



Master of Public Health

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MEASLES VACCINATION IN EUROPEAN UNION

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Abbreviations

EU	European Union
WHO	World Health Organization
ECDC	European Center for Disease Prevention and Control
MCV	Measles containing vaccine
MMR	Measles, Mumps and Rubella vaccine.
UK	United Kingdom
MOH	Ministry of Health
EUVAC.net	A European surveillance network for vaccine preventable infectious disease
SIA	Supplementary Immunization Activity

Abstract

Background

WHO had targeted measles elimination from the European region by 2010, but this was not achieved and a new measles elimination target from European region was set for 2015. Some countries have met the targets whereas others are still far from having met them. Measles vaccine was incorporated in routine childhood vaccination in EU more than 20 year ago. Our objective for this study was to overview the situation in countries with a high measles incidence rate, the strategies adopted and their effectiveness in achieving measles elimination by 2015.

Methods

Nine European countries were studied in terms of the strategies they adopted for the elimination of measles. Data for the number of measles cases, incidence rate and measles vaccine coverage over the past five years (2006-2010) was collected from official reports, literature and European portal for communicable diseases. The current situation in these countries was overviewed in accordance with their vaccination system, strategies and the outcome in terms of achieving the goal of eliminating measles from the region.

Results

Between 2006-2010 a total of 50,293 measles cases occurred in these countries, except Slovakia which following WHO recommendations has reported zero cases for more than five years. There are remarkable differences in the vaccination coverage rates in these selected countries. Bulgaria with 49% contribution to the total number of cases during 2006-2010 recorded was followed by France (15%), Germany (10%) and Romania (8%). High measles incidence rates in these EU countries reveal the existence of suboptimum vaccination coverage.

Conclusion

Countries with periodic SIAs and “catch-up” campaigns in population with low vaccination status have lower measles incidence rate and better coverage. Inter country transmission of this highly infectious disease compounds the difficulty of achieving “zero measles” in the EU by 2015. Lack of harmonization of natural immunization policies may be another barrier to achieving this goal. Popular awareness of the importance of measles and other immunization, as promoted by low risk perception of vaccination in public is necessary. The

presence of low or un-vaccinated population in these EU countries and low vaccination coverage raises doubts to the achievement of measles elimination goal by 2015. High measles vaccination coverage, improved surveillance and mass media campaign to raise awareness to the benefits of vaccination are the key elements of the measles elimination campaigns in European Union.

1. Introduction

This master's thesis provides an overview of European policy-related and general obstacles to measles vaccination. It provides recommendations on the integration and implementation of European Union and national vaccination policies.

Vaccination is considered to be one of the most cost effective interventions in public health for preventing disease, disability and death [1]. Today however as the face of the European Union changes retaining high immunization coverage even in the most underserved countries and countries in transition from the Soviet period is a key challenge to trans European and national health policies.

In an attempt to eliminate the risk of outbreak of some diseases, at various times several governments and other institutions have instituted policies requiring vaccination for all people. However, even though today's vaccines are safe and effective, vaccine-preventable diseases still pose significant threats in the WHO European Region. Comparatively within Europe coverage and mortality rates vary despite various policy attempts by the EU to eradicate measles by a set date. Other frequent obstacles faced by vaccination campaigns also play a role in controlling measles. However for the purpose of this paper the goal is to look across European nations to assess effective policies and provide guidance to those countries with poor coverage in order to meet WHO European Region's goal of eliminating measles by 2015. Therefore, the audiences for this work are national and international policy experts. According to public health good policy, that different solution could be applied when national factors of failure would be identified.

1.1 Background

Measles is one of the most prevalent communicable infectious diseases capable of producing epidemics. It remains the leading cause of vaccine preventable deaths worldwide. Despite the availability of measles vaccines for more than 30 years, measles is still a cause of great public health concern in many European countries [2]. Immunization is the effective way to prevent measles morbidity and mortality. After the successful eradication of small pox followed by interruption and elimination of poliovirus, most of WHO member states are eager to see measles eliminated. Measles elimination has been defined by WHO as a dynamic situation in a large and well-populated geographical area where endemic measles transmission does not occur and where importation of measles virus does not result in sustained transmission.

In 1998, WHO European region set the goal of measles elimination from the region by 2007. The regional situation of immunization was reviewed by experts in 2004 and the measles elimination deadline was extended to 2010[3]. High measles vaccination coverage of the population is considered a key indicator in the measles elimination campaign [4]. It is not a secret now that the measles elimination plan was not accomplished in the European Region by 2010. It was observed that even measles eradication targets were not achieved by some countries, but this does not mean that the goal is not worth striving for or that it is not feasible, as has been demonstrated by some EU member states (e.g. Slovakia, Finland). The goal of measles elimination was not achieved by 2010 but the continuous efforts by Public health authorities over the past 10-12 years lead to dramatic reduction of measles cases in the WHO European Region from 200,000 in 1994 to 7,411 reported cases in 2009 [4].

Measles elimination is achievable with high vaccination coverage as demonstrated through experience in the WHO Americas, where the last endemic measles case was reported in 2002 [6], although imported cases have been reported in 2010. In September 2010, the member states of WHO European Region met in Moscow, Russia and adopted a resolution to renew their commitment to eliminate measles from the region by 2015 [7]. The WHO European Region urged member states to setup national plans to achieve a measles vaccination coverage of over (>95% two doses of MMR vaccine) and to build up strategies to accomplish these plans.

There are 27 countries in the European Union each with their own specific vaccination recommendations, schedule and protocols, so immunization can't be carried out in the same way across Europe. Reports on measles in EU shows that measles virus freely circulates in the region and is not confined to specific populations or countries [8]. Measles outbreaks of

various sizes were experienced in recent years in some EU countries. During the year 2010, a total of 30,367 measles cases were reported in EU, the majority of cases (n=28,692) were reported in the following five countries: Bulgaria, France, Germany and Italy with the largest number of cases occurring in Bulgaria (n=22005) [9]. The declining uptake of measles vaccination in several western European countries threatens the achievement of the elimination goal [10]. Figure 1 shows the situation of measles cases in various EU countries.

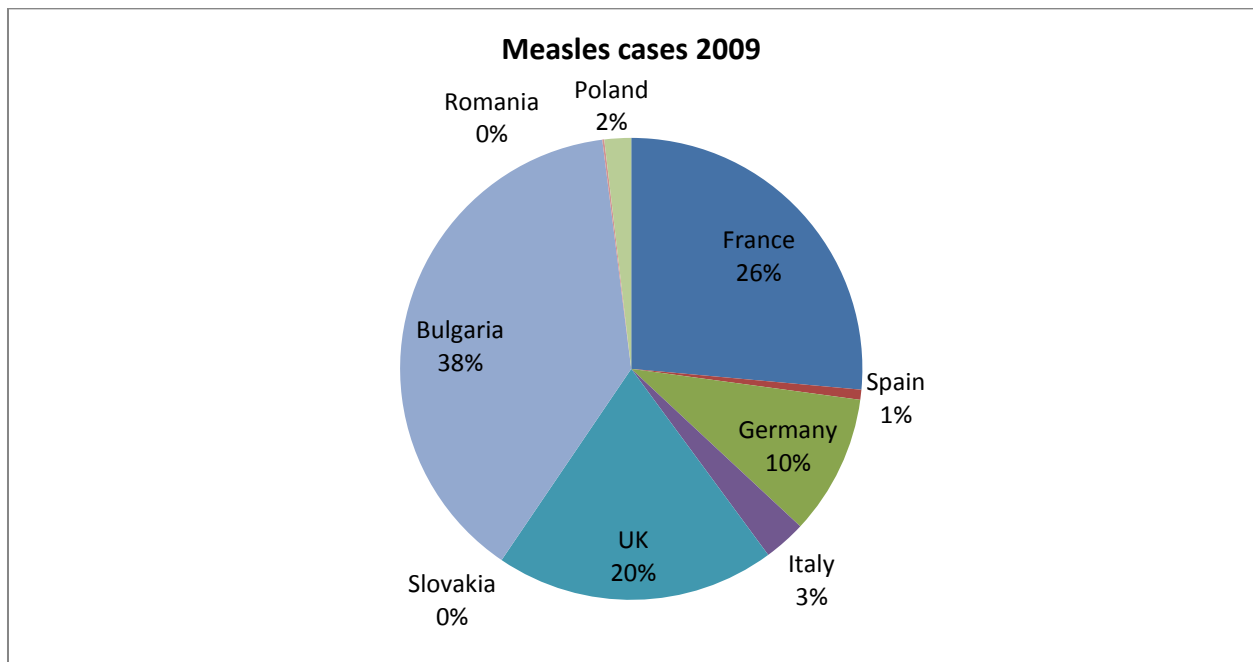


Figure1: Measles cases in 2009 in selected EU countries

1.2 Measles

The Disease

Measles is an acute respiratory illness caused by a morbilli virus of the paramyxovirus family. Clinically it is diagnosed by illness manifested as rash and fever ($>38.5^{\circ}$). The three other symptoms for measles diagnosis are cough, conjunctivitis and coryza (runny nose). The erythematous rash starting at the head and spreads to the trunk and limbs over three to four days. Koplik spots (red spots with bluish-white centers) on buccal mucosa may appear one to two days after the rash.

