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Monitoring pandemic influenza A(H1N1) vaccination coverage in Germany 2009/10 – Results from thirteen consecutive cross-sectional surveys

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Abstract

To monitor pandemic influenza A(H1N1) vaccine uptake during the vaccination campaign in Germany 2009/10, thirteen consecutive cross-sectional telephone-surveys were performed between November 2009 and April 2010. In total 13,010 household-interviews were conducted. Vaccination coverage in persons >14 years of age remained low, both in the general population (8.1%; 95%CI: 7.4–8.8) and in specific target groups such as healthcare workers and individuals with underlying chronic diseases (12.8%; 95%CI: 11.4–14.4). Previous vaccination against seasonal influenza was a main factor independently associated with pandemic influenza vaccination (Odds ratio = 8.8; 95%CI: 7.2–10.8). The campaign failed to reach people at risk who were not used to receive their annual seasonal influenza shot.

1. Introduction

After the first description of a novel influenza A(H1N1) virus in Mexico and the United States in April 2009, the virus rapidly spread worldwide [1]. While many countries suffered their first autochthonous pandemic influenza A(H1N1) wave in the middle of 2009, Germany was at that time primarily affected by imported cases with a peak in case numbers in July 2009 [2]. Subsequently, the number of cases declined in August and September, and an increase in autochthonous pandemic influenza A(H1N1) 2009 cases was observed since October [3]. Case numbers peaked in the middle of November and finally fell to low case counts at the beginning of 2010 [4].

With the declaration of the pandemic phase 6 by World Health Organization (WHO) in June 2009, the production of a pandemic vaccine was enhanced. By October 2009 three vaccines against pandemic influenza A(H1N1) authorised by the European Medicines Agency (EMA) were available in Europe [5]. In Germany the federal states purchased the AS03-adjuvanted H1N1-vaccine Pandemrix® to be given to risk groups and the general population, and exclusively for pregnant women a non-adjuvanted monovalent vaccine manufactured by CSL. On the 12th of October 2009 the German Standing Committee on Vaccination (STIKO) recommended to give priority to the vaccination of primary target groups such as healthcare workers, persons with underlying chronic diseases, and pregnant women. The vaccination campaign started on the 26th of October. With the availability of sufficient numbers of H1N1-vaccine doses, the STIKO expanded its recommendation to the general population on the 14th of December 2009. However, priority was still given to the target groups mentioned above [6]. At that time, a total 40 million doses of the AS03-adjuvanted H1N1-vaccine were available or soon to be distributed, which would have been sufficient to vaccinate approximately half of the German population, since the German regulatory authority recommended one full dose of this adjuvanted vaccine for the immunization against pandemic influenza A(H1N1) for persons over 10 years of age.

The implementation of the vaccination campaign was under the responsibility of the German federal states. Therefore, the distribution of the 10 shot vaccine vials was organized and documented on the state level. Distribution, administration, and reimbursement procedures depended on local and federal regulations. Vaccines were mainly administered by primary healthcare physicians, but in some places also by public health departments or company physicians.

Because of the lack of a centralised register for pandemic influenza A(H1N1) vaccinations in Germany, we established a monitoring tool to collect data on the nationwide progress of the

vaccination campaign. In addition, we used this tool to assess and monitor knowledge, attitude, and behaviour regarding pandemic influenza A(H1N1) vaccination in the German population during the vaccination campaign. Here we present results from the analysis of achieved pandemic influenza vaccination coverage and factors associated with the receipt of a shot against pandemic influenza A(H1N1), which are important parameters for pandemic response planning and evaluation.

2. Methods

Computer-assisted telephone interview (CATI) surveys were carried out on a bi-weekly basis starting in the middle of November 2009 (calendar week [cw] 47) shortly after the initiation of the vaccination campaign against pandemic influenza A(H1N1) in Germany. Each survey was conducted with a sample of approximately 1000 households. At the end of March 2010 a final survey was carried out including a total of 4005 households with approximately 1000 being interviewed per week. For each survey, households were randomly selected. Interviews were conducted by forsa (Gesellschaft für Sozialforschung und statistische Analysen mbH), a large professional market research company with experience in health-related surveys, as part of forsa's daily omnibus survey in Germany. From Monday to Wednesday of each survey week experienced interviewers surveyed representatively selected German speaking individuals, aged 14 years and older, living in private households equipped with a telephone. On a household level the last birthday selection method was applied. To prevent non-response bias, the survey samples were weighted for geographic region, age, sex, and education on the basis of recent population projections of the Federal Statistical Office of Germany.

