Seasonal influenza vaccine uptake in Germany 2007/2008 and 2008/2009: Results from a national Health Update Survey

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Abstract

In 2008/09 a nationwide cross-sectional telephone survey was conducted to assess, among other health-relevant parameters, seasonal influenza vaccination coverage. Data from 21,262 household-interviews representative of the adult population in Germany were collected and analyzed. In seasons 2007/2008 and 2008/2009, vaccine uptake in individuals aged ≥60 years was 57% and 55% and in individuals with underlying chronic diseases 44% and 42%. Living in the eastern part of Germany, higher age, and medium household income level were independently associated with higher vaccine uptake in both target groups. Healthcare workers were significantly less frequently (21.9% in 2007/2008; 20.4% in 2008/2009) vaccinated than the general population (30.8% and 28.1%). Special effort must be undertaken to develop immunization strategies for improved vaccine uptake in target groups, especially in healthcare workers.

Keywords: *vaccination, coverage, influenza, Germany*

1. Introduction

Influenza is considered a major cause of morbidity and mortality worldwide. The World Health Organization (WHO) estimates that influenza epidemics result in three to five million cases of severe illness, and about 250,000 to 500,000 deaths worldwide annually [1]. Influenza-related hospitalizations and fatal cases mainly occur among high-risk groups: in the very young, elderly, and chronically ill. In industrialized countries most influenza-associated deaths occur among people over 65 years of age [1]. Annual vaccination constitutes the most effective method to reduce the burden of influenza disease. Among healthy adults (aged 16-65 years), parenteral influenza vaccines are 80% efficacious against influenza when there is a good match between the vaccine components and the circulating virus strains [2]. However, the effectiveness of the vaccine depends also on the age and immunocompetence of the individual vaccinee [3]. Even though technically feasible, the control of influenza through vaccination poses a great challenge to public health authorities. Current seasonal influenza vaccines, which usually contain three virus subtypes, have to be adjusted annually in order to protect against the virus strains expected to circulate in the upcoming season. Consequently, people at risk as well as everyone who would like to minimize his or her risk of getting infected with influenza have to be reminded of their seasonal influenza shot every year. Furthermore, they need be motivated to actually receive it, and access to vaccination needs to be ensured.

In Germany, an estimated one to five million additional physician consultations are attributable to influenza virus infections during an average influenza season [4]. In seasons with high influenza-activity (e.g. season 1995/1996) it is estimated that there are up to 30,000 excess deaths attributable to influenza [5, 6]. The German Standing Committee on Vaccination (STIKO) currently recommends seasonal influenza vaccination for the following target groups: (1) persons aged ≥60 years, (2) persons with an underlying chronic disease, (3) persons living in nursing or old people's homes, (4) persons with an increased professional

risk (e.g. persons who work in the medical sector), and (5) pregnant women [7]. The vaccination of people belonging to these target groups is free of charge in Germany. Vaccines are usually administered by private physicians, and reimbursement is provided to these physicians by the statutory health insurance fund [8]. In addition, a small but not quantifiable proportion of influenza vaccinations is administered by occupational health physicians.

Since 2006, nation-wide seasonal influenza vaccination campaigns are conducted in Germany each season [9]. Unlike other European countries such as Norway, Belgium, and the Netherlands, Germany has no central immunization register [10]. With the implementation of the 'German Health Update' Survey (GEDA) in 2008, a monitoring tool is now available in Germany for the detailed assessment of vaccination coverage in all age-groups above 18 years. GEDA is a large, population-representative telephone-survey, which is planned to be conducted in Germany on a regular basis. Here we present results from GEDA 2009 with focus on influenza vaccination coverage in the general population and in specific target groups as recommended by STIKO for influenza seasons 2007/2008 and 2008/2009.

2. Methods

2.1. Study population

Germany has a population of approximately 82 million people, of which 68.3 million (83.3%) are 18 years of age or older (Table 1) [11]. A total 65.5 million live in the 10 Western Federal States (WFS) and 16.5 million live in the 6 Eastern Federal States (EFS) [12]. Our study population included persons ≥18 years of age living in private households in Germany and who were able to be contacted by landline telephone. According to the federal network agency there were 38.9 million landline telephones registered in Germany in 2009 [13]. Criteria for exclusion were age ≤17 years or insufficient knowledge of German language.