Virus transmission

Measles transmission occurs readily through respiratory droplets and micro droplets (airborne). It is one of the most prevalent communicable infectious diseases. Primary site of infection is upper respiratory epithelium of the nasopharynx. The incubation period is about ten days and another two or four days before rash appears [11]

Complications of measles

The most common complications of measles include otitis media, vomiting, pneumonia, diarrhea and convulsion. Rare complications include encephalitis and sub-acute sclerosing pan-encephalitis and death. Measles remains one of leading causes of death, as an estimated 24,2000 children died worldwide from measles in 2005 [12]. Disease complications are more severe in poorly nourished and chronically ill children.

1.3 Objectives and Rationale

Primary objective

The main objective of this work is to provide an overview of the current measles vaccination coverage levels in some EU member states and review the criteria used for measles elimination in recent years.

Secondary objectives

Along with these objectives the study will also explore other potential factors that are associated with the measles vaccination coverage differences. The study will identify major barriers in measles vaccination uptake that lead to vaccination disparities among a sample of EU countries. The study also looks at other possible determinants that can potentially influence the measles vaccination coverage. These can be individual factors such as one's religious background, lack of information, prohibitive provider fee, or these can be confounders of the national vaccination system e.g. reporting system, surveillance and accessibility. The study evaluates the strategies adopted in an effort to achieve measles elimination in the selected EU member countries and in conclusion, generates recommendations to strengthen the measles elimination campaigns in EU.

Rationale/ Justification of the Study

After consistent attempts over the past 11-12 year to eliminate measles many members states in EU could not achieve the measles vaccination coverage rate of >95% with two doses of MMR vaccination as recommended by WHO. The number of deaths and complications associated with measles has fallen in EU over time due to improved vaccination strategies. In spite of this progress, the continued circulation of measles puts a substantial cost on the countries health care system. Effective measles elimination

programmes can therefore produce net cost savings in developed countries [13]. This is possible given that European Region of WHO has almost 15 years of experience in designing, implementing, monitoring and evaluating a joint outcome-focused, targeted and innovative policy in health that integrates efforts to promote healthy lifestyles and healthy environment (European Health for All series 6). The target of achieving the necessary high measles vaccination (>95%) recommended by WHO in the region and eliminating measles is still a challenge.

1.4 Study Question

Our research question is summarized as follows:

Research Question

Could the overall EU countries reach the measles elimination goals 2015 with the current strategies?

The research question was explained by looking into multiple factors relevant in the assessment of countries vaccination differences between countries. A comparative analysis was made between the EU countries measles incidence rates between 2006 and 2010. The total number of reported measles cases was assessed during this time period to highlight the trends in these countries and strategies adopted to achieve measles elimination goals. The coverage rates for MCV1 (measles containing vaccine) and MCV2 was analyzed in these countries in recent years to ascertain the barriers towards measles vaccination uptake that lead to difference across countries.

2. Methodology

2.1 Selection of Countries

The countries selected for comparison in this study are France, Spain, Germany, Italy, United Kingdom, Bulgaria, Slovakia, Romania and Poland. Measles outbreaks of various sizes have occurred in these countries in recent years. The contribution of measles cases from these countries to the total number of cases in the EU in 2009 and 2010 is high with 81.64% and 97.36% respectively, except Slovakia reported zero cases and maintained high measles vaccination coverage above 95% over the last few years. Secondly, the vaccination

system in these countries ranges from highly centralized to highly decentralized methods with variable coverage assessment and data collection methods across EU [4].

2.2 Study Design

The vaccination strategies of selected countries are comparable to those recommended by WHO. To understand the vaccination system in these countries, elements of national vaccination system were gathered. The study questions were answered on the basis of literature review, database (Incidence of measles cases/100,000 inhabitants, MCV coverage rates), findings and information obtained from experts in some of these countries.

2.3 Data Source

The measles vaccine coverage rates for MCV1 and MCV2 of these countries were compared during recent years, providing insight into the national measles elimination programs. Measles incidence rates of <1 per million has been identified as an indicator of measles elimination. The various causes of measles cases were assessed in these countries, whether they were on account of vaccination, lack of vaccination, or other reasons.

Journal articles, published and unpublished reports on measles, reports on measles available at national health agencies responsible for vaccination and data available at European Center for Disease Prevention and Control (ECDC) online portal were accessed to gather data. Literature review which was done through the internet using search engines such as Science Direct, Pub Med and Google Scholar. In addition we have retrieved documents and reports from WHO's online portal.

3. Results

From our study following results were obtained.

3.1 Vaccination system in the selected countries

(Annex 1 and 2) indicates that in some EU countries, such as UK the vaccination system is completely centralized and funded by government through general taxation. The vaccination system is coordinated by the Department of Health Joint Committee on Vaccination and Immunization (JCVI) which forms the basic policy, and decisions are made based on scientific evidence collected by division of the Health Protection Agency at the

Communicable Disease Surveillance Center (CDSC). The children are vaccinated free of charge at the assigned vaccination center. Evaluation of vaccination is done by aggregating data locally and collected by CDSC-the COVER program. Immunization is done by the General Practitioners under the supervision of the District Health Office.

The degree of centralization is lower in Italy where only mandatory vaccines are administered free of charge at regional centers, while the recommended vaccines are purchased and decision on choice of vaccine administration is taken by regional vaccination committee. The vaccination plan is designed nationally but regions can decide independently to include vaccination for other disease which are not part of national plan on the basis of local epidemiological situations. Sometimes this leads to significant regional differences particularly in emergency situations. Italy's measles elimination plan for 2003-2007 was implemented nationally with the objective of achieving sustained nation-wide elimination of measles by interrupting indigenous transmission of the infection and reducing the incidence rate below 1 case per 100,000 inhabitants. The plan was successful in achieving the short term objective and by the year 2007, the incidence rate in Italy dropped to 0.72 per 100,000 inhabitants; However, adoption of the second MCV dose and SIA's could have further strengthened the situation, but these measures were not included in the strategy adopted in the Plan 2003-2007, ultimately resulting in an increased number of measles cases in preceding years.

France and Germany have a more decentralized system. In France, vaccination policy is centralized but the implementation is decentralized and vaccination is carried out under the responsibility of MOH. The vaccination schedule and recommendations are set by MOH and cannot be modified at the local level; however, there is no government input in vaccine administration. Several state agencies play specific roles in the national vaccination program. First authorization to measles vaccine was given in 1966 in France and after the introduction of trivalent vaccine MMR a second dose of MMR was recommended in 1996. The measles vaccine is available free of charge to children up to 13 years of age and is financed by National Health Insurance. To achieve measles vaccination coverage of >95% at national level and to eliminate measles; a five year National measles elimination plan 2005-2010 was developed and implemented in June 2005. Objectives set in this plan were to achieve high level of measles vaccination nationally and reach rate of <1 case per 100,000 inhabitants. Strategies adopted in this plan were to improve the reporting and surveillance system, reduce the obstacles to vaccination: arguments against vaccination, to reduce reluctance to vaccinate on the part of professionals and parents. To reduce the incidence rate and improve coverage rates, an intensive national vaccination campaign is required to reach to small

pockets of infected population. Since 2006 there has been a progressive increase in the number of measles cases.

The German model is somehow similar to French vaccination model. Germany doesn't have a national vaccination system; instead a German standing committee on vaccination STIKO (Ständige Impfkommission am Robert Koch-Institut = Permanent Vaccination Committee at the Robert Koch Institute) develops recommendations for vaccination schedule based on scientific evidence and the sixteen German states are advised to adopt this plan publically, although they do not always do so. The vaccines are paid for by insurance companies and generally physicians performing vaccination decide which vaccines are to be administered. The first national measles elimination plan was adopted in September of 1999. The target set in this plan was to reduce the number of measles cases to 1,000 cases per year. The joint decision was made with Federal Government (Bund), the public health care service (*öffentlicher Gesundheitsdienst*), health insurance funds, the medical profession and other partners to take concerted measures to lower the measles incidence in Germany by 90 per cent in five years. Adopting these strategies Germany succeeded in reducing the incidence rate per year. The data for vaccine coverage is collected at school entry examination.

The vaccination administrative system in Spain is decentralized and consists of nineteen autonomous communities. The MOH is responsible for coordination of public health care services and individual responsibilities are divided according to the policy of devolution: the central government is responsible for centralized planning for the country and designing basic health policy while regional authorities and local agencies are responsible for allocation of funds and implementation of national health policies regionally. Following the WHO recommendation to eliminate measles a plan of Measles elimination plan [14] was approved in 2001 with the objectives to enhance epidemiological surveillance and increase vaccination coverage to achieve the 95% population immunity and to ensure that susceptible population didn't exceed 5%, undertake mass vaccination in susceptible population.