The primary objective of our study was to assess the uptake of pandemic H1N1-vaccines in different target groups during the vaccination campaign in real-time. We used a core set of questions over the total study period of 13 surveys including questions on recent vaccination against pandemic or seasonal influenza, self-determination as risk-group for the development of severe pandemic influenza, or criteria for the categorization into specific risk-groups for targeted vaccination as defined by the STIKO, e.g. healthcare worker, policeman, fireman, pregnant women, or the prevalence of specific underlying chronic diseases. The latter group included persons with chronic respiratory diseases, cardiovascular diseases, diabetes mellitus, metabolic disorders, chronic renal diseases, chronic hepatic diseases, diseases or therapies leading to immuno-suppression, as well as chronic neurological and neuromuscular diseases.

Socio-demographic information (e.g. age, sex, education, size of the household) was assessed as part of the omnibus survey structure. Due to the use of an omnibus survey we were able to change questions on short notice. In the last 5 surveys, persons older than 18 years were asked about the vaccination against pandemic influenza of each child living in the same household.

2.1. Statistical methods

Collected data were analyzed for each individual cross-sectional survey, but also for trends of specific outcome parameters such as vaccination coverage over the study period. Because of the increase in vaccination coverage early after campaign initiation (week 47–49) and a stabilisation of the vaccination coverage beginning with week 51, we decided to pool data from all cross-sectional surveys from week 51 in 2009 to week 15 in 2010. The pooled data set of 11,009 interviews was used for further univariate and multivariate analysis of potential factors associated with vaccination against pandemic influenza A(H1N1). The analysis was performed by using complex survey data analysis procedures in STATA 11® (StataCorp, College Station, TX, USA). We calculated proportions with 95% confidence intervals (CI) and *p*-values using logistic regression statistics for complex survey data. Multivariate analysis was performed by using multiple logistic regression models with combined stepwise backward removal and forward selection. Odds ratios (OR) and 95%CI were calculated. Variables categorized as follows: Age-group (14–24, 25–59, ≥60 years of age), sex (male/female), healthcare worker (yes/no), underlying chronic diseases defined by STIKO (yes/no), geographic region (north, middle, south, east), children living in the household (yes/no), degree of education (low = 9 years of school education or less; middle = 10 years of school education; high = university entrance diploma), size of residency (≤5000; 5001–20,000; 20,001–100,000; 100,001–500,000; >500,000 inhabitants), and previous vaccination against seasonal influenza in season 2009/10 (yes/no). Essential Services was defined as self reported profession as policeman or fireman (yes/no). All statistical analysis where weighted with respect to the inclusion probability depending on geographic region, age, sex, and

education of the participants.

3. Results

Between cw 47 in 2009 and cw 14 in 2010, a total 13,010 telephone-interviews were conducted in thirteen cross-sectional surveys: The first nine bi-weekly surveys comprised of approximately 1000 per survey and the final weekly surveys of a total of 4005 interviews. The median age of all respondents (n = 13,010) was 48 years (range: 14–93 years). 52.5% of the interviewed persons were female.

Vaccination coverage against pandemic influenza A(H1N1) in persons ≥14 years of age increased from 4.6% (95%CI: 3.2–6.6) in week 47 to 6.0% (95%CI: 4.3–8.3) in week 49. In the third survey, which was conducted in mid-December (cw 51), vaccination coverage reached a plateau of approximately 8%. Subsequent surveys revealed no significant increase in coverage. Moreover, the proportion of participants who still intended to receive a vaccination or who did not take a final decision yet was declining from 21% in cw 47 to 3% in cw 10 (Fig. 1).

