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Vaccination coverage in German adults

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

Background

Beyond the individual health benefit of vaccinations, the population-related effectiveness of vaccinations is dependent on high vaccination coverage. This is the only way individuals who are too young or too ill for a vaccination can be effectively protected against diseases through the protective effect of so-called herd immunity. The health benefit and economic benefit of vaccinations can only be maximised through high vaccination coverage. Once herd immunity is achieved vaccination will more than proportionately reduce the morbidity rate and increase the average length of outbreak-free intervals [1]. Individual vaccination decisions are dependent on the subjective benefit–risk assessment of each individual [2, 3]. In times of decreasing or low incidence the risk of contracting diseases decreases, but actual or feared vaccination risks are increasingly perceived. Therefore achieving and maintaining high vaccination coverage represents an ongoing challenge.

Current data on incidence and vaccination coverage provide the basis for evidence-based health policy decisions in the field of vaccination. Vaccination coverage is defined as the number of individuals in a population who have received a vaccination or series of vaccinations in relation to the total number of individuals in the population. As vaccination coverage in Germany is not recorded in an immunisation register, monitoring vaccination coverage comprises data from different sources. While for children the school entry examinations provide data on vaccination status for at least one age group, information regarding adults in Germany was, until recently, only available from small, sporadic surveys [4, 5, 6] and evaluations of statutory health insurance data [7] and were mainly focussed on influenza vaccinations. Much time has passed since representative population surveys on vaccination coverage such as the microcensus by the Federal Statistics Office [8] or the German National Health Interview and Examination Survey 1998 (GNHIES98) have been carried out. The aim of this paper is to present an overview of vaccination coverage for standard and selected indication vaccinations recommended by the Standing Committee on Vaccination Recommendations at the Robert Koch Institute (STIKO). Differences in vaccination coverage by age, sex and social status will be analysed and the multimode method will be considered. For tetanus and diphtheria, the current vaccination coverage data will be compared with the data from 10 years ago.

Methods

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 [9, 10, 11, 12, 13]. The first wave (DEGS1) was conducted from 2008–2011 and comprised interviews, examinations and tests [14, 15]. The target population comprises the residents of Germany aged 18–79 years. The study design of DEGS1 is mixed permitting cross-sectional and longitudinal analyses. For this purpose, a random sample from local population registries was drawn to complete the participants from German National Health Interview and Examination Survey 1998 (GNHIES98). A total of 8,152 persons participated, including 4,193 first-time participants (response rate 42%) and 3,959 revisiting participants of GNHIES98 (response rate 62%). There were 7,238 persons who attended one of 180 examination centres, and 914 were interviewed only. The net sample (n=7,988) permits representative cross-sectional and trend analyses for the age range of 18–79 years in comparison with GNHIES98 (n=7,988, including 7,116 in study centres) [10]. The data of the revisiting participants can be used for longitudinal analyses. The cross-sectional and trend analyses are carried out with a weighting factor which corrects deviations in the sample from the population structure (as of 31 Dec 2010) with respect to age, sex, region and nationality as well as community type and education [10].

A separate weighting factor was generated for the examination part of the study. Calculation of the weighting factor also considered re-participation probability of former GNHIES98 participants, based on a logistic regression model. For the purpose of conducting trend analyses, the da-

Tab. 1 DEGS1: Source of information for vaccination status in study participants by sex and age group in percent with 95% confidence intervals. $n_{unweighted}$=7988

	Age group						
Data source	**18–29**	**30–39**	**40–49**	**50–59**	**60–69**	**70–79**	**Total**
Women							
Vaccination card	65.7 (60.9–70.3)	43.6 (38.5–48.8)	47.0 (42.1–51.8)	39.4 (34.7–44.2)	35.0 (29.8–40.6)	30.2 (24.8–36.2)	44.4 (41.7–47.2)
CAPI	21.7 (17.4–26.8)	38.3 (33.0–43.9)	30.3 (26.4–34.5)	27.4 (24.1–30.9)	24.9 (21.3–28.9)	27.6 (23.5–32.1)	28.2 (26.3–30.3)
Card and CAPI	12.1 (9.2–15.7)	17.2 (13.4–21.8)	22.1 (18.4–26.3)	31.9 (27.7–36.6)	39.0 (33.8–44.5)	41.2 (35.3–47.3)	26.5 (23.9–29.2)
No vaccination data	0.4 (0.1–1.4)	0.9 (0.2–3.5)	0.7 (0.3–1.5)	1.3 (0.6–2.7)	1.1 (0.3–4.0)	1.0 (0.4–2.4)	0.9 (0.5–1.5)
Men							
Vaccination card	56.3 (50.7–61.7)	39.3 (33.7–45.1)	32.1 (27.5–37.2)	32.2 (27.2–37.6)	29.0 (24.6–33.9)	30.0 (24.6–36.0)	37.2 (34.3–40.2)
CAPI	31.7 (26.8–37.1)	39.2 (34.3–44.3)	36.6 (31.6–41.9)	32.9 (28.9–37.1)	32.9 (28.8–37.3)	34.7 (29.8–39.9)	34.6 (32.1–37.2)
Card and CAPI	10.5 (7.7–14.0)	20.5 (16.0–25.9)	30.1 (25.4–35.2)	33.7 (28.8–38.9)	37.5 (32.5–42.7)	34.9 (29.5–40.8	27.1 (24.5–29.8)
No vaccination data	1.5 (0.5–4.2)	1.1 (0.4–3.2)	1.2 (0.5–3.1)	1.2 (0.5–2.8)	0.6 (0.2–1.3)	0.4 (0.1–1.3)	1.1 (0.7–1.7)
Total							
Vaccination card	60.9 (57.1–64.5)	41.4 (37.6–45.3)	39.4 (35.6–43.3)	35.8 (32.0–39.8)	32.1 (28.0–36.5)	30.1 (25.3–35.3)	40.8 (38.3–43.4)
CAPI	26.9 (23.4–30.6)	38.7 (35.2–42.3)	33.5 (30.2–37.0)	30.1 (27.6–32.8)	28.8 (26.1–31.7)	30.8 (27.5–34.3)	31.4 (29.7–33.2)
Card and CAPI	11.3 (9.3–13.6)	18.9 (15.7–22.4)	26.2 (22.8–29.8)	32.8 (29.0–36.8)	38.2 (34.3–42.4)	38.4 (33.7–43.2)	26.8 (24.5–29.1)
No vaccination data	1.0 (0.4–2.5)	1.0 (0.4–2.4)	0.9 (0.4–2.0)	1.3 (0.7–2.2)	0.9 (0.3–2.1)	0.7 (0.4–1.6)	1.0 (0.7–1.4)

CAPI computer-assisted personal interview.

ta from the GNHIES98 were age-adjusted to the population level as of 31 Dec 2010. A non-responder analysis and a comparison of selected indicators with data from census statistics indicate a high level of representativity of the net sample for the residential population aged 18–79 years of Germany [10].

To take into account both the weighting as well as the correlation of participants within a community, the confidence intervals were determined with the SPSS 20 procedures complex samples. Differences are considered statistically significant if the 95% confidence intervals do not overlap. The vaccination coverage was stratified by sex, age, socioeconomic status (SES) and place of residence in eastern or western Germany. 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 [16]. The participants were asked to bring their vaccination documents (vaccination card and vaccination certificates) to the medical examination. In the examination centre, completeness of the submitted vaccination documents were checked by the study physician—taking into account the details provided by participants—and then copied. If the documents were complete, the data for medically documented vaccinations were entered at the Robert Koch Institute by specially trained, medically experienced personnel; no computer-assisted personal interview (CAPI) was carried out, however. In the absence of a vaccination card or if the submitted vaccination documents were incomplete, then the vaccination status was recorded (additionally) in CAPI. Subjects who had not submitted a vaccination card for the medical examination were asked to send it in at a later date. The basis of the vaccination coverage data presented here is therefore the vaccinations documented in the vaccination card, details provided by participants in the CAPI interview and information used from both sources. In the CAPI, data for lifetime prevalence for at least one dose of each vaccination was collected using the question "Have you ever been vaccinated against…?" For tetanus, diphtheria and pertussis (whooping cough) participants were asked if the vaccination took place within the last 10 years in order to determine the 10-year prevalence. The vaccination data documented in the vaccination card was processed according to these questions. Furthermore, notes on vaccinations submitted together with the vaccination card that did not correspond to a medically documented vaccination were collected and taken into account on equal terms with the self-reported data in the CAPI.

