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Prevalence of myocardial infarction and coronary heart disease in adults aged 40–79 years in Germany

Results of the German Health Interview and Examination Survey for Adults (DEGS1)

Background and purpose

Cardiovascular diseases are still the most common cause of death in Germany. In recent years, however, a clear reduction in the mortality rates due to cardiovascular diseases (ICD-10: I00-I99) can be noted [1]. A decrease in mortality due to coronary heart disease (CHD) is the main cause for this development [2]. Parallel trends can be observed in numerous other high-income countries and are mainly explained by a reduction in the prevalence of classical risk factors—hypertension, hypercholesterolemia and smoking—as well as by improved therapeutic options in the treatment of acute myocardial infarction and in secondary prevention [3, 4, 5, 6, 7, 8, 9, 10].

In Germany, data on trends in incidence, treatment and outcome of myocardial infarction are available from the regional population-based myocardial infarction register of the Cooperative Health Research in the Region of Augsburg (KORA) which is part of the WHO MONICA Project. According to this study, the incidence of myocardial infarction has fallen continuously in the last 20 years and acute infarctions are treated faster and in better compliance with guideline recommendations, leading to lower case fatality [11, 12].

From a public health point of view, the question arises as to how high the prevalence of survived myocardial infarction and coronary heart disease currently is. This measure provides information on the percentage of the population that must be provided with secondary-preventive measures, specific therapies or rehabilitative and care services. It is possible to further reduce the incidence of myocardial infarction, if coronary heart disease is diagnosed in time and guideline therapies and measures to reduce relevant risk factors are initiated. Furthermore the consequences of myocardial infarction can be minimised through timely diagnosis and invasive therapy to re-establish circulation in the heart muscle. At best, an infarction can be survived without any significant sequelae. If however, extensive damage to the heart muscle results, myocardial infarction can also lead to severely impaired pump function and heart failure. In-patient and out-patient therapy of patients with heart failure accounts for a significant and increasing percentage of the health care provided by health insurance funds [13, 14].

This article presents findings from the first wave of the German Health Interview and Examination Survey for Adults (DEGS1) regarding the prevalence of myocardial infarction and coronary heart disease in adults aged 40–79 years in Germany and analyses the trend in prevalence since the German National Health Interview and Examination Survey 1998 (GNHIES98) [15].

Methods

Study design and sample

The German Health Interview and Examination Survey for Adults ("Studie zur Gesundheit Erwachsener in Deutschland", DEGS) is part of the health monitoring system at the Robert Koch Institute (RKI). The concept and design of DEGS are described in detail elsewhere [16, 17, 18, 19, 20]. The first wave (DEGS1) was conducted from 2008–2011 and comprised interviews, examinations and tests [21, 22]. The target population comprises the residents of Germany aged 18–79 years. DEGS1 has a mixed design, which permits both cross-sectional and longitudinal analyses. For this purpose, a random sample from local population registries was drawn to supplement former participants from the German National Health Interview and Examination Survey 1998 (GNHIES98). A total of 8,152 people participated, including 4,193 first-time participants (response rate 42%) and 3,959 revisiting participants of GNHIES98 (response rate 62%). A total of 7,238 persons attended one of the 180 examination centres, and 914 were interviewed only. The net sample [20] permits representative cross-sectional analyses for the age range 18–79 years (n=7,988, including 7,116 in study centres) and time trend analyses based on comparison with GNHIES98. The analyses presented here refer to the sample of 5,901 persons aged 40–79 years [20].