After pooling data collected in cw 51 and later (n = 11,009), overall vaccination coverage in persons >14 years of age was 8.1% (95%CI: 7.4–8.8). Vaccination coverage increased with age, and the highest coverage (10.4%; 95%CI: 9.1–11.8) was found in persons 60 years and older. Persons with underlying chronic diseases revealed a vaccination coverage of 12.3% (95%CI: 10.8–13.9), and healthcare workers a coverage of 15.9% (95%CI: 12.7–18.6) (Fig. 2). A total of 65 pregnant women were included in the pooled dataset and revealed a vaccination coverage of 8.8% (95%CI: 3.1–22.7). Vaccination coverage in the combined STIKO target-population (people with underlying chronic diseases, pregnant women and Essential Services) was 12.8% (95%CI: 11.4–14.4).

To assess vaccination coverage in children less than 18 years of age, a total 1408 persons 18 years and older, who reported to have at least one child living in the same household, were interviewed in the last five surveys about their children's H1N1-vaccination status. The indirect questioning provided information on 2069 children. Overall vaccination coverage in the age-group under 14 years was 7.8% (95%CI: 6.1–10.0). Since for the age-group 14–17 years both methods (indirect and direct questioning) were used we were able to compare these two methods. Using the indirect question method (n = 376) revealed a slightly lower vaccination coverage in this age-group (4.0%; 95%CI: 2.6–6.4) when compared to the direct interviews (n = 488) in the total sample starting cw 51 (6.0%; 95%CI: 3.6–9.9).

In univariate analysis, a significant difference in H1N1 vaccination coverage was found between men and women (9.0% vs. 7.2%, $p < 0.05$) and between age-groups (Table 1). Individuals living in the southern part of Germany were significantly less likely to be vaccinated than in other regions of the country. Previous vaccination against seasonal influenza in 2009/10 was strongly associated with vaccination against pandemic influenza (OR = 8.87; 95%CI: 7.31–10.77); an effect that remained stable in the individual age-strata. Overall seasonal influenza vaccination coverage in the pooled study population (24.7%; 95%CI: 23.6–25.7) was higher than the overall coverage for pandemic influenza vaccination. Cross tabulating vaccination against pandemic influenza versus 2009/10 seasonal influenza showed a significant correlation: 59.2% (95%CI: 53.8–64.3, $P < 0.001$) of the persons between 14 and 59 years who were immunized against pandemic influenza A(H1N1) received a shot against seasonal influenza in the same season 2009/10. For persons 60 years and older, for whom seasonal influenza vaccination is generally recommended in Germany since 1988, the share with pandemic influenza vaccination was even higher (87.6%; 95%CI: 82.4–91.5). Approximately 75% of persons who stated in the final survey (n = 4005; cw 13 to cw 15) to be vaccinated against pandemic influenza received a shot against seasonal influenza regularly or occasionally in influenza seasons before 2009/10.

In the final logistic regression model, underlying chronic disease, being employed as a healthcare worker, university entrance diploma, and previous receipt of vaccinations against seasonal influenza were independently associated with having received vaccination against pandemic influenza A(H1N1) 2009. A negative association was found with female sex, being a resident of the southern or eastern geographic region, and living in a city with more than 500,000 inhabitants (Table 1).

4. Discussions

By using consecutive cross-sectional telephone-surveys, we were able to monitor the uptake of pandemic influenza vaccines during the vaccination campaign in 2009/10. Although some German federal states published the numbers of distributed vaccine doses and vaccination coverage after the end of the campaign, our surveys provided the only timely source of information on achieved vaccination coverage on a national level, on regional levels, and for specific target and age-groups in Germany during the pandemic. The main finding is that during the influenza A(H1N1) 2009 pandemic, vaccine uptake in the general population was very low. The observed low vaccination coverage in well-defined target groups and among healthcare workers is of special concern and calls for improved vaccination and communication strategies during a pandemic.