The Bulgarian immunization program is under the responsibility of the MOH, which decides on specific regulations and recommendations which are to be implemented across the entire country. Vaccines listed as mandatory are financed by the MOH and they are distributed to twenty eight regional inspectorates (RIPCHs) and are provided to people free of charge. Recommended vaccines are sold in the free market and paid for by patients. Bulgaria doesn't have a specific measles elimination plan; however, they follow the WHO recommendations for measles elimination. The EU case definition and case classification of measles have been adopted in 2005. After a large outbreak in 2009 which showed

weaknesses in the surveillance system, a new web based information system of surveillance for measles was developed in 2009. Supplementary immunization activity (SIA's) was started nationwide in May, 2009 to vaccinate the susceptible population and reduce the number of measles incidence rate.

Among the nine countries Slovakia is the only country where measles vaccination coverage is >95% nationwide over the last five years and reported zero cases. Vaccination program in Slovakia is governed by Public health authority of the Slovak republic (PHR SR). Mandatory vaccines are provided free of charge. Regular immunological surveys are conducted in the country to identify the immunity level and verify the vaccination reporting. WHO recommendation of measles elimination is followed in Slovakia and intensive vaccination and surveillance is carried out where measles infection is identified. The strategies adopted are much identical to those adopted by WHO-Americas which are catch-up, keep up and follow up.

In Romania vaccination system is under the responsibility of Ministry of Public Health. They set the national immunization schedule, design the vaccination activities and applied to entire country. Romania has 42 county authorities (administrative units), county public health authority is responsible for the local implementation of vaccination program. All the vaccines included in childhood vaccination schedule are delivered free of charge to all citizens. Mass immunization campaign was conducted in October, 1998 to immunize school aged children; 1st large nationwide vaccination to achieve the target measles elimination set by WHO European region by 2007. Measles vaccination is conducted twice by GP in childhood and at school in 1st grade school.

The Polish immunization program is coordinated by MOH and General sanitary Inspectorate with the recommendations from Sanitary-Epidemiology board (*Rada Sanitarno-Epidemiologiczna*). Mandatory vaccines are paid by the Government and recommended vaccine are paid by patients individually, employer or by insurance. Measles vaccination coverage is generally high throughout the country with incidence rate <1 per 100,000 inhabitants over the past 5 years.

In all the nine countries compared measles vaccination are administered twice during childhood in the form of triple MMR vaccine against measles, mumps and rubella. The schedule is displayed in the following table.

Table1: Measles vaccination schedule in selected EU countries

Country	1st Dose of MMR	2 nd Dose of MMR
France	9 months (day care) 12months (others)	12-15 months (day care) 13-24 months (other)
Spain	12-15 months	3-6 years But as preventive measure MOH recommends <12 months
Germany	11-14 months	15-23 months
Italy	12-14 months	5-6 years 5-15 ¹
UK	12-15 months	3-5 years
Slovakia	14 months	10 year
Bulgaria	13 months	12 years
Romania	12-15 months	4-6 years
Poland	13-14 months	10 years 11 years ²

1. MMR2 is either second dose or catch-up dose. 2. Only for girls not covered in immunization programmes previously.

3.2 Difference in Evaluation

The method of estimating vaccine coverage and collecting data varies across the EU [15].

Data collection on vaccine coverage, adverse events and epidemiological surveillance is theoretically easier in centralized system as they allow the implementation of plan according to schedule and deadlines. The data is gathered by centralized agency from different vaccination points. Centralized system is efficient in countries such as UK and some other EU countries i.e. Finland. In decentralized system data is gathered from retrospective studies in different times at different locations. The superiority of centralized system sometimes demonstrated when comparing to countries with decentralized vaccination systems e.g. France which achieves lower measles coverage rates.

The reliability of information also varies across EU countries as a function of a good surveillance system is key. A major recently outbreak in Bulgaria served as an example of poor reporting strategy, under-reporting of susceptible population leads to measles outbreak. The data protection laws in countries such as Germany also prohibit the evaluation of vaccine administration, where the official data is gathered only at the time of school entry. The evaluation of coverage by conducting serological surveys to identify susceptible individuals even in very small clusters was very efficient to understand the real situation.

Severe adverse event reported with vaccination might be rare, even if reported, are not frequently studied and its correlation with vaccine administration is some time not clearly demonstrated to public.

3.3 Epidemiological Trends

In the Figure 2 the distribution of measles incidence rate varies considerably among the seven EU countries. The aggregate growth rate of the measles incidence in 7 countries in our consideration has been increasing at a CAGR (Cumulative Average Growth Rate) of 24% per year since 2007. France and Italy have been contributing to the total CAGR per year by 166% and 8% respectively. Otherwise the rest of the countries have negative CAGR.

France and Italy registered a 220% and 400% growth in measles incidence from 2.5 to 8.0 and from 0.3 to 1.5 cases per 100,000 individuals respectively during 2010. Consistent increase in the measles incidence in France leading to an outbreak in 2008[16], 2009 [17] and 2010.

A cyclical incidence pattern has been observed in Germany and UK with slight epidemic peaks. Measles outbreaks were reported from UK in 2006 [18, 19], 2007[19] and 2008 [20].

The total number of incidence rates can easily be depicted from the trend line shown in the graph. It has been increasing since 2007 at a CGAR of 24% as mentioned earlier.

Bulgaria and Slovakia were excluded because of their scattered incidence trends. From 2006 to 2008 the incidence rate in Bulgaria was <1 per 100,000 inhabitants; however, high number of measles cases were reported in 2009-2010 resulted in crude incidence rate of 29.9 and 294.5 per 100,000 inhabitants in 2009 and 2010 respectively. Their scattered incidence rate was hindering us reaching/showing any concrete trend in our incidence rate analysis.

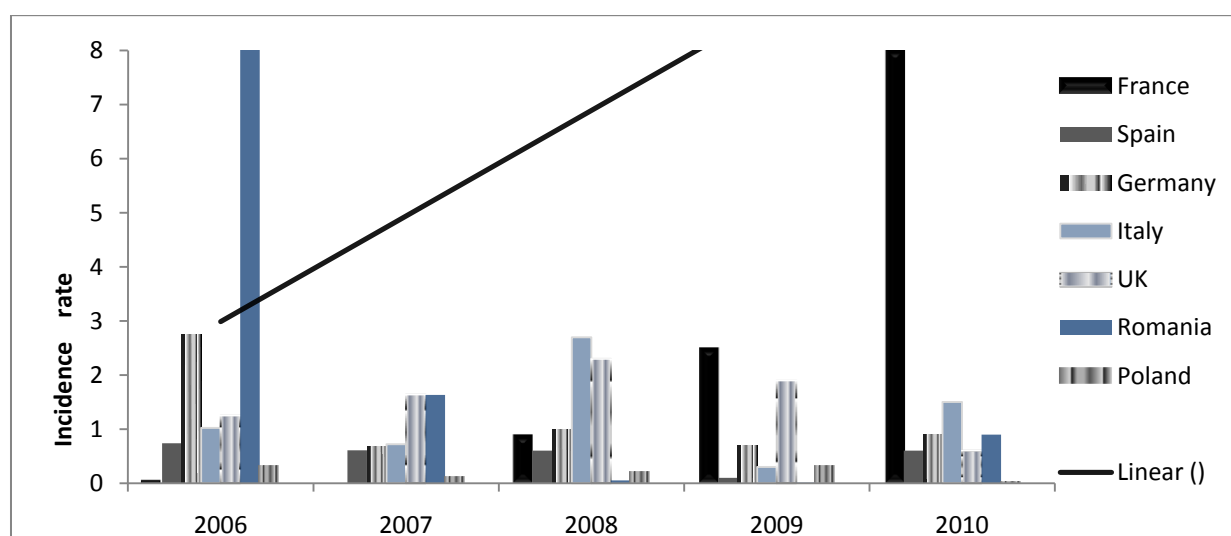


Figure 2: Measles incidence rate in the selected EU countries and trend.

In table 2 during 2006 the reported number of total measles cases in selected EU countries were 7,321 and lowest in 2007 (n=2,682). During 2006-2010 highest number of cases were reported in 2010 (n=29,531). The number of reported measles cases in France is increasing, with a progressively sharp increment of measles cases experienced between 2008 and 2010 reaching a total of 5,019 reported measles cases in 2010. In 2006 number of measles cases reported were high in Romania (n=3,169) followed by Germany (n=2,307), UK (n=740) and Italy (n=595); however, the incidence rate decreases significantly in Romania from 2006 to 2009 and slight increase was seen again in 2010. Bulgaria without indigenous transmission of measles, reported an increased number of measles cases in 2009 and reaching 22,005 measles cases in 2010. Poland recorded a 37% decrease in the incidence of measles cases in five years, decreasing the total number of measles cases from 120 measles cases in 2006 to 10 measles cases in 2010. Slovakia has maintained high national measles vaccination coverage over the five years time period reported zero cases.