Tab. 1 Lifetime prevalence of coronary heart disease (*CHD*), myocardial infarction, angina pectoris or other CHD in adults aged 40–79 years in DEGS1 by age and sex

	40–49 years	50–59 years	60–69 years	70–79 years	Overall
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
CHD overall					
Women (n=3,037)	1.6 (0.7–3.5)	1.8 (0.9–3.2)	10.8 (8.3–13.9)	15.5 (12.2–19.4)	6.4 (5.4–7.6)
Men (n=2,745)	3.0 (1.6–5.6)	6.9 (4.9–9.8)	19.5 (15.9–23.7)	30.5 (25.9–35.5)	12.3 (10.8–14.0)
Overall (n=5,782)	2.3 (1.4–3.8)	4.4 (3.2–5.9)	15.1 (12.8–17.7)	22.3 (19.3–25.5)	9.3 (8.4–10.3)
Myocardial infarction					
Women (n=3,073)	0.6 (0.2–2.5)	0.1 (0.0–0.7)	4.7 (2.8–7.6)	6.0 (3.9–9.2)	2.5 (1.8–3.4)
Men (n=2,766)	2.3 (1.1–4.9)	3.8 (2.5–5.8)	11.9 (8.7–16.0)	15.3 (11.6–19.9)	7.0 (5.8–8.4)
Overall (n=5,389)	1.5 (0.8–2.9)	2.0 (1.3–3.0)	8.2 (6.2–10.7)	10.2 (8.0–12.8)	4.7 (4.0–5.5)
Angina pectoris/other CHD					
Women (n=3,040)	1.6 (0.7–3.5)	1.8 (0.9–3.2)	9.1 (6.9–12.0)	13.8 (10.7–17.6)	5.7 (4.7–6.8)
Men (n=2,744)	2.2 (1.1–4.4)	6.4 (4.3–9.2)	15.2 (12.3–18.6)	27.3 (22.8–32.2)	10.4 (9.1–12.0)
Overall (n=5,784)	1.9 (1.1–3.2)	4.1 (2.9–5.6)	12.1 (10.2–14.4)	19.9 (17.1–23.1)	8.0 (7.2–9.0)

Tab. 2 Temporal trends in the lifetime prevalence of coronary heart disease (*CHD*), myocardial infarction and angina pectoris (*AP*) or other CHD in adults aged 40–79 years comparing DEGS1 (n=5,901) and GNHIES98 (n=4,285) by sex

	GNHIES98[a]	GNHIES98, age-adjusted[b]	DEGS1[b]	Change	Change, age-adjusted
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Women					
CHD overall	8.9 (7.4–10.6)	8.7 (7.2–10.6)	6.4 (5.4–7.6)	−2.5 (−4.4; −0.6)	−2.3 (−4.3; −0.4)
Myocardial infarction	2.4 (1.7–3.2)	2.3 (1.7–3.2)	2.5 (1.8–3.4)	+0.1 (−0.9; +1.1)	+0.2 (−0.09; +1.2)
AP/other CHD	8.4 (7.0–10.1)	8.3 (6.9–10.0)	5.7 (4.7–6.8)	−2.7 (−4.5; −0.9)	−2.6 (−4.5; −0.7)
Men					
CHD overall	12.1 (10.8–13.6)	12.7 (11.2–14.3)	12.3 (10.8–14.0)	+0.2 (−0.18; +2.3)	−0.4 (−2.5; +1.8)
Myocardial infarction	5.3 (4.4–6.4)	5.7 (4.7–7.0)	7.0 (5.8–8.4)	+1.7 (+0.2; +3.2)	+1.3 (−0.4; +2.9)
AP/other CHD	10.8 (9.5–12.3)	11.2 (9.8–12.8)	10.4 (9.1–12.0)	−0.4 (−2.3; +1.5)	−0.8 (−2.8; +1.2)
Overall					
CHD overall	10.4 (9.3–11.7)	10.7 (9.5–12.0)	9.3 (8.4–10.3)	−1.1 (−2.6; +0.4)	−1.4 (−2.9; +0.2)
Myocardial infarction	3.8 (3.1–4.5)	4.0 (3.3–4.8)	4.7 (4.0–5.5)	+0.9 (0.0; +1.9)	+0.7 (−0.3; +1.7)
AP/other CHD	9.6 (8.5–10.7)	9.7 (8.6–11.0)	8.0 (7.2–9.0)	−1.6 (−2.9; −0.1)	−1.7 (−3.2; −0.2)

[a]Adjusted to population structure as of 31 Dec 1997 [b]Adjusted to population structure as of 31 Dec 2010.