The peak of the pandemic influenza wave in Germany occurred in November 2009, and since January 2010 only a few H1N1-cases were still reported leading to reduced public awareness and concern [4]. In our survey, with the beginning of the year 2010 we found hardly any willingness to receive a vaccination against pandemic influenza, and the proportion of people still undecided decreased rapidly in the first weeks of the survey. This has also been observed at a large local health office in Frankfurt, where a peak in administration of H1N1-vaccines shortly after the initiation of the vaccination campaign in November and a sharp decline in administered doses was observed with almost no vaccinations in 2010 [7].

Public polls are established tools to monitor the pandemic influenza situation and the course of immunization campaigns. They are used to guide and evaluate public health decision making [8]. Based on telephone-interviews, the Flash Eurobarometer found that at the end of November 2009 (cw 48) in Germany 1.4% of the general population aged 15 years and over had already received a vaccination against pandemic influenza. The Flash Eurobarometer survey FL287 – Influenza H1N1 was performed to assess attitude, knowledge and behaviour related to pandemic influenza including approximately 1000 interviews in each of the 30 European states under the responsibility of the Gallup Organization for the European Commission [9]. This vaccination coverage is slightly lower than the coverage found in our surveys in cw 47 and cw 49. In the Eurobarometer survey in cw 48, 33% of the 1001 interviewed persons stated that it is still likely or very likely that they will receive a vaccination against pandemic influenza in the near future, which was below the European average in the survey [9]. However other European countries reported low acceptance of vaccination against pandemic influenza A(H1N1) as well, e.g. a study of 36 national telephone surveys conducted in the UK [10]. A Greek telephone-survey showed a falling tendency of willingness to be vaccinated against pandemic influenza A(H1N1) between end of August to October 2009. The proportion of persons responding “definitely yes” decreased from 22.9% (cw 35) to 9.1% (cw 44) [11].

Persons with underlying chronic diseases and healthcare workers were target groups for both vaccination against seasonal influenza and pandemic influenza A(H1N1) 2009 [6]. In both groups H1N1 vaccination coverage remained far below the desired levels. Pregnant women seemed to have followed vaccination recommendations only in a low proportion as well. While personal restraints of pregnant women, e.g. due to the limited safety-data available regarding the use of adjuvanted influenza vaccine in pregnancy and the newly endorsed recommendation in Germany to vaccinate pregnant women against influenza, may have contributed to the low coverage, other studies indicate that health care workers knowledge and attitude may have posed a barrier for higher vaccine coverage in pregnant women as well [12]. Major efforts should be undertaken to increase vaccination coverage in target groups. Especially the low vaccination coverage of healthcare workers is of concern. In other industrialized countries healthcare workers tended to be more frequently vaccinated than in Germany: In the US, 37% of healthcare workers were vaccinated against pandemic influenza by mid-January 2010 [13], and in the Netherlands 85% of general practitioners interviewed during a questionnaire-based survey in February 2010 stated they were vaccinated against pandemic influenza [14].

Our analysis showed a strong association between being vaccinated against seasonal and pandemic influenza. This may indicate that mainly persons who regularly receive vaccination against seasonal influenza were reached by the H1N1 vaccination campaign, although certain target groups for seasonal influenza – such as persons over 60 years of age without underlying chronic diseases – were not regarded as a major risk-group for severe complications due to pandemic influenza A(H1N1) and were thus not defined as a priority group by STIKO [6]. A similar association has been shown in Australia, where persons vaccinated against seasonal influenza in 2009 were more likely to have received the H1N1 vaccine [15]. Also a nationally representative sample of U.S. adults (n = 2067) interviewed via internet between 26th of May and 8th of June 2009 showed that the intention to get

vaccinated against pandemic influenza was strongly associated with the receipt of seasonal influenza vaccination [16]. These findings suggest common attitudinal barriers for the vaccination against pandemic influenza in 2009/10 and insufficient motivation of persons even of well-defined target or risk-groups, if they were not reached by seasonal influenza vaccination efforts in previous years.