Results

Data regarding vaccination status were obtained for 99.0% of participants (**Tab. 1**). For two thirds of adults, the vaccination status is based completely (40.8%) or partially (26.8%) on information from vaccination cards. Women submitted a vaccination card significantly more often than men. The proportion of complete vaccination cards was highest in women aged 18–29 years, the proportion was lowest in 60- to 69-year-old men. In general it was observed that vaccination information could be based less and less on vaccination cards alone as the age of participants increased. In older age groups vaccination status was more often based on the combination of data from the vaccination card and the CAPI.

The proportion of participants for whom no information for the respec-

tive vaccination status could be obtained varied widely depending on the vaccination in question. While no information regarding influenza status could be obtained for only 2.9% of adults, the figure for pertussis was 11.1% (data not shown). Information regarding the number of missing values can be drawn from the data for unweighted case numbers in **Tab. 2**.

Lifetime prevalence

Vaccination prevalences by sex and age group are shown in **Tab. 2**. Vaccination coverage is highest for active immunisation against tetanus (96.0%). Vaccination coverage is statistically significantly higher in men (97.0%; 95% confidence interval (CI) 96.2–97.7) than in women (95.0%; 95% CI 94.0–95.9). 81.5% of adults are vaccinated against diphtheria with at least one vaccine dose. In contrast to tetanus vaccination coverage women are more likely to be vaccinated than men. The study showed that 85.6% of adults are vaccinated against poliomyelitis; the higher vaccination coverage in women in comparison to men is particularly evident in 50–59 year olds. 34.5% of adults have received at least one vaccine dose against pertussis; while there is no difference by sex in the 18–29 age groups, 30- to 59-year-old women are slightly more often vaccinated against pertussis than men in this age group. 32.9% of adults have received at least one vaccine dose against hepatitis B; as with pertussis, women are more likely to be vaccinated than men, with the largest difference being observed in 40–59 year olds. Overall lifetime prevalence of influenza vaccination is 44.7%; there is no difference between women and men. 27.4% of adults have received at least one vaccination against hepatitis A. The vaccination coverage for tick-borne encephalitis (TBE) is 29.4%.

While vaccination coverage against tetanus is only lower in 70–79 year olds in comparison to the other age groups, there is a clear decrease in prevalence for vaccinations against diphtheria and poliomyelitis as the age increases; this decrease can be seen even more clearly for vaccinations against pertussis and hepatitis A and B. In contrast, lifetime prevalence of influenza vaccination increases significantly with age. The highest vaccination coverage is observed in 70- to 79-year-old adults (68.3%), whereas 30.8% of people in the 18–29 age group are vaccinated against influenza (including influenza A (H1N1) virus).

Vaccination during the last 10 years

A total of 71.4% of adults have been vaccinated against tetanus within the preceding 10 years and can be classified as currently vaccinated against tetanus. The vaccination coverage is highest in young adults aged 18–29 and is lowest in 30–39 year

Abstract · Zusammenfassung

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Vaccination coverage in German adults. Results of the German Health Interview and Examination Survey for Adults (DEGS1)

Abstract

In the absence of an immunisation register, vaccination coverage in Germany must be estimated. Ten years after the German National Health Interview and Examination Survey 1998 (GNHIES98), the population survey DEGS1 is one of the data sources that can be used for monitoring vaccination coverage. In the survey, data on vaccination history were obtained from vaccination cards and self-reports. The prevalence of immunisation for tetanus and diphtheria was higher compared to the prevalence estimated 10 years previously in GNHIES98. Nonetheless, 28.6% of adults have not been vaccinated against tetanus and 42.9% have not been vaccinated against diphtheria within the last 10 years. Vaccination is especially low among the elderly, among adults with low socioeconomic status and in western Germany. During the last 10 years, only 11.8% of women and 9.4% of men were vaccinated against pertussis in western Germany; vaccination coverage was twice as high in eastern Germany. In 2009, recommendations were published to combine the next tetanus immunisation with a pertussis immunisation; therefore pertussis vaccination coverage might improve in the coming years. The lifetime prevalence of influenza vaccination obtained in DEGS1 is higher than the annual vaccination rate for influenza. However, the lifetime prevalence among adults aged 60 years or older is still below the annual rate of 75% recommended by the WHO.

Keywords

Health survey · Immunisation coverage · General population · Adults · Germany

Impfstatus von Erwachsenen in Deutschland. Ergebnisse der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1)

Zusammenfassung

In Deutschland werden Impfquoten nicht über ein Impfregister erfasst. Die bevölkerungsrepräsentative Studie zur Gesundheit Erwachsener in Deutschland (DEGS1) ist ein Baustein für das Monitoring der Durchimpfung. Zur Erhebung der Impfdaten wurden Impfpässe und Befragungsdaten genutzt. Der Tetanus- und Diphtherie-Impfstatus Erwachsener ist besser als vor 10 Jahren im „Bundes-Gesundheitssurvey 1998", dennoch haben immer noch 28,6% der Bevölkerung in den letzten 10 Jahren keine Tetanusimpfung und 42,9% keine Diphtherieimpfung erhalten. Insbesondere bei Älteren, bei Erwachsenen mit niedrigem sozioökonomischem Status und in Westdeutschland bestehen Impflücken. Nur 11,8% der Frauen und 9,4% der Männer in Westdeutschland haben innerhalb der letzten 10 Jahre eine Impfung gegen Pertussis erhalten; die Durchimpfung ist in Ostdeutschland doppelt so hoch. Die seit 2009 bestehende Empfehlung, mit der nächstanstehenden Tetanusimpfung gleichzeitig gegen Pertussis zu impfen, lässt jedoch einen Anstieg der Durchimpfung erwarten. Im Vergleich zu den jährlichen Impfraten gegen Influenza ist der Anteil jemals gegen Influenza geimpfter Erwachsener höher. Allerdings liegt bei Frauen und Männern im Alter über 60 Jahren selbst die Lebenszeitprävalenz deutlich unter der von der Weltgesundheitsorganisation (WHO) empfohlenen jährlichen Impfrate von 75%.

Schlüsselwörter

Gesundheitssurvey · Impfquoten · Allgemeinbevölkerung · Erwachsene · Deutschland

Tab. 2 Vaccination coverage of at least one vaccination dose by sex and age group in percent with 95% confidence intervals. $n_{unweighted}$=depends on vaccination, see table

