Statistics, England and Wales. Statistical bulletin. Office for National Statistics, London

127. Eckert O (2015) MUSE - ein neuer Baustein der elektronischen Todesursachenstatistik. Methoden – Verfahren – Entwicklungen. Nachrichten aus dem Statistischen Bundesamt (01):08-10

128. Prognos AG (2013) Studie Aufwand-Nutzen-Abschätzung zum Aufbau und Betrieb eines nationalen Mortalitätsregisters - Endbericht. https://www.bundesgesundheitsministerium.de/fileadmin/Dateien/Publikationen/Forschungsberichte/2014/2014_2/Gutachten_Aufwand-Nutzen-Abschaetzung_nationales_Mortalitaetsregisters.pdf (As at 03.08.2017)

129. Robert Koch-Institut (2015) Gesundheit in Deutschland. Kapitel 2. Wie steht es um unsere Gesundheit? Gesundheitsberichterstattung des Bundes. Gemeinsam getragen von RKI und Destatis. RKI, Berlin http://edoc.rki.de/documents/rki_fv/refNzCggQ8fNw/PDF/29PIbXnI56Jfc.pdf (As at 03.08.2017)

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin

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

Conflicts of interest
The authors declared no conflicts of interest.

Funding
The DEGS study was funded by the Robert Koch Institute and the German Federal Ministry of Health.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
Steppuhn H, Buda S, Wienecke A et al. (2017) Time trends in incidence and mortality of respiratory diseases of high public health relevance in Germany. Journal of Health Monitoring 2(3):3–33
DOI 10.17886/RKI-GBE-2017-061

ISSN 2511-2708

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-064
Robert Koch Institute, Berlin

Authors:
Henriette Steppuhn, Ronny Kuhnert, Christa Scheidt-Nave

12-month prevalence of asthma among adults in Germany

Abstract
Asthma is a chronic inflammatory disease of the airways affecting people of all ages. The disease is characterised by a variable narrowing of the bronchia, which may be accompanied by symptoms such as wheezing or shortness of breath. In GEDA 2014/2015-EHIS, 6.2% of respondents aged 18 years or older with complete information on the respective indicator (n=22,671) reported having had asthma during the past 12 months. The 12-month prevalence among women (7.1%) is higher than among men (5.4%). Overall, women and men with a low level of education more often reported having had asthma than those with a higher level of education. In analyses stratified by age and gender, differences in asthma prevalence with regard to educational level are evident among women under 30 years of age. In a comparison of federal states, the prevalence of asthma ranges from 3.0% to 9.7% among women and from 2.9% to 7.0% among men.

ASTHMA · PREVALENCE · ADULTS · HEALTH MONITORING · GERMANY

Introduction
According to the World Health Organization (WHO), asthma is one of the most common chronic diseases affecting around 235 million people globally [1]. Asthma can occur among people of all ages [2-5]. The disease is characterised by chronic inflammation and increased sensitivity (hyperresponsiveness) of the airways to diverse inhaled stimuli [5, 6]. Asthma patients moreover suffer from variable narrowing of the bronchia (airway obstruction) accompanied by symptoms such as wheezing, shortness of breath, chest tightness or coughing which vary over time and in intensity [5, 6]. Some patients with mild asthma may experience periods when they are completely free of symptoms [5, 7]. In particular, in case of an asthma onset in childhood, remission of symptoms during puberty is frequently observed [4, 8].

Asthma is a heterogeneous disease which results from different underlying disease mechanisms [5, 9]. Allergic asthma and also other forms of non-allergic asthma are marked by a characteristic type of inflammation [5, 9]. This (TH2) type of inflammation is indicated by elevated concentrations of specific immune cells (eosinophils) in the airway mucosa and in the blood (eosinophilic asthma) [5, 6, 9]. Further, mainly adult-onset, forms of asthma exist, where such an overproduction of eosinophils cannot be observed (non-eosinophilic asthma) [5, 6, 9]. It is important to distinguish between eosinophilic and non-eosinophilic asthma, when treating patients with severe asthma [5, 6, 9].

A family history of asthma or of certain allergies (such as hay fever) is an important predisposing factor [5, 10-12]. Asthma thereby results from complex interactions

GEDA 2014/2015-EHIS

Data holder: Robert Koch Institute

Aims: To provide reliable information about the population's health status, health-related behaviour and health care in Germany, with the possibility of a European comparison

Method: Questionnaires completed on paper or online

Population: People aged 18 years and above with permanent residency in Germany

Sampling: Registry office sample; randomly selected individuals from 301 communities in Germany were invited to participate

Participants: 24,016 people (13,144 women; 10,872 men)

Response rate: 26.9%

Study period: November 2014 - July 2015

Data protection: This study was undertaken in strict accordance with the data protection regulations set out in the German Federal Data Protection Act and was approved by the German Federal Commissioner for Data Protection and Freedom of Information. Participation in the study was voluntary. The participants were fully informed about the study's aims and content, and about data protection. All participants provided written informed consent.

More information in German is available at www.geda-studie.de

between genetic and environmental factors [2, 5, 12]. Early childhood yet also prenatal influences are highly relevant in the induction of the disease [2, 5, 12]. Infections, exposure to microbes, pollutants and allergens, but also diet or psychosocial factors may contribute to asthma development [2, 5, 12]. Furthermore, occupational exposures have been identified (e.g., allergens such as flour and cow hair or chemical irritants such as disinfectants and agents used by hairstylists) which can induce or aggravate asthma in adulthood [2, 13]. Providing appropriate medical care to asthma patients is highly important to prevent episodes in which the disease worsens acutely and which can require emergency care or lead to premature mortality [5]. In the majority of patients, however, adequate treatment can minimise the symptoms of asthma and associated limitations in usual activities [5].

Indicator

In the GEDA 2014/2015-EHIS survey, the prevalence of asthma during the past 12 months was assessed by using a self-administered paper-based or online questionnaire. Respondents were asked, 'During the past 12 months, have you had any of the following diseases or conditions?' This question was followed by a list of conditions that also contained 'asthma (allergic asthma included)'. 24,016 adults aged 18 years or older (13,144 women and 10,872 men) participated in GEDA 2014/2015-EHIS. 1,345 respondents (696 women and 649 men) with missing information on the indicator on self-assessed asthma were excluded from the current analysis. The calculations were carried out using a weighting factor that corrects for deviations within the sample from the German population structure (as of 31 December 2014) with regard to gender, age, district type and education. The district type reflects the degree of urbanisation and corresponds to the regional distribution in Germany. The International Standard Classification of Education (ISCED) was used to classify the responses provided on educational level [14]. Lange et al. [15] set out the details of the methodology applied in the GEDA 2014/2015-EHIS study including the method used to calculate the weighting factor and an assessment of the response rate. Background information on the GEDA 2014/15-EHIS is also provided in the article German Health Update: New data for Germany and Europe in Issue 1/2017 of the Journal of Health Monitoring.

Results and discussion

6.2% of adults aged 18 years or older reported having had asthma during the past 12 months. Overall, women (7.1%) show a higher 12-month prevalence of asthma than men (5.4%) (Table 1). Asthma prevalence is highest in the age group 45 to 64 years among men while it remains on a similar level across all age groups among women. Overall, women and men with a low level of education more frequently reported to have had asthma than those with a medium or high level of education (7.7% vs. 5.9% and 5.7%). In analyses stratified by age and gender, these differences with regard to educational level are evident among women aged 18 to 29 years (Table 1). Prevalence estimates vary considerably between federal states ranging from 3.0% in Mecklenburg Western-Pomerania to 9.7% in Brandenburg among women

Table 1
12-month prevalence of asthma by gender, age and educational level (n=12,448 women; n=10,223 men)
Source: GEDA 2014/2015-EHIS

Women	%	(95% CI)
Women total	**7.1**	**(6.5-7.7)**
18-29 Years	7.8	(6.4-9.6)
Low education	13.3	(8.9-19.4)
Medium education	6.5	(5.1-8.2)
High education	5.2	(3.3-8.2)
30-44 Years	6.4	(5.4-7.6)
Low education	8.5	(5.4-13.1)
Medium education	6.1	(4.8-7.6)
High education	6.2	(4.8-8.0)
45-64 Years	7.1	(6.3-8.0)
Low education	7.0	(5.0-9.6)
Medium education	7.1	(6.1-8.4)
High education	7.2	(5.8-8.8)
≥65 Years	7.1	(6.1-8.4)
Low education	7.3	(5.6-9.5)
Medium education	6.7	(5.2-8.5)
High education	6.9	(4.7-10.1)
Total (women and men)	**6.2**	**(5.8-6.7)**

Men	%	(95% CI)
Men total	**5.4**	**(4.8-5.9)**
18-29 Years	3.6	(2.7-4.7)
Low education	4.1	(2.1-7.7)
Medium education	2.9	(2.0-4.1)
High education	5.8	(3.5-9.5)
30-44 Years	5.1	(4.1-6.4)
Low education	7.3	(4.1-12.6)
Medium education	4.4	(3.1-6.1)
High education	5.7	(4.0-8.1)
45-64 Years	6.3	(5.4-7.2)
Low education	8.5	(5.8-12.3)
Medium education	6.6	(5.3-8.1)
High education	5.0	(4.0-6.2)
≥65 Years	5.5	(4.5-6.7)
Low education	8.0	(5.3-11.9)
Medium education	5.3	(3.9-7.0)
High education	4.8	(3.4-6.7)
Total (women and men)	**6.2**	**(5.8-6.7)**

CI=Confidence interval
* n=51 additional missing values (26 women, 25 men) when stratifying by educational level

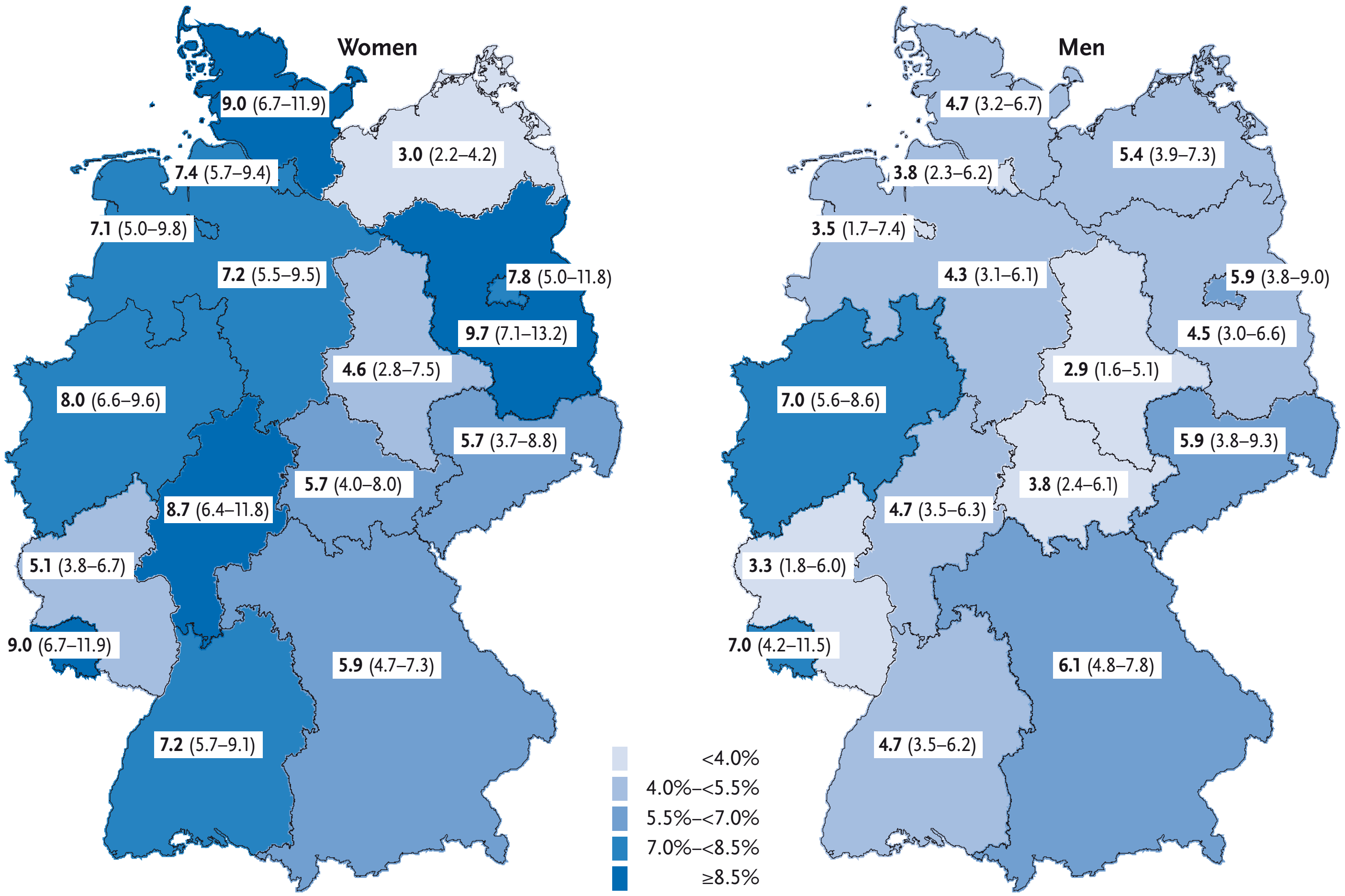
About 6% of adults reported having had asthma during the past 12 months.

and from 2.9% in Saxony-Anhalt to 7.0% in North Rhine Westphalia and Saarland among men (Figure 1).

The current results on the 12-month prevalence of asthma in GEDA 2014/2015-EHIS are consistent with results of the German national telephone health interview survey German Health Update (GEDA 2012) conducted by the Robert Koch Institute in 2012 [16]. This applies both to the overall prevalence of asthma among adults (6.2% vs. 6.3% in 2012) and to estimates by gender (women: 7.1% vs. 7.5%; men: 5.4% vs. 5.0%) [16]. Comparable differences between genders (an overall 1.3 to 1.5-fold higher prevalence of asthma among women) were observed in epidemiological surveys in Europe, Australia and the USA [17]. Results from longitudinal studies moreover point to an increased asthma risk for women relative to men, whereby this difference is already evident in adolescence (see also the Focus article on respiratory diseases in this issue) [17, 18]. Regarding socio-economic differences, the surveys available revealed heterogeneous results. Overall, in the majority of studies, however, a higher prevalence of asthma is related to lower social status [19]. A comparison of GEDA 2014/2015-EHIS results by gender or socio-economic criteria needs to consider further aspects. Differences in the way patients perceive symptoms, seek medical care or adhere to treatment recommendations - and

Figure 1
12-month prevalence of asthma by gender and federal state (n=12,448 women; n=10,223 men)
Source: GEDA 2014/2015-EHIS

Women (7.1%) show a higher 12-month prevalence of asthma than men (5.4%).



Confidence intervals in parentheses

resulting differences in the degree of treatment and asthma control - may all affect levels of self-reported asthma prevalence [20, 21].

Direct comparisons of prevalence estimates obtained from GEDA 2014/2015-EHIS with those obtained from previous German national health surveys need to consider some change in methods and hence preclude analyses of trends in asthma prevalence over time [16, 22-24]. In accordance with the regulation on the harmonisation of European health reporting, GEDA 2014/2015-EHIS used self-reported information on asthma prevalence based on the self-assessment of respondents. As in other

In a comparison of federal states, the prevalence of asthma ranges from 3.0% to 9.7% among women and from 2.9% to 7.0% among men.

large epidemiological surveys [25-34], all national health surveys previously conducted in Germany, starting with the German Health Interview and Examination Survey 1997-1999 (GNHIES98) [16, 22-24], however, collected data on self-reported physician-diagnosed asthma. In comparison with the currently applied indicator on self-assessed asthma, prior results on the prevalence of physician-diagnosed asthma may be less prone to misclassification [32]. In addition, previous national health surveys also assessed the lifetime prevalence of physician-diagnosed asthma which was consistently higher than the recorded 12-month prevalence [16, 22-24]. These differences between lifetime and 12-month prevalence indicate the varying degrees of disease activity over time in individuals with asthma [4, 7, 8]. In some patients, symptoms of asthma may resolve, at least for longer periods of time [4, 7, 8].

In Germany, an increase in the lifetime prevalence of physician-diagnosed asthma was recorded for both genders among adults (1997-1999 and 2008-2011) as well as among children and adolescents (2003-2006 and 2009-2012) [22-24]. At the same time, an increment in the 12-month prevalence was likewise observed; among adults this was attributable mainly to an increase in the prevalence among women [23, 35]. Interview survey data had already indicated a rising prevalence of asthma in the 1990s in Germany especially among children [26, 29, 36-40]. Moreover, an increase in the prevalence of asthma was also observed in other parts of the world during the second half of the last century [29]. Recent data indicates that this trend has come to a halt at least in certain regions such as Australia where prevalence is already high [25, 29, 41]. Among adults, however, a further increase in prevalence over the course of the last decade has nonetheless been recorded in several countries in Europe and in the USA [27, 28, 31, 33, 42].

High regional variation in asthma prevalence has been observed not only in GEDA 2014/2015-EHIS based on analyses stratified by federal state. Using ambulatory health care data, a recent study reported considerable variation in asthma prevalence at the county level ranging from 2.5% to 7.7% for the total population [43]. Earlier European surveys indicated significant regional differences with a high prevalence mainly in the United Kingdom and low prevalence in Eastern European regions [2, 3, 44, 45]. In line with Europe-wide data for adults [2, 46], current asthma prevalence in Germany as recorded in GEDA 2014/2015-EHIS is mid-range compared to other countries of the EU. Previous studies including a national health survey of adults in Germany indicated a lower prevalence of asthma in East than in West Germany [47-51]. The German Health Interview and Examination Survey for Children and Adolescents (KiGGS) 2003-2006, however, which was conducted among children and adolescents most of whom were born after German reunification, revealed no significant differences between East (including Berlin) and West Germany [24]. Future investigations on the regional differences in asthma prevalence among adults in Germany should thus include in-depth analyses that do not only stratify by age and birth year, respectively, but also consider the place where respondents were born and raised.

Previously observed temporal and regional differences in asthma prevalence were related to the develop-

ment of time trends and the geographical distribution of several lifestyle and environmental factors [12, 29, 50]. In addition, the influence of temporal changes and regional differences in degrees of awareness and provision of care, respectively, was also discussed [27, 29, 43, 50]. The recently observed changes in asthma prevalence over time point to the importance of continuous health monitoring based on periodically repeated national health surveys using comparable instruments of data collection. Besides extending the available database from national health interview and examination surveys permitting analyses of trends in the prevalence of physician-diagnosed asthma, it will be highly important to build a reliable database for the analysis of trends in self-assessed asthma prevalence using the current indicator in the context of European health interview surveys. Moreover, clarifying the underlying causes of regional and gender-specific differences in the prevalence of asthma remains a key challenge [12].

References

1. World Health Organization (2017) Asthma. Fact sheet. Updated April 2017. http://www.who.int/mediacentre/factsheets/fs307/en/ (As at 27.07.2017)
2. European Respiratory Society (2013) Major respiratory diseases - adult asthma. In: Gibson J, Loddenkemper R, Sibille Y et al. (eds) The European Lung White Book - Respiratory Health and Disease in Europe. European Respiratory Society, Sheffield
3. European Respiratory Society (2013) Major respiratory diseases - childhood asthma. In: Gibson J, Loddenkemper R, Sibille Y et al. (eds) The European Lung White Book - Respiratory Health and Disease in Europe. European Respiratory Society, Sheffield
4. Fuchs O, Bahmer T, Rabe KF et al. (2017) Asthma transition from childhood into adulthood. Lancet Respir Med 5(3):224-234
5. Global Initiative for Asthma (GINA) (2017) Global Strategy for Asthma Management and Prevention. www.ginasthma.org (As at 03.08.2017)
6. Gillissen A, Welte T (eds) (2014) Weißbuch Lunge 2014 – Herausforderungen, Zukunftsperspektiven, Forschungsansätze – Zur Lage und Zukunft der Pneumologie in Deutschland. Frisch Texte Verlag, Herne
7. Aaron SD, Vandemheen KL, FitzGerald JM et al. (2017) Reevaluation of Diagnosis in Adults With Physician-Diagnosed Asthma. JAMA 317(3):269-279
8. Upham JW, James AL (2011) Remission of asthma: The next therapeutic frontier? Pharmacol Ther 130(1):38-45
9. Wenzel SE (2012) Asthma phenotypes: the evolution from clinical to molecular approaches. Nat Med 18(5):716-725
10. Grabenhenrich LB, Gough H, Reich A et al. (2014) Early-life determinants of asthma from birth to age 20 years: a German birth cohort study. J Allergy Clin Immunol 133(4):979-988
11. Schafer T, Bauer CP, Beyer K et al. (2014) S3-Guideline on allergy prevention: 2014 update: Guideline of the German Society for Allergology and Clinical Immunology (DGAKI) and the German Society for Pediatric and Adolescent Medicine (DGKJ). Allergo J Int 23(6):186-199
12. Jarvis D (2014) Asthma and rhinitis. In: Annesi-Maesano I, Lundbäck B, Viegi G et al. (eds) Respiratory epidemiology. European Respiratory Society, Sheffield
13. Baur X (2011) Obstructive airway disorders representing occupational diseases. Pneumologie 65(11):654-661
14. Eurostat (2016) International standard classification of education (ISCED). http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:International_standard_classification_of_education_%28ISCED%29 (As at 01.03.2017)
15. Lange C, Finger JD, Allen J et al. (in press) Implementation of the European Health Interview Survey (EHIS) in Germany. Further development of the German Health Update (GEDA). Archives of Public Health
16. Robert Koch-Institut (2014) Daten und Fakten: Ergebnisse der Studie "Gesundheit in Deutschland aktuell 2012". Beiträge zur Gesundheitsberichterstattung des Bundes. RKI, Berlin http://edoc.rki.de/documents/rki_fv/recJuHnzacx8A/PDF/28GsWuNtFjVqY.pdf (As at 27.07.2017)

17. Zemp E, Hansen S, Schneider C et al. (2014) Sex, gender and respiratory health. In: Annesi-Maesano I, Lundbäck B, Viegi G et al. (eds) Respiratory epidemiology. European Respiratory Society, Sheffield

18. Vink NM, Postma DS, Schouten JP et al. (2010) Gender differences in asthma development and remission during transition through puberty: the TRacking Adolescents' Individual Lives Survey (TRAILS) study. J Allergy Clin Immunol 126(3):498-504 e491-496

19. Uphoff E, Cabieses B, Pinart M et al. (2015) A systematic review of socioeconomic position in relation to asthma and allergic diseases. Eur Respir J 46(2):364-374

20. Mielck A, Reitmeir P, Wjst M (1996) Severity of childhood asthma by socioeconomic status. Int J Epidemiol 25(2):388-393

21. Zein JG, Erzurum SC (2015) Asthma is Different in Women. Curr Allergy Asthma Rep 15(6):28

22. Langen U, Schmitz R, Steppuhn H (2013) Prevalence of allergic diseases in Germany: results of the German Health Interview and Examination Survey for Adults (DEGS1). Bundesgesundheitsbl Gesundheitsforsch Gesundheitsschutz 56(5-6):698-706 http://edoc.rki.de/oa/articles/reUsXePiiZFs/PDF/29PNwFWSiGnGA.pdf (As at 27.07.2017)

23. Schmitz R, Thamm M, Ellert U et al. (2014) Verbreitung häufiger Allergien bei Kindern und Jugendlichen in Deutschland – Ergebnisse der KiGGS-Studie – Erste Folgebefragung (KiGGS Welle 1). Bundesgesundheitsbl Gesundheitsforsch Gesundheitsschutz 57(7):771-778 https://edoc.rki.de/oa/articles/reanlTxmpPiBk/PDF/27CDfhKBFstMs.pdf (As at 01.03.2017)

24. Schlaud M, Atzpodien K, Thierfelder W (2007) Allergische Erkrankungen – Ergebnisse aus dem Kinder- und Jugendgesundheitssurvey (KiGGS). Bundesgesundheitsbl Gesundheitsforsch Gesundheitsschutz 50(5-6):701-710 https://edoc.rki.de/oa/articles/reRhnrND9xOGA/PDF/27KpokRUqJI.pdf (As at 01.03.2017)

25. Australian Centre for Asthma Monitoring (2011) Asthma in Australia 2011: with a focus chapter on chronic obstructive pulmonary disease. AIHW Asthma Series no. 4. Cat. no. ACM 22. Australian Institute of Health and Welfare, Canberra

26. Bergmann KC, Heinrich J, Niemann H (2016) Current status of allergy prevalence in Germany: Position paper of the Environmental Medicine Commission of the Robert Koch Institute. Allergo J Int 25:6-10

27. Bjerg A, Ekerljung L, Middelveld R et al. (2011) Increased prevalence of symptoms of rhinitis but not of asthma between 1990 and 2008 in Swedish adults: comparisons of the ECRHS and GA(2)LEN surveys. PLoS One 6(2):e16082

28. de Marco R, Cappa V, Accordini S et al. (2012) Trends in the prevalence of asthma and allergic rhinitis in Italy between 1991 and 2010. Eur Respir J 39(4):883-892

29. Eder W, Ege MJ, von Mutius E (2006) The asthma epidemic. N Engl J Med 355(21):2226-2235

30. Hohmann C, Pinart M, Tischer C et al. (2014) The development of the MeDALL Core Questionnaires for a harmonized follow-up assessment of eleven European birth cohorts on asthma and allergies. Int Arch Allergy Immunol 163(3):215-224

31. Kainu A, Pallasaho P, Piirila P et al. (2013) Increase in prevalence of physician-diagnosed asthma in Helsinki during the Finnish Asthma Programme: improved recognition of asthma in primary care? A cross-sectional cohort study. Prim Care Respir J 22(1):64-71

32. Kilpelainen M, Terho EO, Helenius H et al. (2001) Validation of a new questionnaire on asthma, allergic rhinitis, and conjunctivitis in young adults. Allergy 56(5):377-384

33. Moorman JE, Akinbami LJ, Bailey CM et al. (2012) National Surveillance of Asthma: United States, 2001-2010. Vital and Health Statistics. National Center for Health Statistics,

34. Sembajwe G, Cifuentes M, Tak SW et al. (2010) National income, self-reported wheezing and asthma diagnosis from the World Health Survey. Eur Respir J 35(2):279-286

35. Schmitz R (2015) Trends in der Prävalenz von Asthma bronchiale und allergischer Rhinitis bei Erwachsenen in Deutschland 1997-99 und 2008-11. Fortbildungsveranstaltung für den Öffentlichen Gesundheitsdienst. Berlin. http://www.bfr.bund.de/cm/343/trends-in-der-praevalenz-von-asthma-bronchiale-und-allergischer-rhinitis.pdf (As at 01.03.2017)

36. Heinrich J, Hoelscher B, Frye C et al. (2002) Trends in prevalence of atopic diseases and allergic sensitization in children in Eastern Germany. Eur Respir J 19(6):1040-1046

37. Kramer U, Link E, Oppermann H et al. (2002) Studying school beginners in western and eastern Germany: allergy trends and sensitisations 1991-2000. Gesundheitswesen 64(12):657-663

38. Krämer U, Möllemann A, Behrendt J (2001) Epidemiologie allergischer Erkrankungen bei Kindern. Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 44:633–642

39. Landesamt für Verbraucherschutz Sachsen-Anhalt (2014) Auswirkungen der Umwelt auf die Gesundheit von Kindern. Schulanfängerstudie 1991-2014. https://verbraucherschutz.sachsen-anhalt.de/fileadmin/Bibliothek/Politik_und_Verwaltung/MS/LAV_Verbraucherschutz/service/publikationen/fb2/schulanfaengerstudie_internet.pdf (As at 01.03.2017)

40. Maziak W, Behrens T, Brasky TM et al. (2003) Are asthma and allergies in children and adolescents increasing? Results from ISAAC phase I and phase III surveys in Munster, Germany. Allergy 58(7):572-579

41. Anandan C, Nurmatov U, van Schayck OC et al. (2010) Is the prevalence of asthma declining? Systematic review of epidemiological studies. Allergy 65(2):152-167

42. Simpson CR, Sheikh A (2010) Trends in the epidemiology of asthma in England: a national study of 333,294 patients. J R Soc Med 103(3):98-106

43. Pollmanns J, Romano PS, Weyermann M et al. (2017) Impact of Disease Prevalence Adjustment on Hospitalization Rates for Chronic Ambulatory Care-Sensitive Conditions in Germany. Health Serv Res Mar 22

44. Burney P, Chinn S, Jarvis D et al. (1996) Variations in the prevalence of respiratory symptoms, self-reported asthma attacks, and use of asthma medication in the European Community Respiratory Health Survey (ECRHS). Eur Respir J 9:687-695

45. Jarvis D, Newson R, Lotvall J et al. (2012) Asthma in adults and its association with chronic rhinosinusitis: the GA2LEN survey in Europe. Allergy 67(1):91-98

46. To T, Stanojevic S, Moores G et al. (2012) Global asthma prevalence in adults: findings from the cross-sectional world health survey. BMC Public Health 12:204

47. Heinrich J, Richter K, Frye C et al. (2002) European Community Respiratory Health Survey in Adults (ECRHS). Pneumologie 56(5):297-303

48. Filipiak B, Heinrich J, Nowak D et al. (2001) The distribution in specific IgE and the prevalence of allergic symptoms in 25-64-years old inhabitants of an eastern and a western German city – results from Augsburg and Erfurt. Eur J Epidemiol 17(1):77-84

49. Hoffmann F (2007) Prevalence of asthma among German adults: analysis of the German National Telephone Survey. J Asthma 44(6):433-436

50. Kramer U, Schmitz R, Ring J et al. (2015) What can reunification of East and West Germany tell us about the cause of the allergy epidemic? Clin Exp Allergy 45(1):94-107

51. Hermann-Kunz E (1999) Häufigkeit allergischer Krankheiten in Ost- und Westdeutschland. Gesundheitswesen 61(Sonderheft 2):100-105

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin

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

Conflicts of interest
The authors declared no conflicts of interest.

Funding
The GEDA study was funded by the Robert Koch Institute and the German Federal Ministry of Health.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
Steppuhn H, Kuhnert R, Scheidt-Nave C (2017) 12-month prevalence of asthma among adults in Germany. Journal of Health Monitoring 2(3):34–42
DOI 10.17886/RKI-GBE-2017-064

ISSN 2511-2708

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

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-065
Robert Koch Institute, Berlin

Authors:
Henriette Steppuhn, Ronny Kuhnert,
Christa Scheidt-Nave

12-month prevalence of known chronic obstructive pulmonary disease (COPD) in Germany

Abstract
Chronic obstructive pulmonary disease (COPD) is associated with a high disease burden and is one of the leading causes of death worldwide. Smoking is the key modifiable risk factor for COPD in Germany. GEDA 2014/2015-EHIS surveyed the 12-month prevalence of known COPD using the European indicator on self-reported chronic bronchitis, chronic obstructive pulmonary disease, emphysema. Among adults aged 18 years or older with complete information on the indicator (n=22,702), the 12-month prevalence of known COPD is 5.8% (5.8% for women and 5.7% for men). In both genders, the prevalence increases strongly with age. Overall, the presence of COPD was more often reported by women and men with a low educational level than by those with a higher one. In a comparison of federal states, the 12-month prevalence of known COPD varies between 3.6% and 7.5% for women and 4.3% and 11.2% for men.

CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD) · PREVALENCE · ADULTS · HEALTH MONITORING · GERMANY

Introduction
Chronic obstructive pulmonary disease (COPD) is associated with a high disease burden and is one of the leading causes of death in Germany and globally [1-3]. COPD is a prevalent chronic disease of middle and older age [1, 4-7]. It is marked by chronic inflammation and progressive obstruction (narrowing) of the airways and destruction of lung tissue (parenchyma) [1, 8]. Chronic cough and phlegm production (chronic bronchitis) as well as a permanent over-inflation of the air sacks (emphysema) are common among COPD patients and often occur together [1, 8]. Moreover, shortness of breath under physical strain is a typical symptom. At more progressed stages of the disease, patients may also suffer from shortness of breath even at rest [1, 8].

Smoking is the most important modifiable risk factor for COPD in Germany [1, 7-9]. The risk of developing COPD is thereby related to the total amount of cigarette smoking over time (pack years) [7, 9]. Moreover, specific occupational exposures (e.g., coal dust) are important COPD risk factors [1, 7, 9, 10]. COPD is therefore considered a potentially preventable disease [1, 8]. However, impaired growth and functional development of the lungs also affect a person's COPD risk [1, 9, 11]. Besides genetic factors and prenatal influences (e.g., maternal smoking during pregnancy), repeated respiratory infections in early childhood, exposure to airborne pollutants, or childhood asthma potentially contribute to developing COPD in later life [1, 7, 9, 12, 13].

GEDA 2014/2015-EHIS

Data holder: Robert Koch Institute

Aims: To provide reliable information about the population's health status, health-related behaviour and health care in Germany, with the possibility of a European comparison

Method: Questionnaires completed on paper or online

Population: People aged 18 years and above with permanent residency in Germany

Sampling: Registry office sample; randomly selected individuals from 301 communities in Germany were invited to participate

Participants: 24,016 people (13,144 women; 10,872 men)

Response rate: 26.9%

Study period: November 2014 - July 2015

Data protection: This study was undertaken in strict accordance with the data protection regulations set out in the German Federal Data Protection Act and was approved by the German Federal Commissioner for Data Protection and Freedom of Information. Participation in the study was voluntary. The participants were fully informed about the study's aims and content, and about data protection. All participants provided written informed consent.

More information in German is available at www.geda-studie.de

Adults with COPD frequently suffer from other chronic conditions such as cardiovascular diseases [1, 7, 9]. These concurrent conditions considerably impact the quality of life of COPD patients and contribute to the high COPD-related costs of illness [14-17]. COPD-related costs of illness are also significantly determined by the severity of the disease [17, 18]. A recent study of COPD patients in Germany revealed that in comparison to a control group from the region of Augsburg, excess (direct) costs resulting from healthcare utilization ranged between 2,595 and 8,924 EUR per patient in 2012 [17]. The indirect costs (e.g., due to work absence) were significantly higher ranging from 8,621 to 27,658 EUR [17].