2.2. Survey design

Data on influenza vaccination coverage in Germany was collected within the framework of the national telephone health survey GEDA 2009. GEDA is a cross-sectional survey which is part of Germany's nationwide health monitoring. The survey was conducted for the first time between July 2008 and June 2009 and is planned to be carried out on a regular basis in the future. Data acquisition was conducted via computer-assisted telephone interview (CATI) by trained interviewers. The Gabler/Häder sampling design and the last birthday method were used to ensure representativeness [14;15]. Moreover, weighting factors were used in order to make the study population comparable to the general population in Germany. The weighting factors were constructed by taking age, gender, educational status, geographic region, community size and household size into consideration. If not indicated otherwise, all data presented in this paper are weighted data. Response rates were calculated using Response Rate 3 as defined by the American Association for Public Opinion Research (AAPOR) [16]. Response Rate 3 is defined as the number of complete interviews divided by the number of interviews plus the number of non-interviews plus cases of unknown eligibility.

Response Rate 3 estimates what proportion of cases of unknown eligibility is actually eligible. The cooperation rate at respondent level is defined as the proportion of all cases interviewed of all respondents ever contacted. This rate is calculated using only contacts with and refusals from known respondents [16].

The study protocol of the GEDA survey was approved by Germany's federal and regional data-protection commissioners. All data were collected and analyzed in an anonymous manner.

2.3. Definitions

Between 15th of July 2008 and 31st of March 2009 survey participants were asked if they had received an influenza vaccination in the last influenza season 2007/2008. Between 1st of January 2009 and 5th of June 2009 interviewees were asked if they had received an influenza vaccination in season 2008/2009. Accordingly, persons interviewed between January and March 2009 were asked to provide information on their vaccination status for two seasons.

Persons were classified into target groups if they reported (1) to be ≥60 years of age, (2) to have underlying chronic diseases (chronic underlying respiratory, cardiovascular, liver or renal diseases, cancer or diabetes), or (3) to work as a HCW (e.g. physicians, dentists, nurses, geriatric nurses, midwives, pharmacists, opticians, occupational therapists, physiotherapists, radiographers, ambulance workers). If a person fell e.g. into two categories, his or her data were analysed in both target groups. The recommendation to vaccinate pregnant women in Germany was endorsed by STIKO in August 2010; therefore they were not regarded as a target group during the conduct of this survey. Due to study design, persons living in nursing or old people's homes, for whom influenza vaccination is also recommended by STIKO, were only included in the survey if they could be reached by landline telephone.

Participants of GEDA 2009 were not asked if they live in such a home. Therefore persons living in a nursing or old people's home could not be analyzed as a separate target group. Classification into the different education levels was based on the International Standard Classification of Education (ISCED 97) as suggested by the United Nations Educational, Scientific and Cultural Organization (UNESCO) [17]. The educational status 'low' comprised ISCED 97 levels 1 and 2, 'medium' comprised levels 3 and 4, and 'high' comprised levels 5 and 6. To allow comparability among the interviewed persons, household income was adjusted for household size and age of household members by calculating the net equivalent income according to the Organisation for Economic Co-operation and Development (OECD)-modified equivalence scale method [18]. A net equivalent income <70% of the median net equivalent income in the study sample was classified as 'low', those between 70% and 120% of the median as 'medium', and those >120% of the median as 'high'.

2.4. Statistical analysis

Statistical analysis was performed using PASW version 18.0 for Windows (SPSS Inc., Chicago, USA) and EpiInfo version 3.5.1 for Windows (Centres for Disease Control and Prevention, Atlanta, USA). Univariate analyses were performed by using the complete or a stratified data set. Bivariate associations of categorical variables were assessed by using Pearson's Chi-square test. A two-sided p-value <0.05 was considered to indicate a statistically significant difference. Odds ratios (OR) and 95% confidence intervals (CI) were calculated as appropriate. Multivariate analysis was performed by using logistic regression models. Age, sex, and all variables identified in univariate analysis to be potentially associated with influenza vaccination (i.e. p-value <0.2) were included in the first step of the multivariate analyses. Thereafter we removed non-significant independent factors (i.e. p-value ≥0.05) from regression models in a stepwise backward fashion to produce final models.