Variables

Data was collected by a standardised computer-assisted interview conducted by a physician and by a self-completion questionnaire on health-relevant indicators. In detail, the participants were asked whether coronary heart disease had ever been diagnosed by a physician using the following questions: "Has a doctor ever diagnosed you as having had a myocardial infarction?" or "Has a doctor ever diagnosed you as having an impaired blood supply to the heart, narrowing of the coronary arteries or angina pectoris?" To establish the lifetime prevalence of a coronary heart disease, self-reported prevalence of myocardial infarction and of angina pectoris or other coronary heart disorder were summarised.

Socioeconomic status was determined using an index which includes information on school education and vocational training, professional status and net household income (weighted by household needs) permitting classification into low, middle and high status groups [23].

Statistical analysis

The lifetime prevalence of myocardial infarction and of angina pectoris or other coronary heart disorder was calculated as the proportion of participants answering "Yes" of the total number of participants with valid "Yes" or "No" answers and expressed as a percentage with 95% confidence intervals (95% CI). Participants who gave no answer or an answer of "Don't know" were excluded from the respective analyses.

The cross-sectional analyses on lifetime prevalence in DEGS1 were carried out using a weighting factor, which corrects sample deviations from population structure (as of 31 Dec 2010) with regard to age, sex, region and nationality, as well as type of community and education [20]. When calculating the weighting factor for previous participants of GNHIES98, the probability of repeated participation, based on a logistic model, was taken into account. A non-responder analysis and the comparison of selected indicators with data from official statistical sources indicate a high level of sample representativeness for the residential population in Germany [20].

For the analyses of temporal trends, lifetime prevalence in DEGS1 was compared with prevalence data in the German National Health Interview and Examination Survey 1998 (GNHIES98). To this end, the prevalence figures of GNHIES98 were re-calculated using the new methodology of weighting developed in DEGS1. In the course of this the GNHIES98 sample was adjusted to the population structure as of 31 Dec 1997 by weighting the results for age, sex, region, nationality, community type and education [17]. In order to take the demographic changes in population structure since GNHIES98 into account, in a second step of the trend analysis, the GNHIES98 data was age-adjusted to the population structure as of 31 Dec 2010.

In order to take into account both the weighting and the correlation of the participants within a community, the confidence intervals for all analyses were determined using the survey procedures in Stata 12.1 and SAS 9.3 [24]. Differences are deemed to be statistically significant if the respective 95% confidence intervals of the prevalence estimators do not overlap.

Results

Myocardial infarction

The lifetime prevalence of physician-diagnosed, myocardial infarction in the age group 40–79 years is 4.7%. An increase in prevalence can be observed with advancing age, from 1.5% in 40–49 year olds to 10.2% in 70–79 year olds. In women, prevalence at 2.5% is less than half of that in men at 7.0% and prevalence is less than 1% below age 60 years (🔲 Tab. 1).

The comparison between GNHIES98 and DEGS1 reveals an absolute increase in the prevalence of myocardial infarction from 3.8 to 4.7%. This development is almost entirely attributable to an increase in the prevalence in men (+1.7%). No statistically significant change is found in women. Comparing the lifetime prevalence of myocardial infarction in GNHIES98 after age adjustment to the population structure of 31 Dec 2010 to that in DEGS1, there are no statistically significant differences, neither overall nor within both sexes separately (🔲 Tab. 2).