Indicator

GEDA 2014/2015-EHIS surveyed the prevalence of known COPD during the past 12 months based on an instrument from the indicator set of the European health monitoring by using self-administered paper-based or online questionnaires. Respondents were asked, 'During the past 12 months, have you had any of the following diseases or conditions?' This question was followed by a list of conditions that also included 'chronic bronchitis, chronic obstructive pulmonary disease, emphysema'. Out of a total of 24,016 respondents aged 18 years or older (13,144 women, 10,872 men), 1,314 respondents (696 women and 618 men) with missing information on the indicator were excluded from the analysis. COPD prevalence was calculated using a weighting factor that corrects for deviations within the sample from the German population structure (as of 31 December 2014) with regard to gender, age, district type and education. The district type reflects the degree of urbanisation and corresponds to the regional distribution in Germany. The International Standard Classification of Education (ISCED) was used to classify the responses provided on educational level [19]. Lange et al. [20] set out the details of the methodology applied in GEDA 2014/15-EHIS including a description of the method used to calculate the weighting factor and an assessment of the response rate. Background information on GEDA 2014/15-EHIS are also provided in the article German Health Update: New data for Germany and Europe, which was published in Issue 1/2017 of the Journal of Health Monitoring.

Results and discussion

In GEDA 2014/2015-EHIS, 5.8% of adults aged 18 years or older reported the presence of COPD during the past 12 months. The 12-month prevalence of known COPD for women (5.8%) is comparable to the prevalence for men (5.7%). In both genders, the 12-month prevalence increases strongly with age (Table 1). Overall, the presence of COPD was more often reported by women and men with a low educational level than by those with a medium or high one (8.1% vs. 5.7% and 4.0%). Stratified by age and sex, these differences with regard to educational level are particularly evident for women under 65 years of age and for men aged 45 to 64 years (Table 1). The prevalence of known COPD varies considerably between federal states, ranging from 3.6% in Saxony-Anhalt to 7.5% in Bremen for women and from 4.3% in Hesse to 11.2% in Saarland for men (Figure 1).

Table 1
12-month prevalence of known COPD according to gender, age and educational level (n=12,448 women; n=10,254 men)
Source: GEDA 2014/2015-EHIS

The 12-month prevalence of known COPD is 5.8% for women and 5.7% for men.

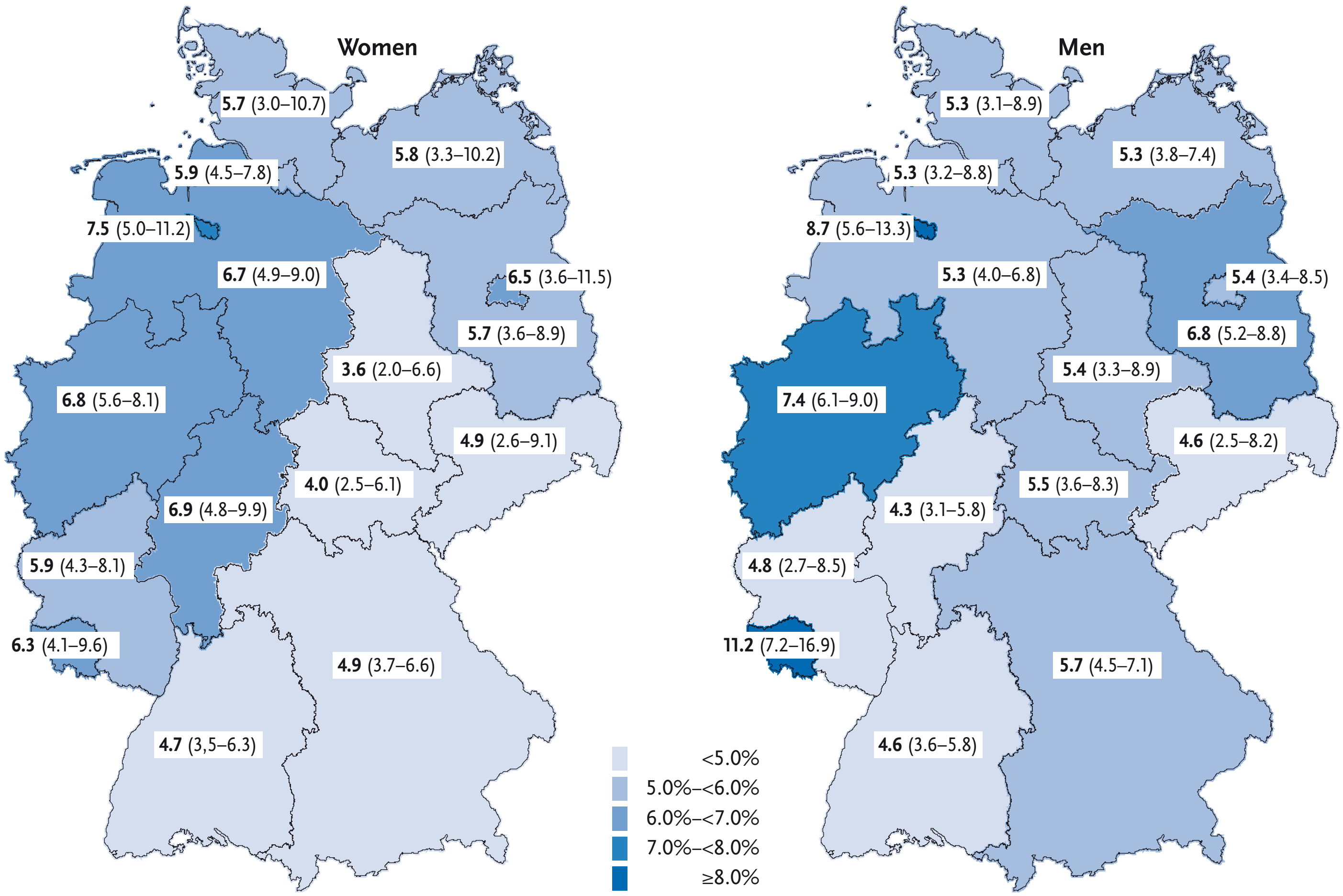
Women	%	(95% CI)	Men	%	(95% CI)
Women total	**5.8**	**(5.2-6.4)**	**Men total**	**5.7**	**(5.2-6.3)**
18-29 Years	2.4	(1.6-3.5)	**18-29 Years**	1.3	(0.8-2.3)
Low education	4.5	(2.5-8.2)	Low education	2.0	(0.7-5.3)
Medium education	2.0	(1.2-3.3)	Medium education	1.2	(0.6-2.4)
High education	0.7	(0.3-1.9)	High education	0.7	(0.3-1.8)
30-44 Years	3.4	(2.7-4.4)	**30-44 Years**	2.0	(1.4-2.9)
Low education	7.4	(4.5-11.9)	Low education	2.8	(1.2-6.2)
Medium education	2.9	(2.0-4.1)	Medium education	2.5	(1.7-3.9)
High education	2.5	(1.5-4.0)	High education	0.9	(0.4-1.9)
45-64 Years	5.1	(4.3-5.9)	**45-64 Years**	6.3	(5.4-7.4)
Low education	7.2	(5.2-9.8)	Low education	12.1	(8.8-16.3)
Medium education	5.1	(4.2-6.2)	Medium education	7.0	(5.8-8.5)
High education	3.3	(2.4-4.5)	High education	3.1	(2.4-4.1)
≥65 Years	11.0	(9.5-12.7)	**≥65 Years**	12.5	(10.9-14.3)
Low education	10.8	(8.6-13.5)	Low education	15.5	(11.7-20.1)
Medium education	11.2	(9.2-13.6)	Medium education	12.2	(10.0-14.8)
High education	9.4	(6.1-14.0)	High education	11.6	(9.4-14.3)
Total (women and men)	**5.8**	**(5.4-6.2)**	**Total (women and men)**	**5.8**	**(5.4-6.2)**

CI=Confidence interval
* n=50 additional missing values (25 women and men) when stratifying by educational level

When comparing these results on the prevalence of known COPD with the results from previous epidemiological studies, considerable methodological differences need to be taken into account. For example, a comparison with the results from the interview survey of adults aged 18 years or older conducted by the Robert Koch Institute in 2012 (GEDA 2012) is not possible because both the type of the interview (written/online questionnaire now, telephone interview then) and the indicator differ [21]. GEDA 2012 surveyed the 12-month prevalence of physician-diagnosed chronic bronchitis defined as coughing with phlegm for at least 3 months per year [21]. Prevalence estimates for this indicator were 6.0% for women and 4.0% for men [21].

Besides interview data, COPD prevalence estimates are mainly based on data obtained from a pulmonary function test (spirometry) [4, 6, 18, 22, 23]. However, there is poor agreement between estimates of spirometrically defined and self-reported COPD prevalence [4, 6, 22, 24, 25]. For example in a population-based cohort study among adults 41 to 90 years of age from the region of Augsburg (KORA), less than 40% of participants with spirometrically defined COPD reported to have physician-diagnosed COPD [22]. This was explained by a high

Figure 1
12-month prevalence of known COPD according to gender and federal state (n=12,448 women; n=10,254 men)
Source: GEDA 2014/2015-EHIS



Confidence intervals in parentheses

In both genders, the 12-month prevalence of known COPD increases strongly with age.

number of undiagnosed COPD cases [22], a fact that results in an underestimation of the actual COPD prevalence when using self-reported information [1, 9, 25, 26].

In line with other studies, GEDA 2014/2015-EHIS survey data also demonstrate that COPD is an age-associated disease [1, 4-7]. A comparison with prevalence estimates of spirometrically defined COPD must, however, take into account that lung function generally decreases with age and also shows considerable variation in the older population [27-29]. In particular, age-specific estimates on COPD prevalence based on spirometry data differ depending on the chosen reference criteria and method of examination, e.g. with or without the use of medications to dilate airways [1, 9, 22, 27-29]. Besides,

The presence of COPD was more often reported by women and men with a low educational level than by those with a higher one.

the available prevalence data on spirometrically defined COPD is based alone on the detection of an airflow obstruction [1, 4, 6]. A clinical diagnosis of COPD, however, also requires the consideration of risk factors, symptoms, the corresponding individual clinical history and, where necessary, further clinical examinations [1, 9, 27, 29].

Results from international surveys including data from Germany reveal a higher prevalence of spirometrically defined COPD among men than among women [5, 7, 18, 24, 30, 31]. For example, the estimated prevalence of spirometrically defined COPD among adults 40 year of age or older was 9.3% for women and 18.1% for men based on data collected in the German study centre Hanover of the international Burden of Obstructive Lung Disease (BOLD) study in 2006 [24]. This difference between women and men was observed independent of disease severity [5]. Higher prevalence among men, however, was only seen among those aged 50 years or older and was considered to be potentially related to the gender-specific differences in smoking habits across age groups [24]. In agreement with the findings presented here, results from this previous survey demonstrated that there were no gender differences regarding the prevalence of a known COPD: 7.7% of women and 7.6% of men reported to have been diagnosed with COPD by a physician [24]. Further analyses on the basis of BOLD and other survey data indicated underlying differences in COPD awareness between women and men, as male gender was associated with an undiagnosed COPD [25]. In the GEDA 2014/2015-EHIS survey conducted across Europe, data collection on the prevalence of known COPD was based on the composite indicator compelling information on chronic bronchitis, chronic obstructive pulmonary disease, emphysema in line with other cross-country surveys [4, 6, 23]. Thereby, however, adults with chronic cough and phlegm production might have been included who have otherwise normal spirometry results and will not develop COPD in later life [1, 32-34]. This is particularly relevant with regard to the prevalence of known COPD assessed among young adults in GEDA 2014/2015-EHIS [31]. Moreover, current findings on the prevalence of known COPD are based on the self-assessment of respondents and not on self-reported medical diagnoses [4, 6, 22, 24]. This increases the likelihood of misclassifying patients with other diseases that are marked by similar symptoms, in particular asthma [31].

In accordance with other data on spirometrically defined COPD, GEDA 2014/2015-EHIS results indicate a higher prevalence of known COPD among adults with a low educational level compared to those with a higher one [7, 9, 35, 36]. In line with these findings, comparable differences in prevalence had previously been reported with regard to different socio-economic criteria [7, 9, 35, 36]. GEDA 2014/2015-EHIS revealed considerable regional differences in the prevalence of known COPD not only between federal states but also between EU countries. Germany thereby ranked in the group of countries presenting the highest prevalence [37] (see issue 1/2017 Journal of Health Monitoring). The interpretation of social and regional differences in known COPD prevalence needs to consider differences in the distribution of risk factors such as smoking (see also the Fact sheet Smoking among adults in Germany in issue 2/2017 Jour-

nal of Health Monitoring) as well as in COPD awareness and care provision [36, 38-40]. Periodically repeated collection of nationally representative population-based data on major modifiable risk factors as well as on lung function, diagnosis, symptoms, and mortality of COPD is essential in order to identify successes and remaining or new challenges of COPD prevention and care.

References

1. Global Initiative for Chronic Obstructive Lung Disease (2017) Global Strategy for the Diagnosis, Management and Prevention of Chronic Obstructive Pulmonary Disease. http://goldcopd.org/gold-2017-global-strategy-diagnosis-management-prevention-copd/ (As at 27.07.2017)
2. Plass D, Vos T, Hornberg C et al. (2014) Entwicklung der Krankheitslast in Deutschland - Ergebnisse, Potenziale und Grenzen der Global Burden of Disease-Studie. Dtsch Arztebl Int 111(38):629-638
3. Global Burden of Disease 2015 Disease and Injury Incidence and Prevalence Collaborators. (2016) Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 388(10053):1545-1602
4. Atsou K, Chouaid C, Hejblum G (2011) Variability of the chronic obstructive pulmonary disease key epidemiological data in Europe: systematic review. BMC Med 9:7
5. Buist AS, McBurnie MA, Vollmer WM et al. (2007) International variation in the prevalence of COPD (the BOLD Study): a population-based prevalence study. Lancet 370(9589):741-750
6. Halbert RJ, Natoli JL, Gano A et al. (2006) Global burden of COPD: systematic review and meta-analysis. Eur Respir J 28(3):523-532
7. European Respiratory Society (2013) Major respiratory diseases - chronic obstructive pulmonary disease. In: Gibson J, Loddenkemper R, Sibille Y et al. (eds) The European Lung White Book - Respiratory Health and Disease in Europe. European Respiratory Society, Sheffield
8. Gillissen G, Welte T (eds) (2014) Weißbuch Lunge 2014 – Herausforderungen, Zukunftsperspektiven, Forschungsansätze – Zur Lage und Zukunft der Pneumologie in Deutschland. Frisch Texte Verlag, Herne
9. Lundbäck B, Bakke P, Ingebrigtsen T et al. (2014) Chronic obstructive pulmonary disease. In: Annesi-Maesano I, Lundbäck B, Viegi G et al. (eds) Respiratory epidemiology. European Respiratory Society, Sheffield
10. Baur X (2011) Obstruktive Atemwegserkrankungen als Berufskrankheiten. Pneumologie 65(11):654-661
11. Lange P, Celli B, Agusti A et al. (2015) Lung-Function Trajectories Leading to Chronic Obstructive Pulmonary Disease. N Engl J Med 373(2):111-122
12. Gauderman WJ, Urman R, Avol E et al. (2015) Association of improved air quality with lung development in children. N Engl J Med 372(10):905-913
13. Martinez FD (2016) Early-Life Origins of Chronic Obstructive Pulmonary Disease. N Engl J Med 375(9):871-878
14. Janson C, Marks G, Buist S et al. (2013) The impact of COPD on health status: findings from the BOLD study. Eur Respir J 42(6):1472-1483
15. Kirsch F, Teuner CM, Menn P et al. (2013) Krankheitskosten für Asthma und COPD bei Erwachsenen in der Bundesrepublik Deutschland. Gesundheitswesen 75(7):413-423
16. Wacker ME, Jorres RA, Karch A et al. (2016) Relative impact of COPD and comorbidities on generic health-related quality of life: a pooled analysis of the COSYCONET patient cohort and control subjects from the KORA and SHIP studies. Respir Res 17(1):81
17. Wacker ME, Jorres RA, Schulz H et al. (2016) Direct and indirect costs of COPD and its comorbidities: Results from the German COSYCONET study. Respir Med 111:39-46
18. Aumann I, Prenzler A (2013) Epidemiologie und Kosten der COPD in Deutschland - Eine Literaturrecherche zu Prävalenz, Inzidenz und Krankheitskosten. Klinikarzt 42(4):168-172
19. Eurostat (2016) International standard classification of education (ISCED). http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:International_standard_classification_of_education_%28ISCED%29 (As at 01.03.2017)
20. Lange C, Finger JD, Allen J et al. (in press) Implementation of the European Health Interview Survey (EHIS) in Germany. Further development of the German Health Update (GEDA). Archives of Public Health

21. Robert Koch-Institut (2014) Daten und Fakten: Ergebnisse der Studie "Gesundheit in Deutschland aktuell 2012". Beiträge zur Gesundheitsberichterstattung des Bundes. RKI, Berlin http://edoc.rki.de/documents/rki_fv/recJuHnzacx8A/PDF/28Gs-WuNtFjVqY.pdf (As at 26.07.2017)

22. Karrasch S, Bruske I, Smith MP et al. (2016) What is the impact of different spirometric criteria on the prevalence of spirometrically defined COPD and its comorbidities? Results from the population-based KORA study. Int J Chron Obstruct Pulmon Dis 11:1881-1894

23. Foo J, Landis SH, Maskell J et al. (2016) Continuing to Confront COPD International Patient Survey: Economic Impact of COPD in 12 Countries. PLoS One 11(4):e0152618

24. Geldmacher H, Biller H, Herbst A et al. (2008) Die Prävalenz der chronisch obstruktiven Lungenerkrankung (COPD) in Deutschland. Ergebnisse der BOLD-Studie. Dtsch Med Wochenschr 133(50):2609-2614

25. Lamprecht B, Soriano JB, Studnicka M et al. (2015) Determinants of underdiagnosis of COPD in national and international surveys. Chest 148(4):971-985

26. Colak Y, Afzal S, Nordestgaard BG et al. (2017) Prognosis of asymptomatic and symptomatic, undiagnosed COPD in the general population in Denmark: a prospective cohort study. Lancet Respir Med 5(5):426-434

27. Mohamed Hoesein FA, Zanen P, Lammers JW (2011) Lower limit of normal or FEV1/FVC < 0.70 in diagnosing COPD: an evidence-based review. Respir Med 105(6):907-915

28. Vollmer WM, Gislason T, Burney P et al. (2009) Comparison of spirometry criteria for the diagnosis of COPD: results from the BOLD study. Eur Respir J 34(3):588-597

29. Criee CP, Baur X, Berdel D et al. (2015) Standardization of Spirometry: 2015 Update Published by German Atemwegsliga, German Respiratory Society and German Society of Occupational and Environmental Medicine. Pneumologie 69(3):147-164

30. Zemp E, Hansen S, Schneider C et al. (2014) Sex, gender and respiratory health. In: Annesi-Maesano I, Lundbäck B, Viegi G et al. (eds) Respiratory epidemiology. European Respiratory Society, Sheffield

31. de Marco R, Accordini S, Cerveri I et al. (2004) An international survey of chronic obstructive pulmonary disease in young adults according to GOLD stages. Thorax 59(2):120-125

32. Allinson JP, Hardy R, Donaldson GC et al. (2016) The Presence of Chronic Mucus Hypersecretion across Adult Life in Relation to Chronic Obstructive Pulmonary Disease Development. Am J Respir Crit Care Med 193(6):662-672

33. Lange P, Vestbo J (2016) Chronic Mucus Hypersecretion and the Natural History of Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med 193(6):602-603

34. Vestbo J, Lange P (2002) Can GOLD Stage 0 provide information of prognostic value in chronic obstructive pulmonary disease? Am J Respir Crit Care Med 166(3):329-332

35. Pleasants RA, Riley IL, Mannino DM (2016) Defining and targeting health disparities in chronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis 11:2475-2496

36. Townend J, Minelli C, Mortimer K et al. (2017) The association between chronic airflow obstruction and poverty in 12 sites of the multinational BOLD study. Eur Respir J 49(6)

37. Organisation for Economic Co-operation and Development/European Union (2016) Health at a Glance: Europe 2016. State of Health in the EU Cycle. OECD Publishing, Paris

38. Burney P, Jithoo A, Kato B et al. (2014) Chronic obstructive pulmonary disease mortality and prevalence: the associations with smoking and poverty--a BOLD analysis. Thorax 69(5):465-473

39. Cerveri I, Accordini S, Verlato G et al. (2001) Variations in the prevalence across countries of chronic bronchitis and smoking habits in young adults. Eur Respir J 18(1):85-92

40. Pollmanns J, Romano PS, Weyermann M et al. (2017) Impact of Disease Prevalence Adjustment on Hospitalization Rates for Chronic Ambulatory Care-Sensitive Conditions in Germany. Health Serv Res Mar 22

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin

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

Conflicts of interest
The authors declared no conflicts of interest.

Funding
The GEDA study was funded by the Robert Koch Institute and the German Federal Ministry of Health.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
Steppuhn H, Kuhnert R, Scheidt-Nave C (2017) 12-month prevalence of known chronic obstructive pulmonary disease (COPD) in Germany. Journal of Health Monitoring 2(3):43–50
DOI 10.17886/RKI-GBE-2017-065

ISSN 2511-2708

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

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-066
Robert Koch Institute, Berlin

Authors:
Judith Fuchs, Ronny Kuhnert,
Christa Scheidt-Nave

12-month prevalence of osteoarthritis in Germany

Abstract
Osteoarthritis is the most common joint disease worldwide. In the advanced stage the disease is characterised by joint pain and loss of joint functionality. In the Robert Koch Institute's GEDA 2014/2015-EHIS health interview survey, 17.9% of adults over 18 reported having suffered from osteoarthritis during the past twelve months, whereby prevalence for women (21.8%) was higher than for men (13.9%). Osteoarthritis becomes more common with age. Among those aged 65 and over, around half of all women (48.1%) and nearly one third of men (31.2%) are affected. Due to population ageing, the prevalence of osteoarthritis in Germany can be expected to increase further in the future.

OSTEOARTHRITIS · PREVALENCE · ADULTS · HEALTH MONITORING · GERMANY

Introduction

In Germany as well as globally, osteoarthritis is the most common joint disease [1, 2]. The disease is characterised by degenerative processes in the joints that begin with the gradual erosion of joint cartilage, and which can lead to the full exposure of bone surfaces. The bones, muscles and ligaments attached to the affected joints can also be affected [3]. Non-modifiable risk factors for osteoarthritis include older age, female gender and genetic predisposition. Further acquired (or contributing) causes include overstress and misload of joints due to congenital misalignments (axis misalignment, hip dysplasia); injuries and accidents; excessive physical activity or inactivity and overweight or obesity. At advanced stages, osteoarthritis causes pain and leads to joint dysfunction, both of which result in loss of mobility, physical disability and limitations in usual activities, and consequently significant loss of quality of life. Beyond the personal burdens suffered by osteoarthritis patients, the disease also generates considerable economic costs [3].

Numerous efforts at the international level currently target musculoskeletal diseases and the related disease burden. When the World Health Organization (WHO) endorsed the Bone and Joint Decade 2000-2010, experts estimated that due to demographic developments the number of patients affected by bone and joint diseases would approximately double between 2000 and 2020 [2]. The WHO strategy therefore focussed on promoting research and enhancing the quality of healthcare services. This initiative led to an increased awareness for musculoskeletal diseases and the insight that the capacity to provide prompt and adequate care would require new models of care [4].

Given the ageing of society, osteoarthritis prevalence in Germany will continue to rise. This will lead to further burdens on the healthcare system. Considering the iden-

GEDA 2014/2015-EHIS

Data holder: Robert Koch Institute

Aims: To provide reliable information about the population's health status, health-related behaviour and health care in Germany, with the possibility of a European comparison

Method: Questionnaires completed on paper or online

Population: People aged 18 years and above with permanent residency in Germany

Sampling: Registry office sample; randomly selected individuals from 301 communities in Germany were invited to participate

Participants: 24,016 people (13,144 women; 10,872 men)

Response rate: 26.9%

Study period: November 2014 - July 2015

Data protection: This study was undertaken in strict accordance with the data protection regulations set out in the German Federal Data Protection Act and was approved by the German Federal Commissioner for Data Protection and Freedom of Information. Participation in the study was voluntary. The participants were fully informed about the study's aims and content, and about data protection. All participants provided written informed consent.

More information in German is available at www.geda-studie.de

tified risk factors for osteoarthritis, which can be divided into those at the person level (age, sex, obesity, genetic predisposition, physical activity and diet) and those at the joint level (injuries, malposition and overstress) [5], sufficient evidence to justify interventions exists only for modifiable risk factors such as obesity and joint injuries [6].

Indicator

The osteoarthritis indicator in the GEDA 2014/2015-EHIS health interview survey was calculated using a self-administered paper-based or online questionnaire. Numerous diseases and conditions were assessed using the questions: 'During the past twelve months have you had any of the following diseases or conditions?' and: 'Has a physician ever diagnosed you with any of the following diseases or conditions?', which was followed by a list of diseases. Participants were expected to provide information on whether they had had osteoarthritis during the past twelve months. The results are presented stratified according to gender, age group and educational level.

The data presented are based on participants' self-assessment of twelve-month prevalence. We can assume these self-assessments to be reliable, but will expect them to lead to lower prevalence rates than for example radiological examinations would [7, 8].

The analyses are based on the data from 22,753 participants aged 18 years and older (12,481 women, 10,272 men) with valid data on osteoarthritis. The calculations were carried out using a weighting factor that corrects for deviations within the sample from the German population (as of 31 December 2014) with regard to gender, age, district type and education. The district type accounts for the degree of urbanisation and reflects the regional distribution in Germany. The International Standard Classification of Education (ISCED) was used to classify the responses provided on educational level [9].

For a detailed description of the methodology applied in the GEDA 2014/2015-EHIS study see Lange et al. 2017 [10] as well as the article German Health Update: New data for Germany and Europe, in Issue 1/2017 of the Journal of Health Monitoring.

Results and discussion

17.9% of adults over 18 report having had osteoarthritis during the past twelve months, whereby prevalence among women (21.8%) is higher than among men (13.9%).

Osteoarthritis is more common among older than among young people. During early adulthood (18 to 29 years) osteoarthritis is very rare with a prevalence of 0.9% among women and 0.4% among men. Among 30- to 44-year-olds this rises to 4.3% (women) and 4.1% (men) (Table 1) and then increases steeply, with 23.2% of women and 16.6% of men in the 45 to 64 age group reporting cases of osteoarthritis. In the age group of those over 65 years of age nearly half of all women (48.1%) and a third of all men (31.2%) are affected. Women in the 45 to 64 and over-65 age groups are affected significantly more frequently by osteoarthritis than men.

In the 45 to 64 age group a correlation between osteoarthritis and education is apparent for both sexes. Peo-

Table 1
12-month prevalence of osteoarthritis stratified according to gender, age and educational level (n=12,481 women; n=10,272 men)
Source: GEDA 2014/2015-EHIS

Women	%	(95% CI)
Women total	**21.8**	**(20.9-22.7)**
18-29 Years	0.9	(0.5-1.5)
Low education	0.9	(0.2-3.4)
Medium education	0.9	(0.5-1.7)
High education	0.9	(0.3-2.6)
30-44 Years	4.3	(3.4-5.3)
Low education	3.8	(2.0-7.1)
Medium education	5.1	(3.9-6.5)
High education	2.6	(1.9-3.7)
45-64 Years	23.2	(21.7-24.7)
Low education	29.1	(24.9-33.6)
Medium education	23.1	(21.3-25.0)
High education	18.0	(15.9-20.2)
≥65 Years	48.1	(45.6-50.6)
Low education	47.9	(44.0-51.7)
Medium education	48.1	(44.7-51.5)
High education	48.9	(43.5-54.3)
Total (women and men)	**17.9**	**(17.3-18.5)**

Men	%	(95% CI)
Men total	**13.9**	**(13.0-14.8)**
18-29 Years	0.4	(0.2-1.2)
Low education	0.2	(0.0-1.4)
Medium education	0.5	(0.1-2.1)
High education	0.7	(0.2-2.2)
30-44 Years	4.1	(3.2-5.3)
Low education	4.4	(1.9-9.9)
Medium education	4.3	(3.0-6.0)
High education	3.7	(2.5-5.5)
45-64 Years	16.6	(15.2-18.2)
Low education	19.2	(15.1-24.0)
Medium education	18.7	(16.5-21.2)
High education	12.0	(10.3-13.9)
≥65 Years	31.2	(28.9-33.7)
Low education	31.7	(27.0-36.8)
Medium education	32.6	(29.2-36.3)
High education	28.6	(25.2-32.2)
Total (women and men)	**17.9**	**(17.3-18.5)**

CI=Confidence interval

Around 22% of women and 14% of men suffer from osteoarthritis during the past twelve months.

ple with higher levels of education report osteoarthritis significantly less often than those from a medium- or low-education background. For the other age groups no significant differences by level of education were observed.

Stratified by federal state there are no regional differences in the prevalence of osteoarthritis.

Comparisons between these results and the findings of previous national health surveys regarding the prevalence of osteoarthritis in Germany are difficult: Methods regarding both the collection of data (telephone interview, paper-based questionnaire, interview by physician) as well as the operationalisation (how questions were posed) of indicators have changed over time, which can lead to discrepancies in prevalence estimates. Personal interaction between interviewers and interviewees and thus, possibilities to clarify questions, for example, can have an impact on responses. Similarly, the composition of a survey's population sample (for example according to age, sex, social status, acute pain) can also lead to discrepancies in prevalence estimates between different surveys [11, 12]. In its 2012 interview survey (GEDA 2012) the Robert Koch Institute reported that 24.5% of women and 16.1% of men aged 18 and over had ever been diagnosed with osteoarthritis or another degenerative joint disease by a physician and that this

Osteoarthritis rates increase with age and particularly during people's second half of life. Nearly half of all women and one third of all men aged 65 and over suffer from osteoarthritis.

Among persons in middle adulthood, osteoarthritis prevalence is lower among women and men with high education than among women and men with medium or low education.

osteoarthritis had persisted into the past twelve months. The available sex-stratified results on the 12-month prevalence of osteoarthritis from GEDA 2014/2015-EHIS are marginally lower, which might be due to the fact that the question here did not include degenerative joint disease. The German Health Interview and Examination Survey for Adults (DEGS1, 2008-2011) surveyed the lifetime prevalence of a medical diagnosis of osteoarthritis or other degenerative joint disease among adults aged 18- to 79-years based on personal interviews. Compared to current prevalence estimates, DEGS1 results for women (22.3%) did not differ much, whereas the estimates for men (18.1%) were significantly higher than in the current study [13]. Results on osteoarthritis prevalence among adults aged 18 to 79 years from an even earlier German national health survey are also not comparable to the current analysis, neither regarding how the question was posed (asking whether a physician had ever diagnosed osteoarthritis or another degenerative joint disease of the hips, knees or spine), nor regarding the timespan (ever diagnosed, persisted into the past four weeks). In this earlier analysis, the estimated overall prevalence was 27.7%. Significantly higher prevalence rates among women were only evident for the older age groups [14]. All publications consistently reveal a significant increase in osteoarthritis prevalence for the second half of life [3, 12, 13, 15].

GEDA 2014/2015-EHIS did not assess the localisation of osteoarthritis. DEGS1 results [11] reveal that in more than half of participants osteoarthritis affected the knee and in about one quarter the hip joint. Around one third of women and one seventh of men reported osteoarthritis in their finger joints. Half of those suffering osteoarthritis reported further joints were affected as well.

Overall, osteoarthritis is a common disease among older people in Germany. Joint pain and loss of function are likely to lead to a loss of quality of life. Osteoarthritis in the lower extremities (hips and knees) obviously involves a higher degree of loss of mobility than osteoarthritis in the upper extremities (fingers, hands and shoulders). Preventive healthcare strategies should first and foremost focus on preventing obesity and joint injuries. With patients who have already developed osteoarthritis the focus should be on maintaining joint functionality. Establishing a continuous database for analyses of time trends as well as collecting additional information through interview and examination surveys on comorbidity, loss of function, administered medications, joint replacements or joint pains will be key to describing the development of osteoarthritis (see the Fact sheet in this issue).

References

1. Woolf AD, Pfleger B (2003) Burden of major musculoskeletal conditions. Bull World Health Organ 81(9):646-656

2. World Health Organization (WHO) (2003) The burden of musculoskeletal conditions at the start of the new millennium. Report of a WHO Scientific Group Technical Report Series. Geneva, P. i-x, 1-218

3. Robert Koch-Institut (eds) (2013) Arthrose. Gesundheitsberichterstattung des Bundes. Heft 54. RKI, Berlin http://edoc.rki.de/documents/rki_fv/reu9tQIZR22VI/PDF/29EzIgbSU9wwE.pdf (As at 11.07.2017)

4. Choong P, Brooks P (2012) Achievements during the Bone and Joint Decade 2000–2010. Best Practice & Research Clinical Rheumatology 26(2):173-181

5. Palazzo C, Nguyen C, Lefevre-Colau MM et al. (2016) Risk factors and burden of osteoarthritis. Ann Phys Rehabil Med 59(3):134-138

6. Johnson VL, Hunter DJ (2014) The epidemiology of osteoarthritis. Best Pract Res Clin Rheumatol 28(1):5-15

7. Pereira D, Peleteiro B, Araujo J et al. (2011) The effect of osteoarthritis definition on prevalence and incidence estimates: a systematic review. Osteoarthritis Cartilage 19(11):1270-1285

8. Schaap LA, Peeters GM, Dennison EM et al. (2011) European Project on OSteoArthritis (EPOSA): methodological challenges in harmonization of existing data from five European population-based cohorts on aging. BMC Musculoskelet Disord 12:272

9. Eurostat (2016) International standard classification of education (ISCED). http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:International_standard_classification_of_education_%28ISCED%29 (As at 13.01.2017)

10. Lange C, Finger JD, Allen J et al. (in press) Implementation of the European Health Interview Survey (EHIS) in Germany. Further development of the German Health Update (GEDA) Archives of Public Health

11. Luong ML, Cleveland RJ, Nyrop KA et al. (2012) Social determinants and osteoarthritis outcomes. Aging health 8(4):413-437

12. Felson DT, Naimark A, Anderson J et al. (1987) The prevalence of knee osteoarthritis in the elderly. The Framingham Osteoarthritis Study. Arthritis Rheum 30(8):914-918

13. Fuchs J, Rabenberg M, Scheidt-Nave C (2013) Prevalence of selected musculoskeletal conditions in Germany. Results of the German Health Interview and Examination Survey for Adults (DEGS1). Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 56(5):678-686 http://edoc.rki.de/oa/articles/reT2unSMgvg/PDF/227lYT4toi5Rk.pdf (As at 11.07.2017)

14. Schneider S, Schmitt G, Mau H et al. (2005) Pravalenz und Korrelate der Osteoarthrose in der BRD. Reprasentative Ergebnisse des ersten Bundesgesundheitssurvey. Orthopade 34(8):782-790

15. Schneider S, Schmitt G, Mau H et al. (2005) Prevalence and correlates of osteoarthritis in Germany. Representative data from the First National Health Survey. Orthopade 34(8):782-790.

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin

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

Conflicts of interest
The authors declared no conflicts of interest.