Table 2: Number of reported measles cases per year

Country	2006	2007	2008	2009	2010
France	45	40	604	1544	5019
Spain	343	265	296	41	288
Germany	2307	571	915	572	787
Italy	595	420	1619	173	861
UK	740	990	1370	1144	374
Slovakia	1	0	0	0	0
Bulgaria	1	1	1	2249	22005
Romania	3169	352	14	8	187
Poland	120	43	100	109	10
Total	7321	2682	4919	5840	29531

Source: Euvact.net status of measles data annual reports [21]. Health protection agency [22]

Figure 4 show total number of measles cases attributed to vaccination, un-vaccination and unavailability of data in selected nine EU countries. During the five years time period of 2006-2010 a total of 50,293 measles cases reported in these countries; of 19,191(38.16%) cases occurred among unvaccinated individuals 4,593(9.13%) occurred in vaccinated individual and 25,465(50.63%) occurred in individuals with unknown status or having no data. It is important to note that, of 25, 4655 measles cases that occurred in Bulgaria in 2009-2010 no

data on immunization status was available for 22,005(89.70%). Excluding Bulgaria among the eight countries 73% of the reported cases during five year occurred among un-vaccinated i.e. unprotected persons.

In the available data of eight countries (figure3) the UK and Germany has the highest number of un-vaccinated cases with 92% and 84% respectively followed by France (79%) and Italy (70%). The number of un-vaccinated cases in Spain and Poland is around 65%. In Spain over 60% of measles cases are attributed to non-vaccination in five years. In Bulgaria 94%17 cases reported was having no record in the country health care statistics. It is well known that measles cases are not reported and the degree of under-notification is higher in Bulgaria. Overall the situation in these EU countries shows that there is a low coverage for measles vaccination and elimination requires very high level of vaccine coverage and low level of population susceptibility.

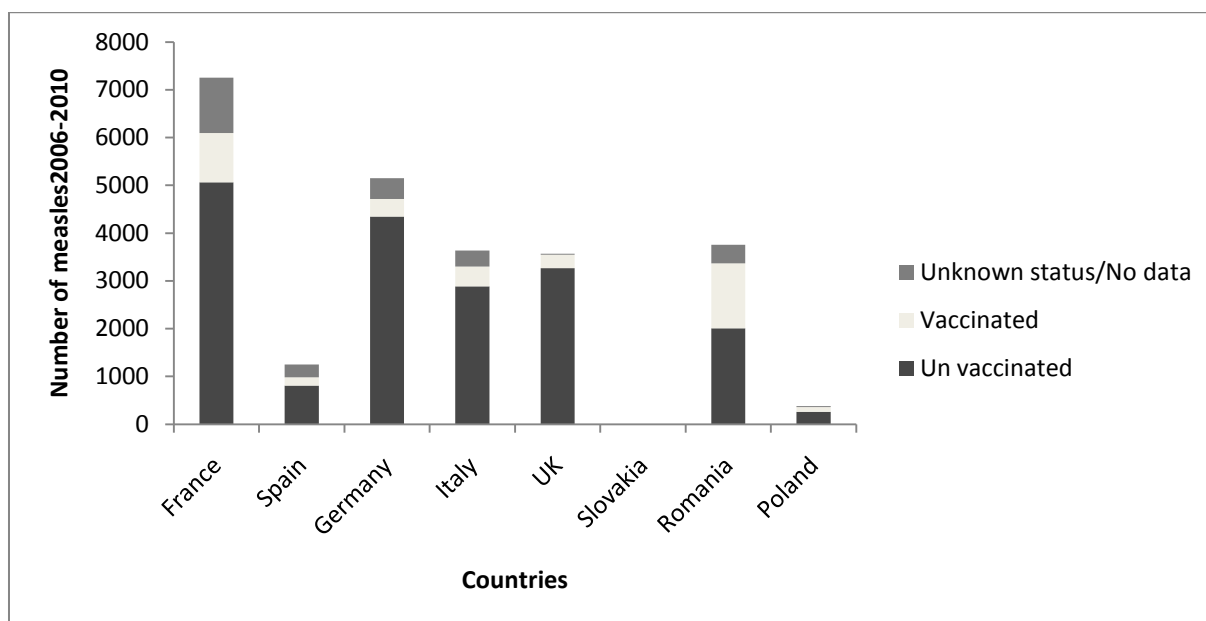


Figure 3: Number of reported measles cases in some EU countries between 2006-2010

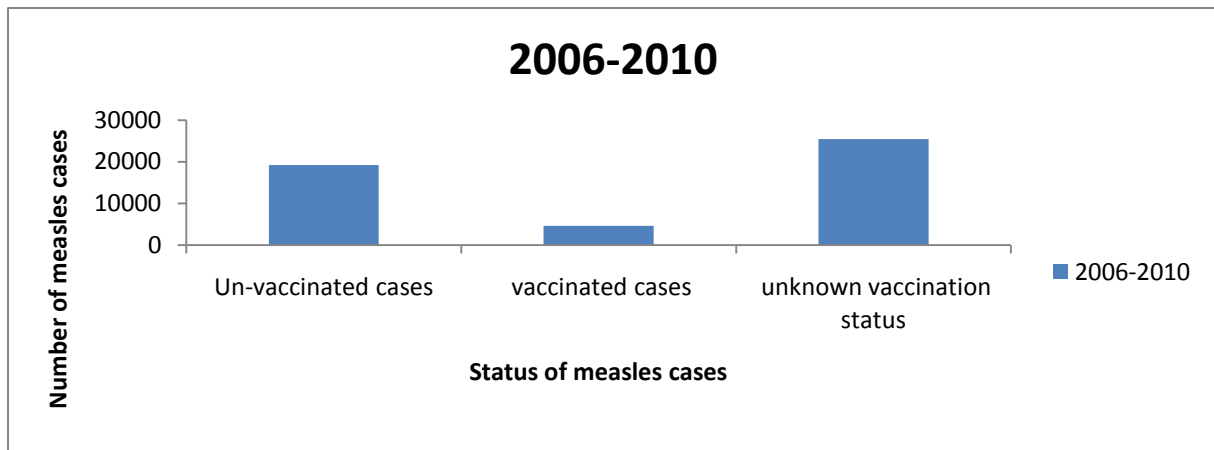


Figure 4: Number of measles cases for the nine studied countries between 2006-2010

In the given data of seven EU countries presented in figure 5 France and Germany has the highest contribution to the total number of cases in these countries in five years with 29% and 21% respectively. The contribution of Romania, UK and Italy is around 15% while Spain and Poland has a lower disease rate contribution among the group. The number of measles cases occurred in Bulgaria is excluded from the analysis in figure 6 because the percentage contribution of Bulgaria to the total number of cases in these countries is almost equal. Bulgaria witnessed an abnormal number of cases reaching to 24,254 during 2009-2010.

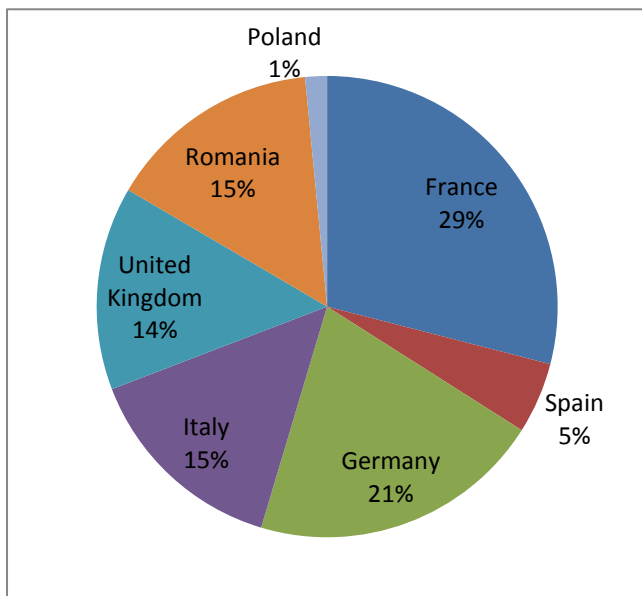


Figure 5: Proportion of measles by country cases to total number (excluding Bulgaria).