3. Results

3.1. Sample characteristics

The response rate in GEDA 2009 was 29.1% and the cooperation rate at respondent level was 51.2%. In total, 21,262 persons were interviewed during the study period. Of these, 50.1% (95%CI: 49.3-51.0%) belonged to one of the three target groups. Prevalence of the different chronic diseases was as follows in the study population (n=21,262): Chronic respiratory diseases 14.1% (95%CI: 13.5-14.7), cardiovascular diseases 11.0% (95%CI: 10.4-11.6), diabetes 8.8% (95%CI: 8.2-9.4), cancer 6.9% (95%CI: 6.5-7.4), chronic liver diseases 2.3% (95%CI: 2.0-2.6), and chronic renal diseases 2.3% (95%CI: 2.0-2.6). Among persons with underlying chronic diseases (n=6,959), 22.1 % (95%CI: 20.7-23.5) stated to suffer from two, and 7.0 % (95%CI: 6.1-8.0) from three or more different underlying chronic diseases.

Of the 21,262 persons included in the survey, 15,552 persons were interviewed to assess vaccination coverage for influenza season 2007/2008, and 12,685 persons were interviewed to assess vaccination coverage for 2008/2009. Mean age was 48.2 years in the first and 49.3 years in the second sub-sample. An overview of the adult population in Germany and the two study sub-samples is given in Table 1 and does not reveal any statistically significant difference in the distribution of demographic characteristics.

3.2. Influenza vaccination coverage in the general population

Influenza vaccination status was available for 15,498 interviewed persons (99.7%) of the study population for season 2007/2008 and for 12,577 persons (99.1%) of the study population for season 2008/2009. Vaccination coverage of the general population and the target groups by sex and residency is presented in Table 2. Among persons not belonging to one of the target groups the proportion vaccinated was 13.6% (95%CI: 12.6-14.7) in the first and 18.3% (95%CI: 17.2-19.4) in the second season. In both seasons people living in the

WFS were significantly less frequently vaccinated than people living in the EFS ($p<0.001$). Vaccination coverage increased with age and was highest in persons 70 years or older (Fig.1).

3.3. Influenza vaccination coverage by target group

3.3.1. Influenza season 2007/2008

7648 persons (49.2%) of the 2007/2008 sub-sample belonged to at least one target group. Of these, 43.7% (95%CI: 42.2-45.3) were vaccinated against seasonal influenza. Vaccination coverage by target group, sex, and residency is presented in Table 2.

Among persons ≥60 years, 53.3% also had an underlying chronic disease. Those had a vaccination coverage of 62.6% (95% CI: 59.7-65.4). To allow comparability with international studies, vaccination coverage was also calculated for persons aged ≥65 years which revealed a coverage rate of 61.1% (95%CI: 58.6-63.5).

A total 4973 (32.0%) of the 15,552 interviewed persons reported to have an underlying chronic disease. Influenza vaccination coverage in this target group was 43.8% (95%CI: 41.9-45.7). Table 3 shows vaccination coverage in persons with different chronic underlying diseases by age-group. When compared with persons not having underlying chronic diseases or working in the medical field, the presence of each underlying disease was strongly associated with vaccination in the ≥60 year-old age-group except underlying chronic liver diseases and diabetes mellitus. Independent from age, highest coverage was usually found in patients with diabetes and with chronic renal disease. In the 18-39 year-old age-group, having cancer and chronic liver disease did not seem to have an influence on the influenza vaccination status (Table 3).

Among the different subgroups of HCWs, vaccination coverage was highest in physicians (including dentists): 29.0% (95%CI: 21.1-38.5). Physicians accounted for 10.6% of HCWs. HCWs working in a nursing profession accounted for 69.0% of persons in this target group. Of these, 21.6% (95%CI: 18.3-25.3) were vaccinated against seasonal influenza.

3.3.2 Influenza season 2008/2009

6427 persons (50.7%) of the sub-sample for influenza season 2008/2009 belonged to at least one target group. Of these, 42.2% (95%CI: 40.5.4-44.0) were vaccinated against seasonal influenza. Vaccination coverage of the different target groups are shown in Table 2. The proportion vaccinated was 61.1% (95% CI: 58.0-64.2) in persons aged ≥60 years with underlying chronic diseases (prevalence 55.2%) and 48.0% (95%CI: 44.5-51.5) in those without an underlying chronic disease. Vaccination coverage in the ≥65 year age-group was 59.2% (95%CI: 56.5-61.8).