Funding
The GEDA study was funded by the Robert Koch Institute and the German Federal Ministry of Health.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
Fuchs J, Kuhnert R, Scheidt-Nave C (2017) 12-month prevalence of osteoarthritis in Germany. Journal of Health Monitoring 2(3):51–56
DOI 10.17886/RKI-GBE-2017-066

ISSN 2511-2708

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

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-067
Robert Koch Institute, Berlin

Authors:
Judith Fuchs, Christa Scheidt-Nave, Ronny Kuhnert

12-month prevalence of osteoporosis in Germany

Abstract
Osteoporosis is a systemic skeletal disease associated with increased bone fragility, which correspondingly leads to increased bone fractures. In the GEDA 2014/2015-EHIS survey, 7.8% of women and 2.0% of men aged 18 and over reported suffering from osteoporosis during the past 12 months. The share of people reporting osteoporosis increases considerably in the age group 65 and over. Elder women significantly more often report osteoporosis than men. As this was the first time the present indicator for the 12-month prevalence of osteoporosis was evaluated in the context of the European Health Interview Survey (EHIS) 2014/2015, there is no comparative data available.

OSTEOPOROSIS · PREVALENCE · ADULTS · HEALTH MONITORING · GERMANY

Introduction
The Umbrella Organization for Osteology (Dachverband Osteologie) defines osteoporosis as a systemic skeletal disease that is characterised by low bone mass and a microarchitectural deterioriation of bone tissue which results in greater bone fragility [1]. With osteoporosis patients, external causes that would not normally affect a healthy bone can already cause bone fractures (fragility fractures). These fragility fractures most commonly occur in the vertebrae, the upper parts of the thigh bone close to the hip (femoral neck and trochanteric region) as well as the forearm close to the wrist (in particular the distal radius) [2].

Various factors contribute to osteoporosis. There are behavioural risk factors, which persons can influence such as a lack of physical exercise and dietary habits, as well as further risk factors such as underlying diseases and also certain medications. These risks can be reduced by treating the underlying causes or by adapting behaviour. Moreover, there are also non-modifiable factors such as age, female gender and familial predisposition [1].

Osteoporosis has health policy relevance mainly because osteoporosis incidence rates and the consequences of fragility fractures increase with age. Fractures of the thigh bone close to the hip as well as of the vertebrae particularly impact people's quality of life and their ability to live independently. Unlike fractures of the vertebrae, which often go unrecognised, fractures of the bone close to the hip joint are rarely overlooked and therefore treated in hospital. Hip fracture surgery and subsequent rehabilitation, as well as age-related co- and multi-morbidity issues generate high costs to the health system [3, 4].

Indicator
The osteoporosis indicator in the GEDA 2014/2015-EHIS health interview survey was calculated using a self-administered paper-based or online questionnaire. Numer-

GEDA 2014/2015-EHIS

Data holder: Robert Koch Institute

Aims: To provide reliable information about the population's health status, health-related behaviour and health care in Germany, with the possibility of a European comparison

Method: Questionnaires completed on paper or online

Population: People aged 18 years and above with permanent residency in Germany

Sampling: Registry office sample; randomly selected individuals from 301 communities in Germany were invited to participate

Participants: 24,016 people (13,144 women; 10,872 men)

Response rate: 26.9%

Study period: November 2014 - July 2015

Data protection: This study was undertaken in strict accordance with the data protection regulations set out in the German Federal Data Protection Act and was approved by the German Federal Commissioner for Data Protection and Freedom of Information. Participation in the study was voluntary. The participants were fully informed about the study's aims and content, and about data protection. All participants provided written informed consent.

More information in German is available at www.geda-studie.de

ous diseases and conditions were surveyed by asking: 'During the past twelve months have you had any of the following diseases or conditions?' and: 'Has a physician ever diagnosed you with any of the following diseases or conditions?' followed by a list of diseases. Respondents were asked to provide information on whether they had had osteoporosis during the past twelve months. The results were presented stratified by gender, age group and education. Differences between these groups are interpreted as statistically significant if the respective confidence intervals do not overlap.

The following analyses are based on the data from 22,344 participants aged 18 and over (12,270 women, 10,074 men) with valid information on having suffered from osteoporosis during the past 12 months. The calculations were carried out using a weighting factor that corrects for deviations within the sample from the German population (as of 31 December 2014) with regard to gender, age, district type and education. District type reflects a particular area's degree of urbanisation and accounts for the regional distribution found in Germany. The International Standard Classification of Education (ISCED) was used to classify the responses provided on educational level [5]. Lange et al 2017 [6] provides a detailed description of the methodology applied in GEDA 2014/2015-EHIS, as does the article German Health Update: New data for Germany and Europe, which was published in Issue 1/2017 of the Journal of Health Monitoring.

Results and discussion

7.8% of women and 2.0% men reported having suffered from osteoporosis during the past 12 months (Table 1). The share of people reporting osteoporosis increases considerably with age. Young and middle-aged adults only rarely report osteoporosis. Prevalence in the age group under 45 is below 1% for both genders (Table 1). In the age group 45 to 64, 4.4% of women and 1.9% of men report osteoporosis. Beyond the age of 65 osteoporosis rates increase significantly: nearly one quarter of women (24%) and 5.6% of men are affected. Osteoporosis rates are significantly higher among women in the age groups 45 to 64 and 65 and over than among men.

Osteoporosis prevalence is significantly higher among women aged 45 to 64 with a low-education background (7.2%) than among those with a medium- (4.0%) or high-education (2.9%) background. Low overall rates of osteoporosis in the other age groups allow no conclusions on the significance of levels of education for differences in osteoporosis prevalence in these groups. Possible links between prevalence and education are subject to controversial discussion among researchers [7], and need to be proved by further studies. These will also need to consider changes in the prescription of hormone replacement therapy, which also affects bone structure.

There are no regional differences in osteoporosis prevalence between federal states.

Estimates on the prevalence of osteoporosis vary depending on the type of data collection, sources and the composition of the survey population. Given that guidelines on the diagnosis and treatment of osteoporosis have changed in recent years [1], comparisons of results need to take into account the time period in which data was collected. However, sex differences regarding the preva-

Table 1
12-month prevalence of osteoporosis by gender, age and educational level (n=12,270 women; n=10,074 men)
Source: GEDA 2014/2015-EHIS

Women	%	(95% CI)
Women total	**7.8**	**(7.2-8.5)**
18-29 Years	0.3	(0.1-1.1)
Low education	-	-
Medium education	0.4	(0.1-1.8)
High education	-	-
30-44 Years	0.7	(0.4-1.2)
Low education	1.8	(0.6-4.8)
Medium education	0.8	(0.4-1.5)
High education	-	-
45-64 Years	4.4	(3.7-5.1)
Low education	7.2	(5.2-9.9)
Medium education	4.0	(3.2-5.0)
High education	2.9	(2.0-4.2)
≥65 Years	24.0	(21.9-26.2)
Low education	25.9	(22.9-29.1)
Medium education	23.4	(20.6-26.4)
High education	18.2	(14.0-23.2)
Total (women and men)	**5.0**	**(4.6-5.4)**

Men	%	(95% CI)
Men total	**2.0**	**(1.7-2.4)**
18-29 Years	0.3	(0.1-0.8)
Low education	0.5	(0.1-2.3)
Medium education	0.3	(0.1-0.9)
High education	-	-
30-44 Years	0.5	(0.2-1.0)
Low education	1.2	(0.4-4.2)
Medium education	0.5	(0.2-1.3)
High education	0.2	(0.0-0.8)
45-64 Years	1.9	(1.4-2.6)
Low education	2.7	(1.3-5.7)
Medium education	2.4	(1.7-3.4)
High education	0.7	(0.4-1.3)
≥65 Years	5.6	(4.5-6.9)
Low education	9.0	(6.3-12.8)
Medium education	5.3	(3.9-7.2)
High education	4.6	(3.2-6.5)
Total (women and men)	**5.0**	**(4.6-5.4)**

CI=Confidence interval

Around 8% of women and 2% of men aged 18 and over reported osteoporosis during the past 12 months.

The share of people reporting osteoporosis increases considerably with age.

lence of self-reported osteoporosis, which are described in this Fact sheet, are confirmed by all previous national surveys that have been conducted in Germany [8-11].

Comparability with the results from a previous telephone interview survey conducted by the Robert Koch Institute in 2012 (GEDA 2012) are limited due to differences in posing the question (time frame: ever vs. 12-months; physician diagnosis vs. self-assessment). Due to EHIS regulations, GEDA 2014/2015-EHIS, was conducted using a new system of data collection. The survey for the first time collected data on the 12-month prevalence of diseases and used the results for comparisons between EU countries.

Overall, the new indicator for the prevalence of osteoporosis in Germany reveals the characteristic pattern of a common and age-related chronic disease with a typically higher prevalence among women compared to men. Current recommendations for osteoporosis prophylaxis include regular physical exercise, preventing immobility and falls as well as ensuring a sufficient intake of calcium and vitamin D. Doctors should also assess whether patients take prescribed medications that increase the risk of fractures. Risks-and-benefits analyses can help to establish the usefulness of such medication on a case-to-case basis [1].

Women aged 45 and older significantly more often report osteoporosis than men.

References

1. Dachverband Osteologie (DVO) (2014) Prophylaxe, Diagnostik und Therapie der Osteoporose bei Männern ab dem 60. Lebensjahr und bei postmenopausalen Frauen. Leitlinie des Dachverbands der Deutschsprachigen Wissenschaftlichen Osteologischen Gesellschaften e.V.
2. World Health Organization (WHO) (1998) Guidelines for preclinical evaluation and clinical trials in osteoporosis. WHO, Geneva
3. Endres HG, Dasch B, Lungenhausen M et al. (2006) Patients with femoral or distal forearm fracture in Germany: a prospective observational study on health care situation and outcome. BMC Public Health 6(1):87
4. Schumacher J, Thiem U, Smektala R et al. (2007) Osteoporose und Sturz: medizinische Versorgung älterer Menschen mit einem erhöhten Frakturrisiko in Deutschland. Zeitschrift für ärztliche Fortbildung und Qualität im Gesundheitswesen - German Journal for Quality in Health Care 101(9):593-597
5. Eurostat (2016) International standard classification of education (ISCED). http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:International_standard_classification_of_education_%28ISCED%29 (As at 13.01.2017)
6. Lange C, Finger JD, Allen J et al. (in press) Implementation of the European Health Interview Survey (EHIS) in Germany. Further development of the German Health Update (GEDA) Archives of Public Health
7. Brennan SL, Pasco JA, Urquhart DM et al. (2009) The association between socioeconomic status and osteoporotic fracture in population-based adults: a systematic review. Osteoporos Int 20(9):1487-1497
8. Hadji P, Klein S, Gothe H et al. (2013) Epidemiologie der Osteoporose – Bone Evaluation Study: Eine Analyse von Krankenkassen-Routinedaten. Dtsch Arztebl International 110(4):52-57
9. Haussler B, Gothe H, Gol D et al. (2007) Epidemiology, treatment and costs of osteoporosis in Germany--the BoneEVA Study. Osteoporos Int 18(1):77-84
10. Fuchs J, Rabenberg M, Scheidt-Nave C (2013) Prevalence of selected musculoskeletal conditions in Germany. Results of the German Health Interview and Examination Survey for Adults (DEGS1). Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 56(5):678-686 http://edoc.rki.de/oa/articles/reT2unSMgvg/PDF/227lYT4toi5Rk.pdf (As at 13.07.2017)
11. Scheidt-Nave C, Starker A (2003) The prevalence of osteoporosis and associated health care use in women 45 years and older in Germany. Results of the first German Telephone Health Survey 2003.Bundesgesundheitsbl Gesundheitsforsch Gesundheitsschutz 2005;48(12):1338-1347

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin

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

Conflicts of interest
The authors declared no conflicts of interest.

Funding
The GEDA study was funded by the Robert Koch Institute and the German Federal Ministry of Health.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
Fuchs J, Scheidt-Nave C, Kuhnert R (2017) 12-month prevalence of osteoporosis in Germany. Journal of Health Monitoring 2(3):57–61
DOI 10.17886/RKI-GBE-2017-067

ISSN 2511-2708

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

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-068
Robert Koch Institute, Berlin

Authors:
Judith Fuchs, Franziska Prütz

Prevalence of joint pain in Germany

Abstract

Joint symptoms and pain belong to the most common diseases worldwide that affect people in their usual activities and lead to loss of quality of life. 29.3% of women and 24.4% of men reported acute joint pain, which is defined as pain suffered during the past 24 hours. With age, these figures increase. Women report pain in 3.9 joints on average and men in 3.6. In both genders the joints most affected are the shoulders, knees and hips. Respondents suffering from joint pain significantly more often report medically diagnosed osteoarthritis or rheumatoid arthritis than respondents who were free of pain.

JOINT PAIN · OSTEOARTHRITIS · ADULTS · HEALTH MONITORING · GERMANY

Introduction

Joint symptoms and pain belong to the most common diseases worldwide. They affect people in their everyday lives and can lead to loss of quality of life [1]. Most commonly joint pain is caused by a musculoskeletal disease such as osteoarthritis (see the Fact sheet in this issue) or rheumatoid arthritis (RA) [2]. The diagnosis of joint diseases and provision of corresponding care leads to considerable costs to the healthcare system [3].

The International Association for the Study of Pain (IASP) defines pain as ‘an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage’ [4]. There are two types of pain: acute and chronic. Acute pain lasts seconds to maximally weeks and has a clearly defined trigger. Chronic pain, in contrast, is not necessarily linked to such damaging factors and is characterised as being permanent or recurrent and lasting for a period of at least three months [5]. Chronic pain is a complex and multidimensional phenomenon influenced by somatic, psychological and social factors [6].

Indicator

For the German Health Interview and Examination Survey for Adults (DEGS1) respondents received a questionnaire asking: ‘Have you had joint pains during the past 12 months?’ and, if yes: ‘Have you had joint pain today?’, which was more narrowly defined by adding: ‘Meaning during the past 24 hours’. This was followed by a table where participants were asked to mark the intensity of their pain during the past 24 hours. The table listed the right and left shoulders, elbows, wrists, fingers, hips, knees, ankles and toes. Pain could be marked as low, medium or strong.

The following sections present data on joint pain by gender, age and educational level, describe which joints are most commonly affected and analyse the rate at which people with joint pains are affected by medically diag-

DEGS1

Data holder: Robert Koch Institute

Objectives: To provide reliable information about the population's health status, health-related behaviour and health care in Germany including analysis of temporal developments and trends.

Survey method: Questionnaires, physical examinations and tests, a physician interview, a medication interview and laboratory investigations (blood and urine sample).

Population: German resident population, aged 18 and above

Sampling: Registry office sample; randomly selected individuals from 180 communities in Germany were invited to participate (120 original sample points of the German National Health Interview and Examination Survey 1998 and 60 new sample points).

Participants: N=8,151 (4,283 women; 3,868 men). The sample included persons who were newly recruited and those who had already participated in the German National Health Interview and Examination Survey 1998 (mixed design).

Response rate: 62% among revisiting participants and 42% first time participants

Survey period: 2008 to 2011

Data protection: This study was undertaken in strict accordance with the data protection regulations set out in the German Federal Data Protection Act and was approved by the German Federal Commissioner for Data Protection and Freedom of Information. DEGS1 was approved by the ethics committee of the Charité-Universitätsmedizin Berlin (No. EA2/047/08). Participation in the study was voluntary. The participants were fully informed about the study's aims and content, and about data protection. All participants provided written informed consent.

More information in German is available at www.degs-studie.de

nosed musculoskeletal diseases such as osteoarthritis, RA or osteoporosis. Differences between groups are interpreted as statistically significant if the respective 95% confidence intervals (CI) of relative frequencies do not overlap.

The analyses are based on data from 7,727 participants aged between 18 and 79 (4,061 women, 3,666 men) with valid data on joint pain. The calculations were carried out using a weighting factor that corrects for deviations within the sample from the German population (as of 31 December 2010) with regard to gender, age, region and nationality, as well as district type and educational level [7]. The district type accounts for the degree of urbanisation and reflects the regional distribution in Germany. The International Standard Classification of Education (ISCED) was used to classify the responses provided on educational level [8]. Scheidt-Nave et al. contains a detailed discussion of the methodology applied in DEGS1 [9].

Results and discussion

57.9% of women and 52.2% of men reported experiencing joint pain during the past 12 months. 29.3% of women and 24.4% of men stated acute joint pain, i.e. that they had suffered from pain during the past 24 hours. With increasing age, the percentage of people experiencing acute joint pain increases. For women it rises from 9.0% among 18- to 29-year-olds to 48% among 65- to 79-year-olds and for men from 11.4% to 34.9% respectively (Table 1).

Women with low education report joint pains more frequently (35.3%) than women from medium (28.6%) or high (24.3%) education backgrounds. No such difference exists for men.

Whilst women report that 3.9 joints were affected on average during the past 24 hours, the corresponding figure for men is 3.6. For both sexes the most frequently reported joints causing pain are the shoulders, knees and hips. Overall, 17.3% of women and 15.1% of men report knee pain, 14.1% of women and 11.6% of men shoulder pain, and 13.3% of women and 11.9% of men pain in the hip joints. Both sides of the body are equally affected (Figure 1 and Figure 2). The percentage of people experiencing strong joint pain is low, and, independently of the joint affected, strong pain is only reported by between 0.2% and 2.2% of respondents.

DEGS1 prevalence rates are slightly lower than those reported in the survey conducted in the town of Herne in 2005 [10], which conservatively estimated that 28.9% of respondents were suffering from acute joint pain. 18.2% of participants reported knee pain and 9.1% hip pain. However, the age span of respondents in this survey (40- to 95-years old) is not immediately comparable to the DEGS sample.

Women with joint pain significantly more often report a medically diagnosed osteoarthritis (46.1%, CI 42.9-49.3) than women without joint pain (12.0%, CI 10.6-15.5). For men, the corresponding share is 40.6% (CI 36.8-44.4) and 10.4% (CI 9.2-11.8). People with joint pain also reported a medically diagnosed RA more often (women: 5.7%, CI 4.4-7.4; men: 5.5%, CI 3.9-7.8) than people who were free of joint pain (women: 1.7%, CI 1.2-2.4; men: 0.7%, CI 0.4-1.3).

Further diseases such as gout, morbus Bechterew or psoriatic arthritis may also lead to joint pain. The same

Table 1
Joint pain according to gender, age and educational level (n = 4,061 women, 3,666 men)
Source: DEGS1

Women	%	(95% CI)
12-month prevalence of joint symptoms		
Women	**57.9**	**(56.1-59.6)**
Total (women and men)	**55.1**	**(53.6-56.5)**
Joint symptoms during the past 24 hours		
Women total	**29.3**	**(27.7-31.0)**
Age		
18-29 Years	9.0	(6.6-12.0)
30-44 Years	16.8	(13.9-20.1)
45-64 Years	37.9	(34.9-41.0)
65-79 Years	48.0	(43.9-52.0)
Educational level		
Low education	35.3	(31.6-39.1)
Medium education	28.6	(26.4-30.8)
High education	24.3	(21.4-27.4)
Total (women and men)	**26.9**	**(25.7-28.1)**

Men	%	(95% CI)
12-month prevalence of joint symptoms		
Men	**52.2**	**(50.1-54.3)**
Total (women and men)	**55.1**	**(53.6-56.5)**
Joint symptoms during the past 24 hours		
Men total	**24.4**	**(22.9-26.1)**
Age		
18-29 Years	11.4	(8.6-14.9)
30-44 Years	15.4	(12.7-18.6)
45-64 Years	32.7	(30.1-35.5)
65-79 Years	34.9	(31.1-38.9)
Educational level		
Low education	22.2	(17.5-27.7)
Medium education	25.7	(23.5-28.1)
High education	23.2	(20.6-26.0)
Total (women and men)	**26.9**	**(25.7-28.1)**

CI=Confidence interval

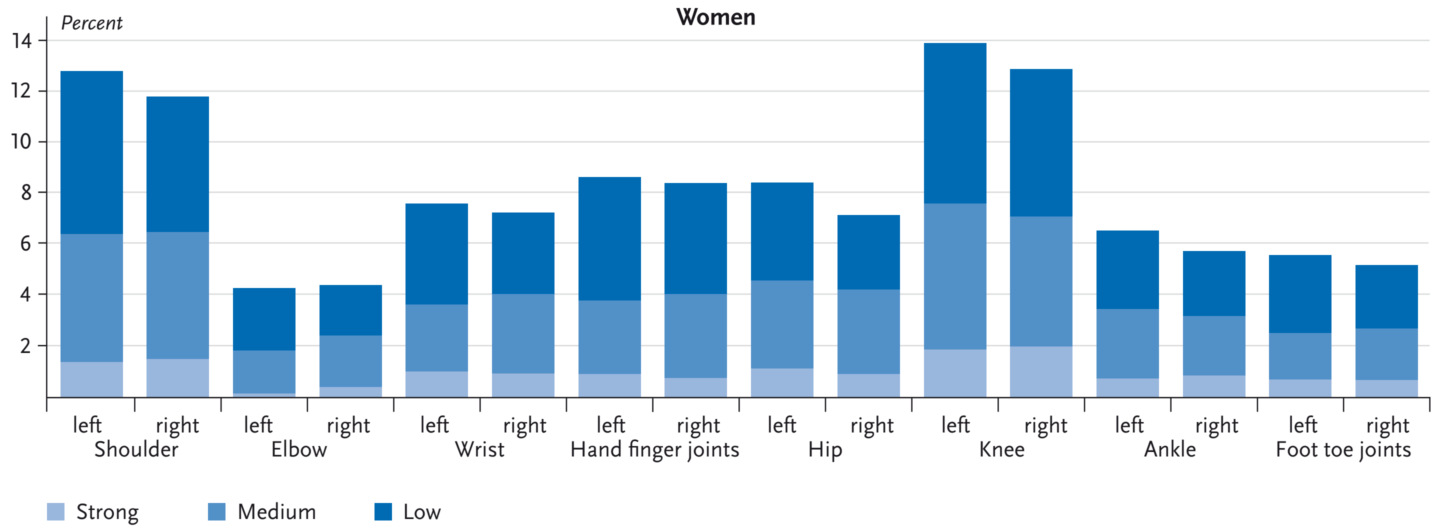
Around 29% of the women and 24% of the men surveyed reported having experienced joint pains during the past 24 hours.

Joint pain rates increase significantly with age.

is true for sports or other accidents, such as in the case of a torn meniscus.

For musculoskeletal diseases, which are a major cause of joint pain, there is currently no cure. This highlights the importance of identifying those factors that effectively prevent pain and loss of functionality. Obesity and a lack of physical exercise can contribute to pain particularly in the joints of the lower extremities [11, 12]. Focus should therefore be put on preventing overweight, promoting physical exercise and the proper prescription of medicines including pain relievers.

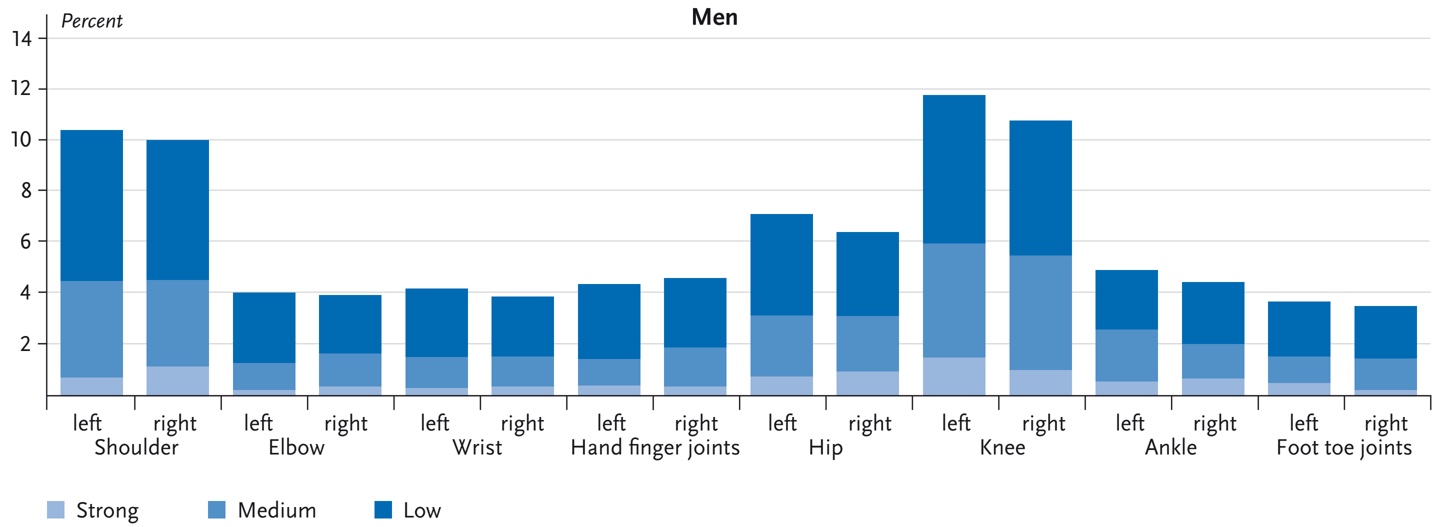
Figure 1
Localisation of joint pain and pain intensity among women (n=4,061)
Source: DEGS1



Pain generally affects more than just one joint.

People who report joint pain more often have osteoarthritis and rheumatoid arthritis than people without pain.

Figure 2
Localisation of joint pain and pain intensity among men (n=3,666)
Source: DEGS1



References

1. Keenan AM, Tennant A, Fear J et al. (2006) Impact of multiple joint problems on daily living tasks in people in the community over age fifty-five. Arthritis Rheum 55(5):757-764

2. Woolf AD, Pfleger B (2003) Burden of major musculoskeletal conditions. Bull World Health Organ 81(9):646-656

3. Kruschinski C, Wiese B, Dierks ML et al. (2016) A geriatric assessment in general practice: prevalence, location, impact and doctor-patient perceptions of pain. BMC Family Practice 17:8

4. International Association for the Study of Pain Task Force on Taxonomy (1994) Classification of Chronic Pain (2nd edn), Seattle

5. Kröner-Herwig B (1996) Chronischer Schmerz — Eine Gegenstandsbestimmung. In: Basler H-D, Franz C, Kröner-Herwig B et al. (eds) Psychologische Schmerztherapie: Grundlagen · Diagnostik · Krankheitsbilder Behandlung. Springer Berlin Heidelberg, Berlin, Heidelberg, P. 3-21

6. Institute of Medicine Committee on Advancing Pain Research CE (2011) The National Academies Collection: Reports funded by National Institutes of Health Relieving Pain in America: A Blueprint for Transforming Prevention, Care, Education, and Research. National Academies Press (US) National Academy of Sciences, Washington (DC)

7. Kamtsiuris P, Hoffmann R, Schaffrath Rosario A et al. (2013) The first wave of the German Health Interview and Examination Survey for Adults (DEGS1) – Sampling design, response, weighting, and representativeness. Bundesgesundheitsbl Gesundheitsforsch Gesundheitsschutz 56(5/6):620-630 http://edoc.rki.de/oa/articles/re8iyCUiEOAw/PDF/22jo4AL9eLDTQ.pdf (As at 15.06.2017)

8. Eurostat (2016) International standard classification of education (ISCED). http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:International_standard_classification_of_education_%28ISCED%29 (As at 13.01.2017)

9. Scheidt-Nave C, Kamtsiuris P, Goesswald A et al. (2012) German health interview and examination survey for adults (DEGS) - design, objectives and implementation of the first data collection wave. BMC Public Health 12(1):730

10. Thiem U, Lamsfuss R, Gunther S et al. (2013) Prevalence of self-reported pain, joint complaints and knee or hip complaints in adults aged >/= 40 years: a cross-sectional survey in Herne, Germany. PLoS One 8(4):e60753

11. Bindawas SM (2016) Relationship between frequent knee pain, obesity, and gait speed in older adults: data from the Osteoarthritis Initiative. Clin Interv Aging 11:237-244

12. Connelly AE, Tucker AJ, Kott LS et al. (2015) Modifiable lifestyle factors are associated with lower pain levels in adults with knee osteoarthritis. Pain Res Manag 20(5):241-248

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin

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

Conflicts of interest
The authors declared no conflicts of interest.

Funding
The DEGS study was funded by the Robert Koch Institute and the German Federal Ministry of Health.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
Fuchs J, Prütz F (2017) Prevalence of joint pain in Germany. Journal of Health Monitoring 2(3):62–67
DOI 10.17886/RKI-GBE-2017-068

ISSN 2511-2708

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

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-069
Robert Koch Institute, Berlin

Authors:
Julia Thom, Ronny Kuhnert,
Sabine Born, Ulfert Hapke

12-month prevalence of self-reported medical diagnoses of depression in Germany

Abstract

Depression is a frequent mental disorder and has a growing importance in health care provision. In GEDA 2014/2015-EHIS, 9.7% of women and 6.3% of men self-reported having received a medical diagnosis of depression during the past 12 months. For both genders, the rate of self-reported diagnoses of depression is highest in the 45- to 64-year age group. Education thereby plays a significant role. Prevalence for women from low education is about double that of women from high education backgrounds (12.2% compared with 6.5%). The education gradient for men is smaller (7.5% compared with 5.1%). Prevalence rates also differ sharply between federal states (for women, between 5.4% and 13.4%; for men, between 3.3% and 9.4%). These results are discussed in the light of data currently available.

DEPRESSION · MEDICAL DIAGNOSIS · ADULTS · HEALTH MONITORING · GERMANY

Introduction

Depression is a mental disorder that is characterised by despondency, lack of motivation, severe weariness and the loss of interest in activities that used to produce pleasure [1]. Further symptoms include difficulties concentrating, a lack of self-confidence and suicidal tendencies in more severe cases. For those affected, depression implies severe impacts on quality of life and the ability to lead a productive life [2]. Among all chronic diseases, depression accounts for the greatest number of disability-adjusted years of life [3] and is considered to be a factor in at least half of all accomplished suicides [4]. Social insurance policies document the increasing care relevance of depression and its role in cases where people become incapable of working, require rehabilitation services and/or retire [5-8]. However, based on the epidemiological data available, the rate of depression in the population is a controversial issue [9-11]. To measure the prevalence of depression, beside further indicators, health monitoring at the Robert Koch Institute also collects data on self-reported medical diagnoses of depression.

Indicator

To survey self-reported medical diagnoses of depression, the GEDA 2014/2015-EHIS survey used self-administered paper-based and online questionnaires. Respondents were asked, 'During the past 12 months, have you had one of the following diseases or disorders?', followed by a list of diseases which also included depression. In the face of previous surveys and to increase the interpretive and comparative value of this data, the discussion in the

GEDA 2014/2015-EHIS

Data holder: Robert Koch Institute

Aims: To provide reliable information about the population's health status, health-related behaviour and health care in Germany, with the possibility of a European comparison

Method: Questionnaires completed on paper or online

Population: People aged 18 years and above with permanent residency in Germany

Sampling: Registry office sample; randomly selected individuals from 301 communities in Germany were invited to participate

Participants: 24,016 people (13,144 women; 10,872 men)

Response rate: 26.9%

Study period: November 2014 - July 2015

Data protection: This study was undertaken in strict accordance with the data protection regulations set out in the German Federal Data Protection Act and was approved by the German Federal Commissioner for Data Protection and Freedom of Information. Participation in the study was voluntary. The participants were fully informed about the study's aims and content, and about data protection. All participants provided written informed consent.

More information in German is available at www.geda-studie.de

following sections only considers respondents who said they had suffered from depression during the past 12 months and also reported having been 'diagnosed at least once by a doctor' with depression. This led to the exclusion of 26.4% (n=657) of respondents who reported depression during the past 12 months but failed to provide a lifetime medical diagnosis.

Whilst such an approach allows for efficient estimates on the prevalence of depression and is also widely used in international health surveys [12, 13], the approach is nonetheless tied to numerous prerequisites and therefore also has its limitations. Respondents need to have 1) consulted a physician; 2) received the diagnosis of depression; 3) this diagnosis needs to meet the diagnostic criteria; and 4) be reported by a physician. When taking part in the survey, the respondent moreover needs to 5) remember having received the diagnosis and 6) be willing to report the diagnosis. Furthermore, this is based on the assumption that psychological psychotherapists who offer specialist medical care and also provide diagnoses of depression are categorised as a sub-group within the larger group of physicians.

The analyses are based on data from 23,179 participants aged 18 years and older (12,777 women and 10,402 men) with valid data on self-reported medical diagnoses of depression. The calculations were carried out using a weighting factor that corrects for deviations within the sample from the German population (as of 31 December 2014) with regard to gender, age, district type and education. The district type reflects the degree of urbanisation and accounts for the regional distribution in Germany. The International Standard Classification of Education (ISCED) was used to classify the responses provided on educational level [14]. Differences between these groups are interpreted as statistically significant if the respective confidence intervals do not overlap.

A detailed description of the methodology used in the GEDA 2014/2015-EHIS study can be found in Lange et al. 2017 [15] as well as in the article German Health Update: New data for Germany and Europe, which was published in Issue 1/2017 of the Journal of Health Monitoring.

Results and discussion

This section presents the results of the analyses, discusses them in the context of further findings from health monitoring and contrasts them with an analysis of the data received from health insurance funds.

The 12-month prevalence of self-reported medical diagnoses of depression in the overall population was 8.1% (Table 1). Women (9.7%) report the diagnosis of depression significantly more often than men (6.3%). Prevalence in both genders is highest in the 45- to 64-year group. These findings confirm the known gender imbalance for mental disorders. The higher prevalence of depression among women compared with men is a classic and apparently stable epidemiological finding, a fact which is confirmed by studies that used numerous different forms of measurement, were implemented in various countries and over long periods of time [16]. Differences between the genders also exist regarding their willingness to seek help because faced with a depressive disorder women are more likely to seek therapy than men [17]. The debate on differences between the genders

Table 1
12-month prevalence of self-reported medical diagnoses of depression diagnosed by a physician according to gender, age and educational level (n=12,777 women; n=10,402 men)
Source: GEDA 2014/2015-EHIS

9.7% of women and 6.3% of men reported a medical diagnosis of depression during the past 12 months.