		Age group						
Sex	$n_{un-weighted}$	18–29	30–39	40–49	50–59	60–69	70–79	Total
Tetanus								
Women	4092	95.5 (92.2–97.4)	96.2 (93.2–97.9)	96.2 (94.2–97.6)	95.4 (93.5–96.8)	94.4 (91.5–96.4)	91.4 (87.8–94.0)	95.0 (94.0–95.9)
Men	3701	98.0 (95.7–99.1)	98.0 (95.1–99.2)	97.6 (95.6–98.7)	97.4 (95.3–98.6)	95.1 (92.2–96.9)	94.9 (92.3–96.7)	97.0 (96.2–97.7)
Total	7793	96.8 (95.0–97.9)	97.1 (95.0–98.3)	96.9 (95.6–97.9)	96.4 (95.1–97.4)	94.7 (92.5–96.3)	93.0 (90.7–94.7)	96.0 (95.3–96.6)
Tetanus in the last 10 years								
Women	4032	73.7 (68.8–78.0)	66.6 (61.1–71.6)	70.9 (66.7–74.8)	69.4 (65.4–73.1)	71.5 (67.1–75.6)	71.8 (67.1–76.1)	70.7 (68.8–72.6)
Men	3649	77.4 (72.2–81.8)	70.6 (64.8–75.7)	71.2 (66.6–75.4)	71.7 (67.6–75.4)	72.1 (67.7–76.1)	67.4 (61.8–72.5)	72.0 (70.0–74.0)
Total	7681	75.6 (71.8–78.9)	68.6 (64.4–72.4)	71.1 (67.9–74.0)	70.5 (67.6–73.3)	71.8 (68.4–75.0)	69.8 (66.2–73.2)	71.4 (69.8–72.9)
Diphtheria								
Women	3881	91.1 (87.0–94.0)	86.0 (80.8–90.0)	87.6 (84.1–90.3)	85.3 (82.2–87.9)	78.8 (75.0–82.2)	71.9 (66.7–76.5)	84.1 (82.5–85.5)
Men	3393	90.6 (86.2–93.7)	84.8 (79.0–89.3)	78.5 (73.7–82.7)	72.8 (68.6–76.7)	73.4 (68.9–77.5)	69.3 (64.1–73.9)	78.7 (76.8–80.5)
Total	7274	90.9 (88.0–93.1)	85.5 (81.7–88.5)	83.1 (80.1–85.7)	79.1 (76.4–81.5)	76.2 (73.1–79.1)	70.7 (67.1–74.0)	81.5 (80.1–82.7)
Diphtheria in the last 10 years								
Women	3792	67.6 (62.6–72.3)	55.4 (49.9–60.8)	61.0 (56.0–65.8)	57.1 (52.7–61.4)	59.1 (54.6–63.5)	55.7 (50.1–61.2)	59.6 (57.3–62.0)
Men	3308	69.6 (63.9–74.8)	54.3 (48.4–60.0)	52.5 (46.9–58.1)	48.4 (44.1–52.7)	50.5 (45.6–55.4)	49.8 (44.4–55.2)	54.5 (52.1–56.8)
Total	7100	68.6 (64.9–72.1)	54.9 (50.9–58.8)	56.8 (52.8–60.7)	52.8 (49.8–55.8)	55.0 (51.5–58.4)	53.0 (49.2–56.9)	57.1 (55.3–58.9)
Pertussis (whooping cough)								
Women	3841	57.9 (52.4–63.3)	52.7 (46.8–58.5)	42.4 (37.8–47.2)	27.0 (23.1–31.2)	19.9 (16.4–24.0)	14.7 (11.4–18.6)	36.6 (34.2–39.0)
Men	3374	56.5 (50.5–62.2)	46.1 (39.9–52.4)	35.5 (30.5–40.7)	19.5 (16.3–23.3)	16.4 (13.1–20.4)	13.3 (10.3–17.1)	32.3 (29.7–35.0)
Total	7215	57.2 (53.2–61.1)	49.4 (44.8–54.1)	38.9 (35.1–42.8)	23.3 (20.5–26.4)	18.2 (15.6–21.2)	14.1 (11.6–17.0)	34.5 (32.3–36.7)
Pertussis in the last 10 years								
Women	3766	30.6 (25.9–35.7)	12.1 (9.2–15.7)	12.2 (9.5–15.6)	10.6 (8.2–13.5)	7.1 (5.2–9.7)	6.9 (4.6–10.2)	13.7 (12.1–15.4)
Men	3317	26.2 (21.5–31.4)	8.9 (6.2–12.5)	10.8 (8.1–14.3)	4.8 (3.4–6.8)	7.8 (5.2–11.5)	7.8 (5.4–11.2)	11.4 (9.9–13.0)
Total	7083	28.4 (24.8–32.4)	10.5 (8.3–13.2)	11.5 (9.4–13.9)	7.7 (6.2–9.6)	7.5 (5.6–9.9)	7.3 (5.4–9.8)	12.5 (11.3–14.0)
Poliomyelitis								
Women	4021	94.3 (90.8–96.5)	89.1 (84.7–92.4)	89.7 (86.0–92.5)	91.7 (88.9–93.9)	82.8 (78.5–86.5)	70.2 (64.9–75.0)	87.1 (85.3–88.7)
Men	3594	91.0 (86.8–93.9)	89.6 (84.6–93.0)	89.4 (85.5–92.3)	83.6 (79.5–86.9)	78.3 (73.8–82.2)	65.3 (59.3–70.8)	84.2 (82.2–86.0)
Total	7615	92.6 (90.1–94.6)	89.3 (86.2–91.8)	89.5 (86.9–91.7)	87.6 (85.2–89.7)	80.6 (77.4–83.5)	68.0 (63.8–71.9)	85.6 (84.2–87.0)
Influenza (flu)								
Women	4124	26.9 (22.8–31.5)	28.3 (23.5–33.6)	37.2 (32.8–41.9)	42.9 (38.5–47.5)	65.0 (60.4–69.4)	67.6 (62.7–72.2)	43.4 (41.0–45.8)
Men	3697	34.6 (29.4–40.2)	36.2 (30.1–42.7)	40.2 (35.5–45.1)	45.0 (40.3–49.8)	62.6 (57.7–67.2)	69.2 (63.3–74.5)	46.1 (43.5–48.6)
Total	7821	30.8 (27.2–34.7)	32.2 (28.1–36.6)	38.7 (35.2–42.3)	44.0 (40.4–47.6)	63.8 (60.2–67.3)	68.3 (64.4–72.0)	44.7 (42.6–46.8)
Hepatitis A								
Women	3909	40.0 (35.6–44.5)	34.8 (30.1–39.8)	29.5 (25.4–34.0)	24.5 (21.2–28.3)	20.6 (16.6–25.4)	12.3 (9.6–15.7)	27.4 (25.4–29.5)
Men	3480	41.3 (36.2–46.6)	37.1 (31.4–43.2)	27.4 (23.4–31.8)	22.1 (18.6–26.1)	20.5 (16.6–24.9)	11.3 (8.7–14.6)	27.3 (25.2–29.5)
Total	7389	40.6 (37.1–44.3)	35.9 (32.1–39.9)	28.4 (25.5–31.6)	23.3 (20.6–26.2)	20.6 (17.6–23.8)	11.9 (9.9–14.1)	27.4 (25.7–29.1)
Hepatitis B								
Women	3912	76.3 (71.8–80.3)	37.7 (32.4–43.3)	33.5 (29.6–37.5)	25.3 (21.6–29.5)	17.3 (13.7–21.7)	9.7 (7.1–13.1)	34.4 (32.4–36.5)
Men	3464	73.3 (68.2–77.9)	35.7 (30.2–41.7)	25.6 (21.5–30.1)	20.0 (16.6–23.9)	15.5 (12.1–19.6)	9.4 (7.0–12.5)	31.3 (29.1–33.6)
Total	7376	74.8 (71.3–78.1)	36.8 (32.7–41.0)	29.5 (26.5–32.6)	22.7 (19.8–25.8)	16.4 (14.0–19.2)	9.5 (7.6–11.9)	32.9 (31.3–34.5)
Tick-borne encephalitis								
Women	4036	38.8 (33.7–44.1)	27.0 (22.0–32.5)	29.1 (24.4–34.2)	25.2 (21.2–29.7)	28.3 (23.5–33.7)	25.0 (19.5–31.3)	29.1 (25.9–32.5)
Men	3636	44.5 (38.6–50.6)	28.0 (23.2–33.3)	25.4 (21.1–30.4)	25.1 (20.7–30.0)	28.1 (23.2–33.6)	25.6 (21.1–30.7)	29.7 (26.6–33.0)
Total	7672	41.7 (37.2–46.2)	27.5 (23.6–31.7)	27.2 (23.4–31.4)	25.2 (21.6–29.1)	28.2 (24.4–32.4)	25.3 (21.1–29.9)	29.4 (26.5–32.4)
Meningococci								
Women	3953	8.3 (5.8–11.7)	3.3 (1.8–6.1)	1.9 (1.2–3.3)	1.7 (0.8–3.9)	1.4 (0.6–3.2)	0.8 (0.4–1.9)	3.0 (2.4–3.7)
Men	3493	9.0 (6.5–12.4)	2.3 (1.0–5.4)	1.9 (1.0–3.5)	1.9 (0.9–4.1)	2.7 (1.2–6.0)	0.8 (0.2–3.0)	3.2 (2.5–4.1)
Total	7446	8.6 (6.8–10.9)	2.8 (1.7–4.6)	1.9 (1.3–2.8)	1.8 (1.1–3.2)	2.0 (1.1–3.7)	0.8 (0.4–1.7)	3.1 (2.6–3.6)

Tab. 3 Vaccination coverage of at least one vaccination dose for measles, mumps, rubella and pneumococci by sex and age group in percent with 95% confidence intervals. $n_{unweighted}$=depends on vaccination, see table