3.4. Analysis of factors potentially associated with vaccine uptake in target groups

As differences in vaccination coverage were marginal between seasons, univariate and multivariate analysis of factors potentially influencing influenza vaccine uptake in target groups was performed by using the complete data set (n=21,262). Results of the analysis are presented in Table 4. Living in the EFS, older age, and medium household income level were independently associated with higher vaccine uptake in persons with an underlying chronic disease and in persons ≥60 years of age (Table 4). In the latter group, belonging to more than one target group was identified as an additional factor associated with vaccine uptake and increased the odds of being vaccinated by 58%. In HCWs only residency remained a significant factor in multivariate analysis. Multivariate analysis revealed no significant association between educational status and influenza vaccination coverage in any of the target groups.

4. Discussion

The World Health Assembly (WHA) has embarked on the goal of attaining influenza vaccination coverage of at least 75% in the elderly population by 2010 [19]. Here we present vaccination coverage data from two influenza seasons in Germany, which were collected in the general adult population as well as in high-risk and other target groups by interviewing a large population-representative sample. Vaccination coverage in the target groups remained low, especially among persons with underlying chronic conditions (~42%) and HCWs (~21%). With a vaccination coverage of approximately 56% in persons 60 years and older, the WHA-goal has not yet been reached in Germany by 2009.

A stagnant influenza vaccination coverage can be observed in Germany since 2005, despite the implementation of annual national influenza campaigns in 2006. Telephone surveys conducted among approximately 2000 participants per season revealed a vaccination coverage in the chronically ill of 29% in 2003/2004, 27% in 2004/2005, 26% in 2006/2007 and 27% in 2007/2008 [20, 21]. The same surveys revealed also stagnant vaccination coverage among HCWs, persons ≥60 years, and in the general adult population [20, 21]. In 2005/2006 influenza vaccination coverage was, however, higher in the examined groups (persons with underlying diseases: 35%) [21]. This might have been a result of an intensive reporting on avian influenza in the media during that year [21].

Multivariate analysis of potential factors as well as analysis of vaccination coverage stratified by type of chronic underlying condition revealed that STIKO-recommendations are not effectively implemented in the younger age groups. It can be assumed that these groups have less frequent contact to their family doctor who could remind them about the vaccination. Further research is needed to explore the reasons for low vaccine uptake in these groups and to identify better access paths to vaccination.

Previous studies have consistently found that acceptance of annual influenza vaccination is considerably higher in the EFS [22, 23]. Significantly higher vaccination

coverage was also found in our study participants living in the EFS, both in the general population and in the target groups examined. The reasons for higher vaccination coverage in the EFS are complex and not adequately investigated yet. One reason may be that – although reunification of East and West Germany took place over twenty years ago – mandatory vaccination practices in the former German Democratic Republic still influence today's general attitude and behaviour towards vaccinations in the EFS [22, 24]. Moreover, differences in vaccination policies on federal state level can be observed between the eastern and western states. For example, the eastern federal state of Saxony-Anhalt is currently the only state in Germany that established a state level immunization registry to assess complete vaccination data of the total federal childhood population below 8 years of age [10].

Similar to previous studies surveying influenza vaccination coverage in Germany [21, 23, 25-28], the lowest coverage in our study was found in HCWs. Coverage among HCWs was even significantly lower than in the general adult population. These findings are of special concern. First, due to their profession HCWs are more likely to be exposed to influenza-patients. Second, if infected they can serve as a source of infection to their unvaccinated patients, who might have underlying chronic diseases that put them at higher risk for severe influenza disease. And most importantly, HCWs can be regarded as important multipliers for the implementation of vaccinations in high risk groups. HCWs do not only have the expertise in vaccine-related topics, but due to their profession they also have access to high risk groups and can often influence the attitude of their patients towards vaccinations.

New approaches to enhance vaccine uptake among HCWs in Germany are currently discussed [29]. Low vaccination coverage among HCWs has been observed not only in Germany but also in several other European and non-European countries [30-39]. Based on data gathered in the Spanish National Health Survey in 2006, vaccination coverage among HCWs in Spain was reported to be 24.2% (95%CI 20.7-28.3) [35]. A cross-sectional study carried out in 2006 in a large multidisciplinary University hospital in Italy found a vaccination

coverage of 20.2% among HCWs [32]. Vaccination coverage in US HCWs, which was based on the findings of a population-based panel survey, was with 61.9% (95%CI 57.5-66.2%) considerably higher [31]. It should be mentioned that the definition of "healthcare worker" may vary in these studies.