Women	%	(95% CI)
Women total	**9.7**	**(9.0-10.3)**
18-29 Years	8.1	(6.7-9.7)
Low education	12.3	(8.8-16.9)
Medium education	7.5	(6.0-9.4)
High education	3.6	(2.2-5.8)
30-44 Years	9.3	(8.0-10.8)
Low education	13.4	(9.3-18.9)
Medium education	10.2	(8.5-12.1)
High education	4.8	(3.6-6.4)
45-64 Years	11.8	(10.8-12.9)
Low education	15.1	(12.1-18.7)
Medium education	11.7	(10.4-13.1)
High education	9.3	(7.7-11.2)
≥65 Years	8.0	(6.7-9.5)
Low education	10.1	(7.9-12.8)
Medium education	6.9	(5.3-8.9)
High education	5.3	(3.4-8.1)
Total (women and men)	**8.1**	**(7.6-8.5)**

Men	%	(95% CI)
Men total	**6.3**	**(5.8-6.9)**
18-29 Years	4.3	(3.2-5.9)
Low education	7.0	(4.2-11.2)
Medium education	3.4	(2.3-4.9)
High education	3.8	(1.5-8.9)
30-44 Years	5.7	(4.5-7.2)
Low education	8.1	(4.5-14.1)
Medium education	6.6	(5.2-8.4)
High education	3.2	(2.1-5.0)
45-64 Years	8.5	(7.5-9.6)
Low education	9.1	(6.5-12.6)
Medium education	9.3	(7.8-11.0)
High education	7.0	(5.7-8.5)
≥65 Years	5.0	(4.0-6.1)
Low education	5.6	(3.7-8.3)
Medium education	5.2	(3.8-7.1)
High education	4.2	(2.9-5.9)
Total (women and men)	**8.1**	**(7.6-8.5)**

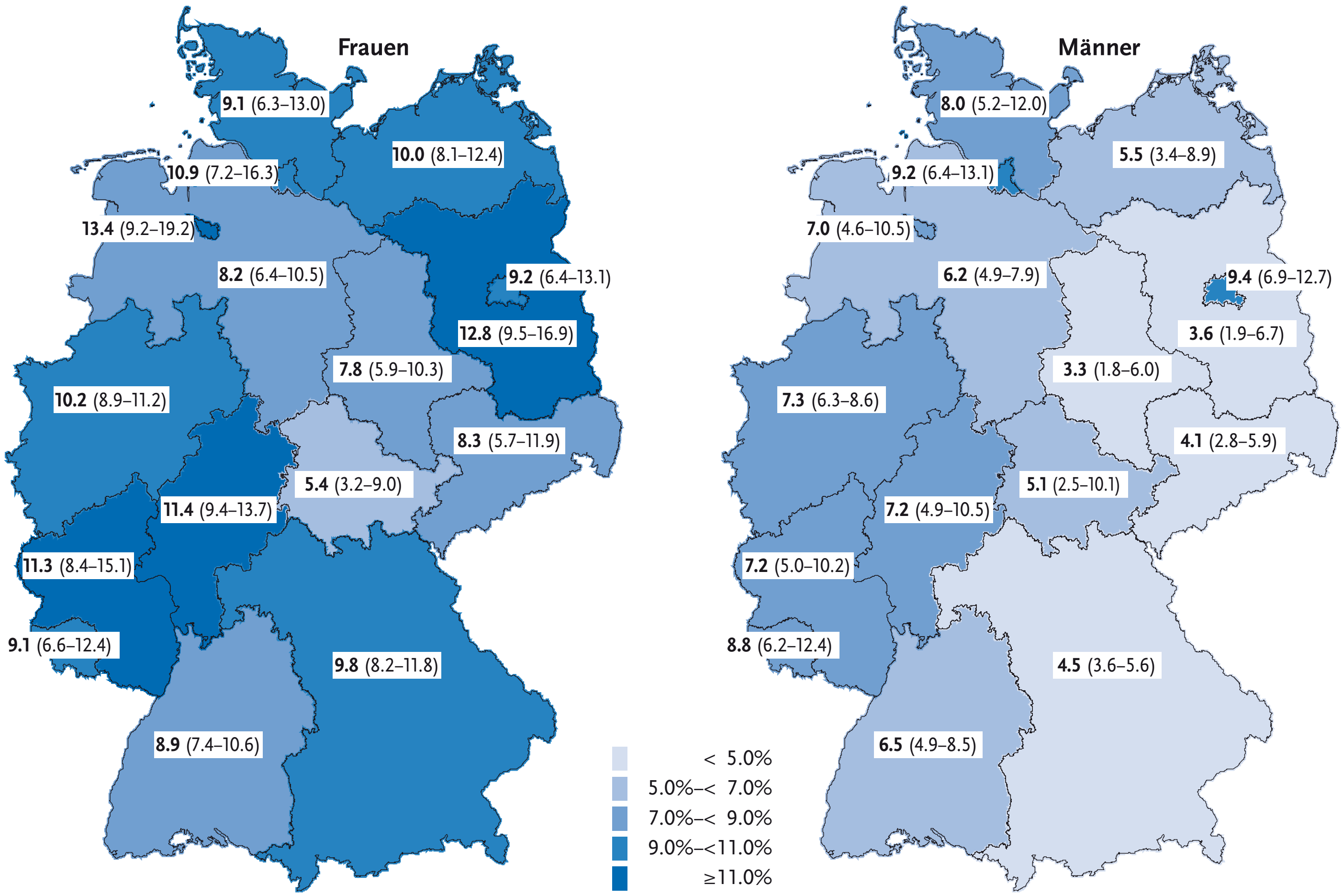
CI=Confidence interval

explains these facts by pointing to both biological mechanisms and the effects of gender roles as well as factors of social stress. On the other hand, these differences are also interpreted as a distortion which results from a selection of diagnostic criteria that more typically reflects female symptoms of depression and therefore underrates depression among men [18, 19].

Increasing levels of education almost halve the prevalence of self-reported medical diagnoses of depression in the overall population (low education of 10.5% vs. high education background of 5.6%, data not shown). The education gradient in the group of women up to the age of 64 with a diagnosed depression is stronger and statistically more relevant than for men. Besides age and gender, the year of data collection also impacts the correlation between education and the prevalence of self-reported medical diagnoses of depression [20-22]. When income and professional status are considered as factors next to education, this leads to equally inconsistent patterns [23-25].

Prevalence rates of self-reported medical diagnoses of depression vary considerably between federal states. Prevalence is highest in the city states (13.4% of women in Bremen and 9.4% of men in Berlin) (Figure 1). Prevalence in the federal states that report the lowest rates of self-reported medical diagnoses of depression is less

Figure 1
12-month prevalence of self-reported medical diagnoses of depression according to gender and federal state (n=12,777 women; n=10,402 men)
Source: GEDA 2014/2015-EHIS



Confidence intervals in parentheses

Significant differences in rates of self-reported medical diagnoses of depression exist between the federal states.

than half of this and affects 5.4% of women in Thuringia and 3.3% of men in Saxony-Anhalt. Excluding Bavaria, where prevalence is low, the map reveals an east to west gradient for men. Surveys from previous years [25] and data from health insurance funds [6, 11] evidence comparable differences between federal states. When comparing urban and rural areas, both of these sources of data highlight that prevalence is highest in the major cities and lowest in provincial towns [11, 23, 24]. In the accounts data from statutory health insurance funds, the frequency of depression diagnoses at the level of individual districts can vary by the factor 3 (between 5.3%

Prevalence of self-reported medical diagnoses of depression is highest at age 45 to 64.

and 18.2%) [26] and non-associated towns (between 7.2% and 21.4%) [11] even if regional differences are adjusted for age, gender and physical morbidity. Complex differences between regions must be taken into account to explain the unequal spatial distribution, such as varying concentrations of risk and protective factors, local factors that influence how willing the population is to seek help, local availability of treatment options as well as the frequency with which depression being treated is recognised and documented [26, 27]. As evidenced by a comparison with surveys from the past few years, the number of self-reported medical diagnoses of depression is no longer rising. Whereas in GEDA 2009, 8% of women and 4.5% of men reported depression [20], GEDA 2014/2015-EHIS results are comparable to the findings presented in GEDA 2012 (women 9.8%; men 6.1%) [22]. However, it has to be considered that the form of data collection has changed between these older surveys (a telephone interview) and GEDA 2014/15-EHIS (a self-administered paper-based or online questionnaire), which might have influenced responses.

This trend is also reflected in the diagnoses of depression according to the accounting data of health insurance funds. This data reveals a continuous increase in the reporting of medical classifications by physicians related to depressive disorders as a cause of incapacity to work over the past few years [6-8]. An evaluation of Company Health Insurance Fund (BKK) data reveals that depression-related absences from work more than doubled between 2003 and 2013 [8]. Using health insurance fund data to calculate values for the 12-month prevalence of depression would lead to rates between 10% and 13% depending on individual funds [11, 26, 28, 29]. Differences between the self-reported medical diagnoses of depression published in GEDA 2014/2015-EHIS and depression diagnoses as recorded by insurance funds exist for example concerning age distribution [6, 20-23, 26, 28]. These facts indicate conceptual differences between the data collected in surveys and accounting data [30]. Accounting data for example depends highly on the capacity of doctors to provide correct medical classifications and the validity of this data on depressive disorders is questionable [29, 31]. On the other hand, the significance of the survey data presented here depends on the degree with which the survey represents the population (response bias) as well as the above-mentioned limitations regarding the indicator itself (willingness to seek help, recall and reporting bias).

Whether a self-reported medical diagnosis of depression actually indicates depression according to clinical diagnostic criteria was a question that was analysed using data from the German Health Interview and Examination Survey for Adults (DEGS1) and its additional mental health module (DEGS1-MH) [32]. Standardised clinical interviews according to current classification criteria detect depression in only 37.2% of respondents who self-reported a medical diagnosis of depression during the past 12 months. 36.2% fulfil the criteria for a different mental disorder, whereas in 26.6% of cases the diagnosis reveals no mental disorder. On the other hand, only 33.0% of those who are diagnosed with depression in a clinical interview report a medical diagnosis of depression. Estimates on the prevalence of depression therefore both under- and overestimate the number of

cases depending on whether diagnostic criteria or self-reported medical diagnoses are used as a basis. Surveys that collect epidemiological data and link it to the data from health insurance funds could provide more differentiated results (data linkage).

If, instead of looking at the diagnoses physicians provide, we use a questionnaire to survey the presence of individual symptoms of depression during the past two weeks (PHQ-8 [33, 34]), 10.1% of the population show depressive symptoms. Women are affected more often than men, there are clear regional differences and contradictory findings related to age. Whereas women aged 18 to 29 show the highest rates of depressive symptoms, it is women aged 45 to 64 who most often report a medical diagnosis of depression. For men, the number of those with depressive symptoms nearly halves at age 65 and above, but remains constant up to that age. This also highlights the fact that pressures can only be reflected in documented diagnoses once patients turn to a doctor. Compared to men, women seek medical consultation more often, a fact which is also true for younger people compared to older people [35]. Physicians who diagnose depressive symptoms in a patient do not necessarily medically classify these as depression. This is the case when for example the number and severity of depressive symptoms is low and do not therefore fulfil the general diagnosis of the disorder or when patients present further symptoms that are then collectively classified as a different mental disorder.

The data on self-reported medical diagnoses of depression published in the health survey enable, as long as we consider the limitations described, a description of the people who receive the diagnosis of depression in the healthcare system. The socio-demographic, socio-economic and regional imbalances in rates of diagnosis of depression reflect as many differences in morbidity as levels of care provision between different groups in the population. An analysis of data based on standardised diagnosed depression within a clinical interview compared to self-reported medical diagnoses highlights that different indicators in epidemiology and healthcare services diagnose reveal different groups of people with depression. Clarifying these discrepancies could contribute to a provision of services according to need, for example through an increased use of screening instruments in medical practice.

The 12-month prevalence of self-reported medically diagnosed depression decreases with increasing education.

References

1. Dilling H, Mombour W, Schmidt MH et al. (eds) (2016) Internationale Klassifikation psychischer Störungen. ICD-10 Kapitel V (F). Diagnostische Kriterien für Forschung und Praxis. In: WHO (Hrsg). Göttingen, Hogrefe
2. Mack S, Jacobi F, Beesdo-Baum K et al. (2015) Functional disability and quality of life decrements in mental disorders: Results from the Mental Health Module of the German Health Interview and Examination Survey for Adults (DEGS1-MH). European Psychiatry 30:793-800
3. World Health Organization (eds) (2016) Global Health Estimates 2015: Disease burden by Cause, Age, Sex, by Country and by Region, 2000-2015. WHO, Genf
4. Hawton K, Casanas ICC, Haw C et al. (2013) Risk factors for suicide in individuals with depression: a systematic review. J Affect Disord 147(1-3):17-28
5. Deutsche Rentenversicherung Bund (eds) (2014) Positionspapier der Deutschen Rentenversicherung zur Bedeutung psychischer Erkrankungen in der Rehabilitation und bei Erwerbsminderung, Berlin
6. Klauber J, Günster C, Gerste B et al. (eds) (2014) Versorgungsreport 2013/2014. Schwerpunkt: Depression. Schattauer, Stuttgart
7. Techniker Krankenkasse (eds) (2015) Depressionsatlas. Auswertungen zu Arbeitsunfähigkeit und Arzneiverordnungen. AQUA - Institut für angewandte Qualitätsförderung und Forschung im Gesundheitswesen GmbH, Göttingen
8. Kliner K, Rennert D, Richter M (2015) Gesundheit in Regionen – Blickpunkt Psyche. BKK Dachverband, BKK Gesundheitsatlas 2015. MWV Medizinisch Wissenschaftliche Verlagsgesellschaft, Berlin
9. Richter D, Berger K (2013) Nehmen psychische Störungen zu? Psychiatrische Praxis 40:176-182
10. Jacobi F, Bretschneider J, Müllender S (2015) Veränderungen und Variationen der Häufigkeit psychischer Störungen in Deutschland. Krankenkassenstatistiken und epidemiologische Befunde. In: Kliner K, Rennert D, Richter M (eds) Gesundheit in Regionen – Blickpunkt Psyche BKK Gesundheitsatlas 2015. Medizinisch wissenschaftliche Verlagsgesellschaft, Berlin, P. 63-71
11. Melchior H, Schulz H, Härter M (2014) Faktencheck Gesundheit - Regionale Unterschiede in der Diagnostik und Behandlung von Depressionen. Bertelsmann Stiftung, Gütersloh
12. Strine TW, Mokdad AH, Balluz LS et al. (2008) Depression and anxiety in the United States: findings from the 2006 Behavioral Risk Factor Surveillance System. Psychiatr Serv 59(12):1383-1390
13. Substance Abuse and Mental Health Services Administration (2011) Results from the 2010 National Survey on Drug Use and Health: Summary of National Findings. Substance Abuse and Mental Health Services Administration, Rockville
14. Eurostat (2016) International standard classification of education (ISCED). http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:International_standard_classification_of_education_%28ISCED%29 (As at 13.01.2017)
15. Lange C, Finger JD, Allen J et al. (in press) Implementation of the European Health Interview Survey (EHIS) in Germany. Further development of the German Health Update (GEDA). Archives of Public Health
16. Parker G, Brotchie H (2010) Gender differences in depression. International Review of Psychiatry 22(5):429-436
17. Moller-Leimkuhler AM (2002) Barriers to help-seeking by men: a review of sociocultural and clinical literature with particular reference to depression. J Affect Disord 71(1-3):1-9
18. Karger A (2014) Geschlechtsspezifische Aspekte bei depressiven Erkrankungen. Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 57(9):1092-1098
19. Karger A (2012) Sind Männer anders depressiv? Ärztliche Psychotherapie und Psychosomatische Medizin 7:224-229
20. Robert Koch-Institut (eds) (2011) Daten und Fakten: Ergebnisse der Studie "Gesundheit in Deutschland aktuell 2009". Beiträge zur Gesundheitsberichterstattung des Bundes. Berlin http://edoc.rki.de/documents/rki_fv/reQXTR7OSGFRg/PDF/20dqmVRMM57G6.pdf (As at 13.07.2017)
21. Robert Koch-Institut (eds) (2012) Daten und Fakten: Ergebnisse der Studie "Gesundheit in Deutschland aktuell 2010". Beiträge zur Gesundheitsberichterstattung des Bundes. Berlin http://edoc.rki.de/documents/rki_fv/remDCCtjOJxI/PDF/21TgKGZEOWNCY.pdf (As at 13.07.2017)
22. Robert Koch-Institut (eds) (2014) Daten und Fakten: Ergebnisse der Studie "Gesundheit in Deutschland aktuell 2012". Beiträge zur Gesundheitsberichterstattung des Bundes. Berlin http://edoc.rki.de/documents/rki_fv/recJuHnzacx8A/PDF/28GsWuNtFjVqY.pdf (As at 13.07.2017)

23. Busch MA, Maske UE, Ryl L et al. (2013) Prevalence of depressive symptoms and diagnosed depression among adults in Germany – Results of the German Health Interview and Examination Survey for Adults (DEGS1). Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 56(5-6):733-739 http://edoc.rki.de/oa/articles/reLPtVNhg9T2/PDF/22QgLkX1lQgU.pdf (As at 13.07.2017)

24. Maske UE, Buttery AK, Beesdo-Baum K et al. (2016) Prevalence and correlates of DSM-IV-TR major depressive disorder, self-reported diagnosed depression and current depressive symptoms among adults in Germany. Journal of Affective Disorders 190:167-177

25. Müters S, Hoebel J, Lange C (2013) Diagnosis Depression: Differences in Women and Men. Robert Koch-Institut, Berlin http://edoc.rki.de/series/gbe-kompakt/4-2/PDF/2.pdf (As at 13.07.2017)

26. Erhart M, Stillfried D (2012) Analyse regionaler Unterschiede in der Prävalenz und Versorgung depressiver Störungen auf Basis vertragsärztlicher Abrechnungsdaten – Teil 1 Prävalenz. Versorgungsatlas. Zentralinstitut für die kassenärztliche Versorgung in Deutschland, Berlin

27. Melchior H, Schulz H, Härter M (2014) Stellenwert regionaler Variationen in der Prävalenz und Behandlung depressiver Erkrankungen und Implikationen für die Versorgungsforschung. Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 57:224-233

28. Grobe T, Kleine-Budde K, Bramesfeld A et al. (in preparation) Prävalenzen von Depressionen bei Erwachsenen – eine vergleichende Analyse bundesweiter Survey- und Routinedaten

29. Institut für Gesundheits- und Sozialforschung (2012) Bewertung der Kodierqualität von vertragsärztlichen Diagnosen – Eine Studie im Auftrag des GKV-Spitzenverbands in Kooperation mit der BARMER GEK. IGES Institut für Gesundheits- und Sozialforschung GmbH, Berlin

30. Geyer S, Jaunzeme J (2014) Möglichkeiten und Grenzen von Befragungsdaten und Daten gesetzlicher Krankenversicherungen. In: Swart E, Ihle P, Gothe H et al. (eds) Routinedaten im Gesundheitswesen Handbuch Sekundärdatenanalyse: Grundlagen, Methoden und Perspektiven. Verlag Hans Huber, Bern, P. 223-233

31. Gerste B, Roick C (2014) Prävalenz und Inzidenz sowie Versorgung depressiver Erkrankungen in Deutschland - Eine Analyse auf Basis der in Routinedaten dokumentierten Depressionsdiagnosen. In: Klauber J, Günster C, Gerste B et al. (eds) Versorgungs-Report 2013/2014. Schattauer, Stuttgart, P. 21-54

32. Maske UE, Hapke U, Riedel-Heller SG et al. (2017) Respondents' report of a clinician-diagnosed depression in health surveys: comparison with DSM-IV mental disorders in the general adult population in Germany. BMC Psychiatry 17(1):39

33. Kroenke K, Strine TW, Spitzer RL et al. (2009) The PHQ-8 as a measure of current depression in the general population. J Affect Disord 114(1-3):163-173

34. Löwe B, Spitzer RL, Zipfel S et al. (2002) Gesundheitsfragebogen für Patienten (PHQ-D). Komplettversion und Kurzform. Testmappe mit Manual, Fragebögen, Schablonen. 2. Auflage. Pfizer, Karlsruhe

35. Rattay P, Butschalowsky H, Rommel A et al. (2013) Utilisation of outpatient and inpatient health services in Germany – Results of the German Health Interview and Examination Survey for Adults (DEGS1). Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 56:832-844 http://edoc.rki.de/oa/articles/reWsjeZR5HISQ/PDF/21nRhaJo8ha7o.pdf (As at 13.07.2017)

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin

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

Conflicts of interest
The authors declared no conflicts of interest.

Funding
The GEDA study was funded by the Robert Koch Institute and the German Federal Ministry of Health.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
Thom J, Kuhnert R, Born S et al. (2017) 12-month prevalence of self-reported medical diagnoses of depression in Germany. Journal of Health Monitoring 2(3):68–76
DOI 10.17886/RKI-GBE-2017-069

ISSN 2511-2708

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

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-070
Robert Koch Institute, Berlin

Authors:
Julia Bretschneider, Ronny Kuhnert,
Ulfert Hapke

Depressive symptoms among adults in Germany

Abstract
Depressive symptoms imply a loss of quality of life, leading to increased morbidity and mortality as well as increased costs to the healthcare system. Information on the prevalence and distribution of depressive symptoms in the population is essential in light of planning prevention and care. GEDA 2014/2015-EHIS surveyed current depressive symptoms among adults in Germany through the Patient Health Questionnaire (PHQ-8). The surveyed prevalence of 10.1% indicates the widespread occurrence of depressive symptoms, regardless of an actual clinical diagnosis of depression. Prevalence for women (11.6%) is higher than for men (8.6%). Further differences exist concerning age and education as well as regional differences. The results are discussed in the light of the data available so far.

PREVALENCE · DEPRESSIVE SYMPTOMS · DEPRESSION · HEALTH MONITORING · GERMANY

Introduction
Depression is one of the most common mental health disorders and is related to a high disease burden both for individuals suffering from the condition as also for society as a whole [1-3]. German social insurance carriers have recorded a significant increase in the role of depression in health services over the past few years, a process which has been accompanied by increasing public awareness [4-6].

The term depression covers a heterogeneous spectrum of depressive disorders which can be categorised for example with regard to the severity and course of depressive symptoms [7]. For a physician to diagnose depression requires, beyond simply confirming the presence of depressive symptoms, the fulfilment of specific diagnostic criteria, such as the presence of certain key symptoms. However, depressive symptoms such as despondency and loss of energy can also affect persons that do not fulfil the necessary clinical diagnostic criteria of depression and for example experience subthreshold depression, or experience such symptoms yet in the context of other mental and physical disorders. Among these are depressive symptoms related to emotionally stressful life events, substance abuse (alcohol, drugs, etc.) and chronic physical illness or as side effects of certain medications. Regardless of their diagnostic classification, depressive symptoms lead to a subjective deterioration in health and health-related quality of life [8, 9] and are associated with increased morbidity and mortality rates [10, 11]. Moreover, depressive symptoms increase the number of outpatient physician visits and sick leave days [12] and in particular in older age lead to increasing health service utilisation [13].

Epidemiological estimates on the prevalence and distribution of depression symptoms in the population are therefore highly relevant to public health and are an

GEDA 2014/2015-EHIS

Data holder: Robert Koch Institute

Aims: To provide reliable information about the population's health status, health-related behaviour and health care in Germany, with the possibility of a European comparison

Method: Questionnaires completed on paper or online

Population: People aged 18 years and above with permanent residency in Germany

Sampling: Registry office sample; randomly selected individuals from 301 communities in Germany were invited to participate

Participants: 24,016 people (13,144 women; 10,872 men)

Response rate: 26.9%

Study period: November 2014 - July 2015

Data protection: This study was undertaken in strict accordance with the data protection regulations set out in the German Federal Data Protection Act and was approved by the German Federal Commissioner for Data Protection and Freedom of Information. Participation in the study was voluntary. The participants were fully informed about the study's aims and content, and about data protection. All participants provided written informed consent.

More information in German is available at www.geda-studie.de

important basis for developing prevention and health-care services. Health monitoring at the Robert Koch Institute initially collected prevalence data for the adult population in Germany in the German Health Interview and Examination Survey for Adults (DEGS1, 2008-2011) [14] and we now report the corresponding data from GEDA 2014/2015-EHIS.

Indicator

GEDA 2014/2015-EHIS surveyed current depressive symptoms through a self-administered paper-based or online questionnaire. The survey applied a German version of the 8-item depression module of the Patient Health Questionnaire (PHQ-8) to evaluate symptoms of a major depressive disorder (but did not consider suicidal thoughts) in accordance with the DSM-IV manual (Diagnostic and Statistical Manual of Mental Disorders, 4th edition) regarding the presence and frequency of symptoms during the past two weeks [9, 15]: Depressed mood or irritable, decreased interest or pleasure, significant weight change or change in appetite, change in sleep, psychomotor agitation or retardation, fatigue or loss of energy, guilt/worthlessness, diminished ability to concentrate. Each of these eight items was rated on a scale between 0 (not at all), 1 (several days), 2 (more than half of the days) and 3 (nearly every day). Sum values between 10 and 24 indicate current depressive symptoms [9]. Prevalence in the following section is presented with 95% confidence intervals (95% CI) stratified by age, gender and educational level as well as federal state. Differences between these groups are interpreted as statistically significant if the respective confidence intervals do not overlap.

The analyses are based on data from 23,602 participants aged 18 years and older (12,900 women and 10,702 men) with valid PHQ-8 data. The calculations were carried out using a weighting factor that corrects for deviations within the sample from the German population (as of 31 December 2014) with regard to gender, age, district type and educational level. The International Standard Classification of Education (ISCED) was used to classify the responses provided on educational level [16]. A detailed description of the methodology used in the GEDA 2014/2015-EHIS study can be found in Lange et al. 2017 [17] as well as in the article German Health Update: New data for Germany and Europe, which was published in Issue 1/2017 of the Journal of Health Monitoring.

Results and discussion

The prevalence of current depressive symptoms among adults in Germany is 10.1% (Table 1). Prevalence among women (11.6%) is significantly higher than among men (8.6%). Gender differences are recorded across all age groups. Significant differences also exist with regard to age: Among women aged 18 to 29, prevalence is 16.4% and therefore higher than among older women. The lowest frequencies are recorded for women and men aged 65 and over (women 8.7%; men 5.4%).

Prevalence is lower among respondents with a high education level than with a medium or low one. Population prevalence of depressive symptoms thereby increases by the factor 2.5 (high education 5.9%; low education 14.8%, data not shown). Differences in prevalence with regard to levels of education are recorded

Table 1
Prevalence of depressive symptoms in the past 2 weeks (PHQ-8 score ≥10) according to gender, age and educational level (n=12,900 women; n=10,702 men)
Source: GEDA 2014/2015-EHIS

Women	%	(95% CI)
Women total	**11.6**	**(10.8-12.4)**
18-29 Years	16.4	(14.5-18.6)
Low education	22.4	(17.4-28.3)
Medium education	15.7	(13.4-18.4)
High education	9.9	(7.5-13.0)
30-44 Years	10.9	(9.5-12.4)
Low education	16.1	(11.5-22.1)
Medium education	11.4	(9.6-13.4)
High education	6.4	(4.8-8.6)
45-64 Years	11.9	(10.8-13.1)
Low education	17.5	(14.1-21.4)
Medium education	11.8	(10.5-13.3)
High education	7.3	(6.0-8.9)
≥65 Years	8.7	(7.4-10.1)
Low education	11.7	(9.4-14.4)
Medium education	7.1	(5.4-9.3)
High education	3.6	(2.2-5.7)
Total (women and men)	**10.1**	**(9.6-10.7)**

Men	%	(95% CI)
Men total	**8.6**	**(7.9-9.4)**
18-29 Years	9.5	(7.7-11.7)
Low education	13.9	(9.8-19.3)
Medium education	8.3	(6.4-10.6)
High education	7.0	(4.1-11.9)
30-44 Years	9.4	(7.9-11.2)
Low education	17.8	(12.2-25.2)
Medium education	10.1	(8.0-12.7)
High education	4.9	(3.5-6.8)
45-64 Years	9.6	(8.5-10.7)
Low education	15.3	(11.7-19.7)
Medium education	10.5	(9.0-12.3)
High education	5.9	(4.7-7.4)
≥65 Years	5.4	(4.5-6.5)
Low education	7.1	(4.8-10.5)
Medium education	5.7	(4.4-7.5)
High education	4.2	(3.0-5.9)
Total (women and men)	**10.1**	**(9.6-10.7)**

CI=Confidence interval

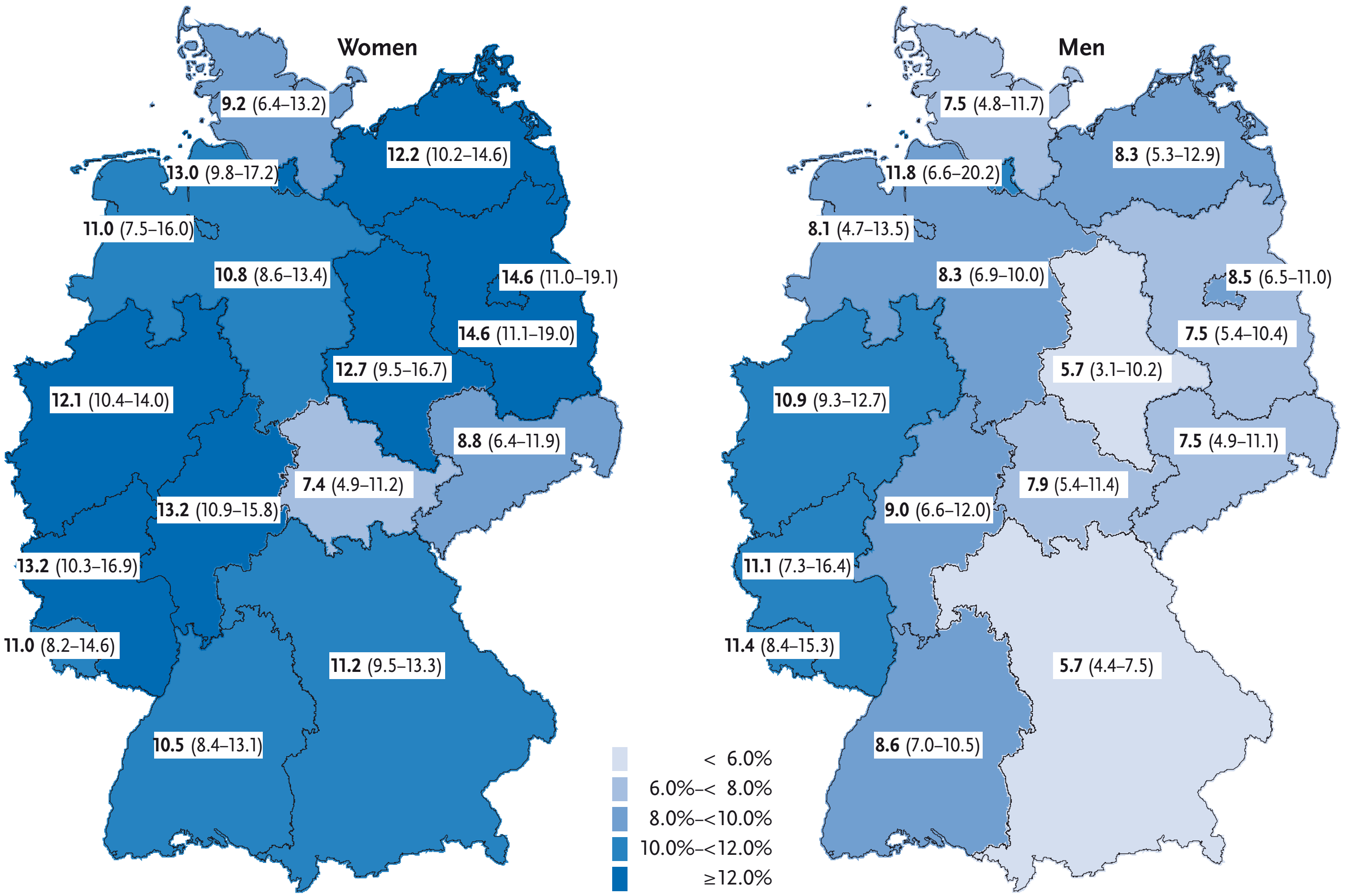
One in ten adults in Germany experiences current depressive symptoms.

across all age groups. Analyses that take into account age, gender and education indicate a prevalence of depressive symptoms of over one fifth (22.4%) of women with low education aged 18 to 29. Analogous analyses for men show the highest prevalence in those with low education aged 30 to 44 (17.8%). Prevalence is lowest in both genders for those aged over 65 with high education (women 3.6%; men 4.2%).

The prevalence of depressive symptoms varies between federal states (Figure 1). Women from Berlin and Brandenburg (14.6%) are nearly twice as likely to present depressive symptoms compared to women from Thuringia (7.4%). Significant differences in prevalence for men are found between Bavaria (5.7%) and Saarland (11.4%), as well as North-Rhine Westphalia (10.9%). Differences in prevalence between women and men are particularly high in Bavaria (11.2% vs. 5.7%) and Brandenburg (14.6% vs. 7.5%) and low in Saarland (11.0% vs. 11.4%) and Thuringia (7.4% vs. 7.9%).

Total prevalence (10.1%) is comparable to current findings from the US-American National Health and Nutrition Examination Survey (NHANES) and the Behavioral Risk Factor Surveillance System (BRFSS) [18, 19]. However, the new data is not consistent with data from previous surveys that were conducted in Germany. According to DEGS1 (2008-2011), the prevalence of

Figure 1
Prevalence of depressive symptoms during the past 2 weeks (PHQ-8 score ≥10) according to gender and federal state (n=12,900 women; n=10,702 men)
Source: GEDA 2014/2015-EHIS



Confidence intervals in parentheses

Women aged 18 to 29 present a particularly high prevalence of depressive symptoms (16.4%).

depressive symptoms (8.1% overall, 6.1% for men) was significantly lower than the prevalence reported by the current survey [14]. An older population survey indicated an overall prevalence of 7.2%, which is even lower than the prevalence recorded by DEGS1 [20]. Whether these differences indicate a trend over time in the prevalence of depressive symptoms among adults and/or men in Germany is unclear and to clarify this question will require further comparative data, also because the PHQ version applied differed as did the surveyed age groups. In the US, however, an increase in depressive symptoms in the population has been documented since 2005 [18].

A higher education translates into a lower prevalence of depressive symptoms.

The prevalence of depressive symptoms varies between federal states.

Previous surveys have already highlighted the importance of differences in prevalence between women and men [8, 14, 19]. The results highlight the importance of the age factor and are in line with the data available, according to which depressive symptoms among adults are clearly and particularly linked to younger age [12, 14, 19]. Equally, the links between depressive symptoms and education [8, 18] as well as socioeconomic status [12, 14, 21] are well known. No comparative data on the differences in prevalence between the German federal states is available. Regional differences could be related to a region's age and social structure, but could also be related to differences in the spatial distribution of risk and protective factors. A comparison between cities and rural areas reveals different levels of prevalence, whereby the frequencies of depressive symptoms are higher in medium-sized and large cities than in small rural towns [12, 14].