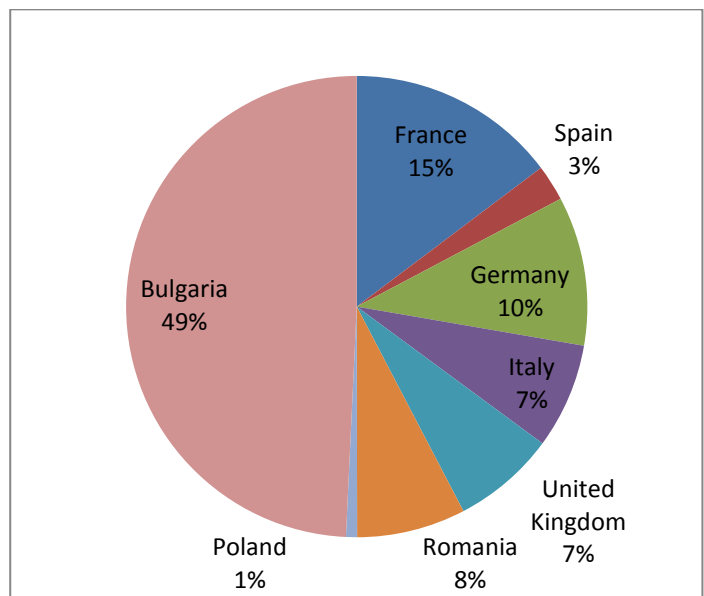


Figure 6: Proportion of measles cases by country to total

In Table 3 MCV1 and MCV2 coverage rates are given for the four year time period for the selected EU countries. Nationally, France and UK has not achieved the WHO recommended >95% measles vaccination coverage in four years. Vaccination coverage for 1st dose of MMR in Spain is above 95% over four years but coverage for 2nd dose of MMR vaccine remained below the WHO >95% recommended level. Poland also successfully achieved the 95% vaccination level for both 1st and 2nd dose and MMR vaccine. In Bulgaria the national average for the 1st dose of MMR vaccine was above 96% in the past years, and Bulgaria ranked among EU countries in 11th place regarding vaccination coverage with MMR but these figures doesn't include many susceptible individuals. Slovakia has maintained high national measles vaccination and in recent years it has been stable at 99%.

Table 3: MCV1 and MCV2 coverage rates in the overall population per year

Country	2006		2007		2008		2009	
	MCV1	MCV2	MCV1	MCV2	MCV1	MCV2	MCV1	MCV2
France	87.0	N/A	87.0	N/A	87.0	N/A	90.0	N/A
Spain	97.0	94.1	97.0	94.9	98.0	94.4	98.0	90.0
Germany	95.0	76.6	95.0	83.2	95.0	88.6	96.0	91.0
Italy	88.0	N/A	90.0	N/A	91.0	N/A	90.0	N/A
UK	85.0	75.1	86.0	74.4	86.0	75.0	86.0	79.0
Slovakia	98.0	98.6	99.0	98.5	99.0	99.0	99.0	99.0
Bulgaria	96.0	93.3	96.0	94.0	96.0	94.3	96.0	93.0
Romania	95.0	96	97.0	96.1	97.0	95.0	N/A	
Poland	99.0	99.0	98.0	98.0	N/A		98.0	95.0

3.4 Barriers in vaccination Uptake

There are many reasons explaining why countries in EU are not meeting the measles immunization goals. Despite the availability of technical and economic resources in EU some countries couldn't achieve the measles elimination targets. The main barriers found are:

Vaccination system

Vaccination systems widely differ across the EU countries from highly centralized to decentralized. Some countries have achieved high vaccination coverage and high uptake of

some antigen but not for other like measles. Delayed schedule, missing dose, reporting procedure all together have impact on the effectiveness of the system.

Perception of vaccination

This has been an issue for most of the EU countries. Poor understanding and low risk perception about measles vaccination by the public and health care professional act as a barrier in vaccination uptake. Inaccurate perception ranges from safety to suspected side effects of MMR vaccination. Weak information circulated by mass media has damaged the confidence in measles vaccination of public and health care professionals leading to the perception of low importance of measles vaccination. Furthermore, most of the people don't realize the severity of vaccine-preventable disease because of success of immunization programs. A survey conducted in Italy on exploring reason why parents don't vaccinate their children found that lack of information account for 9.9% of non MMR vaccination [23]. Another study conducted in Germany found that 12.2% of the participants assume that vaccination can cause overload of a child's immune system [24]. French study on population show that high level of education was related to low devotion to mandatory vaccination [25].

Active opponents

Some groups of people have raised controversies about the vaccination and their relationship with individual rights or natural immunity. These groups are active around the world including EU. Although these groups are not openly against vaccination neither they can be a big challenge to elimination campaign but they are active in disseminating their own interpretation of vaccination leading to misunderstanding in parents mind to vaccinate their children. (For example jabs at www.jabs.org.uk, Dutch association of critical vaccination at www.nvkp.nl).

Political will

Measles immunization is not rated equally important on political agendas across the EU. To achieve the goal of measles elimination from EU by 2015 high level of political commitment and resource mobilization is required. A harmonized immunization program across Europe would be essential to alleviate the ongoing measles crises. Financial support is required to some EU member states to sustain high vaccination coverage, and political commitment is desirable to support these countries to achieve the elimination goal in the near future. High level of political support to public health professional is critical to counterfeit the anti-vaccination sentiment in EU.

Role of media

The role of media is very critical in the measles elimination campaign promoting negative perceptions about measles vaccination, hindering achieving measles vaccination goals of elimination. In the UK Wakefield falsification of evidence associating MMR vaccine with autism has been highlighted by media which has given momentum to anti immunization attitude.

3.5 Successful strategies

WHO Region of the Americas has successfully interrupted indigenous measles virus transmission in 2002 hence achieving the elimination of measles from the region. This achievement was as a result of successful implementation of measles vaccination strategies although voluntary. The strategies in the elimination plan mainly focus on: “Catch-up” campaign were rapidly conducted to interrupt chain of measles transmission, Second achievement was improving routine vaccination services which were achieved by improving access to vaccination services, cover the missing doses, appointments, special housing vaccination activities and SIAs were conducted to reach susceptible population. Measles surveillance system was strengthening across the region and efficient follow up policy was adopted for the targeted population. Mass media campaigns were used to communicate the risk and benefits to population and attract them to vaccination centers.

Slovakia a new European member state, which has successfully maintained above 95% measles vaccination coverage at national level. It has reported zero cases in the last five years. Mass vaccination, SIAs, serological studies and catch-up campaigns were the key tools of their success. During the campaign when lower MMR vaccination rate was discovered at any level of population following actions were taken to improve the coverage.

During the local campaigns vaccination arrangement were made for children who were not vaccinated within the scope of regular vaccination and re-vaccination. Also for children who were vaccinated insufficiently, even if this meant “door to door” vaccination for those who evaded vaccination in any mass organized campaigns.

4. Discussion

The initial goal of measles elimination by 2010 was not achieved because not all the children are vaccinated on time. The required “herd immunity” level for prevention of circulation of the virus was not achieved in Europe and there exist pockets of susceptible groups which are never immunized. Vaccination coverage needs to be closely monitored as it is the best indicator of an immunization programme’s ability to obtain the desired targets.

In this study we found that the total numbers of measles cases in nine EU countries during five years are 50,293, among which 19,192(38.16%) were unvaccinated, no data available for 25,465 (50.63%) measles cases and 4,593 (9.13%) were vaccinated but infected with measles virus. The 38.16% cases which occurred during the five years span in these selected countries can be controlled with effective interventions and increase vaccination coverage which could interrupt of measles transmission. With low coverage measles virus will continue to circulate and measles epidemics will occur. Increased vaccination coverage can provide protection from disease to the susceptible 19,192 individuals in these EU countries. Measles vaccination coverage has fallen down in western and some eastern EU countries below the recommended 95% (for first MMR dose) and coverage rates for the second measles vaccines are even lower.

It is observed that although France has reached high vaccination coverage for many infectious diseases, the measles vaccination rate is low, measles is still prevalent and incidence rate has increased since 2008. France belongs to those EU countries where measles is still highly prevalent and measles vaccination coverage is insufficient. Vaccination coverage remained around 80% to 85% for many years in France as of insufficient catch-up programmes; it has built up cohort of susceptible population and become prone to outbreak [26]. The measles outbreak was noticed in early 2008 [27] which become serious and spread throughout the country reaching total number of 5,019 in 2010. During the first two months of 2011, of the total (n=5,875) reported measles cases in 32 European countries 5,582 were reported from five countries: France (84%), Spain (3%), Romania (3%), Germany (2%) and Bulgaria (2%). The reported measles cases in France in first two months of 2011 are six fold high than the whole of the first quarter in 2010 [28].

It is also clear that not only policy but awareness of risk perception of measles and the perception of the benefit/risk balance of vaccination and strong commitment from health care professionals are essential elements to optimize measles vaccination coverage. The role of doctors seems to be a determining factor in convincing people immunizes themselves and their children’s; according to a French study one of the main reasons stated by the general

population for not vaccinating their children against measles is that their practitioner did not offer measles vaccination [29]. The association between opinion regarding mandatory vaccination and their attitude for towards different vaccination in general population and practitioners is also very important. A survey conducted in France reveals that 56.5% of the respondents from the general population think that immunization against vaccine preventable diseases should be mandatory [30].