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Prevalence of myocardial infarction and coronary heart disease in adults aged 40–79 years in Germany. Results of the German Health Interview and Examination Survey for Adults (DEGS1)

Abstract

In the German Health Interview and Examination Survey for Adults (DEGS1), data on the prevalence of myocardial infarction and coronary heart disease were collected from 2008–2011 in a representative population-based sample of 5,901 adults aged 40–79 years. The results of DEGS1 were compared with the prevalence estimates from the German National Health Interview and Examination Survey 1998 (GNHIES98). The lifetime prevalence of myocardial infarction amongst 40–79 year olds in DEGS1 is 4.7% (women 2.5%; men 7%). In comparison with GNHIES98 a small increase was observed in men, but not in women. The lifetime prevalence of coronary heart disease in adults aged 40–79 years in DEGS1 is 9.3% (women 6.4%; men 12.3%). In comparison to GNHIES98 there is a slight reduction only in women. There is a significant inverse relationship between disease prevalence and socioeconomic status. The trend in prevalence of coronary heart disease is comparable with that in other high-income countries. Given a falling incidence of myocardial infarction and a decrease in the mortality rates due to coronary heart disease, the basically stable prevalence rates indicate a positive development in the field of cardiovascular prevention and therapy.

Keywords

Coronary heart disease · Myocardial infarction · Prevalence · Health survey

Prävalenz von Herzinfarkt und koronarer Herzkrankheit bei Erwachsenen im Alter von 40 bis 79 Jahren in Deutschland. Ergebnisse der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1)

Zusammenfassung

In der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1) wurden von 2008 bis 2011 in einer bevölkerungsrepräsentativen Stichprobe von 5901 Personen in der Altersgruppe von 40 bis 79 Jahren Daten zur Prävalenz von Herzinfarkt und koronarer Herzkrankheit erhoben. Die Ergebnisse von DEGS1 wurden mit denen aus dem Bundes-Gesundheitssurveys 1998 (BGS98) verglichen. Die Lebenszeitprävalenz des Herzinfarktes bei 40- bis 79-Jährigen in DEGS beträgt 4,7% (Frauen 2,5%; Männer 7%). Im Vergleich zum BGS98 zeigte sich ein geringer Anstieg bei Männern, nicht jedoch bei Frauen. Die Lebenszeitprävalenz der koronaren Herzkrankheit bei 40- bis 79-Jährigen beträgt in DEGS1 9,3% (Frauen 6,4%; Männer 12,3%).

Im Vergleich zum BGS98 ergibt sich nur bei Frauen eine geringe Abnahme. Es besteht ein signifikanter inverser Zusammenhang zwischen Erkrankungshäufigkeit und Sozialstatus. Die Entwicklung der Prävalenzen der koronaren Herzkrankheit ist vergleichbar mit der in anderen industrialisierten Ländern. Bei sinkender Inzidenz des Herzinfarktes und einem Rückgang der Mortalitätsraten aufgrund koronarer Herzkrankheit spricht die im Wesentlichen gleichbleibende Prävalenz für eine positive Entwicklung im Bereich der kardiovaskulären Prävention und Therapie.

Schlüsselwörter

Koronare Herzkrankheit · Herzinfarkt · Prävalenz · Gesundheitssurvey

Coronary heart disease

Summarised under the term "coronary heart disease" (CHD) are myocardial infarction and angina pectoris as well as other manifestations of coronary heart disease.

The lifetime prevalence of coronary heart disease in the age group 40–79 years is 9.3% overall. Prevalence increases—with sex-specific variations—with increasing age. In women, prevalence at 6.4% is about half as high as that of men at 12.3% (🔲 Tab. 1).

Compared to GNHIES98, both overall and among men alone there is no statistically significant change in the prevalence either in the raw data or in the age-adjusted data. In women, there is a reduction in prevalence of coronary heart disease from

Tab. 3 Lifetime prevalence of coronary heart disease (*CHD*) overall in DEGS1 by age, sex and socioeconomic status (low, medium or high)