The reported results can be classified in the context of available epidemiological findings on the prevalence of diagnoses of depression. GEDA 2014/2015-EHIS reports a 12-month prevalence of self-reported medical diagnoses of depression of 8.1% which is lower than the overall prevalence of depression symptoms. DEGS1 data (additional mental health module) too reveals a lower prevalence of diagnoses of depression that are recorded through standardised clinical interviews [12, 22, 23]; whereby methodological differences in the surveys need to be considered. When the definition of depressive symptoms according to PHQ is adjusted to include defining criteria for a diagnosis of depression, frequencies also drop [24]. A medical diagnosis moreover depends on patients turning to health services and is influenced by further factors such as healthcare services coverage [25].

To record depressive symptoms, the survey applied the internationally established PHQ instrument. Based on the results from GEDA 2014/2015-EHIS, we can make statements on the adult population in Germany. Identifying the particularly burdened segments of the population provides a basis to develop target groups to which to direct prevention and care. Moreover, the survey reveals relevant questions for future surveys on the prevalence of depressive symptoms, for example concerning trends over time and regional differences. The reported prevalence should be considered as conservative estimates because persons with acute or severe depression are less likely to participate in the survey [26].

References

1. Wittchen HU, Jacobi F, Rehm J et al. (2011) The size and burden of mental disorders and other disorders of the brain in Europe 2010. Eur Neuropsychopharmacol 21(9):655-679
2. World Health Organization (2016) Global Health Estimates 2015: Disease burden by Cause, Age, Sex, by Country and by Region, 2000-2015. www.who.int/entity/healthinfo/global_burden_disease/GHE2015_YLD_Global_2000_2015.xls?ua=1 (As at 02.06.2017)
3. Mack S, Jacobi F, Beesdo-Baum K et al. (2015) Functional disability and quality of life decrements in mental disorders: Results from the Mental Health Module of the German Health Interview and Examination Survey for Adults (DEGS1-MH). European Psychiatry 30:793-800
4. Techniker Krankenkasse (eds) (2015) Depressionsatlas. Techniker Krankenkasse, Hamburg
5. Kliner K, Rennert D, Richter M (2015) Gesundheit in Regionen – Blickpunkt Psyche. BKK Dachverband, BKK Gesundheitsatlas 2015. Medizinisch Wissenschaftliche Verlagsgesellschaft, Berlin

6. Deutsche Rentenversicherung Bund (eds) (2014) Positionspapier der Deutschen Rentenversicherung zur Bedeutung psychischer Erkrankungen in der Rehabilitation und bei Erwerbsminderung. Deutsche Rentenversicherung Bund, Berlin

7. Robert Koch-Institut (eds) (2010) Depressive Erkrankungen. Themenheft 51 Gesundheitsberichterstattung des Bundes. RKI, Berlin http://edoc.rki.de/documents/rki_fv/re7w3qNkJP8NI/PDF/277vEuDUbrtzY.pdf (As at 02.06.2017)

8. Kocalevent RD, Hinz A, Brähler E (2013) Standardization of the depression screener Patient Health Questionnaire (PHQ-9) in the general population. Gen Hosp Psychiatry 35(5):551-555

9. Kroenke K, Strine TW, Spitzer RL et al. (2009) The PHQ-8 as a measure of current depression in the general population. J Affect Disord 114(1-3):163-173

10. Jia H, Zack MM, Thompson WW et al. (2015) Impact of depression on quality-adjusted life expectancy (QALE) directly as well as indirectly through suicide. Soc Psychiatry Psychiatr Epidemiol 50(6):939-949

11. Katon W, Ciechanowski P (2002) Impact of major depression on chronic medical illness. J Psychosom Res 53(4):859-863

12. Maske UE, Buttery AK, Beesdo-Baum K et al. (2016) Prevalence and correlates of DSM-IV-TR major depressive disorder, self-reported diagnosed depression and current depressive symptoms among adults in Germany. J Affect Disord 190:167-177

13. Busch MA, Neuner B, Aichberger MC et al. (2013) Depressive Symptomatik und Inanspruchnahme von Gesundheits- und Pflegeleistungen bei Personen im Alter ab 50 Jahren in Deutschland. Psychiat Prax 40(04):214-219

14. Busch MA, Maske UE, Ryl L et al. (2013) Prevalence of depressive symptoms and diagnosed depression among adults in Germany. Results of the German Health Interview and Examination Survey for Adults (DEGS1). Bundesgesundheitsbl – Gesundheitsforsch – Gesundheitsschutz 56(5-6):733-739 http://edoc.rki.de/oa/articles/reLPtVNhg9T2/PDF/22QgLkX1lQgU.pdf (As at 13.01.2017)

15. Löwe B, Spitzer RL, Zipfel S et al. (2002) Gesundheitsfragebogen für Patienten (PHQ-D). Komplettversion und Kurzform. Testmappe mit Manual, Fragebögen, Schablonen. 2. Auflage. Pfizer, Karlsruhe

16. Eurostat (2016) International standard classification of education (ISCED). http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:International_standard_classification_of_education_%28ISCED%29 (As at 13.01.2017)

17. Lange C, Finger JD, Allen J et al. (in press) Implementation of the European Health Interview Survey (EHIS) in Germany. Further development of the German Health Update (GEDA) Archives of Public Health

18. McGee RE, Thompson NJ (2015) Unemployment and depression among emerging adults in 12 states, Behavioral Risk Factor Surveillance System, 2010. Prev Chronic Dis 12:E38

19. Wittayanukorn S, Qian J, Hansen RA (2014) Prevalence of depressive symptoms and predictors of treatment among U.S. adults from 2005 to 2010. Gen Hosp Psychiatry 36(3):330-336

20. Rief W, Nanke A, Klaiberg A et al. (2004) Base rates for panic and depression according to the Brief Patient Health Questionnaire: a population-based study. J Affect Disord 82(2):271-276

21. Lampert T, Kroll LE, von der Lippe E et al. (2013) Socioeconomic status and healt. Results of the German Health Interview and Examination Survey for Adults (DEGS1). Bundesgesundheitsbl – Gesundheitsforsch – Gesundheitsschutz 56(5-6):814-821 http://edoc.rki.de/oa/articles/reJ1kvingLWZA/PDF/20dRwtjatiixk.pdf (As at 13.01.2017)

22. Jacobi F, Höfler M, Strehle J et al. (2016) Erratum zu: Psychische Störungen in der Allgemeinbevölkerung. Studie zur Gesundheit Erwachsener in Deutschland und ihr Zusatzmodul „Psychische Gesundheit" (DEGS1-MH). Der Nervenarzt 87:88-90

23. Jacobi F, Höfler M, Strehle J et al. (2014) Psychische Störungen in der Allgemeinbevölkerung: Studie zur Gesundheit Erwachsener in Deutschland und ihr Zusatzmodul Psychische Gesundheit (DEGS1-MH). Der Nervenarzt 85:77-87

24. Maske UE, Busch MA, Jacobi F et al. (2015) Current major depressive syndrome measured with the Patient Health Questionnaire-9 (PHQ-9) and the Composite International Diagnostic Interview (CIDI): results from a cross-sectional population-based study of adults in Germany. BMC Psychiatry 15(1):77

25. Melchior H, Schulz H, Härter M (2014) Faktencheck Gesundheit – Regionale Unterschiede in der Diagnostik und Behandlung von Depressionen. Bertelsmann Stiftung, Gütersloh

26. Schmidt CO, Watzke A-B, Schulz A et al. (2013) Die Lebenszeitprävalenz psychischer Störungen in Vorpommern. Psychiat Prax 40(04):192-199

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin

Corresponding author
Julia Bretschneider
Robert Koch Institute
Department of Epidemiology and Health Monitoring
General-Pape-Str. 62–66
D-12101 Berlin, Germany
E-mail: BretschneiderJ@RKI.de

Conflicts of interest
The authors declared no conflicts of interest.

Funding
The GEDA survey received funding from the Robert Koch Institute and the German Federal Ministry of Health.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
Bretschneider J, Kuhnert R, Hapke U (2017) Depressive symptoms among adults in Germany. Journal of Health Monitoring 2(3):77–83
DOI 10.17886/RKI-GBE-2017-070

ISSN 2511-2708

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

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-071
Robert Koch Institute, Berlin

Authors:
Elena von der Lippe, Angela Fehr, Cornelia Lange

Limitations to usual activities due to health problems in Germany

Abstract
Limitations to usual activities due to health problems impact quality of life and well-being. The Global Activity Limitation Indicator (GALI) was developed to assess the trends in limitations to usual activities. The GALI question is applied in a single or routed, multi-question version. GEDA 2014/2015-EHIS for the first time applied a three-question version. Three quarters of respondents reported that they did not experience any limitations to their usual activities. 18.7% of women and 17.0% of men said they had experienced moderate limitations. 6.4% of women and 6.8% of men reported severe limitations. The share of respondents experiencing limitations increases with age and shows a clear education gradient. Changes in methodology, however, mean that current results based on the GALI question cannot be compared to the results from earlier survey waves of the same study.

GLOBAL ACTIVITY LIMITATION INDICATOR (GALI) · HEALTHY LIFE YEARS · HEALTH MONITORING · GERMANY

Introduction
Physical or mental health problems that lead to limitations in usual activities have the potential to significantly impact quality of life and personal well-being. Given the demographic change and the rise in life expectancy, the number of people experiencing limitations to their usual activities will likely increase in the future. The years of life gained may be spent in good or bad health [1, 2]. A key challenge for health policy, therefore, will be to provide the conditions for people to age in good health and maintain their quality of life. That is why it is crucial to investigate if the rise in life expectancy is related to an increase in years spent without limitations to usual activities due to health problems. There seems to be a trend in Germany towards the occurrence of diseases and limitations to usual activities at a later stage in life and therefore towards a longer life with good health [3, 4].

Political measures and preventive healthcare programmes that focus on these developments require an indicator that determines the share of people in the population affected by limitations. The Global Activity Limitation Indicator (GALI) was developed to measure such trends in the limitations to usual activities over time. The GALI question collects data on self-rated limitations. Data obtained through the GALI question is used to calculate the Healthy Life Years (HLY) indicator, which is also known as disability free life expectancy. It provides information on the number of remaining life years that respondents will spend without limitations to usual activities due to health problems [5]. The GALI question is part of the Minimum European Health Module (MEHM) [6] and is also surveyed in the context of the EU-Statistics on Income and Living Conditions (EU-SILC). Prütz and Lange 2016 provide an overview of the available data

GEDA 2014/2015-EHIS

Data holder: Robert Koch Institute

Aims: To provide reliable information about the population's health status, health-related behaviour and health care in Germany, with the possibility of a European comparison

Method: Questionnaires completed on paper or online

Population: People aged 18 years and above with permanent residency in Germany

Sampling: Registry office sample; randomly selected individuals from 301 communities in Germany were invited to participate

Participants: 24,016 people (13,144 women; 10,872 men)

Response rate: 26.9%

Study period: November 2014 - July 2015

Data protection: This study was undertaken in strict accordance with the data protection regulations set out in the German Federal Data Protection Act and was approved by the German Federal Commissioner for Data Protection and Freedom of Information. Participation in the study was voluntary. The participants were fully informed about the study's aims and content, and about data protection. All participants provided written informed consent.

More information in German is available at www.geda-studie.de

sources on disability and social participation [7]. Issue 1/2017 of the Journal of Health Monitoring contains an overview of European health indicators [8].

Indicator

The prevalence of limitations to usual activities was surveyed in GEDA 2014/2015-EHIS through self-administered paper-based or online questionnaires. Respondents were asked: 'Are you limited because of a health problem in activities people usually do? (Yes/No)' Respondents who answered with yes were then asked two further questions: a) 'How severely are you limited in your usual activities? (Severely limited/Moderately limited)'; b) 'For how long have you been limited? (For less than six months/For six months or longer)'. These responses provide the basis to form three categories: severely limited, moderately limited and not limited. Respondents who answered that they were moderately or severely limited in their usual activities for over 6 months are considered as limited due to health problems. If not clarified otherwise, the term limitations in the following refers to the collapsed group of moderately and severely limited.

The analyses are based on data from 23,752 participants aged 18 and above (13,014 women and 10,738 men) with valid data on the GALI question. The calculations were carried out using a weighting factor that corrects for deviations within the sample from the German population (as of 31 December 2014) with regard to gender, age, district type and education. The district type reflects the degree of urbanisation and accounts for the regional distribution in Germany. The International Standard Classification of Education (ISCED) was used to classify the responses provided on educational level [9]. Differences between these groups are interpreted as statistically significant if the respective confidence intervals do not overlap.

A detailed description of the methodology applied in the GEDA 2014/2015-EHIS study can be found in Lange et al. 2017 [10] as well as in the article German Health Update: New data for Germany and Europe in Issue 1/2017 of the Journal of Health Monitoring.

Results and discussion

Three quarters of respondents reported no limitations to their usual activities. 25.2% of women and 23.8% of men said they are long-term limited in their usual activities due to health problems (Table 1 and Table 2). 6.4% of women and 6.8% of men reported severe limitations to their usual activities. When looking at both categories together, severely and moderately limited, it becomes evident that the share of respondents experiencing limitations strongly increases with age. Whereas 12.0% of women and 9.5% of men aged 18 to 29 reported limitations, this figure rises to 41.1% of women and 39.4% of men aged 65 and over. A clear education gradient is evident for both sexes regarding limitations. Across all age groups, the share of women and men facing limitations to usual activities due to health problems is significantly lower for those with high education than those with low education.

Regional differences in the share of people experiencing limitations also exist (Figure 1). Compared to the German average, prevalence among women from

Table 1
12-month prevalence of limitations due to health problems among women according to age and educational level (n=13,014 women)
Source: GEDA 2014/2015-EHIS

Women	Not limited		Moderately limited		Severely limited		Limited (moderately and severely limited)	
	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
Women total	**74.8**	**(73.9-75.8)**	**18.7**	**(17.9-19.6)**	**6.4**	**(5.8-7.1)**	**25.2**	**(24.2-26.1)**
18-29 Years	88.0	(86.2-89.6)	9.9	(8.5-11.6)	2.0	(1.3-3.1)	12.0	(10.4-13.8)
Low education	82.3	(76.8-86.7)	12.1	(8.6-16.7)	5.6	(3.2-9.6)	17.7	(13.3-23.2)
Medium education	89.2	(87.1-91.0)	9.7	(8.0-11.7)	1.1	(0.5-2.2)	10.8	(9.0-12.9)
High education	92.5	(89.1-94.9)	7.1	(4.8-10.4)	0.4	(0.1-1.5)	7.5	(5.1-10.9)
30-44 Years	86.4	(84.6-87.9)	11.6	(10.3-13.1)	2.0	(1.5-2.8)	13.6	(12.1-15.4)
Low education	82.9	(77.0-87.5)	12.0	(8.4-16.9)	5.1	(2.8-8.9)	17.1	(12.5-23.0)
Medium education	84.9	(82.7-86.8)	13.3	(11.5-15.3)	1.8	(1.2-2.8)	15.1	(13.2-17.3)
High education	91.7	(89.8-93.2)	7.5	(6.0-9.4)	0.8	(0.4-1.6)	8.3	(6.8-10.2)
45-64 Years	73.7	(72.0-75.4)	20.5	(19.0-22.1)	5.8	(5.0-6.6)	26.3	(24.6-28.0)
Low education	64.7	(59.8-69.3)	24.2	(20.4-28.6)	11.1	(8.4-14.5)	35.3	(30.7-40.2)
Medium education	74.5	(72.4-76.4)	20.2	(18.4-22.1)	5.3	(4.5-6.4)	25.5	(23.6-27.6)
High education	79.4	(76.9-81.7)	18.1	(16.0-20.5)	2.5	(1.7-3.6)	20.6	(18.3-23.1)
≥65 Years	58.9	(56.7-61.1)	27.6	(25.6-29.6)	13.5	(11.9-15.3)	41.1	(38.9-43.3)
Low education	54.2	(50.6-57.9)	29.1	(25.9-32.5)	16.6	(14.1-19.5)	45.8	(42.1-49.4)
Medium education	61.6	(58.5-64.6)	26.4	(24.0-28.9)	12.0	(9.9-14.5)	38.4	(35.4-41.5)
High education	65.7	(60.3-70.7)	26.5	(21.9-31.7)	7.8	(5.4-11.1)	34.3	(29.3-39.7)
Total (women and men)	**75.5**	**(74.7-76.3)**	**17.9**	**(17.2-18.5)**	**6.6**	**(6.2-7.1)**	**24.5**	**(23.7-25.3)**

CI=Confidence interval

Three quarters of GEDA 2014/2015-EHIS respondents report no limitations to usual activities.

Baden-Württemberg (21.6%) is significantly lower, while among women from Brandenburg it is significantly higher (32.0%). For men, no such differences compared to the German average were observed. A significant difference was recorded for men from Baden-Württemberg (21.7%) compared to men from Saxony-Anhalt (28.6%). These results, however, do not take into account the regional differences in the age composition of the population. The different age patterns in the federal states could explain regional differences regarding limitations due to health problems. Studies show that the shift between the age groups is stronger in East than in West Germany. In East Germany, the share of those aged 65 and over is 23%, whereas in the west it is 21% [11].

The GALI question can be implemented in different ways. Whereas GEDA 2014/2015-EHIS applied the three-question version (see above), data for the indicator can also be collected through a single question with multiple dimensions (existence of a limitation, its duration and severity). Previous GEDA survey waves [12-14] used a single-question version. In 2015, the German question-

Table 2
12-month prevalence of limitations due to health problems among men according to age and educational level (n=10,738 men)
Source: GEDA 2014/2015-EHIS

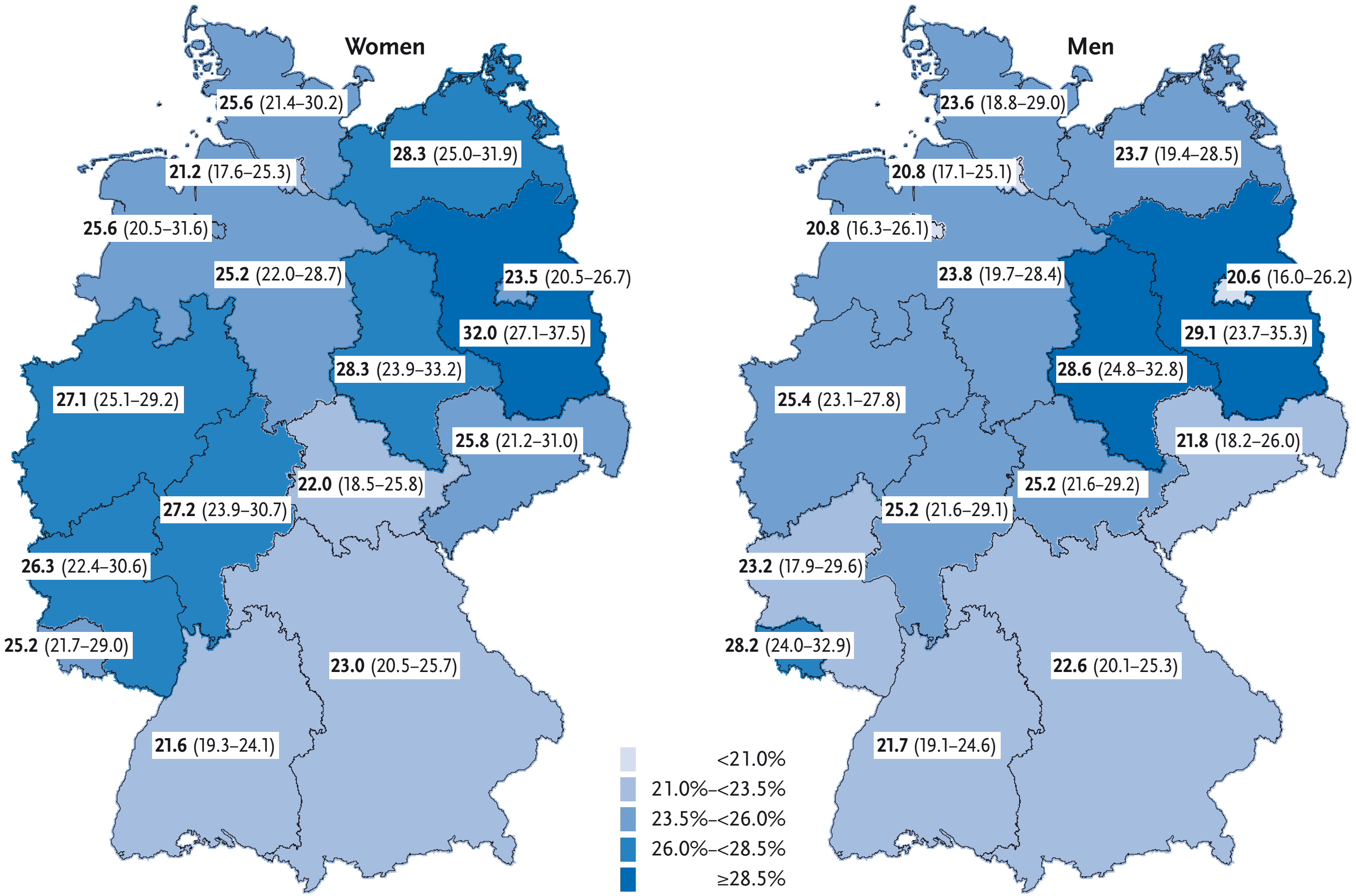
6.4% of women and 6.8% of men report they are severely limited.

Men	Not limited		Moderately limited		Severely limited		Limited (moderately and severely limited)	
	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
Men total	**76.2**	**(75.1-77.2)**	**17.0**	**(16.1-17.9)**	**6.8**	**(6.2-7.5)**	**23.8**	**(22.8-24.9)**
18-29 Years	90.5	(88.6-92.2)	7.0	(5.6-8.8)	2.5	(1.6-3.7)	9.5	(7.8-11.4)
Low education	87.6	(82.8-91.2)	6.8	(4.3-10.5)	5.6	(3.3-9.5)	12.4	(8.8-17.2)
Medium education	91.1	(88.6-93.1)	7.6	(5.7-9.9)	1.3	(0.6-2.8)	8.9	(6.9-11.4)
High education	93.4	(88.5-96.3)	5.2	(3.1-8.7)	1.4	(0.2-9.2)	6.6	(3.7-11.5)
30-44 Years	85.9	(83.9-87.8)	11.4	(9.8-13.2)	2.6	(1.8-3.8)	14.1	(12.2-16.1)
Low education	77.2	(68.9-83.8)	14.7	(9.5-22.2)	8.1	(4.4-14.3)	22.8	(16.2-31.1)
Medium education	84.2	(81.2-86.8)	13.3	(10.9-16.1)	2.5	(1.6-3.9)	15.8	(13.2-18.8)
High education	92.5	(90.4-94.1)	6.9	(5.3-8.9)	0.6	(0.3-1.5)	7.5	(5.9-9.6)
45-64 Years	72.5	(70.6-74.3)	19.6	(18.1-21.3)	7.9	(6.9-9.1)	27.5	(25.7-29.4)
Low education	65.9	(60.7-70.8)	22.0	(18.2-26.3)	12.1	(8.9-16.1)	34.1	(29.2-39.3)
Medium education	67.9	(65.0-70.6)	22.5	(20.1-25.1)	9.7	(8.2-11.4)	32.1	(29.4-35.0)
High education	83.2	(81.2-85.1)	13.6	(11.9-15.5)	3.2	(2.3-4.3)	16.8	(14.9-18.8)
≥65 Years	60.6	(58.5-62.8)	26.4	(24.5-28.4)	13.0	(11.6-14.6)	39.4	(37.2-41.5)
Low education	57.7	(52.8-62.6)	27.3	(22.9-32.1)	15.0	(12.0-18.6)	42.3	(37.4-47.2)
Medium education	60.2	(56.9-63.4)	25.7	(23.0-28.6)	14.1	(12.0-16.5)	39.8	(36.6-43.1)
High education	62.6	(59.2-65.9)	27.3	(24.0-31.0)	10.1	(8.0-12.5)	37.4	(34.1-40.8)
Total (women and men)	**75.5**	**(74.7-76.3)**	**17.9**	**(17.2-18.5)**	**6.6**	**(6.2-7.1)**	**24.5**	**(23.7-25.3)**

CI=Confidence interval

naire for the EU-Statistics on Income and Living Conditions (EU-SILC), implemented in Germany by the Federal Statistical Office, applied the three-question version, thereby deviating from earlier surveys. The change in the formulation of the question means that current results for the GALI question are not comparable to the results from previous survey waves of the same study. This applies both to the GEDA survey and to EU-SILC. However, similar shifts in the results of both surveys compared to their earlier waves are observed. In GEDA 2014/2015-EHIS, 75.5% of respondents report that they do not experience limitations, whereas in GEDA 2012 the corresponding figure was 67.1%. The share of respondents who experience severe or moderate limitations (GEDA 2012) changed between GEDA 2012 (11.3%) and GEDA 2014/2015-EHIS (6.6%) as did the share of those experiencing moderate limitations (GEDA 2012 21.7%; GEDA 2014/2015-EHIS 17.9%). Published EU-SILC results for Germany reveal that in 2015 21.2% of the population experienced limitations to their usual activities (women 21.7%; men 20.6%) [15]. In comparison, in 2014, 36.2% of respondents reported limitations to usual activities [16]. Independently of each other, 2015 EU-SILC and GEDA 2014/2015-EHIS data therefore reveal similar shifts to previous survey

Figure 1
12-month prevalence of limitations due to health problems (severely and moderately limited) according to gender and federal state (n=13,014 women; n=10,738 men)
Source: GEDA 2014/2015-EHIS



Confidence intervals in parentheses

The share of respondents reporting limitations increases with age and shows a strong education gradient.

There are some significant differences in limitations to usual activities between federal states.

waves. These results highlight that the indicator is sensitive to changes in the way questions are posed [17]. This aspect will be further analysed and discussed in order to identify relevant potentials for improvement.

The demographic change and the rise in life expectancy will require changes at the level of prevention and healthcare provision. Periodically collected data on limitations to usual activities due to health problems and the extent and duration of such limitations are a potentially valuable contribution to strengthening needs-based prevention and healthcare, also at regional level, where applicable.

References

1. Jagger C (2000) Compression or expansion of morbidity--what does the future hold? Age and Ageing 29(2):93-94
2. Fries JF (2003) Measuring and monitoring success in compressing morbidity. Ann Intern Med 139(5 Pt 2):455-459
3. Trachte F, Sperlich S, Geyer S (2015) Kompression oder Expansion der Morbidität? Zeitschrift für Gerontologie und Geriatrie 48(3):255-262
4. Unger R, Schulze A (2013) Können wir (alle) überhaupt länger arbeiten? Trends in der gesunden Lebenserwartung nach Sozialschicht in Deutschland. Comparative Population Studies – Zeitschrift für Bevölkerungswissenschaft 38(3):545-564
5. European Commission (2017) Healthy Life Years. http://ec.europa.eu/health/indicators/healthy_life_years/hly_en (As at 04.05.2017)
6. European Health Expectancy Monitoring Unit (2010). The Minimum European Health Module. EHEMU Technical report 2010. http://www.eurohex.eu/ehleis/pdf/Reports_2010/2010TR4.6_Health%20Module.pdf (As at 02.06.2017)
7. Prütz F, Lange C (2016) Daten zu Behinderung und Teilhabe in Deutschland. Anforderungen, Auswertungsmöglichkeiten und Ergebnisse. Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 59(9): 1103-1116.
8. Fehr A, Lange C, Fuchs J et al. (2017) Health monitoring and health indicators in Europe. Journal of Health Monitoring 2(1): 3-21 http://edoc.rki.de/oa/articles/reZ6OLMSdImyQ/PDF/239ufPuDm2rO.pdf (As at 03.07.2017)
9. Eurostat (2016) International standard classification of education (ISCED). http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:International_standard_classification_of_education_(ISCED) (As at 13.01.2017)
10. Lange C, Finger JD, Allen J et al. (in press) Implementation of the European Health Interview Survey (EHIS) in Germany. Further development of the German Health Update (GEDA) Archives of Public Health
11. Bundesinstitut für Bevölkerungsforschung (2016) Bevölkerungsentwicklung. Daten, Fakten, Trends zum demografischen Wandel. Wiesbaden
12. Robert Koch-Institut (eds) (2011) Daten und Fakten: Ergebnisse der Studie »Gesundheit in Deutschland aktuell 2009«. Beiträge zur Gesundheitsberichterstattung des Bundes. Robert Koch-Institut, Berlin http://edoc.rki.de/documents/rki_fv/reQXTR7OSGFRg/PDF/20dqmVRMM57G6.pdf (As at 03.07.2017)
13. Robert Koch-Institut (eds) (2012) Daten und Fakten: Ergebnisse der Studie »Gesundheit in Deutschland aktuell 2010«. Beiträge zur Gesundheitsberichterstattung des Bundes. Robert Koch-Institut, Berlin http://edoc.rki.de/documents/rki_fv/remDCCtjOJxI/PDF/21TgKGZEOWNCY.pdf (As at 03.07.2017)
14. Robert Koch-Institut (eds) (2014) Daten und Fakten: Ergebnisse der Studie »Gesundheit in Deutschland aktuell 2012«. Beiträge zur Gesundheitsberichterstattung des Bundes. Robert Koch-Institut, Berlin http://edoc.rki.de/documents/rki_fv/recJuHnzacx8A/PDF/28GsWuNtFjVqY.pdf (As at 03.07.2017)
15. Statistisches Bundesamt (2014) Leben in Europa. Einkommen und Lebensbedingungen in Deutschland und der Europäischen Union Fachserie 15 Reihe 3. Wiesbaden.
16. Statistisches Bundesamt (2015) Leben in Europa. Einkommen und Lebensbedingungen in Deutschland und der Europäischen Union Fachserie 15 Reihe 3. Wiesbaden.
17. Thelen J, Kroll L, Ziese T (2010) Qualitätsaspekte europäischer Gesundheitsindikatoren am Beispiel des Indikators „Gesunde Lebensjahre". In: Gesellschaft für Versicherungswissenschaft und -gestaltung (GVG) (eds) EU-Gesundheitspolitik im nicht-harmonisierten Bereich. Aktuelle Entwicklungen der Offenen Methode der Koordinierung. Nanos Verlag, Bonn, P. 179-199

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin

Corresponding author
Dr Elena von der Lippe
Robert Koch Institute
Department of Epidemiology and Health Monitoring
General-Pape-Str. 62–66
D-12101 Berlin, Germany
E-mail: vonderLippeE@rki.de

Conflict of interest statement
The authors declared no conflicts of interest.

Funding
The GEDA study was funded by the Robert Koch Institute and the German Federal Ministry of Health.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
von der Lippe E, Fehr A, Lange C (2017) Limitations to usual activities due to health problems in Germany. Journal of Health Monitoring 2(3):84–90
DOI 10.17886/RKI-GBE-2017-071

ISSN 2511-2708

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

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-072
Robert Koch Institute, Berlin

Authors:
Anke-Christine Saß, Ronny Kuhnert, Alexander Rommel

Accident injuries of adults in Germany

Abstract
In 2014, according to estimates by the Federal Institute for Occupational Safety and Health (BAuA), around 9.8 million people in Germany suffered accident injuries. Over 22,000 people died. Federal statistics, however, cannot comprehensively describe accidents in Germany. Here, the Robert Koch Institute health surveys provide an important addition. In the GEDA 2014/2015-EHIS survey, 10.5% of men and 6.9% of women reported that they had suffered accident injuries requiring medical treatment during the past 12 months. Young men aged 18 to 29 have the highest accident risk (18.1%). The overall accident injury figures have hardly changed since the previous GEDA 2012 survey. Preventing accidents is a highly important topic not only for the victims of accidents and their families, but also for society as a whole. According to the World Health Organization, a largely untapped potential for accident prevention remains.

ACCIDENT · INJURY · ADULTS · HEALTH MONITORING · GERMANY

Introduction
Preventing accidents is highly important, both for the victims of accidents and their families and also for society as a whole. According to the Federal Institute for Occupational Safety and Health (BAuA) estimates, around 9.8 million people suffered accident injuries in 2014 [1]. More than 22,000 people died in accidents (ICD-10: V01-X59; ICD-10: International Statistical Classification of Diseases and Related Health Problems, 10th revision) [2]. Besides unintentional accident injuries, injuries can also be caused intentionally, for example during fights (interpersonal violence such as attacks or brawls) or in cases of intentional self-harm. The World Health Organization (WHO) estimates that 72% of all injuries in Europe are unintentional [3]. The medical treatment of injuries accounts for around 5% of total annual medical expenses (ICD-10: S00-T98; 2008) [4]. In 2015, around 11% of incapacity days for economically active members of the AOK health insurance fund were related to injuries [5]. Nearly every 10th premature death (death before the age of 65) in 2015 was due to injury [6].

Official statistics, however, cannot provide a comprehensive picture of accidents in Germany (see info box) [7]. Fatal accidents are recorded in cause of death statistics. Occupational accidents are documented comprehensively by the corresponding accident insurance providers; traffic accidents are recorded in road accident statistics. These statistics, however, fail to provide systematic data on further important fields such as accidents that occur at home, during leisure time or those road accidents where the police is not involved. Representative surveys (such as health surveys) can provide

Info box:

Official German statistics collect data on injuries based on the ICD classifications:

Chapter XIX (S00-T98) Injury, poisoning and certain other consequences of external causes

- The affected part of the body and type of injury is coded; no distinction is made between intentional and unintentional injuries (accidents)

Chapter XX (V01-Y98) External causes of morbidity and mortality

- Differentiation between intentional and unintentional injuries (accidents) is possible; is only used to codify causes of death (cause of death statistics)

additional information and ensure a clearer overall picture of non-fatal accidents in Germany. They are therefore an important supplement [7].

Numerous health surveys which the Robert Koch Institute (RKI) conducted during the past few years provide cross-sectional and time series data on accidents for adults (and children) in Germany. The GEDA 2014/2015-EHIS survey provides current data. This survey integrated the European Health Interview Survey (EHIS) into the German Health Update survey (GEDA 2014/2015), which also involved substantial changes to the way in which questions are posed. This created challenges regarding numerous health topics as well as for non-fatal accidents mainly because, whilst GEDA 2014/2015-EHIS aims to ensure the comparability of findings across Europe, the survey also hopes to provide relevant data for preventive healthcare and health policy in Germany.

Indicator

GEDA 2014/2015-EHIS surveyed accident injuries through self-administered paper-based or online questionnaires. The first question was, 'During the past 12 months have you suffered an injury from one of the following accidents? This includes injuries caused by poisoning, animals or insects. Injuries caused intentionally by other people are excluded.' The available answer categories were 'Road accident', 'Accident at home', and 'Accident during leisure time'.

All of those who had suffered an accident were then asked whether their injuries had required medical treatment, 'Following your accident, did you require medical attention? If you suffered several accidents, this question refers to your severest accident, i.e. the accident that required the most medical care.' Respondents could answer, 'Care in hospital or other healthcare facility as inpatient or outpatient', 'Care provided by physician or nurse', 'No medical attention'.