The results of our survey were weighted to control for possible selection biases. Nevertheless, there might be a potential for the introduction of residual bias due to the telephone sample procedures. In certain age-groups, intensive mobile phone usage might lead to lower accessibility during household-based telephone surveys, as well as limited accessibility for other reasons such as vulnerable persons being hospitalised or living in nursing homes, or the missing representation of non-German speaking persons. For legal reasons persons below the age of 14 years were not interviewed directly. There might be additional recall bias when using indirectly obtained data for persons below 14 years of age. Using a standard omnibus system with additional topics not related to the study aim may limit potential bias due to rejection or higher interest in the pandemic influenza topic. A limitation of our study was that no surveys were conducted before the initiation of the vaccination campaign, which would have provided additional data before and at the beginning of the influenza wave in Germany.

In conclusion, our results show that consecutive cross-sectional telephone surveys are useful tools for real-time monitoring of vaccine uptake during a vaccination campaign and to generate data for in-depth evaluations after the campaign. During the course of a campaign, such data are essential to inform decision makers and guide communication efforts. In addition, timely available data on vaccination coverage by age- and target groups are crucial for the interpretation of reported vaccine side-effects and for the rapid assessment of the vaccine effectiveness, for example by using the screening method [4].

Overall, vaccination coverage in Germany especially in the target groups was far below anticipated levels. A careful evaluation of the 2009/10 pandemic influenza vaccination campaign is necessary to improve strategies for future pandemic preparedness and response planning. Vaccination campaigns should be supported by surveys for real-time monitoring of the vaccine uptake especially if a centralized register for vaccination data is missing. If conducted well ahead of time, such surveys should guide planning or implementing of such campaigns.

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Tables and Figures

Table 1. Univariate and multivariate analysis of factors associated with vaccination against pandemic Influenza, Germany, 2010 (*n* = 11,009, pooled data cw51 – cw15).

Variable	H1N1 vaccination coverage	Univariate analysis		Multivariate analysis	
		Odds ratio (OR)	Confidence interval (95%CI)	Odds ratio (OR)	Confidence interval (95%CI)
Age					
14–24	5.0%	1			
25–60	7.7%	1.59	(1.14 – 2.23)	NS	
>60	10.4%	2.22	(1.57–3.15)	NS	
Sex					
Male	9.0%	1		1	
Female	7.2%	0.79	(0.66–0.95)	0.67	(0.55–0.82)
Underlying chronic disease					
No	6.5%	1		1	
Yes	12.3%	2.03	(1.68–2.45)	1.33	(1.08 - 1.65)
Healthcare worker					
No	7.5%	1		1	
Yes	15.9%	2.31	(1.79–2.99)	2.98	(2.21–4.03)
Essential services					
No	8.0%	1			
Yes	11.3%	1.48	(0.95–2.32)	NS	.
Geographic region					
North	10.3%	1		1	
Middle	9.0%	0.86	(0.67–1.10)	0.87	(0.66–1.16)
South	5.0%	0.46	(0.34–0.61)	0.49	(0.35–0.67)
East	9.1%	0.87	(0.66–1.16)	0.68	(0.50–0.93)
Highest education					
Low	8.7%	1		1	
Middle	7.1%	0.80	(0.64–1.01)	0.86	(0.67–1.10)
High	8.9%	1.03	(0.84–1.26)	1.29	(1.03–1.60)
Residency (population)					
≤5000	7.6%	1		1	
5001 to 20.000	7.9%	1.04	(0.77–1.40)	0.98	(0.71–1.35)
20.001 to 100.000	9.6%	1.30	(0.98–1.73)	1.10	(0.80–1.51)
100.001 to 500.000	7.3%	0.96	(0.69–1.35)	0.80	(0.55–1.16)
>500.000	7.0%	0.92	(0.66–1.28)	0.68	(0.48–0.97)
Children in household					
No	8.6%	1			
Yes	6.8%	0.93	(0.80–1.07)	NS	
Seasonal influenza vaccination					
No	3.2%	1		1	
Yes	22.9%	8.87	(7.31–10.77)	8.82	(7.19–10.82)

NS = not significant.

Figure 1. Immunization status and intention to receive vaccination against pandemic Influenza A(H1N1) in the general population by calendar week, Germany, 2009/10 (*n* = 9005, about 1000 per cw).