In Italy, although the number of reported measles cases has diminished since the introduction of measles vaccines planning 2003-2007 and there is a constant decrease in measles virus circulation, but vaccine coverage is not sufficient to interrupt transmission. The plan aimed to force efforts to reach target coverage (95%) in children at 24 months of age, introduce second MMR dose and to perform catch-up vaccination program. The implementation of measles elimination plan brought efforts to increase vaccination coverage; however the wide inter-regional difference registered in the past are now much less evident [31]. Vaccine coverage at 24 months of age although yet at target levels not achieved situation is improved in all regions of country. A second important point in this campaign was immunization campaigns throughout schools to increase the immunization against measles. Vaccination acceptance issue was also raised in Italy and was demonstrated by higher refusals of immunization during this campaign for measles elimination in school vaccination and reason found was poor understanding of the disease by parents.

It was also explored that Bulgaria, after several years without reporting measles transmission reported an increase number of measles cases in 2009-2010 where more than 24,000 people contracted measles and 24 people (mostly children) were reported to have died from complications of measles. Measles vaccination coverage for the 1st dose in 2008 was reported 96% which is the recommendation of WHO, but the outbreak reveals the poor monitoring and poor reporting system or insufficient identification of the susceptible population. The primary reasons identified by the ECDC investigation team for measles outbreak in Bulgaria were lower immunization coverage than the official reported rates and sub-optimal population being missed in immunization campaign. Low vaccination coverage experienced in sub-optimal population of which 90% of cases occurred in Roma community [38]. These under-vaccinated groups frequently act as entry point for imported measles, which develop into outbreaks. The ECDC investigation team also found that Roma population was not included in studies on vaccination coverage as: 1) they were not registered with a GP or health care professional; 2) possibility of inaccurate recording of immunization not given; 3) immunization being delayed due to false contradiction. According to a report 55% of Roma indicates that they have only limited access to health care facilities and 46% don't have health insurance and are deprived of access to any health care services

[32]. The multiple socioeconomic factors, health care reforms in Bulgaria and their unplanned long term consequences also contribute to measles outbreak.

In our work we found that situation in Spain, UK and Germany are roughly similar. There is an ongoing measles outbreak in Spain, in first eight weeks of 2011, a total of 407 measles cases have been reported to EUVAC.net. The outbreak starts in Granada in small community with low measles vaccination coverage and by 7, December 2010, a total of 59 confirmed measles cases have been reported. Although the incidence rate in Spain is below 1 per 100,000 inhabitants followed recommended rates for achieving elimination of measles yet there have been many un-vaccinated individuals. The response to vaccination was slow as parents were not aware of, or perceived the severity of measles vaccination too low to vaccinate their children or having some ideological or cultural objections to vaccination [33]. It was pointed out that catch-up program implementation can control the situation to vaccinate the susceptible population but till now it has not been launched.

The experience was highly successful during the measles elimination plan in WHO Americas strategies adopted were focused on catch-up campaign to rapid interrupt chains of measles transmission as these campaign results in rapid increase in population immunity and a high coverage can interrupt transmission rapidly. During the Pan-American measles elimination, “catch-up” campaign was conducted in a period of low measles transmission. “Catch-up” is a one-time rapid campaign to interrupt measles transmission. In Pan-America’s measles elimination campaign all children aged 9 to 14 were vaccinated irrespective of their vaccination history. The program was funded by their respective Governments and partly by collaborative agencies. Social mobilization for the active participation in the campaign was done through health care centers and media. Germany has achieved immediate reduction in the number of reported measles cases after 2006 but still didn’t achieve the >95% national measles vaccination coverage

A sensitive and efficient surveillance system is an important element for monitoring measles elimination program. Apart from notification and reporting serological surveys are very important to perform on a regular basis, on representative sample of population to confirm or rule out measles virus infection, and to quantify the size of susceptible reservoir in population. To provide early awareness and information on current situation to public health workers in America’s weekly measles surveillance bulletin was circulated, summarizing recent outbreak in countries, total cases under investigation and confirmed measles cases by country [34]. In the EU among the nine selected countries Slovakia maintained successfully above 95% measles vaccination coverage nationally and reported zero cases in last five years. Mass vaccination, serological surveys and vaccination of targeted population were the

main tools of achievements. Slovakia adopted its plan of measles elimination similar to Pan Americas. Slovakia continues regular measles vaccination but beside regular vaccination they focus on: 1) Supplementary immunization activities (SIAs) in areas with low vaccination status irrespective of vaccination history or illness; 2). Vaccination of individuals identified as susceptible or source of infection; 3) vaccination in refugee camps if no measles vaccination document found and children vaccination with MMR was made compulsory in these camps; 4) Enhance public communication, information and communication through patient information leaflets (PIL); 5) immunological surveys conducted rapidly to verify the immunity of population and to maintain the immunity level recommended by WHO in the individual age categories, i.e. the proportion of susceptible person in case of measles should not exceed 15% among 1-4 years old , 10% among 5-9 years old and 5% among 10 years old. From the results, it was explored that mandatory vaccination has a relation with coverage rates. It will not leave choice to those with low vaccination status.

From our results, EU regional strategies of measles elimination mainly focus on reaching high immunization coverage with two doses of measles through strengthening their vaccination system and routine immunization activities but didn't include the periodic follow up supplementary immunization activities (SIAs). SIAs have been validated as a tool to catch-up those individuals with low vaccination status as experienced by WHO in the Americas and regionally in Slovakia. The most important limitation are those relating to the evaluation of the vaccination coverage in these countries, lack of active reminder system to pick up missed patient appointments and missing doses. It is also important to strengthen the surveillance, reporting system and conducting serological studies to identify the immunity gaps in the population. These activities will help to reach the susceptible population early. If early measure to control measles spread were not taken in EU there is risk of resurgence in areas where measles is eliminated.

During the first 19 weeks of 2011, 118 measles cases were reported in United States which is the highest number of reported measles cases since 1996. Of 118 reported cases 46 were imported, among those 40 (87%) were imported from WHO European region [35]. The average data of the countries in our consideration show that the un-vaccinated cases are weight more than the vaccinated cases. Here more than the effectiveness of the vaccination, the vaccination management in these countries is to be questioned. The data is depicting grave lack of seriousness and effectiveness of the vaccination program in these countries as 73% of measles cases are actually un-vaccinated i.e. unprotected. It is not a lack of vaccine effectiveness, but rather more a lack of effectiveness of vaccination programs in there EU countries, often in wealthy and highly insured societies.

The findings in this study are subjected to some limitations. First, the information reported in various papers was not homogenous and not all the assessed literature provided measles case-distribution data stratified by age group. Many of the published reports are based on initial research done in an event of outbreak and, the number of reported measles cases varies considerably from the reports published after outbreak. Another limitation is the language barrier, most of the countries data is published in their native languages and in our study we only accessed data published in English, putting the limitation in amount of data we could collect.

To meet the new measles elimination goal of 2015, serious efforts and innovative approaches need to be implemented by these countries. Besides, strengthening the routine immunization activities, supplementary activities such as SIAs, catch-up campaign and use of mass media campaign for public to enhance the health awareness are required.

5. Recommendations

Following are some of the most important recommendations which can play a key role in achieving measles elimination by 2015:

5.1 Communication

Role of communication is very important in elimination campaign. Communication reduces the challenges that hinders immunization program. It may include strong advocacy, community mobilization, educational program or launching healthy activities.

Health care Professional

The reliability of source of information and their dissemination to public is very important. Health care professionals, doctor, nurses and pharmacists generally being highly trusted by the public are the most important means of advocating and providing information. Their role in providing sufficient information on the consequences of not vaccinating their children can convenes hesitant parents to vaccinate their children. The German study has shown that 95% of the participants identified their pediatrician as the most important source of information on vaccination [36].

Role of Media

It is assumed that media has strong influence in moulding the perception and changing the attitude of the people. Today, as most of the people in the developed world are connected to internet, the importance is not limited to TV, Radio and

newspaper. It is evident that 45% of EU adults use internet to obtain health information and only one third of people who obtain information verify with their doctors [37]. The impact has been experienced in UK where media coverage led to MMR vaccine controversy alleging the link between MMR vaccine and autism lead to perception as genuine threat leading to reduce uptake of measles vaccine in UK. It is very important to boost the health literacy of media professionals, so that they can convey accurate message which is very important in elimination campaign. They will better explain the safety of measles vaccine and help increase the general knowledge of benefits of vaccination. Publishing safety information and motivation statements on highly navigated sites will provide information to audience of different ages. Use of posters with motivating pictures and text which illustrate the importance of measles vaccination are also important and has been experienced recently in UK where short leaflets with key messages on measles vaccination were distributed in public places. This will also tackle the active opponents: anti vaccination groups, religious or other individual and social factors hindering measles vaccination uptake.