		Age group						
Sex	$n_{un-weighted}$	18–29	30–39	40–49	50–59	60–64	65–79	Total
Measles								
Women	2791	82.2 (77.7–86.0)	47.2 (41.3–53.1)	27.3 (23.3–31.8)	16.6 (13.6–20.0)	4.1 (2.0–8.1)	n.r.	39.5 (37.0–42.1)
Men	2322	77.2 (71.6–81.9)	46.2 (40.1–52.4)	22.8 (18.6–27.6)	16.1 (12.9–19.9)	3.4 (1.7–6.4)	n.r.	36.7 (33.9–39.5)
Total	5113	79.8 (76.3–82.9)	46.7 (42.2–51.2)	25.1 (21.8–28.7)	16.3 (14.0–19.0)	3.8 (2.3–6.0)	n.r.	38.1 (36.0–40.3)
Mumps								
Women	2770	77.8 (73.0–81.9)	31.2 (25.9–37.1)	14.3 (11.4–17.7)	11.0 (8.8–13.6)	3.3 (1.5–7.3)	n.r.	30.7 (28.4–33.1)
Men	2302	73.7 (68.2–78.5)	31.3 (26.2–37.0)	13.7 (10.8–17.3)	11.8 (9.1–15.3)	2.8 (1.4–5.3)	n.r.	29.5 (27.2–31.9)
Total	5072	75.8 (72.2–79.1)	31.3 (27.4–35.4)	14.0 (11.7–16.7)	11.4 (9.5–13.6)	3.1 (1.8–5.3)	n.r.	30.1 (28.4–31.9)
Rubella								
Women	2819	80.4 (75.9–84.1)	54.5 (48.5–60.5)	38.1 (34.0–42.4)	17.0 (14.0–20.4)	4.7 (2.5–8.7)	n.r.	43.6 (41.3–46.0)
Men	2298	65.2 (59.3–70.6)	18.9 (15.0–23.5)	12.2 (9.4–15.8)	12.1 (9.4–15.5)	3.1 (1.6–6.2)	n.r.	24.9 (22.7–27.3)
Total	5117	73.1 (69.6–76.3)	37.5 (33.3–41.9)	25.5 (22.8–28.4)	14.6 (12.4–17.0)	3.9 (2.5–6.3)	n.r.	34.6 (32.9–36.3)
Pneumococci								
Women	1015	n.r.	n.r.	n.r.	n.r.	n.r.	33.2 (29.0–37.6)	33.2 (29.0–37.6)
Men	965	n.r.	n.r.	n.r.	n.r.	n.r.	29.3 (25.3–33.6)	29.3 (25.3–33.6)
Total	1980	n.r.	n.r.	n.r.	n.r.	n.r.	31.4 (28.1–34.9)	31.4 (28.1–34.9)

n.r. not recorded.

olds and 70–79 year olds. The proportion of adults who have been vaccinated against diphtheria within the last 10 years is 57.1% and is significantly higher in women as compared to men. The relative difference between lifetime prevalence of a vaccination and the prevalence of a vaccination within the last 10 years is highest between pertussis vaccinations (34.5%; 32.3–36.7 versus 12.5%; 11.3–14.0); this discrepancy is smallest for 18–29 year olds and largest for 30–39 year olds. There are no significant differences by sex (**Tab. 2**).

Vaccination coverage (lifetime prevalence for at least one vaccine dose) for measles, mumps, rubella and pneumococci are shown in **Tab. 3**. In total, 38.1% of 18–64 year olds have been vaccinated against measles, with 30.1% vaccinated against mumps. Vaccination coverage for measles is highest in the 18–29 age group (79.8%) and decreases with age to 3.8% among 60–64 year olds. Rubella vaccinations were recorded in 34.6% of 18–64 year olds. As with measles and mumps, the prevalence decreases with age. In the 18–49 age groups, women are statistically significantly more likely to be vaccinated against rubella than men. In all 31.4% of adults aged between 65 and 79 have been vaccinated against pneumococci; there is no difference between men and women.

Vaccinations and socioeconomic status

Vaccination coverage for women and men stratified by SES is shown in **Tab. 4**. Vaccination coverage against tetanus, diphtheria, poliomyelitis, pertussis, hepatitis A and hepatitis B decreases as SES decreases. Differences between high and middle and between middle and low SES are statistically significant for most vaccinations. Different association between SES and vaccination coverage is found for measles and mumps (data for mumps not shown), for vaccinations against influenza in women and for vaccinations against rubella in men. For these vaccinations there is slightly higher coverage in adults with low SES compared to adults with high SES; however, vaccination coverage does not differ (except for the differences for rubella vaccinations in men) significantly by SES. SES is not associated with coverage of vaccination against pneumococci and against influenza in men.

Vaccination in eastern and western Germany

Vaccination coverage stratified by residency in eastern and western Germany is shown in **Tab. 5**. Vaccination coverage is higher in eastern Germany for tetanus, diphtheria and pertussis. While the association between vaccination coverage and SES was obvious for lifetime prevalences, differences between east and west are more pronounced for vaccination coverage within the last 10 years. The east–west difference is particularly evident with vaccination coverage for pertussis (women: 22.9% versus 11.8%; men: 20.3% versus 9.4%). Considerable differences can also be observed in vaccination coverage for measles and influenza; coverage is statistically significantly higher in eastern Germany than in western Germany. In contrast, for hepatitis A, hepatitis B and TBE (TBE data not shown), vaccination coverage is slightly higher in western Germany than in eastern Germany; however, the differences are not statistically significant.

Tab. 4 Vaccination coverage by sex, age group and socioeconomic status in percent with 95% confidence intervals. $n_{unweighted}$=depends on vaccination, see table