Vaccination coverage among persons ≥60 years of age was approximately 55% in both seasons and was therefore below the WHA-goal of attaining a vaccination coverage of 75% in the elderly by 2010. Vaccination coverage in the EFS (~70%) was much closer to the WHA-goal than in the WFS (~50%). The United Kingdom (UK), where in the annual vaccine uptake survey a coverage of 73.5% was found for influenza season 2007/2008, seems to be currently one of the few European countries that are close to the WHA-goal [40]. In a comparative study, Blank et al. assessed influenza vaccination coverage in influenza season 2007/08 in the five most populous EU-member states (Germany, UK, Italy, France and Spain). In the general population, Germany reached the second highest vaccination coverage (28.1%) [20]. In specific target groups, however, Germany revealed the lowest coverage in the elderly (Germany 48.7% vs. UK 70.2%) and in persons with underlying chronic diseases (Germany 26.5% vs. UK 56.0%) [20]. The findings of Blank et al. as well as our findings indicate that vaccination campaigns in Germany fail to reach high-risk and other target populations for which the influenza vaccination is recommended.

While the vaccination coverage in the general population in Germany 2007/2008 assessed by Blank et al. was similar to that found in our study [20], vaccination coverage in the target groups diverged significantly from our findings. Vaccination coverage in persons ≥65 years of age (48.7% vs. 61.1%) and in persons with underlying chronic conditions (26.5% vs. 43.8%) was considerably lower than in our study population. However, it should be noted that our study sample was with over 15,000 interviewed persons more than seven times larger than the study sample examined by Blank et al. [20] and can therefore possibly be regarded as more representative especially in smaller subgroups.

Our study has several limitations. Vaccination status and chronic underlying disease status were self-reported by the survey participants and, as the survey was anonymous, could not be verified by any medical record documentation. However, self-report of influenza vaccination status has been previously found to have an adequate degree of reliability [41, 42], and we only asked for influenza vaccinations in the previous one or two seasons. Only telephone landlines were used in the GEDA-Survey. Consequently, people using exclusively a mobile phone were not included in this study. Mobile phone numbers were not used because they cannot be randomly selected easily and do not allow any regional mapping in Germany. Due to the fact that many mobile phone users have an additional landline number, it is very likely that this group was at least partly represented in our study population. Furthermore the response rate (29.1%) in GEDA 2009 was relatively low. It should be emphasized that we used a very conservative approach to calculate the response rate [16] and that our response rate is comparable to other studies using a similar approach (e.g. CDC-Behavioral Risk Factor Surveillance System [43]). Considering the complex weighting procedures used in GEDA 2009 and the good cooperation rate (51.2%) it can be assumed that data quality is overall good in our study. A further limitation of the study was that persons who were not able to speak German or could not be interviewed via telephone (e.g. some persons in nursing or old people's homes) were excluded from the survey.

In conclusion, our results indicate that influenza vaccination coverage in the target groups in Germany is still unsatisfactorily low. Especially the low vaccination coverage in persons with chronic underlying diseases and in HCWs is of concern. Special effort must be undertaken to improve vaccine uptake in HCWs, since this group can be regarded as particular critical. Measures intended to increase vaccine uptake in HCWs could for example include vaccination at the workplace and peer to peer communication about chronic underlying medical conditions and education about importance of influenza immunization. Since private physicians are usually the first contact point for patients with vaccination-

related questions in Germany they should be a main target of concerted communication and educational campaigns. Further research is needed to identify more efficient strategies for enhanced vaccine uptake and to improve the established vaccination campaigns. Monitoring tools are essential to assess the impact and to guide such strategies. Due to its nationwide representativeness and its conception as an annual survey, the GEDA-survey could be used as such a monitoring tool in the future.