5.2 Vaccination System

Strategy

Strategies adopted in EU member states vary regionally. High national vaccination coverage of above 95% for the 1st dose of MMR vaccine is required to envisage elimination of measles. Along with improved routine immunization the policy needs to focus on other critical component i.e. SIAs, serological studies to early interrupt the measles transmission. Harmonization of immunization in policies across European region should be a high political and professional objective in the coming years.

Mandatory measles vaccination

A good control on measles cases has been experienced in countries where measles vaccine is mandatory leaving no choice but vaccination of the susceptible population. Implementation of compulsory measles vaccination linked to school entry can avert the situation in measles epidemic EU countries but requires political commitment.

Enhance surveillance

The surveillance and reporting system needs to be more efficient and use of European portal for control of communicable diseases i.e. EUVAC.net is very helpful to share information of measles case and updates to the member states in EU. Case based surveillance system needs to be strengthened to reach and monitor vulnerable and high risk population.

Access

Free access to vaccination services should be available for everyone. Although in most of EU countries measles vaccination is accessible free of cost irrespective of their nationality, the policy is still not standardized in all countries as illustrated by the case of Bulgaria where Roma ethnic groups have limited access to health care and were identified as major source of measles outbreak in Bulgaria in 2009-2010 due to un-vaccination.

6. Conclusion

From the study, it is concluded that interrupting measles transmission in EU requires high level of measles vaccination and harmonization of immunization policies to increase herd immunity and prevent inter country transmission. Despite with high national immunization coverage of MMR vaccine in some EU countries, consistent measles outbreaks in recent years in EU demonstrate the existence of non-immunized population. Measles cases have been reported from a number of countries in EU; however, the contribution of our selected countries to the total number of measles cases is highest. The importance of enhancing surveillance system by case based investigation and by seroprevalence surveys is critical to monitor the progress towards elimination. Apart from this combined effort of EU member states, it is crucial to reduce the poor understanding or low risk perception on the part of general public about measles vaccination, lack of active reminder system, reporting and evaluation mechanisms which are demonstrated as barriers to vaccination uptake in EU. There is also risk of spread of measles epidemic to other continents from which measles has been eliminated. The maintenance of a good surveillance system and optimal national vaccination coverage are the cornerstones to achieving the goal of measles elimination by 2015. To reach measles elimination goal by 2015, high level of political and societal commitment by sharing resources and experience are needed along with inter country cooperation and coordination of vaccination policies.

References

1. Verweij M, Dawson A. Ethical principles for collective immunisation programmes. *Vaccine* 2004;22(23-24):3122-6.
2. Siedler, W. Hellenbrand, G. Rasch: Measles outbreaks in Germany. *Euro surveillance Weekly* 2002; Vol.6, Issue 12
3. WHO. Eliminating Measles and Rubella and Preventing Congenital Rubella Infection. WHO European Region Strategic Plan, 2005–2010. World Health Organization; 2005. Available at: <http://www.euro.who.int/document/E87772.pdf> (accessed 21 April 2011).
4. Schmitt, H.J, R Booy, et al. (2007). "How to optimize the coverage rate of infant and adult immunization in Europe." *BMC Medicine* 5 (1): 1-8-8.
5. Centralized information system for infectious diseases(CISID) [database on the Internet]. Copenhagen: World Health Organization Regional Office for Europe; 2009. Available from: <http://data.euro.who.int/cisid/?TabID=226538>.
6. Lopalco PL, Martin R. Measles still spreads in Europe: who is responsible for the failure to vaccinate? *EuroSurveill.*2010;15(17):pii=19557. Available online: <http://www.eurosurveillance.org/ViewArticle>.
7. World Health Organization (WHO). Resolution. Renewed commitment to elimination of measles and rubella and prevention of congenital rubella syndrome by 2010 and Sustained support for polio-free status in the WHO European Region. Moscow, Russia, WHO Regional Office for Europe; 2010. Available from: http://www.euro.who.int/data/asset_
8. Steffens I, Martin R, Lopalco PL. Spotlight on measles 2010: Measles elimination in Europe – a new commitment to meet the goal by 2015. *Euro Surveill.*2010;15(50):pii=19749. Available online <http://www.eurosurveillance.org/ViewArticle/measles>.
9. Measles surveillance annual report 2010 published on 8, April 2011, Reporter Mark Muscat and Henrik Bang, Available online at EUVAC.NET Available online at: http://www.euvac.net/graphics/euvac/pdf/annual_2010.pdf (accessed 21, April 2011)
10. WHO, Weekly epidemiological record; 7 January 2011, No. 1-2, 2011, 86, 1-16 available at: www.who.int/wer.
11. Chin J (ed.) (2000) *Control of Communicable Diseases Manual*, 17th edition. Washington, DC: American Public Health Association.
12. Wolfson LJ et al for the Measles Initiative. Has the 2005 measles mortality reduction goal been achieved? A natural history modeling study. *The Lancet*, 2007, 369:191–200
13. Miller MA, Redd S, Hadler S, Hinman A: A model to estimate the potential economic benefits of measles eradication for the United States. *Vaccine* 1998, 16:1917-22.
14. Plan de Acción para la Eliminación Del Sarampión en Andalucía [Action plan for measles elimination in Andalusia]. Sevilla; Dirección General de Salud Pública y Participación, Consejería de Salud, Junta de Andalucía [Andalusian Regional Ministry of Health]; 2001. Spanish.
15. Schmitt HJ, Booy R, Aston R, et al. How to optimize the coverage rate of infant and adult immunizations in Europe. *BMC Medicine* 2007; 5:11
16. Thierry S, Alsibai S, Parent du Châtelet I, on behalf of the investigation team. An outbreak of measles in Reims, eastern France, January-March 2008 preliminary report. *EuroSurveill.* 2008;13(13):pii=8078. <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=8078>.
17. http://www.invs.sante.fr/beh/2009/39_40/beh_39_40_2009.pdf
18. Increase in measles cases in 2006, in England and Wales CDR Weekly. Volume 16 Number 12. 2006. [Cited on 5 may 2011] Available from: <http://www.hpa.org.uk/cdr/archives/2006/cdr1206.pdf>
19. Cohuet S, Morgan O, Bukasa A, Heathcock R, White J, Brown K, et al. Outbreak of measles among Irish Travellers in England, March to May 2007. *Euro Surveill* 2007;12(6):E070614.1. <http://www.eurosurveillance.org/ew/2007/070614.asp#1>

20. Health Protection Agency. Confirmed cases of measles in England and Wales – an update. Health
21. EUVAC.NET A surveillance community network for vaccine preventable diseases, *Status of measles surveillance data*. [online](updated 14 April, 2011) Available at: http://www.euvac.net/graphics/euvac/status_2011.html [Accessed 15 April, 2011]
22. Health Protection Agency, 1996-2010. *Confirmed cases of measles, mumps and rubella*. [online](updated 23 February 2011) Available at: http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733833790 [Accessed 14 April 2011].
23. Istituto Superiore di Sanità, ICONA Working Group. ICONA 2008: National vaccination coverage survey among children and adolescents, Rapporti ISTISAN. 2009 Sep; 29:118.
24. Heininger U. An internet-based survey on parental attitudes towards immunisation. *Vaccine*. 2006 Sep 11; 24(37-39):6351-5
25. Nicolay N, Levy-Bruhl D, Gautier A, Jestin C, Jauffret-Roustide M. Mandatory immunisation: The point of view of the French general population and practitioners. *Vaccine*. 2008 Oct 9; 26(43):5484-93
26. Lévy-Bruhl D, Pebody RG, Veldhuijzen I, Valenciano M, Osborne K. ESEN: a comparison of vaccination programmes – Part three : measles mumps and rubella. *Euro Surveill*. 1998; 3(12):pii=112. Available from: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=112>
27. Parent du Châtelet I, Floret D, Antona D, Lévy-Bruhl D. Measles resurgence in France in 2008, a preliminary report. *Euro Surveill*. 2009; 14(6):pii=19118. Available from: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19118>
28. Measles surveillance January-February Report 2011. Available from: http://www.euvac.net/graphics/euvac/pdf/2011_jan_feb.pdf
29. Baudier F, Léon C. Immunization: un geste à conforter. *Baromètre santé 2005. Premiers résultats*. INPES ed.; 2006. p. 85–92
30. Nicolay N, Levy-Bruhl D, Gautier A, Jestin C, Jauffret-Roustide M. Mandatory immunisation: The point of view of the French general population and practitioners. *Vaccine*. 2008 Oct 9; 26(43):5484-93
31. Ciofi degli Atti ML, et al. Do Changes in policy affect vaccine coverage levels? Results of a national study to evaluate childhood vaccination coverage and reasons for missed vaccination in Italy. *Vaccine* 2004; 22:4351–7
32. Open society Institute (2007), How the Global Fund can Improve Roma Health. An assessment of HIV and TB programs in Bulgaria, Macedonia, Romania, and Serbia. Public health program; www.soros.org/health.
33. López Hernández B, Laguna Sorinas J, Marín Rodríguez I, Gallardo García V, Pérez Morilla E, Mayoral Cortés JM. Spotlight on measles 2010: An ongoing outbreak of measles in an unvaccinated population in Granada, Spain, October to November 2010. *Euro Surveill*. 2010; 15(50):pii=19746. Available online: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19746>
34. Pan American Health Organization. Weekly measles bulletin is launched. *EPI newsletter*. December 1994; 16:8
35. Centers for Disease Control and Prevention. [Measles United States, January-May 20, 2011]. *MMWR* 2011; 60 : (20); 666-668.
36. Heininger U. An internet-based survey on parental attitudes towards immunisation. *Vaccine*. 2006 Sep 11; 24(37-39):6351-5.
37. Waisbord S, Larson HJ. Why Invest in Communication for Immunisation? Evidence and Lessons Learned. [Http://www.ponline.org](http://www.ponline.org). Accessed 26 May 2011.
38. ECDC and WHO risk assessment mission, 7-12 February 2010, measles outbreak in Bulgaria, march 19 2010.