		Age group				
Sex/social status	**$n_{unweighted}$**	**18–29**	**30–44**	**45–64**	**65–79**	**Total**
Tetanus						
Women	4041					
Low	644	90.2 (78.6–95.8)	86.8 (74.5–93.7)	92.4 (87.5–95.5)	86.7 (77.8–92.4)	89.2 (85.2–92.2)
Middle	2515	96.5 (92.7–98.4)	98.2 (96.7–99.0)	96.0 (94.2–97.3)	94.5 (91.7–96.4)	96.3 (95.3–97.2)
High	882	99.5 (96.3–99.9)	99.4 (95.9–99.9)	97.0 (93.7–98.6)	97.5 (91.3–99.3)	98.2 (96.7–99.0)
Men	3648					
Low	570	95.7 (86.5–98.7)	89.7 (79.5–95.2)	95.7 (89.9–98.2)	91.0 (82.6–95.5)	93.4 (90.3–95.6)
Middle	2069	98.5 (95.4–99.5)	98.4 (95.7–99.4)	97.2 (95.1–98.4)	95.3 (92.7–97.0)	97.4 (96.5–98.1)
High	1009	100.0 (100.0–100.0)	99.8 (98.5–100.0)	98.7 (96.8–99.5)	98.0 (95.5–99.1)	99.1 (98.4–99.5)
Diphtheria						
Women	3831					
Low	587	84.7 (71.4–92.4)	67.8 (52.7–79.9)	79.8 (71.9–85.9)	65.3 (55.7–73.8)	74.1 (68.9–78.7)
Middle	2395	91.4 (86.4–94.7)	90.2 (86.3–93.1)	85.1 (82.2–87.7)	78.1 (73.8–81.9)	86.0 (84.3–87.6)
High	849	99.4 (96.1–99.9)	93.5 (88.4–96.4)	87.1 (82.3–90.8)	82.1 (70.9–89.6)	90.5 (87.9–92.5)
Men	3348					
Low	521	86.6 (74.4–93.5)	60.1 (46.9–71.9)	64.0 (55.8–71.5)	63.0 (52.1–72.7)	67.8 (62.3–72.8)
Middle	1886	91.1 (85.8–94.5)	84.5 (78.2–89.2)	73.3 (68.9–77.2)	69.7 (64.5–74.4)	78.7 (76.1–81.1)
High	941	95.4 (83.8–98.8)	93.0 (86.8–96.4)	85.0 (80.1–88.8)	79.8 (72.7–85.5)	88.1 (85.2–90.4)
Pertussis						
Women	3791					
Low	596	58.4 (46.8–69.2)	26.8 (16.7–39.9)	24.1 (17.6–31.9)	10.7 (6.5–17.1)	27.4 (23.1–32.1)
Middle	2364	55.6 (48.5–62.6)	54.0 (48.6–59.2)	28.9 (25.0–33.1)	17.1 (13.7–21.2)	37.3 (34.4–40.2)
High	831	64.6 (51.9–75.6)	56.6 (49.1–63.8)	34.4 (28.6–40.8)	23.2 (16.2–32.1)	44.7 (40.4–49.1)
Men	3327					
Low	518	52.6 (40.8–64.2)	34.6 (24.6–46.2)	17.7 (12.3–24.8)	15.8 (8.9–26.4)	28.5 (23.8–33.7)
Middle	1888	58.1 (51.2–64.6)	42.7 (36.4–49.2)	21.8 (18.2–25.9)	13.8 (10.5–18.0)	32.2 (29.1–35.4)
High	921	55.8 (40.3–70.3)	50.9 (42.1–59.7)	26.0 (20.6–32.2)	19.9 (13.9–27.7)	36.7 (31.9–41.7)
Poliomyelitis						
Women	3970					
Low	617	88.2 (76.0–94.6)	72.7 (57.7–83.9)	81.6 (73.2–87.9)	61.3 (52.5–69.4)	74.9 (69.9–79.3)
Middle	2471	95.1 (91.0–97.4)	91.5 (87.4–94.4)	90.8 (88.0–92.9)	79.2 (74.6–83.1)	89.3 (87.5–90.9)
High	882	100.0 (100.0–100.0)	95.1 (89.4–97.8)	94.2 (90.7–96.4)	87.3 (78.6–92.8)	94.6 (92.1–96.3)
Men	3544					
Low	545	92.3 (82.2–96.9)	64.8 (52.7–75.2)	77.9 (70.5–83.9)	54.3 (44.1–64.2)	73.1 (67.8–77.9)
Middle	2010	89.0 (82.9–93.1)	92.9 (88.2–95.8)	84.6 (80.9–87.8)	65.9 (60.2–71.2)	84.0 (81.6–86.2)
High	989	98.4 (94.1–99.6)	97.2 (93.7–98.8)	95.6 (92.8–97.3)	82.2 (75.5–87.3)	94.3 (92.4–95.7)
Influenza						
Women	4070					
Low	651	27.5 (18.8–38.3)	34.5 (23.2–48.0)	48.1 (39.6–56.8)	67.9 (60.2–74.7)	47.9 (43.0–52.9)
Middle	2534	27.2 (22.0–33.1)	29.2 (25.0–33.8)	45.6 (41.2–50.1)	69.8 (64.9–74.3)	43.2 (40.5–46.0)
High	885	23.7 (14.7–35.8)	33.8 (27.2–41.1)	41.3 (34.8–48.1)	65.4 (54.3–75.1)	38.9 (34.7–43.2)
Men	3643					
Low	580	39.2 (27.8–52.0)	32.9 (23.1–44.5)	54.9 (45.8–63.7)	63.2 (51.8–73.3)	48.3 (43.3–53.4)
Middle	2059	35.1 (28.6–42.2)	34.5 (28.6–40.9)	46.4 (41.8–51.1)	67.6 (62.1–72.7)	45.2 (42.2–48.2)
High	1004	25.9 (16.7–38.0)	37.9 (30.4–46.0)	47.1 (40.5–53.8)	71.7 (63.5–78.6)	45.5 (41.1–50.0)

Tab. 4 Vaccination coverage by sex, age group and socioeconomic status in percent with 95% confidence intervals. $n_{unweighted}$=depends on vaccination, see table (Continued)

		Age group				
Sex/social status	**$n_{unweighted}$**	**18–29**	**30–44**	**45–64**	**65–79**	**Total**
Hepatitis A						
Women	3858					
Low	608	25.1 (17.0–35.5)	17.4 (8.5–32.4)	19.0 (13.4–26.3)	8.0 (3.7–16.3)	16.3 (12.9–20.4)
Middle	2400	43.9 (38.1–49.9)	33.5 (28.7–38.8)	23.0 (19.7–26.8)	16.2 (13.1–20.0)	27.9 (25.5–30.4)
High	850	45.7 (33.9–58.0)	47.2 (39.6–54.9)	32.5 (27.5–37.8)	26.0 (18.9–34.5)	38.3 (34.2–42.6)
Men	3433					
Low	546	27.0 (18.0–38.3)	12.9 (7.0–22.7)	9.6 (5.5–16.4)	3.3 (1.4–7.5)	12.6 (9.5–16.4)
Middle	1940	40.8 (34.1–47.9)	30.2 (24.3–36.8)	21.1 (17.8–25.0)	13.0 (10.1–16.6)	25.5 (22.8–28.4)
High	947	61.8 (48.1–73.8)	54.1 (45.8–62.3)	36.6 (31.4–42.2)	29.3 (21.8–38.2)	44.2 (39.7–48.9)
Hepatitis B						
Women	3861					
Low	611	74.8 (62.8–83.9)	20.1 (10.3–35.5)	22.9 (16.4–31.0)	7.5 (4.2–13.2)	28.0 (23.9–32.6)
Middle	2408	77.8 (72.4–82.4)	36.5 (31.5–41.8)	26.6 (23.1–30.4)	11.2 (8.4–14.8)	35.0 (32.6–37.5)
High	842	71.1 (57.6–81.6)	46.0 (38.4–53.8)	29.9 (24.6–35.8)	22.2 (14.7–32.1)	40.2 (36.2–44.4)
Men	3416					
Low	541	55.6 (43.0–67.5)	11.7 (6.2–21.0)	7.5 (4.1–13.3)	4.2 (1.8–9.3)	17.8 (14.1–22.3)
Middle	1930	76.1 (70.0–81.3)	29.5 (24.1–35.5)	19.2 (15.8–23.3)	10.3 (7.7–13.7)	31.2 (28.3–34.1)
High	945	86.9 (76.4–93.1)	49.3 (40.6–58.1)	31.6 (26.2–37.5)	23.9 (17.2–32.2)	43.1 (38.9–47.5)
Measles						
Women	2758					**18–64**
Low	376	82.1 (70.4–89.8)	36.7 (23.7–51.9)	23.6 (17.1–31.5)	n.r.	45.5 (39.4–51.8)
Middle	1708	82.7 (76.7–87.5)	43.7 (38.3–49.2)	14.3 (11.8–17.3)	n.r.	39.3 (36.3–42.3)
High	674	82.0 (69.3–90.2)	45.5 (37.7–53.5)	13.2 (9.1–18.8)	n.r.	37.0 (32.2–42.2)
Men	2303					
Low	356	75.5 (63.4–84.6)	24.8 (16.5–35.3)	20.9 (14.5–29.2)	n.r.	37.6 (31.6–44.0)
Middle	1309	77.3 (69.7–83.5)	37.9 (31.2–45.1)	15.1 (12.1–18.7)	n.r.	37.4 (33.8–41.0)
High	638	78.6 (65.0–87.9)	42.5 (34.5–51.0)	12.7 (8.7–18.3)	n.r.	34.4 (29.6–39.7)
Rubella						
Women	2787					
Low	372	79.6 (68.4–87.5)	32.8 (20.7–47.8)	21.1 (14.3–30.0)	n.r.	43.0 (37.1–49.2)
Middle	1733	80.1 (74.0–85.0)	55.9 (50.2–61.5)	18.5 (15.5–22.1)	n.r.	44.4 (41.5–47.3)
High	682	84.5 (72.4–91.9)	56.9 (49.2–64.2)	15.9 (11.9–20.9)	n.r.	43.3 (39.0–47.7)
Men	2282					
Low	356	66.4 (52.8–77.7)	12.0 (6.6–20.8)	17.1 (11.4–24.8)	n.r.	29.4 (23.8–35.8)
Middle	1295	66.6 (58.9–73.6)	16.9 (12.7–22.1)	10.1 (7.7–13.1)	n.r.	26.2 (23.4–29.3)
High	631	56.2 (41.7–69.7)	15.5 (10.3–22.6)	9.2 (6.2–13.6)	n.r.	18.6 (14.9–23.0)
Pneumococci						
Women	999					**65–79**
Low	220	n.r.	n.r.	n.r.	29.1 (22.3–37.1)	29.1 (22.3–37.1)
Middle	635	n.r.	n.r.	n.r.	36.3 (31.1–41.7)	36.3 (31.1–41.7)
High	144	n.r.	n.r.	n.r.	27.5 (19.7–37.0)	27.5 (19.7–37.0)
Men	939					
Low	150	n.r.	n.r.	n.r.	27.8 (20.2–36.9)	27.8 (20.2–36.9)
Middle	536	n.r.	n.r.	n.r.	29.7 (24.8–35.0)	29.7 (24.8–35.0)
High	253	n.r.	n.r.	n.r.	30.6 (24.0–38.0)	30.6 (24.0–38.0)

n.r. not rectorded.