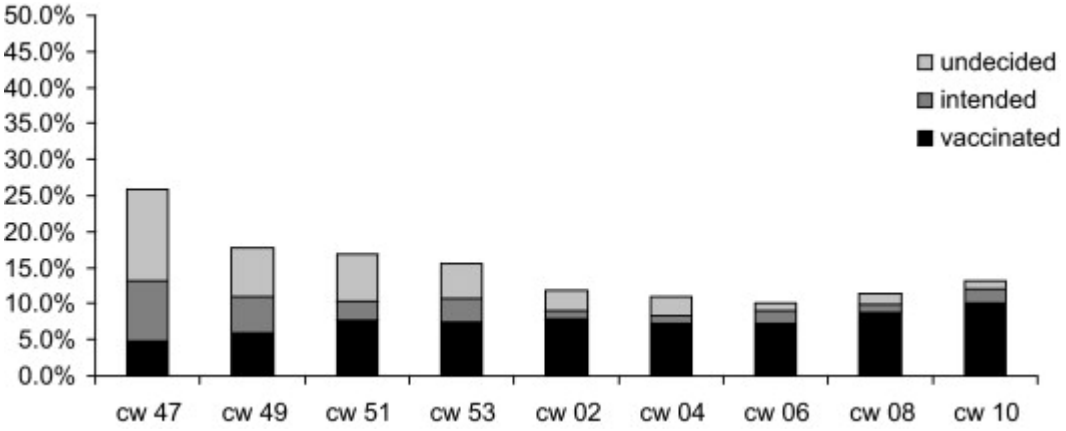
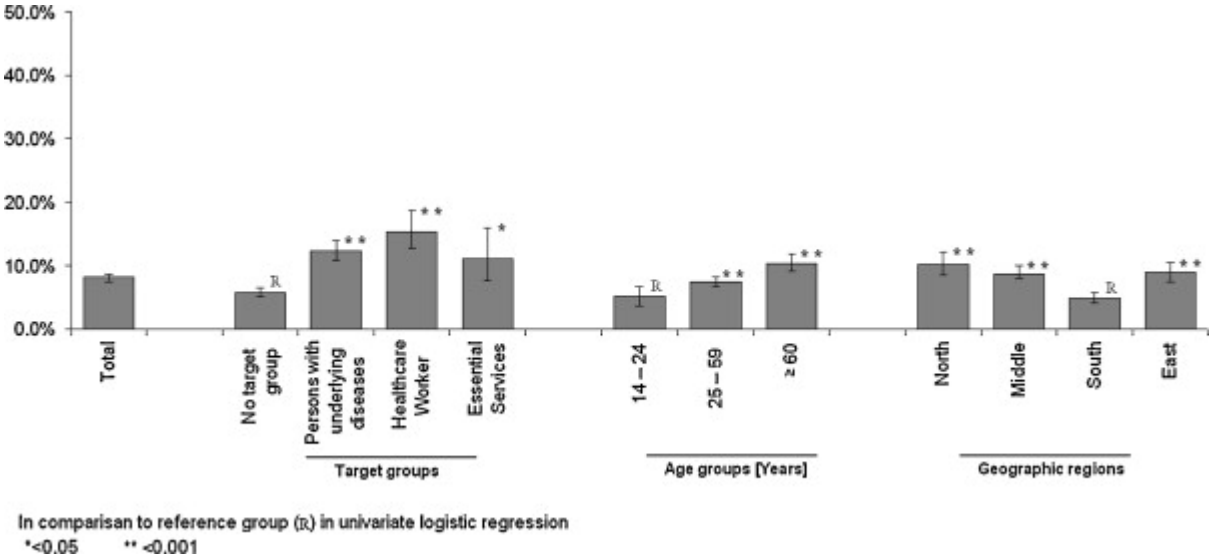


Figure 2. Vaccination coverage (95%CI) against pandemic influenza A(H1N1) in specific target groups, age, and geographic region, Germany, 2010 (*n* = 11,009, pooled data cw51 – cw15).



In comparisan to reference group (R) in univariate logistic regression
*<0.05 ** <0.001