	40–49 years	50–59 years	60–69 years	70–79 years	Overall
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Women (n=3,037)					
Low	4.7 (1.5–13.4)	–	15.5 (8.7–26.1)	16.0 (10.4–23.8)	10.0 (7.2–13.7)
Medium	1.4 (0.4–4.4)	2.4 (1.2–4.8)	9.8 (6.9–13.7)	15.5 (11.1–21.2)	6.2 (4.8–7.8)
High	0.3 (0.0–2.4)	1.1 (0.3–4.3)	8.0 (3.8–15.7)	8.7 (4.0–17.8)	2.7 (1.7–4.4)
Men (n=2,745)					
Low	6.6 (2.3–17.6)	11.6 (6.2–20.4)	27.1 (16.1–42.0)	34.3 (22.9–47.9)	17.9 (13.5–23.2)
Medium	2.7 (1.3–5.7)	6.8 (4.1–11.0)	17.9 (13.8–22.8)	29.4 (23.8–35.6)	11.8 (9.9–14.0)
High	1.3 (0.3–6.8)	2.9 (1.3–6.2)	18.2 (12.2–26.2)	30.3 (21.0–41.4)	9.2 (7.0–12.1)
Overall (n=5,782)					
Low	5.7 (2.7–11.8)	6.5 (3.4–11.8)	20.7 (13.7–30.1)	22.5 (16.6–29.7)	13.7 (11.1–16.9)
Medium	2.0 (1.0–3.8)	4.5 (3.0–6.8)	13.5 (10.9–16.5)	21.9 (18.0–26.4)	8.8 (7.6–10.2)
High	0.9 (0.2–3.8)	2.0 (1.0–3.9)	14.4 (10.2–20.1)	22.5 (15.9–30.8)	6.5 (5.1–8.1)

8.9 to 6.4%. In the age-standardised comparison of DEGS1 and GNHIES98 there is an absolute fall in prevalence of 2.3% (■ **Tab. 2**). The reduction in prevalence can primarily be attributed to a reduction in angina pectoris and/or other manifestations of coronary heart disease amongst older women (data not shown in detail).

The lifetime prevalence of coronary heart disease both overall and in men and women separately is highest in persons of low socioeconomic status and vice versa. This observation is also true for most age and sex-specific subgroups, but not in the highest age group overall and in men. The social gradient in general is more pronounced in men than in women (■ **Tab. 3**).

Discussion

Myocardial infarction

The lifetime prevalence of myocardial infarction in DEGS1 agrees well with the results of the telephone survey German Health Update (GEDA 2010) which was conducted by the RKI at the same time with the same wording of questions for disease prevalence [25]. In this the prevalence for both genders in the age group 40–79 years were 4.5% overall, for women 2.3% and for men 6.9% (own calculations for the age group 40–79 years). The validity of self-reports of diagnosed myocardial infarction is likely to be very high. Any such event would be well-remembered by the person affected since it is generally ac-companied by severe pain and emergency treatment [30].

Compared with GNHIES98 a small increase in the crude prevalence of survived myocardial infarction of 0.9% is evident, which can be attributed to a statistically significant increase amongst men (+1.7%). In the age-adjusted analysis this increase is no longer found and thus the increase in the crude prevalence can at least in part be explained by the demographic ageing of the population. One further reason for the increase in crude lifetime prevalence, given falling incidence of myocardial infarction, is the fact that persons having myocardial infarctions are more likely to survive longer due to improved therapeutic possibilities [11, 12].

The lifetime prevalence in DEGS1 and the small changes over time is comparable with current data from England and the USA. In the Health Survey for England (HSE) [26] and in the United States' National Health and Nutrition Examination Survey (NHANES) [5] the prevalence of myocardial infarction and angina pectoris were established in a manner similar to DEGS1 on the basis of self-reports regarding physician-diagnosed illnesses. For the year 2006, the prevalence of myocardial infarction reported from England was 1.7% in women and 4.1% in men [26]. For the period 1994–2006 no relevant changes were reported for either sex; in the older age group, however, a gradual increase was reported for both sexes [27]. For the USA—based on the NHANES data from 2008—a lifetime prevalence of

3.1% (women 2.2%; men 4.3%) was reported [5]. For the period from 1999–2008 in adults aged 25–74 years, a reduction in prevalence of myocardial infarction was observed in men, and no relevant change in women [28].