Tab. 5 Vaccination coverage of at least one vaccination dose by sex, age group and residence in eastern or western Germany (including Berlin) in percent with 95% confidence intervals. $n_{unweighted}$=depends on vaccination, see table

		Age group				
Sex/east–west	**$n_{un-weighted}$**	**18–29**	**30–44**	**45–64**	**65–79**	**Total**
Tetanus in the last 10 years						
Women	4032					
East	1125	81.5 (74.2–87.1)	81.1 (74.1–86.6)	73.7 (68.5–78.3)	87.2 (81.5–91.3)	79.8 (76.6–82.8)
West	2907	72.3 (66.8–77.2)	67.8 (63.4–72.0)	67.3 (63.6–70.8)	69.7 (65.4–73.7)	68.8 (66.7–70.9)
Men	3649					
East	1031	77.0 (68.1–84.0)	71.9 (62.6–79.7)	77.6 (72.2–82.1)	79.4 (72.8–84.8)	76.5 (73.2–79.5)
West	2618	77.4 (71.5–82.4)	70.2 (65.8–74.3)	71.1 (67.8–74.1)	65.8 (60.8–70.5)	71.1 (68.7–73.3)
Diphtheria in the last 10 years						
Women	3792					
East	1068	69.4 (58.4–78.6)	74.2 (65.9–81.1)	64.4 (58.5–69.8)	76.2 (68.3–82.7)	70.2 (66.2–73.9)
West	2724	67.3 (61.7–72.5)	56.1 (51.4–60.7)	55.5 (51.4–59.5)	53.9 (49.2–58.6)	57.4 (54.8–60.0)
Men	3308					
East	977	73.2 (62.6–81.6)	60.1 (51.5–68.0)	57.0 (52.3–61.7)	68.3 (61.5–74.4)	62.9 (59.2–66.5)
West	2331	68.9 (62.3–74.8)	52.2 (47.3–57.0)	47.9 (44.0–51.8)	46.6 (42.0–51.3)	52.6 (49.9–55.3)
Pertussis in the last 10 years						
Women	3766					
East	1054	48.6 (37.9–59.5)	25.3 (18.7–33.2)	17.8 (12.7–24.4)	11.2 (6.3–19.2)	22.9 (18.4–28.0)
West	2712	27.2 (22.4–32.7)	9.9 (7.6–12.7)	8.8 (6.8–11.3)	5.8 (3.8–8.5)	11.8 (10.3–13.4)
Men	3317					
East	964	40.7 (29.1–53.5)	19.5 (13.0–28.2)	11.9 (8.7–16.1)	18.9 (12.6–27.3)	20.3 (16.5–24.7)
West	2353	23.0 (18.2–28.6)	7.7 (5.6–10.7)	5.9 (4.4–8.0)	5.8 (3.8–8.8)	9.4 (8.0–11.1)
Poliomyelitis						
Women	4021					
East	1103	93.1 (83.7–97.3)	90.5 (83.5–94.7)	83.4 (77.8–87.8)	66.9 (54.9–77.0)	82.5 (77.7–86.4)
West	2918	94.5 (90.5–96.9)	89.1 (84.7–92.3)	90.9 (88.2–93.0)	75.7 (71.3–79.6)	88.0 (86.1–89.7)
Men	3594					
East	1017	96.6 (89.8–98.9)	91.0 (84.2–95.0)	83.2 (76.8–88.2)	57.8 (48.7–66.4)	82.4 (77.9–86.0)
West	2577	89.8 (84.9–93.3)	88.7 (84.4–91.9)	86.5 (83.5–89.1)	69.3 (64.3–73.9)	84.6 (82.3–86.6)
Influenza						
Women	4124					
East	1138	55.7 (45.7–65.2)	51.3 (41.6–60.8)	70.5 (64.3–76.1)	82.2 (76.7–86.7)	67.0 (62.7–71.0)
West	2986	22.0 (18.1–26.6)	27.4 (23.3–32.1)	40.0 (36.3–43.9)	65.3 (60.9–69.5)	38.7 (36.5–40.9)
Men	3697					
East	1041	46.9 (36.7–57.4)	45.3 (36.4–54.5)	66.8 (61.5–71.8)	82.0 (76.5–86.4)	61.2 (57.1–65.1)
West	2656	32.0 (26.2–38.4)	33.6 (28.7–38.9)	44.3 (40.0–48.7)	64.5 (59.1–69.5)	42.9 (40.3–45.6)
Hepatitis A						
Women	3909					
East	1090	38.9 (28.6–50.2)	35.4 (28.3–43.2)	20.9 (16.9–25.5)	10.6 (7.2–15.4)	24.3 (20.4–28.7)
West	2819	40.2 (35.4–45.2)	34.1 (29.9–38.6)	25.2 (21.9–28.7)	15.5 (12.4–19.2)	28.0 (25.8–30.4)
Men	3480					
East	992	44.7 (34.6–55.3)	35.1 (27.1–43.9)	18.1 (12.7–25.3)	10.0 (6.5–15.2)	25.0 (20.1–30.8)
West	2488	40.6 (34.9–46.6)	34.1 (29.2–39.3)	23.6 (20.6–26.9)	15.3 (12.3–18.9)	27.8 (25.5–30.2)
Hepatitis B						
Women	3912					
East	1088	83.6 (74.0–90.1)	32.4 (25.0–40.8)	21.7 (18.1–25.8)	8.8 (5.9–13.1)	30.5 (27.3–34.0)
West	2824	75.0 (69.9–79.5)	36.8 (32.3–41.6)	27.7 (24.3–31.4)	11.7 (9.2–14.9)	35.2 (32.8–37.6)
Men	3464					
East	985	80.2 (70.5–87.2)	31.0 (22.7–40.6)	16.1 (11.4–22.3)	6.7 (4.0–11.0)	29.1 (24.8–33.8)
West	2479	71.9 (66.0–77.1)	32.7 (27.8–37.9)	20.9 (17.8–24.3)	12.9 (10.2–16.0)	31.8 (29.3–34.4)

Tab. 5 Vaccination coverage of at least one vaccination dose by sex, age group and residence in eastern or western Germany (including Berlin) in percent with 95% confidence intervals. $n_{unweighted}$=depends on vaccination, see table (Continued)

		Age group				
Sex/east–west	**$n_{un-weighted}$**	**18–29**	**30–44**	**45–64**	**65–79**	**Total**
Measles						
Women	2791					
East	774	90.4 (80.0–95.7)	73.9 (66.8–80.0)	25.2 (20.7–30.3)	n.r.	53.4 (48.2–58.5)
West	2017	80.7 (75.7–84.9)	36.5 (31.6–41.7)	13.5 (11.0–16.4)	n.r.	36.7 (34.0–39.5)
Men	2322					
East	656	92.1 (86.1–95.7)	67.8 (59.2–75.4)	28.6 (23.2–34.7)	n.r.	54.3 (50.1–58.5)
West	1666	74.0 (67.6–79.6)	31.4 (26.7–36.6)	12.6 (9.9–15.9)	n.r.	33.0 (30.1–36.0)
Pneumococci						
Women	1015					
East	301	n.r.	n.r.	n.r.	57.9 (50.5–64.9)	57.9 (50.5–64.9)
West	714	n.r.	n.r.	n.r.	27.2 (22.9–32.0)	27.2 (22.9–32.0)
Men	965					
East	292	n.r.	n.r.	n.r.	49.7 (41.7–57.7)	49.7 (41.7–57.7)
West	673	n.r.	n.r.	n.r.	24.6 (20.4–29.2)	24.6 (20.4–29.2)

n.r. not recorded.