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Figures and Tables

Table 1
Overview of the German population and of the two study population sub-samples, Germany, 2007-09

Characteristics	**Study population influenza season 2007/08*** (*n*=15,552)		**Study population influenza season 2008/09*** (*n*=12,685)		**German population ≥18 years, 2008**** (*n*=68,318,799)	
	n	% (95% CI)	*n*	% (95%CI)	*n*	%
Male	7,593	48.8 (47.8-49.9)	6,109	48.2 (47.0-49.3)	33,165,264	48.5
Female	7,959	51.2 (50.1-52.2)	6,576	51.8 (50.7-53.0)	35,153,535	51.5
WFS	12,334	79.3 (78.5-80.1)	9,977	78.7 (77.7-79.6)	54,012,646	79.1
EFS	3,218	20.7 (19.9-21.5)	2,708	21.3 (20.4-22.3)	14,306,153	20.9
Age ≥ 60 years	4,469	28.7 (27.7-29.8)	3,989	31.4 (30.3-32.6)	20,957,744	30.7
Healthcare workers	768	4.9 (4.6-5.3)	578	4.6 (4.2-5.0)	2,622,000	3.8
Persons with underlying chronic conditions	4,973	32.0 (31.0-33.0)	4,197	33.1 (32.0-34.2)	unknown	

* weighted data; ** data by the Federal Statistical Office of Germany **[44]**. WFS = western federal states; EFS = eastern federal states

Table 2

Influenza vaccination coverage in the general adult population and defined target groups by sex and residency, Germany, influenza season 2007/08 and 2008/09

		General population (≥18 years)	Persons aged ≥60 years	Persons with underlying chronic diseases	Healthcare workers
		% (95%CI)*	% (95%CI)*	% (95%CI)*	% (95%CI)*
Season 2007/08					
Total		30.8 (29.8-31.8)	56.6 (54.5-58.8)	43.8 (41.9-45.7)	21.9 (19.0-25.1)
Sex	*male*[a]	29.6 (28.2-31.1)	54.3 (51.0-57.5)	43.0 (40.2-45.9)	24.6 (17.7-33.1)
	female	32.0 (30.6-33.3)**	58.5 (55.6-61.3)**	44.5 (42.0-47.0)	21.1 (18.1-24.4)
Residency	*WFS*[a]	27.7 (26.7-28.8)	52.5 (50.0-55.0)	40.0 (37.8-42.1)	18.9 (16.0-22.1)
	EFS	42.7 (40.5-45.0)**	71.6 (67.7-75.2)**	58.6 (54.7-62.5)**	35.4 (26.9-44.8)**
Season 2008/09					
Total		28.1 (27.0-29.2)	55.2 (52.9-57.6)	42.1 (39.9-44.2)	20.4 (17.2-24.0)
Sex	*male*[a]	27.2 (25.6-28.8)	56.4 (52.8-59.9)	42.8 (39.6-46.1)	31.9 (22.8-42.6)
	female	28.9 (27.5-30.5)**	54.4 (51.2-57.5)	41.5 (38.6-44.4)	17.4 (14.3-20.9)**
Residency	*WFS*[a]	25.1 (24.0-26.4)	50.5 (47.8-53.2)	38.1 (35.7-40.6)	16.9 (13.8-20.5)
	EFS	39.1 (36.6-41.6)**	72.5 (68.2-76.3)**	57.6 (53.1-61.9)**	33.2 (24.6-43.0)**

*weighted data; **significant difference in univariate analysis when compared to reference category in the respective group ($p<0.05$); WFS = western federal states; EFS = eastern federal states; [a]reference category

Table 3
Odds ratios for being vaccinated against seasonal influenza by age group and type of underlying chronic condition, Germany, influenza season 2007/08