GEDA 2014/2015-EHIS supplemented both of these questions, which form part of the EHIS instrument, with questions on occupational accidents so as to include accidents at work in the overall picture of accidents in Germany. Commuting accidents, i.e. accidents that occur on the way to work, were excluded. Insurance legislation in Germany covers these accidents through occupational accident insurance. Respondents were asked about occupational accidents and medical attention for resulting injuries by asking, 'Did you suffer an injury at work during the past 12 months? This does not include commuting accidents', and, 'Did you require medical attention for your occupational accident?' Possible answers were 'Yes' or 'No'.

To calculate the indicator 'Accident injury requiring medical attention', a combination of the questions asked was used. To enter this category, a person had to have suffered a road accident, an accident at home or during leisure time and then sought medical attention in a hospital or other medical facility either as an inpatient or outpatient. Respondents who had suffered an occupational accident that had required medical attention were also included. Such a definition provides an overview of all non-fatal accidents in Germany (excluding minor injuries). Moreover, this approach allows us to continue the already established RKI time series. The results should

GEDA 2014/2015-EHIS

Data holder: Robert Koch Institute

Aims: To provide reliable information about the population's health status, health-related behaviour and health care in Germany, with the possibility of a European comparison

Method: Questionnaires completed on paper or online

Population: People aged 18 years and above with permanent residency in Germany

Sampling: Registry office sample; randomly selected individuals from 301 communities in Germany were invited to participate

Participants: 24,016 people (13,144 women; 10,872 men)

Response rate: 26.9%

Study period: November 2014 - July 2015

Data protection: This study was undertaken in strict accordance with the data protection regulations set out in the German Federal Data Protection Act and was approved by the German Federal Commissioner for Data Protection and Freedom of Information. Participation in the study was voluntary. The participants were fully informed about the study's aims and content, and about data protection. All participants provided written informed consent.

More information in German is available at www.geda-studie.de

be seen as estimates, as they combine two not fully identical questions/answers.

The results are stratified by gender, age and education. The International Standard Classification of Education (ISCED) was used to classify the responses provided on educational level [8]. Differences between these groups are interpreted as statistically significant if the respective confidence intervals do not overlap.

The analyses are based on the data from 23,147 participants aged 18 years and above (12,625 women, 10,522 men) with valid data on road and occupational accidents as well as accidents at home and during leisure time. The calculations were carried out using a weighting factor that corrects for deviations within the sample from the German population (as of 31 December 2014) with regard to gender, age, district type and education. The district type reflects the degree of urbanisation and accounts for the regional distribution in Germany.

For a detailed description of the methodology applied in the GEDA 2014/2015-EHIS study, see Lange et al. 2017 [9] as well as the article German Health Update: New data for Germany and Europe in Issue 1/2017 of the Journal of Health Monitoring. This includes the questionnaire which was used in the survey.

Results and discussion

As reported by GEDA 2014/2015-EHIS, 8.6% of adults in Germany suffered injuries from accidents during the past 12 months that required medical treatment (accident prevalence). Prevalence for men was 10.5% and slightly lower for women at 6.9% (Table 1). Compared to GEDA 2012, accident injury rates in GEDA 2014/2015-EHIS remained nearly unchanged (8.7% in 2012) [10]. Accident prevalence rates by gender also remained nearly constant. The survey registered a marginal decrease in the rate for men and a slight increase for women (rates of 10.9% and 6.6% respectively for accident injuries in 2012).

Stratified by age and gender, the group of young men aged 18 to 29 particularly stands out. Presenting an 18.1% accident injury rate over the past 12 months, this group is involved particularly often in accidents that require medical attention. Accident prevalence among men decreases with age, but up to the 45- to 64-year age group remains significantly higher than for women. The rate for men aged 65 and above then drops to 5.3%. Compared to the other age groups, the rates are significantly higher for the youngest group and significantly lower for the oldest group.

Accident prevalence for young women is also higher, yet lower than for men. 9.8% of women aged 18 to 29 suffer accident injuries. These rates for women drop at middle age, but, unlike men, begin to increase again at age 65. In this age group, 8.5% suffer accident injuries. The figures for the youngest and oldest age group are therefore significantly higher than for the other age groups.

Riskier behaviour (risk seeking behaviour) is referred to as an explanation for the observed gender differences (and the particularly high accident prevalence among young men) [11]. Further differences, in which gender also plays a role, exist for the prevalence of occupational accidents. In numerous male dominated professions, the accident risk is simply higher, such as in the building sector [11].

Table 1
12-month prevalence of accidents requiring medical treatment according to gender, age and educational level (n=12,625 women; n=10,522 men)
Source: GEDA 2014/2015-EHIS

Women	%	(95% CI)
Women total	**6.9**	**(6.3-7.4)**
18-29 Years	9.8	(8.3-11.7)
Low education	13.2	(9.4-18.3)
Medium education	10.0	(8.1-12.3)
High education	3.7	(2.1-6.7)
30-44 Years	5.3	(4.3-6.4)
Low education	9.2	(5.5-15.2)
Medium education	5.4	(4.1-7.0)
High education	2.9	(2.1-4.0)
45-64 Years	5.3	(4.6-6.1)
Low education	6.0	(4.1-8.6)
Medium education	5.3	(4.5-6.3)
High education	4.2	(3.2-5.6)
≥65 Years	8.5	(7.3-10.0)
Low education	8.9	(6.7-11.6)
Medium education	8.5	(6.8-10.5)
High education	7.2	(4.7-10.7)
Total (women and men)	**8.6**	**(8.2-9.2)**

Men	%	(95% CI)
Men total	**10.5**	**(9.7-11.3)**
18-29 Years	18.1	(15.6-20.9)
Low education	23.1	(17.3-30.1)
Medium education	17.2	(14.2-20.8)
High education	13.1	(9.2-18.2)
30-44 Years	11.0	(9.6-12.7)
Low education	11.9	(7.7-18.0)
Medium education	13.8	(11.4-16.4)
High education	5.9	(4.4-7.7)
45-64 Years	9.5	(8.3-10.8)
Low education	11.3	(8.4-14.9)
Medium education	11.1	(9.4-13.1)
High education	5.9	(4.8-7.1)
≥65 Years	5.3	(4.3-6.5)
Low education	5.6	(3.4-8.9)
Medium education	4.0	(2.9-5.5)
High education	7.5	(5.5-10.2)
Total (women and men)	**8.6**	**(8.2-9.2)**

CI=Confidence interval

11% of men and 7% of women suffered accident injuries requiring medical treatment during the past 12 months.

Compared to GEDA 2012, age and gender patterns for the distribution of accident injuries are similar. However, this survey did not record an increase in accident prevalence for women aged 65 and above [10]. The only comprehensive survey of accidents and injuries so far was conducted in 2010 in the context of the accident module (GEDA 2010). The results of this survey, which the RKI published in the Contributions to Federal Health Reporting series, provided detailed insights on the accidents suffered by adults [7]. Like the current GEDA survey, the GEDA 2010 accident module already hinted at this tendency of accident rates among older women to increase again [7]. By surveying the type of accidents women suffered, it became clear that women aged 65 and above are more likely to suffer falls than men. Compared to men, the results from hospital diagnosis statistics also indicate an increased risk of injury for women aged 65 and above (inpatient treatment of injuries classified under ICD-10: S00-T98) [12].

Concerning education, GEDA 2014/2015-EHIS reveals a slightly lower accident prevalence among women and men from a high education background (Table 1). However, this does not apply equally to all age groups. The accident module in GEDA 2010 provided a more differentiated picture: people of high socio-economic status tended to report more accidents in leisure time, whereas

Young men aged 18 to 29 presented the highest risk of suffering an accident (18% are accident victims during the past 12 months).

The share of accident victims has remained constant since the previous GEDA survey: 9% (2012 and 2014/2015).

people with low social status more frequently reported occupational accidents [7]. For the overall prevalence of accident by social status, however, no differences were recorded. Conclusive evidence supports the existence of this strong correlation between the risk of suffering occupational accidents and social status: Employees in high status jobs significantly less often suffer accidents than those working in low status jobs. Mainly, this is due to the fact that the latter occupations more often involve hazardous work [13, 14].

GEDA 2014/2015-EHIS also provides regional prevalence data by federal state. The information system of Federal Health Reporting (www.gbe-bund.de, in German) provides data on accident prevalence by federal state, age and gender. There are only marginal differences in the prevalence of accidents between the German federal states.

Concerning the place of accident, GEDA 2014/2015-EHIS reveals that most non-fatal accidents occur at home or during leisure time. 6.4% of women (CI 5.9-6.9) and 6.2% of men (CI 5.7-6.8) reported accidents at home. 7.3% of women (CI 6.7-7.9) and 10.8% of men (CI 10.0-11.7) reported accidents during leisure time. Due to the format of the corresponding questions in the EHIS questionnaire, no conclusions can be drawn on the percentage of these accidents that required medical treatment. For fatal accidents too, cause of death statistics indicate that 80% occur at home or during leisure time [2]. Current GEDA survey results are therefore in line with earlier GEDA survey waves as well as with the annual estimates of Germany's Federal Institute for Occupational Safety and Health (BAuA) [1, 7, 10, 15, 16]. In GEDA, the workplace figures as the third most frequent place of accident and a significantly higher number of men suffer occupational accidents than women (5.9% vs. 2.7%; CI 5.4-6.6 and 2.3-3.1).

A comparison of accident prevalence as reported in GEDA 2014/2015-EHIS with other data sources is not fully possible. This is due to the differences in survey methods and content, for example that official hospital diagnosis statistics do not differentiate between unintentional and intentional injuries. BAuA annually estimates total accident prevalence in Germany and does also differentiate according to places of accident. The current estimate reports that roughly 12% of the population suffer accident injuries per year [1]. GEDA 2014/2015-EHIS reports a lower prevalence of just under 9% for adults. BAuA figures, however, also include children and numerous surveys indicate that children are more likely to suffer accidents than adults [17-19].

In spite of highly positive developments, such as the significant decrease in fatal road accidents during the past 20 years [20], accident injuries remain a prime public health concern, regarding not only the prevalence of accidents, their sometimes dire consequences and related high costs of treatment, but also concerning prevention: The WHO considers that most intentional and unintentional injuries could be prevented [3].

Most (non-fatal and fatal) accidents occur at home and during leisure time.

References

1. Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (2016) Unfallstatistik 2014. Unfalltote und Unfallverletzte 2014 in Deutschland. https://www.baua.de/DE/Angebote/Publikationen/Fakten/Unfall-statistik-2014.pdf?__blob=publicationFile&v=1 (As at 17.05.2017)

2. Statistisches Bundesamt (2016) Sterbefälle durch Unfälle nach äußeren Ursachen und Unfallkategorien. www.gbe-bund.de (As at 17.05.2017)

3. World Health Organization (2017) Violence and injuries. Data and statistics. www.euro.who.int/en/health-topics/disease-prevention/violence-and-injuries/data-and-statistics (As at 17.05.2017)

4. Statistisches Bundesamt (2010) Krankheitskosten in Mio. € für Deutschland. Gliederungsmerkmale: Jahre, Alter, Geschlecht, ICD-10. www.gbe-bund.de (As at 17.05.2017)

5. Wissenschaftliches Institut der AOK (2016) Arbeitsunfähigkeit bei erwerbstätigen AOK-Mitgliedern. Gliederungsmerkmale: Jahre, Deutschland, Geschlecht, Wirtschaftszweig - WZ 2008, ICD10. www.gbe-bund.de (As at 17.05.2017)

6. Statistisches Bundesamt (2017) Vorzeitige Sterblichkeit, Tod unter 65 Jahren. Gliederungsmerkmale: Jahre, Region, Geschlecht, ICD-10, Art der Standardisierung. www.gbe-bund.de (As at 17.05.2017)

7. Robert Koch-Institut (2013) Das Unfallgeschehen in Deutschland. Ergebnisse des Unfallmoduls der Befragung „Gesundheit in Deutschland aktuell 2010". Beiträge zur Gesundheitsberichterstattung des Bundes. RKI, Berlin http://edoc.rki.de/documents/rki_fv/re4CBMHqMjwf2/PDF/213Q4vHuL1F6w.pdf (As at 24.05.2017)

8. Eurostat (2016) International standard classification of education (ISCED). http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:International_standard_classification_of_education_(ISCED) (As at 13.01.2017)

9. Lange C, Finger JD, Allen J et al. (in press) Implementation of the European Health Interview Survey (EHIS) in Germany. Further development of the German Health Update (GEDA) Archives of Public Health

10. Robert Koch-Institut (eds) (2014) Daten und Fakten: Ergebnisse der Studie »Gesundheit in Deutschland aktuell 2012«. Beiträge zur Gesundheitsberichterstattung des Bundes. RKI, Berlin http://edoc.rki.de/documents/rki_fv/recJuHnzacx8A/PDF/28Gs-WuNtFjVqY.pdf (As at 24.05.2017)

11. Saß A, Rommel A (2016) Unfälle aus Geschlechterperspektive. In: Kolip P, Hurrelmann K (eds) Handbuch Geschlecht und Gesundheit. Hogrefe Verlag, Bern, P. 275-286

12. Statistisches Bundesamt (2016) Diagnosedaten der Krankenhäuser (Fälle je 100.000 Einwohner), Gliederungsmerkmale: Jahre, Wohnsitz, Alter, Geschlecht, Verweildauer, ICD10-3-Steller. www.gbe-bund.de (As at 24.05.2017)

13. Robert Koch-Institut (eds) (2016) Arbeitsunfälle in Deutschland. Faktenblatt zu GEDA 2012: Ergebnisse der Studie "Gesundheit in Deutschland aktuell 2010". RKI, Berlin http://edoc.rki.de/series/gbe-faktenblaetter/2016-6/PDF/6.pdf (As at 24.05.2017)

14. Rommel A, Varnaccia G, Lahmann N et al. (2016) Occupational Injuries in Germany: population-wide national survey data emphasize the importance of work-related factors. PloS one 11(2):e0148798

15. Robert Koch-Institut (eds) (2010) Daten und Fakten: Ergebnisse der Studie »Gesundheit in Deutschland aktuell 2009«. Beiträge zur Gesundheitsberichterstattung des Bundes. RKI, Berlin http://edoc.rki.de/documents/rki_fv/reQXTR7OSGFRg/PDF/20dqmVRMM57G6.pdf (As at 24.05.2017)

16. Robert Koch-Institut (eds) (2012) Daten und Fakten: Ergebnisse der Studie »Gesundheit in Deutschland aktuell 2010«. Beiträge zur Gesundheitsberichterstattung des Bundes. RKI, Berlin http://edoc.rki.de/documents/rki_fv/remDCCtjOJxI/PDF/21TgK-GZEOWNCY.pdf (As at 24.05.2017)

17. Kahl H, Dortschy R, Ellsäßer G (2007) Verletzungen bei Kindern und Jugendlichen (1–17 Jahre) und Umsetzung von persönlichen Schutzmaßnahmen. Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 50(5):718-727

18. Saß AC, Poethko-Müller C, Rommel A (2014) Das Unfallgeschehen im Kindes- und Jugendalter – Aktuelle Prävalenzen, Determinanten und Zeitvergleich. Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 57(7):789-797

19. Varnaccia G, Saß AC, Rommel A (2014) Das Unfallgeschehen bei Kindern und Jugendlichen in Deutschland. Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 57(6):613-620

20. Statistisches Bundesamt (2016) Statistik der Straßenverkehrsunfälle. Verletzte und Getötete bei Straßenverkehrsunfällen. www.gbe-bund.de (As at 17.05.2017)

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin, Germany

Corresponding author
Dr Anke-Christine Saß
Robert Koch Institute
Department of Epidemiology and Health Monitoring
General-Pape-Str. 62–66
D-12101 Berlin, Germany
E-mail: SassA@rki.de

Conflicts of interest
The authors declared no conflicts of interest.

Funding
The GEDA study was funded by the Robert Koch Institute and the German Federal Ministry of Health.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
Saß AC, Kuhnert R, Rommel A (2017) Accident injuries of adults in Germany. Journal of Health Monitoring 2(3):91–97
DOI 10.17886/RKI-GBE-2017-072

ISSN 2511-2708

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

Journal of Health Monitoring · 2017 2(3)
DOI 10.17886/RKI-GBE-2017-062
Robert Koch Institute, Berlin

Authors:
Christin Heidemann, Christa Scheidt-Nave

Prevalence, incidence and mortality of diabetes mellitus in adults in Germany – A review in the framework of the Diabetes Surveillance

Abstract

Continuous monitoring of the key epidemiological indicators of diabetes is necessary for evaluating the magnitude of diabetes as a public health problem, but is currently not being undertaken in Germany. A comprehensive literature review covering the last decades was conducted to give an overview of population-based studies reporting on diabetes prevalence, diabetes incidence, and diabetes-related mortality among adults in Germany. This review differentiates between known and unknown diabetes, but not between individual types of diabetes.

Numerous studies have identified a considerable increase in the prevalence of known diabetes among the adult population over time. Until the 1960s, the prevalence of known diabetes remained below 1%. However, current nationwide estimates for Germany are much higher and range between 7.2% (population aged 18 to 79 years) based on health examination surveys of the Robert Koch Institute (RKI), 8.9% (population aged 18 years and over) based on RKI telephone health interview surveys and 9.9% (among all age groups) based on statutory health insurance data. Few available estimates point to an increase in the incidence of known diabetes since the 1960s. For example, a comparison of data from the diabetes register of the former German Democratic Republic (GDR) in 1960 with current follow-up data from RKI survey participants shows that incidence rates increased from 1.2 (all age groups) to 6.9 (population aged 18 to 79 years) per 1,000 person-years. Data on diabetes-related mortality are also scarce, but indicate that excess mortality persists among people with known diabetes compared to those in the same age group without the condition, despite the finding of decreasing mortality rates among people with known diabetes. For example, the mortality rate based on early data from the GDR diabetes register was 1.9-fold higher among people with known diabetes than among the general population; current mortality follow-up data of RKI survey participants show a 1.7-fold higher mortality rate among people with known diabetes compared to those without the condition. Given the limited data that are currently available and the considerable variation of diagnostic criteria, it is not possible to estimate time trends in the prevalence, incidence or mortality of unknown diabetes.

An extension of available health monitoring approaches and an improved use of existing data sources for secondary analysis are needed for a reliable evaluation of dynamics in diabetes epidemiology in Germany. To achieve these goals, a national diabetes surveillance system is currently being established under the auspices of the RKI.

DIABETES MELLITUS · PREVALENCE · INCIDENCE · MORTALITY · EPIDEMIOLOGY

Info box 1: Prevalence [66, 67]
The frequency of a specific disease among a population at a particular time. It is usually expressed as a percentage (proportion) of a given population.

Since the 1960s, the proportion of people with known diabetes (prevalence) has increased almost ten-fold.

1. Introduction

Diabetes mellitus is a metabolic disorder involving a disruption of the regulation of blood glucose levels [1]. It results in chronically elevated blood glucose concentrations, which, if left untreated or treated insufficiently, can lead to serious complications including myocardial infarction, stroke, renal failure, blindness and amputations. Clearly, it can therefore reduce people's quality of life and life expectancy, while also producing high levels of costs for health care systems [2].

Information about the spread of diabetes mellitus (Prevalence, Info box 1) is particularly relevant to attempts to classify the disorder within the public health context. Around 3,500 years ago, descriptions of symptomatology demonstrate that severe cases of diabetes were rare [3].Even as late as the first half of the 20th century, the prevalence of diabetes in Europe was still estimated to be considerably lower than 1% [4, 5]. However, since the 1960s, there has been a marked increase in the prevalence of diabetes in Germany that has led it to be viewed as endemic [6]. In fact, an alarming increase in the prevalence of diabetes has occurred throughout the world [7]; so much so that this situation has been described as a 'diabetes pandemic' [8, 9]. In addition to known (medically diagnosed) diabetes, unknown (medically undiagnosed) diabetes also plays an important role because it is suggested that a large number of cases go unreported [10]. There are estimations that point to a period of latency between the onset of diabetes and a medical diagnosis of the condition of at least six years on average [11]. During this time, a considerable proportion of people with unknown diabetes begin to develop diabetes-specific complications [12-14]. However, changes to the criteria used for diagnosis (Info box 4) and diabetes screening could lead to a shift in the ratio of unknown to known cases over time.

Time trends in diabetes prevalence are directly associated with developments in the rate of new cases (Incidence rate, Info box 2) and the death rate (Mortality rates, Info box 3) within a given population [15]. In turn, the incidence rate is closely associated with changes in behaviour (such as dietary habits, physical activity and associated body weight) as well as living conditions (such as economic, social and environmental factors at the individual and regional level) that have an impact on diabetes development. Apart from increases in life expectancy in the general population, the mortality rate among people with diabetes is particularly influenced by the quality of diabetes care. In addition, demographic changes (such as population ageing and migration) play a role in epidemiological developments linked to diabetes. In Germany – as in most other countries – information about the interplay of the prevalence, incidence and mortality rates linked to diabetes is limited due to the lack of continuous data collection [16-18].

This article aims to summarise available data on the prevalence, incidence and mortality of diabetes among adults in Germany and to describe time trends wherever possible. It considers both known and unknown diabetes. This article also explores approaches that could be used to continuously monitor key indicators of dynamics in diabetes epidemiology in Germany.

Info box 2: Incidence [66, 67]
The frequency of new cases among a population within a given time period. It is often expressed as a percentage (proportion) of new cases within a population (cumulative incidence) or the number of new cases per 1,000 person-years (incidence rate).

Cumulative incidence (%): The number of new cases related to the number of people at risk; in other words, the percentage of a population that does not have the disease in question at the beginning of a defined period (for example a ten-year study period) but that could develop the disease during this time. As an example, people who already have diabetes at the start of a study period are excluded from calculations of cumulative incidence.

Incidence rate (per 1,000 person-years): The number of new cases related to the person-time at risk; in other words, the number of new cases related to the time span accumulated by all of the people who are at risk of developing the disease and among whom it could possibly be observed during the study period. As an example, not everyone is at risk of getting diabetes during the entire study period because they may either be diagnosed with diabetes or die from other causes before the study has been completed.

2. Method

A narrative literature review of the PubMed bibliographic database was conducted to identify studies that have published data on diabetes prevalence, incidence and mortality in Germany. In addition, we hand-searched the bibliographies of relevant original research articles and literature reviews. However, only studies that directly provided or permitted calculation of the following data on prevalence, incidence or mortality were included within this review: prevalence as a percentage of the population with diabetes (Info box 1); incidence as a rate, in other words, as the number of new cases of diabetes per 1,000 person-years (Info box 2); age-standardised or age-adjusted mortality rate comparing all-cause mortality rates among people with diabetes to rates among people without diabetes or in the general population (Info box 3). Given the limited availability of data on incidence, studies were also included if they provided current nationwide estimates of the cumulative incidence (Info box 2). However, studies that only provided data on children or adolescents, or on population subgroups at particular risk of diabetes (such as people with obesity, a history of heart disease or those living in nursing homes), were not included in the review. Depending on the study in question, 'diabetes' was usually defined as all types of the disorder or just type 2 diabetes – the most predominant form of diabetes in adults [10, 18]. Detailed descriptions of the study populations and the definition of diabetes used in the studies included in this review are set out in the figures and tables presented below.

3. Prevalence

3.1 Prevalence of known diabetes

Numerous estimates of the prevalence of known diabetes are available from various studies that have been conducted over recent decades. The individual estimates of prevalence from studies undertaken after around 1960 are summarised in Figure 1 (for national-level studies) and in Figure 2 (for regional studies). Overall, the available data demonstrate that the prevalence of known diabetes has strongly increased over time.

Until the beginning of the 20th century, prevalence estimates of known diabetes were based on mortality and clinical case statistics; these identified a prevalence of between 0.2% and 0.4% [4, 5, 19]. Estimates made during the Second World War, which were derived from statistics covering the provision of insulin and dietary supplements to diabetes patients, suggest a decrease in prevalence. In part, this is due to the increased mortality among people with diabetes due to deficient or low-quality medication and food supplies as well as a higher susceptibility to infection [5, 19].

Living conditions improved in the 1950s and 1960s. This went along with an increased intake of high-calorie foods, reduced levels of physical activity and increases in the prevalence of overweight and obesity in the population; at the same time, life expectancy among people with diabetes increased due to improved treatment. As a result, the prevalence of known diabetes increased considerably [5, 6, 20-22]. In addition, diabetes screening activities mainly conducted in East Germany (the former German Democratic Republic, GDR) and to a

Info box 3: Mortality [66, 67]

The frequency of deaths among a population within a given time period. This is often provided as a percentage (proportion) of deaths within a population (cumulative mortality) or the number of deaths per 1,000 person-years (mortality rate).

Age-standardised or age-adjusted mortality rates:

Age-standardisation or age-adjustment is used to compare the rate of death among population groups with different age structures. These statistical methods can provide an assessment of a mortality rate that is independent of demographic differences. As an example, in this article age-standardised or age-adjusted mortality rates are compared between people with diabetes and the general population or people without diabetes. The resulting higher risk of death (known as the standardised mortality ratio or hazard ratio, Table 3) is referred to here as the excess mortality of people with diabetes compared to the reference group.

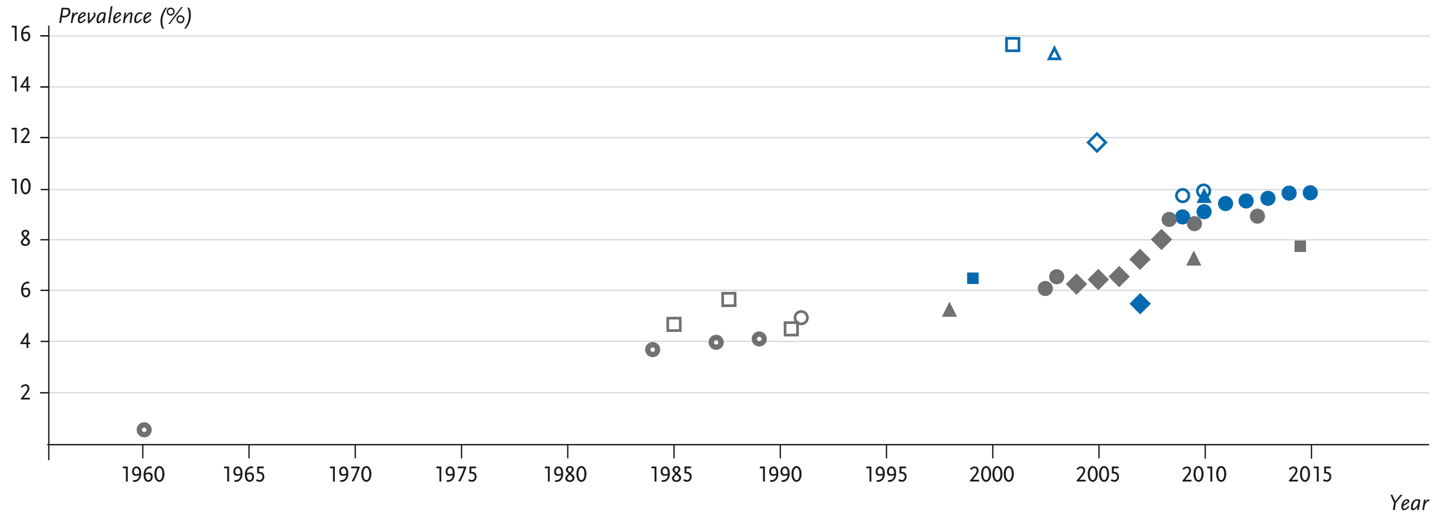
lesser degree in West Germany had a role in increasing the prevalence of known diabetes due to better detection of undiagnosed diabetes [4, 6, 20, 22, 23]. Data from the GDR diabetes register, which covers almost all diabetes cases treated in the country between 1960 and 1989, show a continuous increase in prevalence during this period from 0.6% to 4.1% [23]. While there is no comparable database to describe time trends for West Germany during this time period, estimates that are available from various sources suggest that the prevalence in West Germany increased by a similar magnitude [24-27].

From 1990 until about 2000, data available from population studies offer no evidence of a further rise in the prevalence of known diabetes. Population-based surveys conducted in the Augsburg region (Cooperative Health Research in the Region of Augsburg, KORA; Monitoring Trends and Determinants in Cardiovascular Disease, MONICA) between 1989/1990 and 1999-2001 [28] and a comparison of data from the German nationwide survey (Nationwide Health Survey, NUS) conducted between 1990 and 1992 with data from the German National Health Interview and Examination Survey 1998 (GNHIES98) conducted between 1997 to 1999 [29] do not demonstrate an increased prevalence. Moreover, even after comparisons over time were expanded to include data from the RKI telephone health interview surveys (GSTel) conducted between 2002 and 2005, no increase over time was observed [30].

During the first decade of the 21st century, data from periodically repeated nationwide examination, telephone and postal surveys [31-33], as well as trend analyses based on insurance data from AOK Baden-Württemberg and AOK Hesse [34, 35], all demonstrate a clear increase in prevalence. According to data from the RKI examination surveys conducted between 1997 and 1999 (GNHIES98) and 2008 and 2011 (German Health Interview and Examination Survey for Adults, DEGS1), the prevalence of known diabetes rose from 5.2% to 7.2% among persons aged 18 to 79 years [31]. Health insurance data covering everyone insured by AOK Hesse between 2000 and 2009 showed a rise from 6.5% to 9.7% [35]. Differences in prevalence estimates derived from these and other studies conducted over a similar time period (Figures 1 and 2) are most likely attributable to differences in criteria used to define diabetes and in the groups of people included in the studies in question, which can differ according to the data source (Info box 5). Consistent across studies based on survey and health insurance data, about one third of the observed increase is attributable to demographic ageing [31, 35]. Further reasons for the current increase in prevalence may be improvements in early disease detection (such as increased awareness among doctors or changes in diagnostic criteria: see Info box 4), partial improvements made to diabetes care (such as the introduction of Disease Management Programmes) [36, 37] and the associated longer life expectancy. In addition, changes in the prevalence of behavioural risk factors also need to be considered. However, these demonstrate partly opposing trends and – according to a summary measure provided by the German Diabetes Risk Score – provide no evidence of a current increase in the overall level of risk [38].

Establishing a continuous monitoring system for the prevalence of known diabetes among adults in Germany

Figure 1
Nationwide studies providing data on the prevalence of known diabetes among adults in Germany

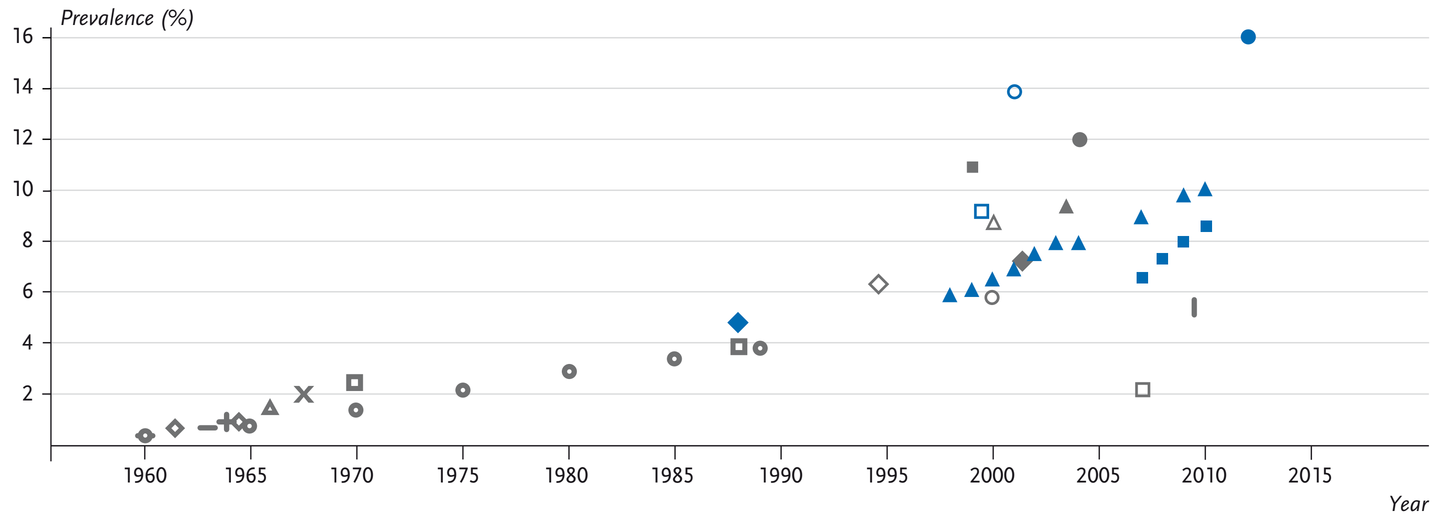


	Study population	Definition of known diabetes
● (grey)	RKI interview surveys (via telephone): ≥18-year-olds, N~8,000 to~22,000 [32, 79-82]	Self-report of physician-diagnosed diabetes
■ (grey)	RKI interview survey (online/paper-based): ≥18-year-olds, N=23,345 [83]	Self-report of having diabetes (not including gestational diabetes) in the last 12 months
▲ (grey)	RKI examination surveys: 18-79-year-olds, N~7,000 [31]	Self-report of physician-diagnosed diabetes or of anti-diabetic medication
◆ (grey)	Postal surveys: 18-79-year-olds, N~1,500 [33]	Self-report of diabetes diagnosis (≥1 visit to a doctor per quarter or regular anti-diabetic medication)
● (blue)	Claims data from physicians on insurees from all statutory health insurance funds: all ages, N~70 million [40]	Physician-diagnosed diabetes (ICD-10 E10-E14 in ≥2 of 4 quarters with additional ICD-tag 'G' (confirmed) in outpatient diagnoses)
○ (blue)	Sample of insurees from all statutory health insurance funds: all ages, N~65 million [39]	Physician-diagnosed diabetes (ICD-10 E10-E14 with additional ICD-tag 'G' (confirmed) in outpatient diagnoses)
▲ (blue)	Sample of insurees from the AOK: all ages, N~24 million [84]	Physician-diagnosed type 2 diabetes (ICD-10 E11-E14 in ≥2 of 4 quarters in outpatient diagnoses) or prescription of anti-diabetic medication (in ≥2 of 4 quarters)
■ (blue)	Sample of insurees from 6 statutory health insurance funds: all ages, N~15 million [85]	Physician-diagnosed diabetes or prescription of anti-diabetic medication
◆ (blue)	Sample of insurees from the Techniker Krankenkasse: all ages, N~5.4 million [86]	Physician-diagnosed type 2 diabetes (ICD-10 E11 with additional ICD-tag 'G' (confirmed) in ≥2 quarters in outpatient diagnoses or in ≥1 quarter in inpatient diagnoses for the period between Jan 2006 and Dec 2008)
□ (blue)	HYDRA patient sample from general practices: ≥16-year-olds, N=43,549 [87]	Physician data on diabetes diagnosis on the day the study was conducted
△ (blue)	DETECT patient sample from general practices: ≥18-year-olds, N=55,518 [88]	Physician data on diabetes diagnosis on the day the study was conducted or anti-diabetic medication
◇ (blue)	GEMCAS patient sample from general practices: ≥18-year-olds, N=35,869 [89]	Physician-diagnosed diabetes
○ (grey)	Health Survey East/West 91: 25-69-year-olds, N=7,448 [29] (own calculation)	Self-report of diabetes diagnosis
□ (grey)	GCP surveys (West Germany): 25-69-year-olds, N~5,000 [26] (own calculation)	Self-report of diabetes diagnosis
⊙ (grey)	GDR diabetes register (East Germany): all ages, N~17 million [22, 23, 51]	Physician-diagnosed diabetes

For graphical presentation, the midpoint of the respective study period (0.5 yearly steps) is entered into the horizontal axis.