Abstract in French

La vaccination contre la rougeole dans l'Union Européenne

Contexte

L'OMS avait planifié l'élimination de la rougeole en Europe en 2010, mais cet objectif n'a pas été atteint et un nouveau plan d'élimination a été fixé par l'Union Européenne pour 2015. Certains pays ont atteint les objectifs fixés alors que d'autres sont loin de les avoir atteints. La vaccination contre la rougeole a été intégrée dans la vaccination systématique des enfants dans les pays de l'Union européenne depuis plus de vingt ans. L'objectif de notre étude était d'analyser la situation des pays avec un taux d'incidence de rougeole élevé, les stratégies adoptées et leur efficacité pour atteindre l'élimination de la rougeole d'ici à 2015.

Méthodes

L'analyse des stratégies adoptées a été réalisée pour neuf pays européens. Les données sur le nombre de cas de rougeole, le taux d'incidence et de la couverture vaccinale contre la rougeole, au cours des cinq dernières années (2006-2010), ont été recueillies à partir des rapports officiels, la littérature et le portail européen des maladies transmissibles. La situation actuelle dans ces pays a été décrite à partir de leur système de vaccination, des stratégies et ses résultats vis-à-vis de l'objectif d'élimination de la rougeole.

Résultats

Pendant la période 2006-2010, 50293 cas de rougeole ont été recensés dans ces pays, à l'exception de la Slovaquie, où aucun cas n'a été rapporté dans les cinq dernières années. Il existe d'importantes différences dans les taux de vaccination de ces différents pays. La Bulgarie (49%) était le pays qui a contribué le plus au nombre de cas recensés entre 2006 et 2010, suivi de la France (15%), l'Allemagne (10%) et la Roumanie (8%). Les taux d'incidence élevés dans ces pays mettent en évidence une sous-couverture vaccinale.

Conclusion

Les pays qui ont mis en place avec des campagnes régulières d'information adressées aux populations présentant un taux de vaccination faible ont un taux d'incidence de rougeole moins élevé et une meilleure couverture. Les transmissions entre les pays de cette maladie

très contagieuse rendent difficile l'objectif de zéro cas en 2015 dans l'Union Européenne. Le manque d'harmonisation entre les réglementations peut être une autre barrière pour atteindre cet objectif. La présence de population peu ou pas vaccinée dans ces pays européens et le taux de couverture vaccinale faible remet en question la possibilité de l'élimination de la rougeole en 2015. Des taux de vaccination élevés, une amélioration de la surveillance et la mise en place de campagnes médiatiques pour informer les gens des bénéfices de la vaccination sont les éléments clés des campagnes d'élimination de la rougeole dans l'Union Européenne.

Annex 1: Main characteristic of vaccination system in France, Spain, Germany, Italy and United Kingdom

	France	Spain	Germany	Italy	United Kingdom
Vaccination System					
Kind of vaccination program exist	Decentralized	Decentralized (19 Autonomous Communities)	Decentralized	Centralized (Low Degree)	Centralized
Financing Mechanism	For all vaccines 65% reimbursed by Social Security. MMR and influenza is free financed by National Health insurance scheme.	Individually purchase by each Autonomous Community. No National Fund provided	Health Insurance (Public health Services)	National Health System and regional vaccination committees.	National Health System (NHS) financed from Taxation
MMR Vaccines Providers					
Vaccine Providers	Private practitioners (pediatricians' and GPs), Public maternal and child health Clinics.	Pediatrician, Physician or nurses in school	Pediatricians, Public health Services	Vaccination Clinics, Local health care Units	In primary Care practice, Community based pediatric services
Risk/Benefit Information Providers	GPs, Pediatricians', immunization clinics.	Autonomous Communities inform physicians', parents. Spanish pediatrics' care through website.	Pediatricians, Private practioner, Public health authorities.	Vaccination Clinics, GPs and regional health authorities	GPs, Physicians, Nurses, Department of Health
How vaccination is Carry out?					
Compulsory/Voluntary?	Voluntary	Voluntary	Voluntary	voluntary	Voluntary
Reminder System	Individual letters by National Health Insurance By post card	Physician, Letters to parents and meetings. Mostly verbal	By Pediatricians' during consultations	GPs and local health authorities	GPs by computerized system
Vaccination at School	Possible	Possible: Yes (But parents authorization required)	Possible	Possible: meningococcal vaccine often administered at school.	Possible
Registration System, Recording and Assessment of Coverage					
Surveillance of vaccine preventable diseases ,Coverage assessment	Institut de Veille Sanitaire (InVS) www.invs.sante.fr , Direction de la recherche des études de l'évaluation et des statistiques (DREES)	Ministerio de Sanidad y Consumo (National Vaccination programme), Institute of health Carlos III www.isciii.es	By surveys, by school entrance health examination	Ministero Della salute by surveys and cluster sampling.	Cover programme (by Health protection agency) .Data collected locally from primary care trust(PCT)
Measles elimination Programs	2005-2010	2000	1999	2003-2007	
Provider Fee					
Provider's Fee	No Administration Fee	No (administered free)	7-21 Euros	Free of charge	Free of charge
Epidemiology					
Measles Cases in 2010	5019 cases	288 cases	787 case	861cases	374 cases
Incidence Rate 2010	8.0	0.6	0.9	1.5	0.6

Annex 2: Main characteristics of vaccination system in Slovakia, Bulgaria, Romania and Poland

	Slovakia	Bulgaria	Romania	Poland
Vaccination System				
Kind of vaccination program exist	Decentralized	Decentralized low level. MOH at center and 28 Regional Inspectorates for protection and control of public health regionally.	Centralized (Decisions are made at ministry of public health and implemented to whole country.	Centralized descision are made at ministry of health and General sanitary inspectorate and sanitary epidemiology board.
Financing Mechanism	Public Health Insurance (PHI). 10 mandatory vaccines financed by PHI.	Mandatory vaccines by Ministry of Health. Recommended vaccines paid by patients.	Childhood vaccination is free to all citizens financed by ministry of health	State, Self-government, National Health fund Mandatory vaccines by Ministry of Health Recommended paid by individuals/Employer/Insurance
MMR Vaccines Providers				
Vaccine Providers	Private practitioners (pediatricians' and GPs)	GPs, Pediatricians, Physicians at immunization centers, hospitals.	School nurses, Physicians, GPs	GPs, Private practitioner, hospitals and clinics
Risk/Benefit Information Providers	GPs, Pediatricians. Patient Information leaflet (PIL).	Physicians and GPs in Immunization facilities, Health care centers	County authorities of Public Health, Physicians, GPs.	
How vaccination is Carry out?				
Compulsory/Voluntary?	Compulsory	Compulsory		Mandatory
Reminder System	Family doctors, GPs and annual review of immunization coverage.	Not efficient system exist		N/A
Vaccination at School	Possible	Possible	Yes	N/A
Registration System, Recording and Assessment of Coverage				
Surveillance of vaccine preventable diseases	Regional Office of Public health	Regional Inspectorate for protection and Control of Public health.	National Centre for Communicable Diseases Surveillance and Control (ISPB)	National Institute of Hygiene www.psh.gov.pl
Coverage assessment	Institute of Public Health Authority of the Slovak Republic (UVZSR)	Department of epidemiology at National Center of Infectious and Parasitic Diseases (NCIPD).	National Centre for Communicable Diseases Surveillance and Control (ISPB)	General sanitary Inspectorate
Provider Fee				
Provider's Fee	No Administration Fee	Mandatory vaccines are free.	Free for all	Mandatory vaccine are free while recommended are paid by patients themselves/ employer/insurance.
Epidemiology				
Measles Cases in the year 2010	Zero cases	22005	187	10
Incidence rate per 100,000 inhabitants in the year 2010	Zero	294.5	0.9	0.03