Age group (years)	Reference group* (*n*=9,925)		Cardiovascular disease (*n*=1,634)		Diabetes (*n*=1,351)		Chronic respiratory disease (*n*=2,155)		Cancer (*n*=1,037)		Chronic liver disease (*n*=362)		Chronic renal disease (*n*=346)	
	proportion vaccinated (95%CI)	OR (95% CI)	proportion vaccinated (95%CI)	OR (95% CI)	proportion vaccinated (95%CI)	OR (95% CI)	proportion vaccinated (95%CI)	OR (95% CI)	proportion vaccinated (95%CI)	OR (95% CI)	proportion vaccinated (95%CI)	OR (95% CI)	proportion vaccinated (95%CI)	OR (95% CI)
18-39	15.8 (14.5-17.2)	Ref.	22.6 (13.4-35.6)	1.56 (0.91-2.66)	21.1 (13.2-32.0)	1.42 (0.93-2.17)	18.6 (15.3-22.5)	1.22 (0.98-1.51)	15.9 (9.1-26.2)	1.00 (0.57-1.77)	12.3 (5.0-27.3)	0.75 (0.32-1.74)	29.5 (15.6-48.8)	2.23 (1.10-4.55)
40-59	20.8 (19.3-22.5)	Ref.	30.3 (24.4-36.9)	1.65 (1.31-2.08)	42.1 (35.4-49.1)	2.76 (2.21-3.45)	28.8 (25.2-32.7)	1.54 (1.29-1.83)	30.8 (25.1-37.1)	1.69 (1.30-2.19)	37.8 (28.2-48.4)	2.31 (1.61-3.31)	33.7 (23.2-46.0)	1.93 (1.27-2.93)
≥ 60	49.8 (46.6-53.0)	Ref.	64.3 (60.1-68.4)	1.82 (1.57-2.11)	68.4 (63.2-73.2)	2.19 (1.85-2.59)	64.6 (59.4-69.5)	1.84 (1.54-2.19)	64.1 (58.6-69.3)	1.81 (1.51-2.17)	62.8 (51.3-73.0)	1.70 (1.24-2.33)	71.8 (60.5-80.8)	2.56 (1.87-3.51)

* reference category =persons who neither have an underlying chronic disease nor do work as healthcare worker

Table 4
Univariate and multivariate analysis of factors potentially associated with vaccination coverage in defined target groups

Variable	Age ≥60 years		Persons with underlying chronic diseases		Healthcare workers	
	Univariate OR (95%CI)	Multivariate OR (95%CI)	Univariate OR (95%CI)	Multivariate OR (95%CI)	Univariate OR (95%CI)	Multivariate OR (95%CI)
Sex						
male	1 (ref)		1 (ref)		1 (ref)	
female	1.14 (1.03-1.25)		1.08 (0.92-1.19)		0.79 (0.56-1.12)	
Residency						
WFS	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
EFS	2.33 (2.05-2.65)	2.71 (2.32-3.16)	2.15 (1.91-2.42)	2.31 (1.99-2.68)	2.14 (1.52-3.03)	2.14 (1.52-3.03)
Age						
18-29	-	-	1 (ref)	1 (ref)	1 (ref)	
30-39	-	-	1.04 (0.78-1.39)	1.21 (0.84-1.74)	0.94 (0.59-1.48)	
40-49	-	-	1.35 (1.04-1.75)	1.61 (1.16-2.24)	1.25 (0.82-1.90)	
50-59	-	-	2.84 (2.23-3.61)	3.17 (2.37-4.35)	1.36 (0.83-2.20)	
60-69	1 (ref)	1 (ref)	5.21 (4.12-6.60)	6.25 (4.58-8.54)	3.93 (1.79-8.64)	
≥70	2.00 (1.81-2.21)	1.79 (1.59-2.03)	10.21 (8.11-12.85)	10.94 (8.06-14.84)	1.07 (0.17-6.89)	
Educational status						
low	1 (ref)		1 (ref)		1 (ref)	
medium	0.96 (0.86-1.07)		0.85 (0.76-0.95)		0.99 (0.57-1.73)	
high	0.88 (0.77-1.02)		0.82 (0.72-0.95)		1.74 (0.98-3.11)	
Household income						
low	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	
medium	1.34 (1.15-1.57)	1.30 (1.10-1.53)	1.63 (1.41-1.87)	1.36 (1.17-1.59)	1.13 (0.62-2.09)	
high	0.96 (0.81-1.13)	1.19 (1.00-1.41)	1.18 (1.02-1.38)	1.14 (0.97-1.35)	1.93 (1.07-3.49)	
Belonging to more than one target group						
no	1 (ref)	1 (ref)	1 (ref)		1 (ref)	
yes	1.76 (1.59-1.95)	1.58 (1.39-1.79)	4.69 (4.23-5.20)		2.83 (1.45-5.53)	

OR=Odds Ratio; WFS = western federal states; EFS = eastern federal states; ref = reference category

Fig. 1
Influenza vaccination coverage in the general adult population in Germany by age-group, influenza season 2007/08 and 2008/09 (proportion and 95% confidence interval)