AOK	Allgemeine Ortskrankenkasse (a large statutory health insurance company)
GCP	German Cardiovascular Prevention Study
GDR	German Democratic Republic
DETECT	Diabetes Cardiovascular Risk-Evaluation: Targets and Essential Data for Commitment of Treatment
DHP	Deutsche Herz-Kreislauf-Präventionsstudie
GEMCAS	German Metabolic and Cardiovascular Risk Project
HYDRA	Hypertension and Diabetes Risk Screening and Awareness
ICD-10	International statistical classification of diseases and related health problems, 10th revision
RKI	Robert Koch Institute
TK	Techniker Krankenkasse (a statutory health insurance company)

Figure 2
Regional studies providing data on the prevalence of known diabetes among adults in Germany



	Study population	Definition of known diabetes
●	Sample of insurees from the AOK, Berlin: all ages, N=730,196 [90]	Physician-diagnosed type 2 diabetes (verified)
■	Sample of insurees from the AOK, Baden-Wuerttemberg: all ages, N~4 million [34]	Physician-diagnosed type 2 diabetes (ICD-10 E11, E12 or E14 in ≥3 of 4 quarters) or presricption of anti-diabetic medication (ATC A10A or A10B ≥2 per year or 1 per year with a diagnosis of type 2 diabetes or plus glucose or HbA1c measurements in the same quarter)
▲	Sample of insurees from the AOK, Hesse: all ages, N=300,000 [35, 91-93]	Physician-diagnosed diabetes (in ≥3 of 4 quarters) or prescription of anti-diabetic medication (≥2 per year or 1 per year with a diagnosis of diabetes or plus glucose or HbA1c measurements in the same quarter)
◆	Sample of insurees from the AOK, Dortmund: all ages, N=6,478 [27]	Physician-diagnosed diabetes (in ≥2 of 4 quarters) or prescription of anti-diabetic medication (≥4 per year) or blood glucose measurement (in ≥3 of 4 quarters)
○	ESTHER patient sample from general practices, Saarland: 50-75-year-olds, N=9,953 [94]	Physician-diagnosed diabetes or anti-diabetic medication
□	SESAM 2 patient sample from general practices, Saxony: 2-102-year-olds, N = 8,877 [95]	Physician-diagnosed diabetes
I	GHS, Mainz-Bingen: 35-74-year-olds, N=15,010 [96]	Physician-diagnosed diabetes or diabetes therapy
●	CARLA, Halle: 45-74-year-olds, N=1,382 [97] ■ SHIP, Western Pomerania: 45-74-year-olds, N=2,247 [97]	Self-report of diabetes diagnosis or of anti-diabetic medication and age at diagnosis >30 years
▲	DHS, Dortmund: 45-74-year-olds, N=883 [97] ◆ HNR, Essen/Bochum/Mulh.: 45-74-year-olds, N=4,734 [97]	
○	KORA S4, Augsburg: 45-74-year-olds, N=2,442 [97]	
□	KORA F4, Augsburg: 35-39-year-olds, N=1,653 [47] △ KORA S4, Augsburg: 55-74-year-olds, N=1,353 [98]	Self-report of physician-diagnosed diabetes or of anti-diabetic medication (verified)
◇	Population sample from 5 federal states: 18-70-year-olds, N=2,150 [99]	Self-report of diabetes diagnosis or of diabetes therapy
⊙	GDR diabetes register, district of Neubrandenburg: all ages, N~620,000 [100]	Physician-diagnosed diabetes
▣	GDR diabetes register, East Berlin: all ages, N~1.3 million [101]	
△	GDR diabetes register, district of Erfurt: all ages, N~1.2 million [102]	
◈	GDR diabetes register, district of Schwerin: all ages, N~590,000 [103]	
—	GDR diabetes register, district of Rostock: all ages, N~830,000 [6]	
X	Diabetes Screening, Munich: all ages, N=789,000 [25]	Self-report of diabetes diagnosis
+	Serial examination, Herrenberg: all ages, N=10,036 [24]	Physician-diagnosed diabetes

For graphical presentation, the midpoint of the respective study period (0.5 yearly steps) is entered into the horizontal axis.
Additional studies exclusively reported on sex-specific prevalences [16, 28, 104, 105].

AOK	Allgemeine Ortskrankenkasse (a large statutory health insurance company)
ATC	Anatomical Therapeutic Chemical Classification
CARLA	Cardiovascular Disease, Living and Ageing in Halle
HbA1c	glycated haemoglobin
GDR	German Democratic Republic
GHS	Gutenberg-Gesundheitsstudie
DHS	Dortmund Health Study
ESTHER	Epidemiologische Studie zu Chancen der Verhütung, Früherkennung und optimierten Therapie chronischer Erkrankungen in der älteren Bevölkerung
HNR	Heinz Nixdorf Recall Study
ICD-10	International statistical classification of diseases and related health problems, 10th revision
KORA	Cooperative Health Research in the Region of Augsburg
SESAM	Sächsische Epidemiologische Studien in der Allgemeinmedizin
SHIP	Study of Health in Pomerania

Info box 4: Laboratory criteria for the diagnosis of diabetes over time

1 Fasting glucose: Glucose measured after a period of fasting that lasts for at least 8 hours or at least 10 hours/overnight depending on the guideline in question. Measurements are made using venous plasma.
2 OGTT glucose: Glucose measured in the oral glucose tolerance test (OGTT), i.e. 2 hours (or 1 hour according to earlier guidelines [69]) after drinking a solution of 75g glucose (or 50g/100g glucose according to earlier guidelines [68]) after a period of fasting. Measurements are made using venous plasma.
3 HbA1c: Glycated haemoglobin, i.e. form (A1) of haemoglobin to which the glucose links to (glycation). The proportion of HbA1c compared to the total level of haemoglobin represents the average glucose concentration over the past few weeks. Measurements are made using whole blood.

Some guidelines also refer to measurements of random glucose for the diagnosis of diabetes (i.e. glucose measured at any time of the day, regardless of the time since the last food intake) using ≥11.1 mmol/l (≥200mg/dl) as a cut-off in the presence of classic symptoms of diabetes (unexplained weight loss, excessive urine excretion, excessive thirst).

For further information on laboratory methods, requirements for measurement and repeated testing, please refer to the detailed descriptions provided in the references. The same applies to diagnostic criteria based on glucose measurements in capillary or whole blood as well as for the criteria used to diagnose gestational diabetes.

	Fasting glucose[1]	1h-OGTT glucose[2]	2h-OGTT glucose[2]	HbA1c[3]
WHO 1965 [68]	–	–	≥7,2mmol/l (≥130mg/dl)	
NDDG 1979 [69]	≥7,8mmol/l (≥140mg/dl)	≥11,1mmol/l (≥200mg/dl)	≥11,1mmol/l (≥200mg/dl)	
WHO 1980 [70]	≥8,0mmol (≥145mg/dl)		≥11,0mmol/l (≥198mg/dl)	–
WHO 1985 [71]	≥7,8mmol/l (≥140mg/dl)			
ADA 1997 [72]		–		
WHO 1999 [73]			≥11,1mmol/l (≥200mg/dl)	
ADA 2010 [74]	≥7,0mmol/l (≥126mg/dl)			
DDG 2010 [75]				≥48mmol/mol (≥6,5%)
WHO 2011 [76]				

Abbreviations: ADA: American Diabetes Association, DDG: German Diabetes Association, NDDG: National Diabetes Data Group, WHO: World Health Organization

appears feasible. Time trend analyses need to consider continuously collected data from nationwide, population-based RKI interview and examination surveys [31, 32] as well as routine data for secondary analysis available at the national level within the statutory health insurance system (Info box 5) [39, 40]. A comprehensive analysis is essential in this context, since the available data sources all have specific strengths and limitations (Info box 5).

3.2 Prevalence of unknown diabetes

Some studies have been conducted over recent decades on unknown diabetes; Table 1 summarises the prevalence estimates that they have identified. A number of major systematic diabetes screenings and serial examinations that were conducted during the 1960s are included as examples. Numerous other screening activities have been summarised elsewhere [4, 19, 20, 41]. In general, the data on unknown diabetes is fragmented and a reliable analysis of trends is not feasible due to the varying criteria used to define the condition.

The earliest estimates of the prevalence of unknown diabetes are based on screenings undertaken during the 1950s and 1960s, which were mainly based on urine glucose screening (glucosuria screening) in combination with heterogeneous forms of follow-up examinations. These earlier estimates usually suggest a prevalence of below 1% or a ratio of persons with known diabetes to newly diagnosed cases of about 1:1 [42]. As of the 1970s, glucosuria screening, which has a low sensitivity, moderate specificity and an unfavourable cost-benefit ratio, became increasingly less important [23, 43, 44].

Subsequent estimates of prevalence start to become available during the mid-1990s. These are mainly derived from regional cohort studies and are partly based on

Info box 5: Primary and secondary data

Definition: In contrast to primary data, secondary data are data that are not directly collected for a research interest that was specified in advance or that are evaluated differently from their intended usage [64].

Data sources: Primary data sources that are important for the identification of the frequency of diseases include 1) the examination and interview surveys conducted regularly at nationwide level by the Robert Koch Institute (RKI) [77] and 2) ongoing cohort studies such as the GNC that is being undertaken in 18 study centres [50]. Secondary data sources include administrative data routinely collected within the German social security and health system for documentation and reimbursement. Of particular importance in this context are nationwide routine data that come from multiple statutory health insurers such as 1) the data reported to the German Federal Insurance Office (BVA) for the Morbidity-oriented Risk Structure Compensation (Morbi-RSA). Since 2014, these data have been merged for research purposes in accordance with the Data Transparency Regulation (DaTraV) and are held by the German Institute of Medical Documentation and Information (DIMDI). Another important source of nationwide routine data is 2) the data collected on people with statutory health insurance sent for billing purposes by contract doctors and that are regularly analysed by the Central Research Institute of Ambulatory Health Care in Germany (Zi) [65].

Advantages and limitations: Primary data sources such as the RKI examination surveys often include information on health-related behaviours and laboratory measures. This permits monitoring of risk factor profiles and undiagnosed conditions, such as unknown diabetes. However, these surveys miss certain groups of people (e.g. nursing home residents, people who are very old) and not everyone who is

Continued on next page

fasting blood glucose levels in combination with glucose values measured 2 hours after an oral glucose tolerance test (2h-OGTT glucose) or at a random time (random glucose) (Info box 4). However, some are based on measurements of glycated haemoglobin (HbA1c). This method is now recognised as a criterion for diagnosis (Info box 4) and it is especially employed in epidemiological studies because HbA1c measures are not affected by fasting time. Nevertheless, as the studies employed different methods, and each method relates to a different aspect of glucose metabolism [45], they also identified different groups of people. Therefore, study results differ considerably depending on the method employed by the study in question [46]. Different study regions or age ranges within individual study populations makes a direct comparison of prevalence even more difficult. For example, the KORA F4 study that covers the Augsburg region employed fasting glucose levels and 2h-OGTT glucose measurements and identified a prevalence of unknown diabetes of 2.0% among 35- to 59-year-olds and of 3.9% among 35- to 79-year-olds between 2006 and 2008 [47, 48]. Using the same criteria the Study of Health in Pomerania (SHIP)-TREND, which covers Western Pomerania and was conducted between 2008 and 2012, found a prevalence of 7.1% among 35- to 79-year-olds [48]. Data from nationwide RKI health examination surveys that are based on HbA1c measurements identified a 3.4% prevalence of unknown diabetes between 1997 and 1999 and a 2.0% prevalence between 2008 and 2011 among 18- to 79-year-olds [49]. This study, which is still the only one to have employed a comparable definition of unknown diabetes at two points in time, identified a decrease in the prevalence of unknown diabetes over the last decade.

In order to continuously monitor the prevalence of unknown diabetes in the adult population in Germany, it is essential that studies employ a definition that is comparable over time. Currently, this can only be done by continuing the RKI health examination surveys, which are conducted at relatively wide intervals. Nevertheless, cohort studies, such as the German National Cohort (GNC) [50], which is being conducted in 18 study centres, will also provide valuable point estimates of the ratio of people with known and unknown diabetes.

4. Incidence

4.1 Incidence rate of known diabetes

Few estimates of incidence rates (Info box 2) are available for known diabetes from studies that were conducted over the last few decades with various designs; the results are summarised in Table 2. Overall, these estimates indicate a clear increase in the incidence rate of known diabetes since 1960.

An incidence rate of 1.2 per 1,000 person-years (py) was observed from data sourced from the GDR diabetes register for 1960 [23]. Until 1989, when the registry was closed, an increased incidence rate of 3.8 per 1,000 py was observed [22, 51]. Apart from changes in people's behaviour, the frequency of glucosuria screening activities [22] as well as changes to the diagnostic criteria used to define diabetes (Info box 4) most likely contributed to what was described as a stepwise increase in incidence rates.

Info box 5 (continued)

invited actually participates (e.g. there is a lower probability of participation among people with multimorbidity). Existing data sources available for secondary analysis, such as routine data within the statutory health insurance system, in contrast, include all age groups and large sample sizes, and hence permit the conduction of stratified analyses (such as by region) as well as more timely estimates of health indicators. Nevertheless, even these data do not cover the entire population (e.g. people with private health insurance or people who do not use the healthcare system are not included) [65, 78].

There is some evidence that the rate of people newly diagnosed with diabetes (incidence rate) has increased since the 1960s.

For the subsequent period, point estimates from regional cohort studies indicate continued increase in diabetes incidence rates [52-54]. A recent investigation based on pooled data from five regional cohort studies (Diabetes-Collaborative Research of Epidemiologic Studies, DIAB-CORE; follow-up between 1997 to 2010) found an incidence rate of 11.8 per 1,000 py among 45- to 74-year-olds [54].

Our own analyses of nationwide data from the panel of adults who participated in two subsequent RKI health examination surveys with an average follow-up time of 12 years (follow-up period: 1997-1999 to 2008-2011) revealed an incidence rate of known diabetes of 6.9 per 1,000 py among people aged 18 to 79 years at baseline and 11.4 per 1,000 py among people aged 45 to 79 years at baseline. Based on current population estimates [55] this amounts to an estimate of about 442,000 new cases of known diabetes occuring annually among 18- to 79-year-olds in Germany. Based on routine data that are made available for research in accordance with the Data Transparency Regulation (Info box 5), a recent nationwide study has provided estimates of the type 2 diabetes incidence rate among persons 40 years and older within the German statutory health insurance system. Incidence rates amounted to 13 per 1,000 py among women and 16 per 1,000 py among men. These rates were calculated using a differential equation that took the following variables into account: 1) the prevalence of known diabetes among people with statutory health insurance between 2009 and 2010, 2) mortality rates for the general population in Germany as obtained from official statistics, and 3) the ratio of mortality rates among people with and without diabetes based on estimates available from the neighbouring country of Denmark [39]. A further nationwide analysis of routine data available within the German statutory health insurance system was carried out by the Central Research Institute of Ambulatory Health Care in Germany (Info box 5). Among persons 40 years and older, these authors found a slight decrease in the cumulative incidence (Info box 2) of type 2 diabetes from 1.63% in 2012 to 1.47% in 2014. Calculations of the proportion of new cases within a given year were based on the requirement of a three-year pre-observation period during which the participants had received no medical diagnosis of diabetes [40].

Continuous monitoring of incidence rates of known diabetes among the general adult population in Germany at the national level, such as through continued follow-up of RKI health survey participants, is currently not being realised. However, using available routine data provides a feasible approach to obtain estimates of the cumulative incidence on a regular basis [40]. It would also be possible to use available data for continous calculations of incidence rates using the known mathematical relationships between prevalence, incidence and mortality [39]. Country-wide estimates on the prevalence of known diabetes are available on a regular basis using data collected within the RKI Health Monitoring framework and from the routine data sources of the statutory health insurance system. Regular estimates of the mortality rate among the general population are made available by official cause-of-death statistics. Data on the ratio of mortality rates among people

Table 1
Studies providing data on the prevalence of unknown diabetes among adults in Germany

Study population	Study period	Definition of unknown diabetes	Prevalence	Reference time point*
Nationwide surveys				
DEGS1: 18-79-year-olds; N=7,017 [49]	2008-2011	HbA1c ≥6.5%	Total: 2.0% (Women: 1.2%; Men: 2.9%)	31 Dec 2010
GNHIES98: 18-79-year-olds; N=6,655 [49]	1997-1999	HbA1c ≥6.5%	Total: 3.8% (Women: 3.2%; Men: 4.3%)	31 Dec 2010
			Total: 3.4%	31 Dec 1997
GNHIES98: 18-79-year-olds; N=5,275 [29]	1997-1999	HbA1c >6.1% and either serum glucose ≥126mg/dl or glucose in urine ≥50mg/dl	Women: 2.0%; Men: 2.1%	31 Dec 1997
Regional studies				
KORA F4 (Augsburg): 35-79-year-olds; N=2,617; SHIP-TREND (Vorpommern): 35-79-year-olds; N=1,980 [48]	KORA: 2006-2008 SHIP: 2008-2012	Fasting glucose ≥7.0mmol/l or 2h-OGTT glucose ≥11.1mmol/l	KORA: 3.9% SHIP: 7.1%	31 Dec 2007
KORA F4 (Augsburg): 35-59-year-olds; N=1,653 [47]	2006-2008	Fasting glucose ≥7.0mmol/l or 2h-OGTT glucose ≥11.1mmol/l	Total: 2.0% (Women: 1.6%; Men: 2.4%)	31 Dec 2007
Screening participants in routine health examinations of BASF employees: ≈16-64-year-olds; N=13,086 [106]	2004-2005	Fasting glucose ≥7.0 mmol/l or random glucose ≥11.1mmol/l	Total: 0.7%	
Screening participants of a sample of people insured by Techniker Krankenkasse (Thüringen, Düsseldorf) ≥55-year-olds; N=4,314 [107]	2003	Physician-diagnosed 'manifest diabetes mellitus type 2' and no self-report of diabetes diagnosis	Total: 2.8%	
HNR (Essen, Bochum, Mülheim): 45-74-year-olds; N=4,595 [108]	2000-2003	Fasting glucose ≥7.0mmol/l or random glucose ≥11.0mmol/l	Women: 3.2%; Men: 7.6%	
KORA S4 (Augsburg): 55-74-year-olds; N=1,353 [98]	1999-2001	Fasting glucose ≥7.0mmol/l or 2h-OGTT glucose ≥11.1 mmol/l	Total: 8.2% (Women: 6.9%; Men: 9.3%)	31 Dec 2000
EPIC-Potsdam: 35-59-year-olds; N≈27,500 [16]	1994-1998	Fasting or random glucose	Women: 0.4%; Men: 1.0%	2007
Sample of randomly selected cities/rural districts in 5 federal states in Germany: 18-70-year-olds; N=2,150 [99]	1993-1996	HbA1c >6.0%	Total: 1.6%	
Diabetes screening programme in Munich: All ages, N=789,289 [25]	1967/1968	Urine test strip discolouration and medical confirmation in follow-up examination	Total: about 0.7-1.1%	

* for age-standardisation

Continued on next page

Abbreviations:
GNHIES98 German National Health Interview and Examination Survey 1998
DEGS1 German Health Interview and Examination Survey for Adults
EPIC European Prospective Investigation into Cancer and Nutrition
HNR Heinz Nixdorf Recall Study
HbA1c glycated haemoglobin
KORA Cooperative Health Research in the Region of Augsburg
OGTT oral glucose tolerance test
SHIP Study of Health in Pomerania

Table 1 ***(continued)***
Studies providing data on the prevalence of unknown diabetes among adults in Germany

Study population	Study period	Definition of unknown diabetes	Prevalence	Reference time point*
Diabetes screening programme of employees of administrations and of a pharmaceutical-chemical company (West Berlin) 16–65-year-olds, N=4,187 [109]	1965/1966	2h-OGTT glucose ≥7.8 mmol/l during screening and 'manifest unknown diabetes' in follow-up examination	Total: 1.0%	
Serial examination of the population of the town of Herrenberg: all ages, N=7,976 [24]	1964	Urine test strips with glucosuria >0.5% or urine test strips with glucosuria >0-0.5% plus medical confirmation in follow-up examination	Total: 0.6%	
Serial examination of the population in 5 areas of the district of Magdeburg: ≥14-year-olds (≥18-year-olds in one district), N=164,896 [41]	1964/1965	Abnormal result of urine glucose test and confirmation in follow-up examination	Total: 0.5%	
Serial examination of the population of the district of Schwerin: ≥14 years (1961/1962) or ≥12 years (1964/1965), N≈je 380.000 [103]	1964/1965, 1961/1962	Urine test strip discolouration and blood glucose 7.2-11.1 mmol/l 2hours after the main meal with confirmation in follow-up examination	1964/1965: 0.2% 1961/1962: 0.3%	
Serial examination of the population in 10 out of 14 areas of the districts of Neubrandenburg: 6-80-year-olds, N=318.687 [110]	1961/1962	Urine test strip discolouration and confirmation in follow-up examination	Total: 0.3%	
Patient data				
GEMCAS (nationwide patient sample from general practices): ≥18 years, N=35.869 (N=1.511 practices) [89]	2005	Random glucose ≥11.1 mmol/l or fasting glucose ≥7.0 mmol/l	Total: 0.9%	2003
Diabetes screening programme of the German Medical Association of the former Federal Republic of Germany (West Germany) N=1.474.827 (N≈25.000 doctors) [111]	1964/1965	Urinary glucose test	Total: 1.8%	

Major systematic diabetes screening activities during the 1960s are exemplarily listed in Table 1; numerous other screenings have already been summarised elsewhere [4, 19, 20, 41]. Further studies not listed in Table 1 or Figure 1 or Figure 2 provide results on the total prevalence of known and unknown diabetes [112-114].
* for age-standardisation

Abbreviations:
GEMCAS German Metabolic and Cardiovascular Risk Project
OGTT oral glucose tolerance test

Table 2
Studies providing data on the incidence of diabetes among adults in Germany

Study population		Follow-up period*	Definition of diabetes incidence at follow-up	Incidence per 1,000 person-years	Method for consideration of bias
Nationwide surveys					
GNHIES98 re-participants: 18-79-year-olds, N=3.779 (own calculation)		1997-1999, 2008-2011	Self-report of physician-diagnosed diabetes or of anti-diabetic medication for the first time	**Known diabetes** 18-79-year-olds: 6.9 (Women: 7.4; Men: 6.3) 45-79-year-olds: 11.4 (Women: 10.9; Men: 12.0)	Weighting for loss of non-returnees to follow-up; standardised to population structure of Germany as of 31 Dec 1997
GNHIES98 re-participants with an examination: 18-79-year-olds, N=2.750 (own calculation)			Self-report of physician-diagnosed diabetes or of anti-diabetic medication for the first time or HbA1c ≥6.5% for the first time	**Known or unknown diabetes** 18-79-year-olds: 7.9 (Women: 9.0; Men: 6.8) 45-79-year-olds: 12.8 (Women: 12.4; Men: 13.3)	
Register data					
GDR diabetes register: all ages, entire population [23, 51]		Each year (reporting date 31 Dec) between 1960 and 1089	Physician-diagnosed diabetes for the first time	**Known diabetes** 1989: 3.8 1960: 1.2	
GDR diabetes register, district of Neubrandenburg: all ages, entire population [115]				**Known diabetes** 1980: 3.4 (Women: 2.2; Men: 4.5) 1976: 3.4 (Women: 2.4; Men: 4.3) 1972: 2.5 (Women: 1.9; Men: 3.4) 1970: 2.5 (Women: 2.0; Men: 3.0) 1964: 1.2 (Women: 0.9; Men: 1.5) 1960: 0.8 (Women: 0.5; Men: 1.0)	
Regional studies					
DIAB-CORE Consortium with SHIP (Western Pomerania), CARLA (Halle/Saale), DHS (Dortmund), HNR (Essen, Bochum, Mülheim), KORA (Augsburg): 45-74-year-olds	N=8,787 [54]	SHIP: 1997-2001, 2002-2006 CARLA: 2002-2006, 2007-2010 DHS: 2003-2004, 2006-2008 HNR: 2000-2003, 2006-2008 KORA: 1999-2001, 2006-2008	Self-report of physician-diagnosed diabetes for the first-time	**Known diabetes** Total: 11.8 SHIP: 13.0 (Women: 10.0; Men: 16.3) CARLA: 16.2 (Women: 11.7; Men: 21.9) DHS: 16.2 (Women: 15.0; Men: 17.8) HNR: 11.8 (Women: 8.6; Men: 15.3) KORA: 9.0 (Women: 7.2; Men: 11.1)	Weighting for loss of non-returnees to follow-up; standardised to population structure of Germany as of 31 Dec 2007
	N=7,250 [116]			**Known diabetes** Total: 12.6 (Women: 9.2; Men: 16.1)	

* Baseline – follow-up

Continued on next page

Abbreviations:
GNHIES98 German National Health Interview and Examination Survey 1998
GDR German Democratic Republic
DIAB-CORE Diabetes-Collaborative Research of Epidemiologic Studies
SHIP Study of Health in Pomerania
CARLA Cardiovascular Disease, Living and Ageing in Halle
DHS Dortmund Health Study
HNR Heinz Nixdorf Recall Study
KORA Kooperative Health Research in the Region of Augsburg
HbA1c glycated haemoglobin

Table 2 *(continued)*
Studies providing data on the incidence of diabetes among adults in Germany

Study population	Follow-up period*	Definition of diabetes incidence at follow-up	Incidence per 1,000 person-years	Method for consideration of bias
KORA S4/F4 (Augsburg): 55-74-year-olds, N=887 [58]	1999-2001, 2006-2008	Medically verified diabetes diagnosis after self-report of diabetes diagnosis for the first time or fasting glucose ≥7.0 mmol/l or 2h-OGTT glucose ≥11.1 mmol/l for the first time	**Known or unknown diabetes** Total: 15.5 (Women: 11.3; Men: 20.2)	Standardised to population structure of Germany as of 31 Dec 2007
SHIP (Western Pomerania): 20-79-year-olds, N=2,841; DETECT (nationwide sample of patients from general practices): ≥18-year-olds, N=4,936 [59]	SHIP: 1997-2001, 2003-2006 DETECT: 2003, 2007-2008	Self-report of diabetes diagnosis or of anti-diabetic medication for the first time or HbA1c ≥6.5% for the first time	**Known or unknown diabetes** Total: 14.4	
EPIC-Potsdam: 35-65-year-olds, N=27,067 [53]	1994-1998, 2005	Medically verified diabetes diagnosis after self-report of diabetes diagnosis or diabetes therapy for the first time	**Known diabetes** Total: 4.8	
MONICA Augsburg: 35-74-year-olds, N=6,166 [52]	1984-1995, 1998	Self-report of diabetes diagnosis or of anti-diabetic medication for the first time	**Known diabetes** Women: 4.0; Men: 5.8	Standardised to population structure of Germany as of 31 Dec 1989
Health insurance data				
Nationwide sample of insurees from all statutory health insurance funds: ≥40-year-olds [39]	2009, 2010	By differential equation calculated incidence based on the change in diabetes prevalence between 2009 and 2010 in the sample of insurees (physician-diagnosed diabetes [ICD-10 E10-E14, with the additional ICD-tag, 'G' (confirmed) in outpatient diagnoses]) and the mortality among people with and without diabetes in the Danish population	**Known diabetes** Women: 13; Men: 16	
Sample of insurees from the AOK Baden-Württemberg: all ages, N≈3.5 million per year [34]	2007-2009, the next year	Physician-diagnosed type 2 diabetes for the first time (ICD-10 E11, E12 or E14 in ≥3 of 4 quarters) or prescription of anti-diabetic medication for the first-time (ATC A10A or A10B ≥2 per year or 1 per year plus type 2 diabetes diagnosis or plus glucose or HbA1c measurement in the same quarter)	**Known diabetes** 2010: 8.6 (Women: 8.3; Men: 9.2) 2009: 7.7 (Women: 7.3; Men: 8.3) 2008: 8.2 (Women: 7.8; Men: 8.9)	Standardised to population structure of Baden-Württemberg as of 31 Dec of the respective year
Nationwide sample of insures from the Techniker Krankenkasse: all ages, N=5,4 million [86]	2006-2007, 2008	Inpatient type 2 diabetes diagnosis for the first time (ICD-10 E11 with additional ICD-tag 'G' (confirmed)) or two outpatient type 2 diabetes diagnoses in different quarters of 2008 or in/before 2008	**Known diabetes** Total: 4.1	Standardised to population structure of Germany as of 31 Dec 2008

* Baseline – follow-up

Continued on next page

Abbreviations:
- AOK: Allgemeine Ortskrankenkasse (a large statutory health insurance company)
- ATC: Anatomical Therapeutic Chemical Classification
- DETECT: Diabetes Cardiovascular Risk-Evaluation: Targets and Essential Data for Commitment of Treatment
- EPIC: European Prospective Investigation into Cancer and Nutrition
- ICD-10: International statistical classification of diseases and related health problems, 10th revision
- KORA: Cooperative Health Research in the Region of Augsburg
- MONICA: Monitoring Trends and Determinants in Cardiovascular Disease
- OGTT: oral glucose tolerance test
- SHIP: Study of Health in Pomerania
- HbA1c: glycated haemoglobin

Table 2 ***(continued)***
Studies providing data on the incidence of diabetes among adults in Germany

Study population	Follow-up period*	Definition of diabetes incidence at follow-up	Incidence per 1,000 person-years	Method for consideration of bias
Patient data				
SESAM 2 (patient sample from general practices in Saxony): 2-102-year-olds, N=8,877 (N=270 practices) [95]	10/1999-09/2000	Physician-diagnosed diabetes for the first time	**Known diabetes** Total: 3.0	

Further studies not listed in Table 2 provide cumulative incidences (percentages) [40, 84] or incidence rates (per 1,000 person-years) for subgroups of individuals with normal or impaired glucose metabolism [117].
* Baseline – follow-up

Abbreviations:
SESAM Sächsische Epidemiologische Studien in der Allgemeinmedizin

Currently available data do not permit estimation of time trends in the prevalence and incidence of unknown diabetes.

with and without known diabetes, which has been 'borrowed' from the neighbouring country of Denmark until now, could be frequently made available also for Germany if follow-up of RKI health survey participants for vital status (mortality follow-up) could be conducted on a regular basis [56, 57].

4.2 Overall incidence of unknown and known diabetes overall

The incidence rate of unknown and known diabetes combined has only recently been estimated by a number of studies. However, results from these studies are difficult to compare due to differences in study design, age range and reference region (Table 2).

Based on KORA S4/F4 cohort data (follow-up period: 1999-2001 to 2006-2008), the incidence rate for known diabetes and unknown diabetes (defined using fasting blood glucose level and 2h-OGTT glucose) combined was estimated to be 15.5 per 1,000 py among 55- to 79-year-olds from the Augsburg area [58]. A comprehensive analysis of data from the SHIP cohort in Western Pomerania (follow-up period: 1997-2001 to 2003-2006; 20- to 79-year-olds) and a nationwide sample of patient data (Diabetes Cardiovascular Risk-Evaluation: Targets and Essential Data for Commitment of Treatment, DETECT; follow-up period: 2003 to 2007/2008; people aged 18 years or above) revealed an incidence rate for known and (HbA1c-defined) unknown diabetes of 14.4 per 1,000 py [59]. Our own analyses of nationwide data from adults who participated in two RKI examination surveys spaced approximately 12 years apart (follow-up period: 1997-1999 to 2008-2011) resulted in an incidence rate of known and (HbA1c-defined) unknown diabetes of 7.9 per 1,000 py among persons aged 18 to 79 years at baseline and a rate of 12.8 per 1,000 py among those aged 45 to 79 years at baseline. Based on current population statistics in Germany [55], this corresponds to approximately 507,000 new cases of diabetes per year in the population 18 to 79 years of age.