Coronary heart disease

The lifetime prevalence of coronary heart disease in DEGS1 compared to GN-HIES98 shows a reduction of 1.1% in the crude analysis. The decrease is primarily due to a reduction in prevalence of angina pectoris and other coronary heart diseases from 8.4 to 5.7% in women. The reduction remains virtually unchanged in the age-adjusted analysis and therefore is not explained by the changed age structure.

Data from the telephone survey German Health Update (GEDA 2010), which was conducted at the same time as DEGS1, show a slightly higher prevalence at 10.6% overall (women 8.0%; men 13.4%; own calculations for the age group 40–79 years) [25]. This difference can possibly be explained by differential response behaviour in face-to-face interviews by study doctors in DEGS1 compared to telephone interviews by trained lay interviewers in GEDA. The validity of self-reported coronary heart disease is known to be less pronounced than that of myocardial infarction, since this diagnosis is not as clearly defined for a lay person [29, 30].

In the Health Survey for England 2006, a CHD prevalence of 5.2% was reported (women 4.0%; men 6.5%) with no change in overall prevalence over time, only the oldest age group (75 and over) showed a small increase in both sexes [26]. In the USA, on the basis of the NHANES data from 2008, the prevalence of CHD was established as 7% (women 6.1%; men 8.3%) [5]. In the annual telephone survey in the USA (the Behavioral Risk Factor Surveillance System) a reduction in the lifetime prevalence was evident. In the period between 2006 and 2010 a decrease of 0.7% is reported and this decrease is more pronounced amongst women than men [31].

The higher prevalence of myocardial infarction and CHD in Germany, in comparison with the aforementioned countries, can primarily be explained by the fact that within the German population,

the proportion of those in the age group 65 and over at 20.4% is significantly higher than in the United Kingdom (16.6%) and in the USA (13.1%) [32]. Apart from this, considerably higher mortality rates from coronary heart disease are recorded in the USA than in Germany. They are approximately 50% higher in women and about 20% higher in men [5]. In addition, national differences in the prevalence of cardiovascular risk factors need to be taken into account [33].

The decrease in the prevalence of coronary heart disease amongst women by 2.3% is surprising. Sex-specific differences in the prevalence of myocardial infarction and coronary heart disease are known and attributable to biological factors, differences in health behaviour, as well as to aspects of medical care. These factors also influence case fatality rates in men and women [34]. However, as more attention has been paid to diagnosis and treatment of coronary heart disease amongst women in the past 10 years [35, 36, 37], it is unlikely that the disease was diagnosed more rarely in women over time or that it is less perceived by them. Further analyses will have to show to what extent sex-specific differences in cardiovascular risk profiles may explain this selective reduction of prevalence amongst women.

Socioeconomic status

Lifetime prevalence of coronary heart disease is inversely associated with socioeconomic status both in women and in men—the higher the socioeconomic status, the lower the prevalence. This connection is well documented in literature and is not solely attributable to the known social class-specific differences in health behaviour [38, 39]. Psychosocial factors as well as working and living conditions play an equally crucial role [40, 41].

Conclusion and outlook

The presented data on the prevalence of myocardial infarction and coronary heart disease are in general indicative of a positive development over the past decade. The increase in lifetime prevalence of myocardial infarction while incidence

figures are falling [11] can be attributed to demographic ageing and improved chances of survival. The increasing implementation of prevention measures and therapy strategies for coronary heart disease according to evidence-based guidelines shows measureable successes [12, 42]. However, prevalence of CHD continues to be associated inversely with socioeconomic status.

The data now available from DEGS1 offer the opportunity to further investigate to what extent the developments presented here can be traced back to specific changes in the prevalence of cardiovascular risk factors such as hypertension, dyslipidaemia, diabetes, life-style factors and living conditions. These modifiable risk factors are of particular interest for public health, in order to develop targeted prevention measures to reduce incidence of cardiovascular disease and to improve survival.

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Conflict of interest. On behalf of all authors, the corresponding author states that there are no conflicts of interest.

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