Vaccination coverage in Germany over time

Vaccination coverage recorded in DEGS1 regarding at least (any) one vaccination within the last 10 years increases from 70.1% (68.3–71.9) to 83.6% (82.3–84.8) compared to the values determined in GNHIES98 (**Tab. 6**). The significant increase in the proportion of adults who were vaccinated in the decade prior to each survey is due to significantly increased vaccination coverage in 40–79 year olds. In all age groups, the percentage of adults who have received a tetanus vaccination within the last 10 years improved; the biggest increase can be seen in over 69 year olds.

The clear increase in vaccination coverage against tetanus in 50- to 79-year-old women offsets the gender difference observed 10 years ago. Vaccination coverage for diphtheria has also increased significantly; here the greatest increase can be observed in the youngest age group. Ten years ago, vaccination coverage tended to be higher in men than in women, but this trend has now been reversed: today, women are significantly more likely to be vaccinated against diphtheria than men. The reversal of this relationship is due to a 67% increase among 30- to 39-year-old women (40–49 year olds: 74%).

Discussion

Tetanus

Tetanus (lockjaw) is a potentially fatal disease caused by a bacterium found mainly in soil that can lead to infection following minor injuries to the skin [17]. The vaccination recommendations for tetanus have remained unchanged for many years and primary immunisation is recommended during infancy. In childhood and adolescence, two booster vaccinations are recommended and, in adulthood, a booster shot should be administered every 10 years [18].

Lifetime prevalence for tetanus vaccinations in DEGS1 is over 95%, yet only 71.4% of 18–79 year olds have currently adequate immunisation against tetanus. Across all age groups there is an association between lower vaccination coverage and lower SES. As was the case more than a decade ago, vaccination coverage is better among younger adults than in the higher age groups. Vaccination coverage in eastern Germany 20 years after reunification is also considerably higher than in western Germany. However, the general development of tetanus vaccination coverage is favourable. The proportion of adults currently adequately vaccinated against tetanus today is 10 percentage points higher than in the years 1997–1999 in GNHIES98 [19]. Older adults in particular are better protected against tetanus today than 10 years ago. More adults in Germany are vaccinated against tetanus than in other European countries (for example France 62.3% [20], Spain 60–80% [21] and the USA 61.6%). Like in Germany, the American data also show that vaccination gaps increase with age: 64.0% of 19–49 year olds received a tetanus vaccination within the past 10 years, but the figure for over 64 year olds is only 53.4% [22].

Pertussis

Pertussis is a highly contagious bacterial disease caused by a toxin-producing bacterium that presents a particularly serious threat to the health of infants and young children [23]. Young infants cannot be sufficiently protected by vaccinations due to their age but at the same time they are particularly endangered by whooping cough. Preventive vaccination is not only of crucial importance for infants, but also for older children and adults [24]. General pertussis vaccination of all infants and small children has been recommended by STIKO since 1991. In the German Democratic Republic (GDR), the whooping cough vaccination was compulsory from 1964, whereas in the Federal Republic of Germany (FRG) this vaccination was only

Tab. 6 Comparison of vaccination coverage of at least one vaccination dose from DEGS1 and GNHIES98 by sex and age in percent with 95% confidence intervals (both studies weighted to the age structure as of 31 Dec 2010). $n_{unweighted}$=depends on vaccination and study, see table

		Age group						
Sex	$n_{un-weighted}$	18–29	30–39	40–49	50–59	60–69	70–79	Total
DEGS vaccinated in the last 10 years (any vaccination)								
Women	4043	89.1 (85.4–91.9)	76.7 (71.2–81.4)	82.6 (79.2–85.6)	79.6 (75.9–82.9)	84.5 (80.8–87.6)	85.1 (80.9–88.4)	83.0 (81.2–84.6)
Men	3637	89.6 (85.4–92.7)	82.3 (77.2–86.4)	80.7 (76.7–84.1)	84.3 (81.0–87.2)	84.8 (81.5–87.7)	82.9 (78.1–86.7)	84.2 (82.3–85.8)
Total	7680	89.3 (86.8–91.4)	79.5 (75.8–82.7)	81.7 (79.2–83.9)	82.0 (79.5–84.2)	84.6 (82.2–86.8)	84.1 (81.0–86.7)	83.6 (82.3–84.8)
DEGS tetanus in the last 10 years								
Women	4032	73.7 (68.8–78.0)	66.6 (61.1–71.6)	70.9 (66.7–74.8)	69.4 (65.4–73.1)	71.5 (67.1–75.6)	71.8 (67.1–76.1)	70.7 (68.8–72.6)
Men	3649	77.4 (72.2–81.8)	70.6 (64.8–75.7)	71.2 (66.6–75.4)	71.7 (67.6–75.4)	72.1 (67.7–76.1)	67.4 (61.8–72.5)	72.0 (70.0–74.0)
Total	7681	75.6 (71.8–78.9)	68.6 (64.4–72.4)	71.1 (67.9–74.0)	70.5 (67.6–73.3)	71.8 (68.4–75.0)	69.8 (66.2–73.2)	71.4 (69.8–72.9)
DEGS diphtheria in the last 10 years								
Women	3792	67.6 (62.6–72.3)	55.4 (49.9–60.8)	61.0 (56.0–65.8)	57.1 (52.7–61.4)	59.1 (54.6–63.5)	55.7 (50.1–61.2)	59.6 (57.3–62.0)
Men	3308	69.6 (63.9–74.8)	54.3 (48.4–60.0)	52.5 (46.9–58.1)	48.4 (44.1–52.7)	50.5 (45.6–55.4)	49.8 (44.4–55.2)	54.5 (52.1–56.8)
Total	7100	68.6 (64.9–72.1)	54.9 (50.9–58.8)	56.8 (52.8–60.7)	52.8 (49.8–55.8)	55.0 (51.5–58.4)	53.0 (49.2–56.9)	57.1 (55.3–58.9)
GNHIES98 vaccinated in the last 10 years (any vaccination)								
Women	3612	83.4 (79.6–86.7)	74.5 (71.0–77.7)	65.9 (61.7–69.8)	62.9 (58.2–67.4)	62.0 (56.4–67.2)	59.9 (52.5–66.9)	68.3 (66.0–70.4)
Men	3351	88.9 (85.7–91.5)	78.7 (74.4–82.4)	69.6 (65.2–73.7)	67.2 (62.5–71.6)	64.9 (59.2–70.2)	58.6 (50.7–66.1)	72.1 (69.9–74.1)
Total	6963	86.2 (83.6–88.4)	76.6 (73.8–79.3)	67.8 (64.7–70.8)	65.1 (61.5–68.5)	63.4 (59.0–67.6)	59.3 (53.5–64.8)	70.1 (68.3–71.9)
GNHIES98 tetanus in the last 10 years								
Women	3554	75.9 (71.5–79.8)	66.7 (62.7–70.4)	59.5 (55.3–63.6)	54.4 (49.9–58.7)	49.1 (43.5–54.6)	37.6 (30.9–44.7)	57.9 (55.7–60.0)
Men	3295	84.7 (80.9–87.9)	75.2 (70.6–79.3)	63.9 (59.4–68.1)	60.5 (55.4–65.4)	57.5 (51.9–62.9)	46.1 (38.6–53.8)	65.6 (63.3–67.9)
Total	6849	80.2 (77.4–82.8)	71.0 (67.9–74.0)	61.7 (58.6–64.8)	57.4 (53.8–60.9)	53.2 (48.8–57.5)	41.4 (36.2–46.8)	61.7 (59.8–63.6)
GNHIES98 Diphtheria in the last 10 years								
Women	3423	25.3 (20.9–30.2)	33.6 (29.3–38.1)	35.2 (31.0–39.8)	37.4 (33.1–41.9)	43.7 (39.0–48.5)	47.5 (41.1–54.1)	36.8 (34.7–38.9)
Men	3047	35.3 (30.4–40.7)	41.7 (37.1–46.5)	40.3 (35.5–45.3)	41.8 (37.7–46.0)	43.2 (37.7–48.9)	46.1 (38.0–54.3)	41.2 (38.7–43.8)
Total	6470	30.0 (26.4–33.9)	37.7 (34.3–41.1)	37.8 (34.4–41.2)	39.5 (36.4–42.7)	43.5 (39.6–47.4)	46.9 (41.5–52.3)	38.9 (37.1–40.8)

recommended from 1969–1974. After this, the vaccination was only recommended for particular risk groups among children under 2 years of age. After increasing incidence of pertussis was observed, above all among adolescents and young adults, STIKO recommended a pertussis booster vaccination in 2000 for children and adolescents aged 9–17 years. Due to the limited duration of immunity achieved by the vaccination of around 4–12 years [25], an additional booster vaccination was recommended in 2006 for children aged 5–6 years old. The STIKO had decided in 2004 to expand the indication for a preventative pertussis vaccination, according to which persons with close contact to infants were to be vaccinated against pertussis (before birth of the child if possible). In 2009 an additional pertussis vaccination in adulthood with a combination vaccine including tetanus and diphtheria was recommended at the next due tetanus–diphtheria vaccination [26].