Currently available data do not permit estimation of time trends in overall diabetes incidence rates among adults in Germany. In the future, the total incidence rate could be calculated using the differential equation mentioned above [39]. For this, estimates of the prevalence of known and unknown diabetes will be available, albeit

Table 3
Studies providing data on overall mortality among adults with diabetes compared to adults without diabetes in Germany

Study population	Follow-up period[1]	Definition of diabetes and reference group at baseline	Mortality among adults with diabetes compared to the reference group			Methods to account for bias
				Crude[2] mortality rate[3]	Age-adjusted hazard ratio[4]	
Nationwide surveys						
GNHIES98 Mortality Follow-up: 18-79-year-olds, N=6,299 [57]	1997-1999, 2008-2011	**Known diabetes:** Self-report of physician-diagnosed diabetes or of anti-diabetic medication		27.4	1.7	Follow-up for vital status completed for 98%; Adjusted for age, sex
		Unknown diabetes: HbA1c ≥6.5%		29.4	1.9	
		Prediabetes: HbA1c: 5.7-5.9%/6.0-6,4%		11.3/8.6	1.0/1.0	
		Reference: No known or unknown (pre-) diabetes		4.1	1 (reference)	
Register data						
GDR diabetes register: all ages, All people with known diabetes (compared to the general population) [60]	Each year between 1961 and 1987	**Known diabetes:** Physician-diagnosed diabetes; Reference: general population	Non-insulin-dependent diabetes	1961: ≈47 1987: ≈67	–	Follow-up for vital status completed for nearly 100%; Standardised to age structure of the general population
			Insulin-dependent diabetes	1961: ≈64 1987: ≈77	–	
			Total diabetes	–	1961: 1.9 1987: 1.7	
Regional studies						
ERFORT (Erfurt area): 40-59-year-olds, N=1,125 men [61]	1973-1975, 2003	**Known diabetes:** Self-report of physician-diagnosed diabetes	10 years 20 years 30 years	21.5 38.1 43.1	2.2 2.2 1.9	Follow-up for vital status completed for 98%; Adjusted for age
		Unknown diabetes: 1h-OGTT glucose ≥200 mg/dl	10 years 20 years 30 years	17.0 24.5 31.5	1.8 1.5 1.5	
		Reference: No known or unknown diabetes	10 years 20 years 30 years	8.0 15.4 20.6	1 (reference)	

[1] Baseline – follow-up
[2] not age-adjusted or age-standardised
[3] per 1,000 person-years
[4] or age-standardised mortality ratio

Continued on next page

Abbreviations:
GNHIES98 German National Health Interview and Examination Survey 1998
GDR German Democratic Republic
ERFORT Erfurt Male Cohort Study
HbA1c glycated haemoglobin
OGTT oral glucose tolerance test

Table 3 ***(continued)***
Studies providing data on overall mortality among adults with diabetes compared to adults without diabetes in Germany

Study population	Follow-up period[1]	Definition of diabetes and reference group at baseline	Mortality among adults with diabetes compared to the reference group: Crude[2] mortality rate[3]	Mortality among adults with diabetes compared to the reference group: Age-adjusted hazard ratio[4]	Methods to account for bias
KORA S4 (Augsburg area): 55-74-year-olds, N=1,466 [62]	1999-2001, 2008-2009	**Known Diabetes:** Verified self-report of physician-diagnosed diabetes	30.7	2.6	Follow-up for vital status completed for 99%; Adjusted for age, sex
		Unknown diabetes: Fasting glucose ≥7.0 mmol/l or 2h-OGTT glucose ≥ 11.1 mmol/l	35.4	2.8	
		Prediabetes: Fasting glucose 6.1-6.9 mmol/l or 2h-OGTT glucose 7.8-11.0 mmol/l	13.3	1.1	
		Reference: No known or unknown (pre-) diabetes	10.5	1 (reference)	
Patient data					
Erfurt-Study (district of Erfurt): all ages, N=208 people with diabetes (compared to N=208 paired controls) [118]	1970, 1985	**Known diabetes:** History of physician-diagnosed diabetes of ≥20 years; Reference: paired metabolically healthy people		2.1	Follow-up for vital status completed for 93%; Case-control pairing according to age, sex, body weight

A further study, which is not listed in Table 3, exclusively provides age- and gender-specific mortality ratios [102].
1 Baseline – follow-up
2 not age-adjusted or age-standardised
3 per 1,000 person-years
4 or age-standardised mortality ratio

Abbreviations:
KORA Cooperative Health Research in the Region of Augsburg
OGTT oral glucose tolerance test

at larger intervals, from the national RKI health examination surveys [49]. Moreover, continued mortality follow-up of RKI health survey participants would permit periodically repeated estimates of mortality rates among people with and without known or unknown diabetes [56, 57]. In addition, ongoing cohort studies in Germany will continue to contribute point estimates of overall diabetes incidence.

5. Mortality

5.1 Mortality among people with known diabetes

Only a small number of studies have provided data on diabetes-related excess mortality (Table 3), in other words, the mortality rate of people with diabetes compared to the general population or people without diabetes (Info box 3). Results from these studies show that

There is evidence that the risk of death among people with known diabetes is about twice as high as among people without the condition; the increased risk of death (excess mortality) among people with unknown diabetes appears to be about as high as among people with known diabetes.

mortality rates among people with diabetes have decreased over recent decades. However, the results also suggest that mortality rates among people with diabetes remain higher than among people of the same age who do not have diabetes.

According to early estimates based on data from the GDR diabetes register, the ratio of age-standardised mortality rates among people with known diabetes compared to the general population slightly declined from 1.9 in 1961 to 1.7 in 1987, although this decrease was not statistically significant [60].

More recently, the Erfurt Male Cohort Study (ERFORT study; follow-up period: 1973-1975 to 2003) demonstrated a 1.9-fold higher risk of death from all causes among 40- to 59-year-old men with known diabetes [61], the KORA S4 study (follow-up period: 1999-2001 to 2008/2009) identified a 2.6-fold higher risk among 55- to 74-year-olds [62]; and the GNHIES98 (follow-up period: 1997-1999 to 2008-2011) found a 1.7-fold higher risk of mortality among 18- to 79-year-olds [57]. Each study compared age-adjusted mortality rates among people with known diabetes to people without known or unknown diabetes.

Official statistics on causes of death provided by the Federal Statistical Office provide data for monitoring mortality rates in the general population (of 100,000 inhabitants) [63]. However, the mortality follow-up of persons participating in the national RKI health examination surveys is currently the only nationwide data source that can be used to calculate population-based mortality rates among adults with diabetes compared to those without diabetes [56, 57]. It would therefore be important to continue the follow-up of survey participants' vital statistics (so far running for GNHIES98 and DEGS1). Looking forward, the mortality follow-up of people participating in the on-going German National Cohort [50] as well as mortality data that will be available for secondary analysis of existing data from the statutory health insurance system will also provide information about diabetes-related excess mortality.

5.2 Mortality among people with unknown diabetes

The only estimates of excess mortality among people with unknown diabetes that currently exist are from the three follow-up studies mentioned in the last section (Table 3). Therefore, it is currently impossible to estimate time trends in this regard.

The ERFORT study found that the risk of death among people with unknown diabetes was 1.5 times higher compared to people without diabetes [61]. The KORA S4 study identified the rate as 2.8 times higher [62] and the GNHIES98 study found a rate that was 1.9 times higher [57]. Thus, the risk of death among people with unknown diabetes is of a similar magnitude as the risk of death observed among people with known diabetes. In contrast, the studies found no increased risk of death among people with 'prediabetes' [57, 62] (Table 3).

The continuation of the mortality follow-up of people participating in the national RKI health examination surveys, therefore, would also be useful in order to gain regular estimates (albeit at larger intervals) of the excess mortality linked to unknown diabetes and diabetes overall [56, 57]. In addition, following up the vital statistics

Data on key measures (core indicators) of diabetes epidemiology in Germany is yet limited, but will be expanded and consolidated within the framework of the German National Diabetes Surveillance System.

of participants from ongoing cohort studies could provide point estimates of excess mortality related to unknown diabetes.

6. Conclusion

Population-based estimates of the prevalence, incidence and excess mortality of known and unknown diabetes are key indicators in order to conduct a reliable evaluation of developments in diabetes epidemiology. Providing regular estimates of these indicators that are comparable over time, therefore, is a major goal of the national diabetes surveillance system that is currently being established in Germany. With the exception of the prevalence of known diabetes (where regularly collected primary and secondary data demonstrate an increase over the last few decades), the data being collected on these key indicators of diabetes epidemiology in Germany is currently fragmented. Estimates of incidence rates and the excess mortality associated with known diabetes that are currently available, mainly from cohort studies, only enable cautious conclusions to be drawn on time trends. Estimates of the prevalence, incidence and mortality of unknown diabetes in Germany are scarce and do not permit the evaluation of time trends.

An expansion of existing approaches is therefore needed in order to resolve the current issues with the data. Thus, the regular continuation of the mortality follow-up of people taking part in the RKI national health examination surveys would permit monitoring of the mortality rates among people with diabetes compared to those without the condition, albeit at larger intervals. This could reduce the large gaps that exist in recurrent estimates of excess mortality in relation to both known and unknown diabetes. As demonstrated by recent studies, improved access to secondary analysis of existing data would help produce more timely estimates of the prevalence, as well as the incidence of known diabetes. Routine data available within the statutory health insurance system are of particular importance in this respect. While these routine data sources cover most of the population, certain groups of people (for example, people insured by private health insurers) are not represented in the sample. Moreover, indicators calculated based on routine data will be limited to known diabetes. The use of mathematical equations could therefore be considered as a further means of closing existing gaps in the data. As an example, population-based incidence rates of known and unknown diabetes could be derived from the mathematical relationships between the data on diabetes prevalence and excess mortality provided by the national RKI health examination surveys.

A national diabetes surveillance system is currently being established at the RKI. The various approaches and available data sources are currently being assessed with regard to their availability and whether they can be integrated into a continuous monitoring of dynamics in diabetes epidemiology as a means of providing a data-supported foundation for health policy decision-making in Germany [64, 65]. Taking into account demographic trends, a foundation could also be used for projections of burden of disease.

References

1. Zaccardi F, Webb DR, Yates T et al. (2016) Pathophysiology of type 1 and type 2 diabetes mellitus: a 90-year perspective. Postgrad Med J 92(1084):63-69
2. van Dieren S, Beulens JW, van der Schouw YT et al. (2010) The global burden of diabetes and its complications: an emerging pandemic. Eur J Cardiovasc Prev Rehabil 17 Suppl 1:S3-8
3. Polonsky KS (2012) The past 200 years in diabetes. N Engl J Med 367(14):1332-1340
4. Schliack V (1971) Die Verbreitung des Diabetes mellitus: Häufigkeit und Vorkommen in Europa und Amerika In: Pfeiffer EF (eds) Pathophysiologie und Klinik. Springer-Verlag Berlin Heidelberg, P. 333-364
5. Rostoski O (1958) Über die Zunahme der Zuckerkranken. Munch Med Wochenschr 100(9):342-346
6. Kaeding A (1964) Die Verbreitung des Diabetes mellitus in Deutschland. Der Diabetiker 14(4):107-112
7. NCD Risk Factor Collaboration (2016) Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4.4 million participants. Lancet 387(10027):1513-1530
8. Editorial (2011) The diabetes pandemic. Lancet 378(9786):99
9. Hu FB, Satija A, Manson JE (2015) Curbing the Diabetes Pandemic: The Need for Global Policy Solutions. JAMA 313(23):2319-2320
10. International Diabetes Federation (2015) IDF Diabetes Atlas, 7th edn. Chapter 3 The global picture. Brussels, Belgium. http://www.diabetesatlas.org/ (As at 19.12.2016)
11. Porta M, Curletto G, Cipullo D et al. (2014) Estimating the delay between onset and diagnosis of type 2 diabetes from the time course of retinopathy prevalence. Diabetes Care 37(6):1668-1674
12. Spijkerman AM, Dekker JM, Nijpels G et al. (2003) Microvascular complications at time of diagnosis of type 2 diabetes are similar among diabetic patients detected by targeted screening and patients newly diagnosed in general practice: the hoorn screening study. Diabetes Care 26(9):2604-2608
13. Koopman RJ, Mainous AG, 3rd, Liszka HA et al. (2006) Evidence of nephropathy and peripheral neuropathy in US adults with undiagnosed diabetes. Ann Fam Med 4(5):427-432
14. Harris MI (1993) Undiagnosed NIDDM: clinical and public health issues. Diabetes Care 16(4):642-652
15. Wareham NJ, Forouhi NG (2005) Is there really an epidemic of diabetes? Diabetologia 48(8):1454-1455
16. Schulze MB, Rathmann W, Giani G et al. (2010) Diabetesprävalenz - Verlässliche Daten stehen noch aus. Dtsch Arztebl 107(36):A 1694-1696
17. Tamayo T, Rosenbauer J, Wild SH et al. (2014) Diabetes in Europe: an update. Diabetes Res Clin Pract 103(2):206-217
18. Zimmet P, Alberti KG, Magliano DJ et al. (2016) Diabetes mellitus statistics on prevalence and mortality: facts and fallacies. Nat Rev Endocrinol 12(10):616-622
19. Schliack V (1965) Über die Diabetes-Morbidität. Dtsch Med Wochenschr 90(52):2321-2327
20. von Knorre G (1964) Ergebnisse einer Diabetes-Reihenuntersuchung in einem Landkreis 1961/1962. Dtsch Ges Wes 19:593-598
21. Schliack V (1980) Zur Diabetesmorbidität unter besonderer Berücksichtigung der DDR sowie zur Krankheitsprognose. Z Arztl Fortbild (Jena) 74(13-14):668-670
22. Michaelis D, Jutzi E, Albrecht G (1987) Prevalence and incidence trends of non-insulin-dependent diabetes mellitus (NIDDM) in the population of the GDR. Dtsch Z Verdau Stoffwechselkr 47(6):301-310
23. Michaelis D, Jutzi E (1991) Epidemiologie des Diabetes mellitus in der Bevölkerung der ehemaligen DDR: Alters- und geschlechtsspezifische Inzidenz- und Prävalenztrends im Zeitraum 1960-1987. Z Klin Med 46:59-64
24. Glogner P, Duerr F (1964) Suchaktion auf Diabetes und Nephropathien. Dtsch Med Wochenschr 89:2081-2083
25. Mehnert H, Sewering H, Reichstein W et al. (1968) Früherfassung von Diabetikern in München 1967-68. Dtsch Med Wochenschr 93(43):2044-2050
26. Helmert U, Janka HU, Strube H (1994) Epidemiologische Befunde zur Häufigkeit des Diabetes mellitus in der Bundesrepublik Deutschland 1984 bis 1991. Diab Stoffw 3:271-277
27. Hauner H, von Ferber L, Koster I (1992) Schätzung der Diabeteshäufigkeit in der Bundesrepublik Deutschland anhand von Krankenkassendaten. Sekundardatenanalyse einer repräsentativen Stichprobe AOK-Versicherter der Stadt Dortmund. Dtsch Med Wochenschr 117(17):645-650
28. Meisinger C, Heier M, Doering A et al. (2004) Prevalence of known diabetes and antidiabetic therapy between 1984/1985 and 1999/2001 in southern Germany. Diabetes Care 27(12):2985-2987

29. Thefeld W (1999) Prävalenz des Diabetes mellitus in der erwachsenen Bevölkerung Deutschlands. Gesundheitswesen 61 Spec No:S85-89

30. Heidemann C, Kroll L, Icks A et al. (2009) Prevalence of known diabetes in German adults aged 25-69 years: results from national health surveys over 15 years. Diabet Med 26(6):655-658

31. Heidemann C, Du Y, Schubert I et al. (2013) Prevalence and temporal trend of known diabetes mellitus: results of the German Health Interview an Examination Survey for Adults (DEGS1). Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 56(5-6):668-677 http://edoc.rki.de/oa/articles/re8zBK9JuD8n2/PDF/29RbpZ8kv1L4c.pdf (As at 01.03.2017)

32. Heidemann C, Du Y, Scheidt-Nave C (2011) Diabetes mellitus in Germany. GBE kompakt 2(3):1-7. Robert-Koch-Institut, Berlin. http://edoc.rki.de/series/gbe-kompakt/2-3/PDF/3.pdf (As at 01.03.2017)

33. Hoffmann F, Icks A (2011) Diabetes prevalence based on health insurance claims: large differences between companies. Diabetic Medicine 28(8):919-923

34. Boehme MW, Buechele G, Frankenhauser-Mannuss J et al. (2015) Prevalence, incidence and concomitant co-morbidities of type 2 diabetes mellitus in South Western Germany–a retrospective cohort and case control study in claims data of a large statutory health insurance. BMC Public Health 15:855

35. Koster I, Schubert I, Huppertz E (2012) Fortschreibung der KoDiM-Studie: Kosten des Diabetes mellitus 2000-2009. Dtsch Med Wochenschr 137(19):1013-1016

36. Du Y, Heidemann C, Schaffrath Rosario A et al. (2015) Changes in diabetes care indicators: findings from German National Health Interview and Examination Surveys 1997-1999 and 2008-2011. BMJ Open Diabetes Res Care 3(1):e000135

37. Fuchs S, Henschke C, Blumel M et al. (2014) Disease management programs for type 2 diabetes in Germany: a systematic literature review evaluating effectiveness. Dtsch Arztebl Int 111(26):453-463

38. Paprott R, Mensink GBM, Schulze MB et al. (2017) Temporal changes in predicted risk of type 2 diabetes in Germany: findings from the German Health Interview and Examination Surveys 1997-1999 and 2008-2011. BMJ Open 7(7):e013058

39. Tamayo T, Brinks R, Hoyer A et al. (2016) The Prevalence and Incidence of Diabetes in Germany. Dtsch Arztebl Int 113(11):177-182

40. Goffrier B, Schulz M, Bätzing-Feigenbaum J (2017) Administrative Prävalenzen und Inzidenzen des Diabetes mellitus von 2009 bis 2015. Versorgungsatlas-Bericht Nr 17/03:1-35. Zentralinstitut für die kassenärztliche Versorgung in Deutschland (Zi), Berlin. http://www.versorgungsatlas.de/fileadmin/ziva_docs/79/VA-79-Bericht_Final.pdf (As at 07.09.2017)

41. Apel H, Beier W, Berbig G et al. (1967) Reihenuntersuchungen auf Diabetes mellitus im Bezirk Magdeburg 1964-65. Z Arztl Fortbild (Jena) 61(12):633-637

42. Schliack V (1963) Empfehlungen zur Durchführung von Diabetes-Suchaktionen. Dtsch Ges Wes:230-232

43. Schneider H, Ehrlich M, Lischinski M et al. (1996) Bewirkte das flächendeckende Glukosurie-Screeningder 60er und 70er Jahre im Osten Deutschlands tatsächlich den erhofften Prognosevorteil für die frühzeitig entdeckten Diabetiker? Diab Stoffw 5:33-38

44. Herron CA (1979) Screening in diabetes mellitus: report of the Atlanta workshop. Diabetes Care 2(4):357-362

45. Bennett CM, Guo M, Dharmage SC (2007) HbA(1c) as a screening tool for detection of Type 2 diabetes: a systematic review. Diabet Med 24(4):333-343

46. NCD Risk Factor Collaboration (2015) Effects of diabetes definition on global surveillance of diabetes prevalence and diagnosis: a pooled analysis of 96 population-based studies with 331,288 participants. Lancet Diabetes Endocrinol 3(8):624-637

47. Meisinger C, Strassburger K, Heier M et al. (2010) Prevalence of undiagnosed diabetes and impaired glucose regulation in 35-59-year-old individuals in Southern Germany: the KORA F4 Study. Diabet Med 27(3):360-362

48. Tamayo T, Schipf S, Meisinger C et al. (2014) Regional differences of undiagnosed type 2 diabetes and prediabetes prevalence are not explained by known risk factors. PLoS One 9(11):e113154

49. Heidemann C, Du Y, Paprott R et al. (2016) Temporal changes in the prevalence of diagnosed diabetes, undiagnosed diabetes and prediabetes: findings from the German Health Interview and Examination Surveys in 1997-1999 and 2008-2011. Diabet Med 33(10):1406-1414

50. German National Cohort Consortium (2014) The German National Cohort: aims, study design and organization. Eur J Epidemiol 29(5):371-382

51. Michaelis D, Jutzi E, Vogt L (1993) Epidemiology of insulin-treated diabetes mellitus in the East-German population: differences

in long-term trends between incidence and prevalence rates. Diabete Metab 19(1 Pt 2):110-115

52. Meisinger C, Thorand B, Schneider A et al. (2002) Sex differences in risk factors for incident type 2 diabetes mellitus: the MONICA Augsburg cohort study. Arch Intern Med 162(1):82-89

53. Schulze MB, Schulz M, Heidemann C et al. (2008) Carbohydrate intake and incidence of type 2 diabetes in the European Prospective Investigation into Cancer and Nutrition (EPIC)-Potsdam Study. Br J Nutr 99(5):1107-1116

54. Schipf S, Ittermann T, Tamayo T et al. (2014) Regional differences in the incidence of self-reported type 2 diabetes in Germany: results from five population-based studies in Germany (DIAB-CORE Consortium). J Epidemiol Community Health 68(11):1088-1095

55. Statistisches Bundesamt (2017) Bevölkerungsstand. Bevölkerung: Deutschland, Stichtag, Altersjahre (Stichtag 31.12.2015). Ausgangsdaten der Bevölkerungsfortschreibung aus dem Zensus 2011. http://www.gbe-bund.de (As at 31.05.2017)

56. Wolf IK, Busch M, Lange M et al. (2014) Mortality follow-up of the German Health Interview and Examination Survey for Adults (DEGS): methods and first results. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 57(11):1331-1337

57. Paprott R, Schaffrath Rosario A, Busch MA et al. (2015) Association between hemoglobin A1c and all-cause mortality: results of the mortality follow-up of the German National Health Interview and Examination Survey 1998. Diabetes Care 38(2):249-256

58. Rathmann W, Strassburger K, Heier M et al. (2009) Incidence of Type 2 diabetes in the elderly German population and the effect of clinical and lifestyle risk factors: KORA S4/F4 cohort study. Diabetic Medicine 26(12):1212-1219

59. Schneider HJ, Friedrich N, Klotsche J et al. (2011) Prediction of incident diabetes mellitus by baseline IGF1 levels. Eur J Endocrinol 164(2):223-229

60. Michaelis D, Jutzi E (1990) Trends in mortality rates in the diabetic population of the GDR. Exp Clin Endocrinol 95(1):83-90

61. Meisinger C, Wolke G, Brasche S et al. (2006) Postload plasma glucose and 30-year mortality among nondiabetic middle-aged men from the general population: the ERFORT Study. Ann Epidemiol 16(7):534-539

62. Kowall B, Rathmann W, Heier M et al. (2011) Categories of glucose tolerance and continuous glycemic measures and mortality. Eur J Epidemiol 26(8):637-645

63. Statistisches Bundesamt (2015) Todesurschenstatistik. Sterbefälle, Sterbeziffern (je 100000 Einwohner, altersstandardisiert) (ab 1998). http://www.gbe-bund.de (As at 04.04.2017)

64. Gabrys L, Schmidt C, Heidemann C et al. (2017) Diabetes surveillance in Germany - Background, concept and prospects. Journal of Health Monitoring 2 (1):91-104. Robert Koch-Institut, Berlin. http://edoc.rki.de/oa/articles/remfJF4Dma6I/PDF/24SGnUvGo4j2.pdf (As at 08.06.2017)

65. Schmidt C, Batzing-Feigenbaum J, Bestmann A et al. (2017) Integration von Sekundärdaten in die Nationale Diabetes-Surveillance : Hintergrund, Ziele und Ergebnisse des Sekundärdaten-Workshops am Robert Koch-Institut. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 60(6):656-661

66. Ressing M, Blettner M, Klug SJ (2010) Data Analysis of Epidemiological Studies: Part 11 of a Series on Evaluation of Scientific Publications. Dtsch Arztebl Int 107(11):187-192

67. Gordis L (2001) Epidemiologie: Maße der Erkrankungshäufigkeit. Verlag im Kilian, Marburg, P. 35-71

68. World Health Organization (1965) Diabetes mellitus: Report of a WHO Expert Comittee. Technical Report Series 310:1-44. World Health Organization, Geneva. http://apps.who.int/iris/bitstream/10665/38442/1/WHO_TRS_310.pdf (As at 06.06.2017)

69. National Diabetes Data Group (1979) Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. Diabetes 28(12):1039-1057

70. World Health Organization (1980) WHO Expert Comittee on diabetes mellitus: Second report. Technical Report Series 646:1-80. World Health Organization, Geneva. http://apps.who.int/iris/bitstream/10665/41399/1/WHO_TRS_646.pdf (As at 06.06.2017)

71. World Health Organization (1985) Diabetes mellitus: Report of a WHO study group. Technical Report Series 727:1-113. World Health Organization, Geneva. http://apps.who.int/iris/bitstream/10665/39592/1/WHO_TRS_727.pdf (As at 06.06.2017)

72. Genuth S, Alberti KG, Bennett P et al. (2003) Follow-up report on the diagnosis of diabetes mellitus. Diabetes Care 26(11):3160-3167

73. World Health Organization (1999) Definition, diagnosis and classification of diabetes mellitus and its complications. Report of a WHO conulstation. Part 1: Diagnosis and classification of diabetes mellitus. World Health Organization, Geneva.

http://apps.who.int/iris/bitstream/10665/66040/1/WHO_NCD_NCS_99.2.pdf (As at 06.06.2017)

74. American Diabetes Association (2010) Diagnosis and classification of diabetes mellitus. Diabetes Care 33 Suppl 1:S62-69

75. Kerner W, Brückel J (2010) Definition, classification and diagnosis of diabetes mellitus. Exp Clin Endocrinol Diabetes 122(7):384-386

76. World Health Organization (2011) Use of glycated haemoglobin (HbA1c) in the diagnosis of diabetes mellitus. Abbreviated report of a WHO consultation.1-25. World Health Organization, Geneva. http://www.who.int/diabetes/publications/diagnosis_diabetes2011/en/(As at 06.06.2017)

77. Kurth BM, Lange C, Kamtsiuris P et al. (2009) Gesundheitsmonitoring am Robert Koch-Institut. Sachstand und Perspektiven. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 52(5):557-570

78. Ohlmeier C, Frick J, Prütz F et al. (2014) Nutzungsmöglichkeiten von Routinedaten der Gesetzlichen Krankenversicherung in der Gesundheitsberichterstattung des Bundes. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 57(4):464-472

79. Robert Koch-Institut (2014) Daten und Fakten: Ergebnisse der Studie „Gesundheit in Deutschland aktuell 2012“. Beiträge zur Gesundheitsberichterstattung des Bundes. RKI, Berlin. http://edoc.rki.de/documents/rki_fv/recJuHnzacx8A/PDF/28GsWuNtFjVqY.pdf (As at 01.11.2016)

80. Robert Koch-Institut (2012) Daten und Fakten: Ergebnisse der Studie „Gesundheit in Deutschland aktuell 2010“. Beiträge zur Gesundheitsberichterstattung des Bundes. RKI, Berlin. http://edoc.rki.de/documents/rki_fv/remDCCtjOJxI/PDF/21TgKGZEOWNCY.pdf (As at 01.11.2016)

81. Robert Koch-Institut (2010) Daten und Fakten: Ergebnisse der Studie „Gesundheit in Deutschland aktuell 2009“. Beiträge zur Gesundheitsberichterstattung des Bundes. RKI, Berlin. http://edoc.rki.de/documents/rki_fv/reQXTR7OSGFRg/PDF/20dqmVRMM57G6.pdf (As at 01.11.2016)

82. Hoffmann F, Icks A (2012) Diabetes 'Epidemic' in Germany? A Critical Look at Health Insurance Data Sources. Exp Clin Endocrinol Diabetes (EFirst)

83. Heidemann C, Kuhnert R, Born S et al. (2017) 12-Month prevalence of known diabetes mellitus in Germany. Journal of Health Monitoring 2(1):48-56. Robert Koch-Institut, Berlin. http://edoc.rki.de/oa/articles/rei427ccepm96/PDF/27H3uMDZmc4wQ.pdf (As at 05.04.2017)

84. Muller N, Heller T, Freitag MH et al. (2015) Healthcare utilization of people with type 2 diabetes in Germany: an analysis based on health insurance data. Diabet Med 32(7):951-957

85. Stock SA, Redaelli M, Wendland G et al. (2006) Diabetes–prevalence and cost of illness in Germany: a study evaluating data from the statutory health insurance in Germany. Diabet Med 23(3):299-305

86. Wilke T, Ahrendt P, Schwartz D et al. (2013) Inzidenz und Prävalenz von Diabetes mellitus Typ 2 in Deutschland: Eine Analyse auf Basis von 5,43 Mio. Patientendaten. Dtsch Med Wochenschr 138(3):69-75

87. Lehnert H, Wittchen HU, Pittrow D et al. (2005) Prävalenz und Pharmakotherapie des Diabetes mellitus in der primärärztlichen Versorgung. Dtsch Med Wochenschr 130(7):323-328

88. Pittrow D, Stalla GK, Zeiher AM et al. (2006) Prävalenz, medikamentöse Behandlung und Einstellung des Diabetes mellitus in der Hausarztpraxis. Med Klin (Munich) 101(8):635-644

89. Hauner H, Hanisch J, Bramlage P et al. (2008) Prevalence of undiagnosed Type-2-diabetes mellitus and impaired fasting glucose in German primary care: data from the German Metabolic and Cardiovascular Risk Project (GEMCAS). Exp Clin Endocrinol Diabetes 116(1):18-25

90. Kauhl B, Pieper J, Schweikart J et al. (2017) Die räumliche Verbreitung des Typ 2 Diabetes Mellitus in Berlin - Die Anwendung einer geografisch gewichteten Regressionsanalyse zur Identifikation ortsspezifischer Risikogruppen. Gesundheitswesen

91. Koster I, Huppertz E, Hauner H et al. (2014) Costs of Diabetes Mellitus (CoDiM) in Germany, direct per-capita costs of managing hyperglycaemia and diabetes complications in 2010 compared to 2001. Exp Clin Endocrinol Diabetes 122(9):510-516

92. Köster I, Huppertz E, Hauner H et al. (2011) Direct Costs of Diabetes Mellitus in Germany - CoDiM 2000-2007. Exp Clin Endocrinol Diabetes 119(6):377-385

93. Hauner H, Köster I, Schubert I (2007) Prevalence of Diabetes mellitus and Quality of Care in Hesse, Germany, 1998–2004. Dtsch Arztebl 104(41):A2799-2805

94. Maatouk I, Wild B, Wesche D et al. (2012) Temporal predictors of health-related quality of life in elderly people with diabetes: results of a german cohort study. PLoS One 7(1):e31088

95. Frese T, Sandholzer H, Voigt S et al. (2008) Epidemiology of diabetes mellitus in German general practitioners' consultation–results of the SESAM 2-study. Exp Clin Endocrinol Diabetes 116(6):326-328

96. Raum P, Lamparter J, Ponto KA et al. (2015) Prevalence and Cardiovascular Associations of Diabetic Retinopathy and Maculopathy: Results from the Gutenberg Health Study. PLoS One 10(6):e0127188

97. Schipf S, Werner A, Tamayo T et al. (2012) Regional differences in the prevalence of known type 2 diabetes mellitus in 45-74 years old individuals: Results from six population-based studies in Germany (DIAB-CORE Consortium). Diabet Med 29(7):e88-95

98. Rathmann W, Haastert B, Icks A et al. (2003) High prevalence of undiagnosed diabetes mellitus in Southern Germany: target populations for efficient screening. The KORA survey 2000. Diabetologia 46(2):182-189

99. Palitzsch K-D, Nusser J, Arndt H et al. (1999) Die Prävalenz des Diabetes mellitus wird in Deutschland deutlich unterschätzt - eine bundesweite epidemiologische Studie auf Basis einer HbA1c-Analyse. Diab Stoffw 8:189-200

100. Schubert A, Schneider H (1992) Zur Bestandsentwicklung des Diabetes mellitus in einer ländlichen Region des Landes Mecklenburg-Vorpommern. Z Arztl Fortbild (Jena) 86(23-24):1185-1189

101. Ratzmann KP (1991) Eine Analyse von alters- und geschlechtsspezifischer Diabetesprävalenz sowie Behandlungsart: Die Berlin-Studie. Akt Endokr Stoffw 12:220-223

102. Panzram G, Zabel-Langhennig R (1981) Prognosis of diabetes mellitus in a geographically defined population. Diabetologia 20(6):587-591

103. Kruger HU (1967) On the increase in morbidity of diabetes mellitus. Results of repeated serial studies in the same population during the years 1961-1962 and 1964-65 in the District of Schwerin. Dtsch Gesundheitsw 22(7):301-307

104. Elkeles T, Beck D, Roding D et al. (2012) Health and lifestyle in rural northeast Germany: the findings of a Rural Health Study from 1973, 1994, and 2008. Dtsch Arztebl Int 109(16):285-292

105. Muschik D, Tetzlaff J, Lange K et al. (2017) Change in life expectancy with type 2 diabetes: a study using claims data from lower Saxony, Germany. Popul Health Metr 15(1):5

106. Oberlinner C, Neumann SM, Ott MG et al. (2008) Screening for pre-diabetes and diabetes in the workplace. Occup Med (Lond) 58(1):41-45

107. Scherbaum WA, Dicken HD, Verheyen F et al. (2006) Nachweis eines bisher unerkannten Diabetes mellitus Typ 2 mittels Risikofragebogen. Effizienz beim allgemeinen Populations-Screening. Dtsch Med Wochenschr 131(40):2208-2212

108. Icks A, Kruse J, Dragano N et al. (2008) Are symptoms of depression more common in diabetes? Results from the Heinz Nixdorf Recall study. Diabet Med 25(11):1330-1336

109. Gutsche H (1967) Auswertung einer Diabetes-Früherkennungsaktion in Berlin. Bundesgesundheitsblatt 26:408-412

110. Jung HD (1963) Prophylaktische Diabetes-Reihenuntersuchung zur Aufdeckung eines unerkannten Diabetes-mellitus mittels Ferment-Teststreifen im Agrarbezirk Neubrandenburg. Der Diabetiker 13:47-49

111. Bundesärztekammer (1966) Diabetes-Früherkennungsaktion 1964/65. Dtsch Arztebl 20:1325-1327

112. Volzke H, Ittermann T, Schmidt CO et al. (2015) Prevalence trends in lifestyle-related risk factors. Dtsch Arztebl Int 112(11):185-192

113. Li J, Jarczok MN, Loerbroks A et al. (2013) Work stress is associated with diabetes and prediabetes: cross-sectional results from the MIPH Industrial Cohort Studies. Int J Behav Med 20(4):495-503

114. Buyken AE, von Eckardstein A, Schulte H et al. (2007) Type 2 diabetes mellitus and risk of coronary heart disease: results of the 10-year follow-up of the PROCAM study. Eur J Cardiovasc Prev Rehabil 14(2):230-236

115. Schubert A, Faika E (1982) Ist der Diabetes mellitus auf dem Wege zum epidemiologischen Zustand des Gleichgewichts? Z Gesamte Inn Med 37(22):763-767

116. Muller G, Wellmann J, Hartwig S et al. (2015) Association of neighbourhood unemployment rate with incident Type 2 diabetes mellitus in five German regions. Diabet Med 32(8):1017-1022

117. Schottker B, Raum E, Rothenbacher D et al. (2011) Prognostic value of haemoglobin A1c and fasting plasma glucose for incident diabetes and implications for screening. Eur J Epidemiol 26(10):779-787

118. Panzram G, Pissarek D, Lundershausen R et al. (1987) Prospektive Verlaufsbeobachtungen beim Langzeitdiabetes. Ergebnisse der Erfurt-Studie. Dtsch Med Wochenschr 112(34):1283-1287

Imprint

Journal of Health Monitoring

Author details
Robert Koch Institute
Department of Epidemiology and Health Monitoring, Berlin

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

Conflicts of interest
The authors declared no conflicts of interest.

Note
External contributions do not necessarily reflect the opinions of the Robert Koch Institute.

Publisher
Robert Koch Institute
Nordufer 20
D-13353 Berlin, Germany

Editors
Susanne Bartig, Johanna Gutsche, Dr Franziska Prütz, Martina Rabenberg, Alexander Rommel, Dr Anke-Christine Saß, Stefanie Seeling, Martin Thißen, Dr Thomas Ziese
Robert Koch Institute
Department of Epidemiology and Health Monitoring
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

Please cite this publication as
Heidemann C, Scheidt-Nave C (2017) Prevalence, incidence and mortality of diabetes mellitus in adults in Germany – A review in the framework of the Diabetes Surveillance in Germany. Journal of Health Monitoring 2(3):98–121
DOI 10.17886/RKI-GBE-2017-062

ISSN 2511-2708

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