The estimated vaccination coverage in adults (34%) shows that pertussis vaccination protection is still insufficient in Germany. In light of the limited duration of immunity against pertussis both after vaccination as well as after having had pertussis, the low 10-year prevalences (women 13.7%, men 11.4%) in particular underline the unsatisfactory situation in Germany; this shortcoming is significantly more pronounced in western Germany than in eastern Germany. When interpreting the results, however, it must be considered that the additional recommendation of a vaccination for all adults was only made in 2009 and that implementation is scheduled gradually in the context of due booster vaccinations against tetanus and diphtheria.

A pertussis vaccination for adults is currently only recommended in a few countries (Australia, Canada, USA, France and Germany) [24]. Data regarding vaccination coverage achieved in adults to date are available only on a very limited scale. Two years after the Advisory Committee on Immunization Practices (ACIP) in the USA issued the recommendation that all adults should receive a pertussis vaccine with their next tetanus vaccination, the results of the National Immunization Survey in 2007 showed that the proportion of pertussis vaccines combined with tetanus vaccines was only 20.7% [27]. However, the proportion of pertussis vaccines combined with tetanus vaccines increased significantly in the following years and averaged 52.1% in surveys conducted from 2005–2008 [28].

Influenza

Seasonal influenza (flu) is an acute viral infection that appears among the population of the northern hemisphere almost every winter in clusters lasting several weeks, known as the influenza wave. Because influenza viruses are highly vari-

able, one single immunisation is not sufficient. STIKO recommends an annual influenza vaccination with a vaccine adapted to the circulating viruses for, amongst others, persons over 60, persons with chronic diseases and persons at higher risk due to occupational exposure [18]. In 2003, the WHO laid down a target vaccination coverage of 75% for older persons and the chronically ill by 2010 [29].

Although the lifetime prevalence for flu vaccinations in DEGS1 stratified by age shows that vaccination coverage is higher in older men as compared to younger men, even the lifetime prevalence among adults over 60 is far below the annual rate of 75% recommended by the WHO. In eastern Germany, the proportion (82%) of 70–79 year olds who have been vaccinated against influenza in the past suggests that the figure is likely approaching the WHO target. Vaccination coverage for influenza in all age groups is higher in eastern Germany than in western Germany and this indicates significantly greater acceptance of vaccinations by the population in those regions.

The lifetime prevalence of influenza vaccination of 44.7% among 18–79 year olds recorded in DEGS1 is considerably lower than the result (55.2%) of a telephone survey on vaccination coverage among over 13 year olds in Germany conducted in 2006/2007 with 2,007 respondents [30]. However, with figures of 63.3% among 60–69 year olds and 68.3% among 70–79 year olds, the proportion of over 59 year olds who have received at least one influenza vaccination is significantly higher than found in the survey of influenza vaccinations in GEDA (German Health Update, annual telephone surveys at the Robert Koch Institute) based on the previous season (2007/2008: 56.6%; 2008/2009: 55.2%). Although the vaccination coverage recorded in DESG1 indicates a somewhat higher general acceptance of the flu vaccination among the elderly in particular, the differentiated evaluations from GEDA studies regarding vaccinations in the previous flu season show that the recommendation to repeat flu vaccinations annually is not being implemented satisfactorily [31]. In a comparison with France, Italy, Spain and Great Britain, the recommendation that older men and women in particular should be vaccinated against influenza seems to be implemented worst of all in Germany [30]. The discrepancy between the rate of influenza vaccinations planned by respondents for the next season and the vaccination rates subsequently recorded is particularly high in Germany [32]. In Germany, like in other countries, medical consultation is of great importance for positive vaccination decisions [31, 33, 34]. However, a survey of doctors' practices carried out in 2009 shows that only two thirds of them motivate high-risk patient groups to receive the influenza vaccination [35]. A similar survey of American physicians in 2001 showed that more than three in four doctors recommend an influenza vaccination [36].

Methodology

The vaccination rates reported here are based on vaccinations documented in the vaccination card as well as self-reported vaccinations; the information is therefore based on multiple sources. The reason for this approach was that self-reported vaccination data are subject to recall bias, which can lead to both over- and underestimation. Strength and direction depend on the type of surveyed vaccination [37, 38, 39]. On the other hand, vaccinations of adults in particular are often not fully documented in the vaccination card (follow-up documents, lost vaccination cards, vaccinations documented only on notes or at the doctor's practice/hospital). Therefore, in a survey based only on vaccination cards, underestimation would be likely. In DEGS1, incomplete vaccination documentation among older adults in particular meant that additional, self-reported vaccinations were taken into account. This approach led to higher vaccination coverage than would have been obtained solely through an evaluation of vaccination cards; this was particularly significant for influenza vaccination coverage.

The methodological approach to collecting data for vaccination coverage in DESG1 was therefore motivated by the attempt to guarantee the highest sensitivity possible ("missing" no vaccinations) on the one hand while ensuring the validity of data on the other. The proportion of participants for whom it was possible to survey vaccination status based solely on medically documented vaccinations was 40.8%. This figure is lower than in a Dutch study where either validation using vaccination cards or verification via regional vaccination centres was possible for 68% of participants [40].

The proportion of missing information or "Don't know" answers can also provide valuable information concerning the validity of the recorded data. With regard to pertussis vaccination status, no data could be obtained in DEGS1 for 11% of adults; almost all missing information concerns adults whose vaccination status was requested in CAPI interviews. Similar problems with self-reported pertussis vaccinations were observed in the National Health Interview Survey (NHIS) when surveying adults in the USA. Of persons who declared that they had received a tetanus vaccination in the years 2005–2008, 69.8% could not specify whether this vaccine contained a pertussis component [28].

On the other hand, differences in vaccination coverage between participants who submitted a vaccination card and those whose vaccination status is based on self-reported data can be due to real differences between the groups: seroepidemiological studies on the prevalence of IgG antibodies against measles in children with and without vaccination cards showed lower vaccination coverage in children for whom no vaccination card was brought to the examination [41].

The comparison with data from telephone studies in GEDA 2009 gives no indication of differences in vaccination coverage rates due to methodology. The data for lifetime prevalence of tetanus vaccination obtained in DEGS1 via the multimode process (96.0%) show comparatively high coverage, as was the case in GEDA 2009 (95.4%) [31]; the 10-year prevalence in DEGS1 (71.4%) is only slightly lower compared to GEDA 2009 (73.1%) [42].

Conclusion

The current vaccination status of adults for tetanus and diphtheria is better than

10 years ago, yet 28.6% of the population are still without up-to-date protection against tetanus and 42.9% have not received a diphtheria vaccination within the last 10 years. Among older women and men in particular, but also in the 30- to 39-year-old age group, there are vaccination gaps which require increased efforts to check vaccination protection and motivation towards vaccinations. Vaccination coverage against pertussis is particularly low in western Germany. An increase in vaccination coverage is expected as a result of the recommendation (in place since 2009) to vaccinate against pertussis at the same time as the next due tetanus booster vaccination. However, the experiences in the USA of implementing such a recommendation suggest that a marked increase is not to be expected 2 years after the recommendation. Compared to the annual influenza vaccination rates found by GEDA, the proportion of women and men who have received an influenza vaccination at least once in their life is higher in DEGS1. In view of European studies showing that the discrepancy between intended and actual influenza vaccination in Germany is particularly large, an increase in annual vaccination rates therefore appears possible and is of particular importance for the influenza vaccination target groups defined by STIKO.

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