Eurosurveillance

Europe's leading journal on infectious disease epidemiology, prevention and control

Vol. 15 | Weekly issue 17 | 29 April 2010

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European Centre for Disease Prevention and Control

www.eurosurveillance.org

Spotlight on measles 2010

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Citation style for this article:
Citation style for this article: Editorial team. Spotlight on measles 2010. Euro Surveill. 2010;15(17):pii=19559. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19559

This article has been published on 29 April 2010

Eurosurveillance is committed to highlight issues around measles and facilitate the rapid exchange of information that may help to implement measures that prevent the further spread of the disease. Since March 2007, we have published over 50 papers on various aspects of measles, mainly as rapid communications reporting on ongoing outbreaks but also in the form of surveillance reports and perspective papers focussing on disease trends and policy issues.

In order to support all those who tackle measles and their elimination, we have introduced a special series for the year 2010, highlighting articles that describe ongoing measles outbreaks. Under the running title *Spotlight on measles 2010* we report on ongoing outbreaks relevant for Europe with the intention to demonstrate that measles is not a problem of any one country individually, and to show creative solutions of how to deal with the challenges impeding elimination such as low coverage in various population groups and opposition to vaccines. It is true that most of the facts on measles and the reasons for their continued circulation in the European Union (EU) are well known. However, instead of entering in a measles fatigue, vigilance across Europe is needed. The fact that many outbreaks in the EU in 2009 started after importation of a case from another Member State and that cases were exported to the measles-free Americas further illustrate the potential international implications of national measles outbreaks [1].

Another occasion for the international spread of measles are mass gatherings. The 2008 European Football Championships for instance took place in Austria and Switzerland at a time when large outbreaks of measles were ongoing in both countries, a situation that required particular vigilance [2]. Curiously enough, the Football Championships seem to coincide with measles outbreaks. Currently, an outbreak is ongoing in South Africa [3], and during the 2006 International Federation of Association Football (FIFA) World Cup football tournament in Germany, a large outbreak was ongoing in parts of the country where matches were played [4]. In Canada, a community outbreak of measles started after the Winter Olympic Games in 2010 [5].

The *Spotlight on measles 2010* series started in February with a report from Ireland [6], followed by one from Germany [7]. The two articles showed the variety of aspects and approaches that need to be considered when aiming at stopping outbreaks and increasing vaccination coverage in areas where pockets of unimmunised people exist.

Much progress has been made in the fight against measles, and the goal of eliminating the disease is within reach, but to finally achieve measles elimination within the European region, all those concerned with public and individual health will now need to go the extra mile. We hope that progress is being made and that we will have to report less and less frequently on measles in the years to come. Meanwhile we hope to be able to track down outbreaks wherever they occur and look forward to receiving your contributions reporting measures taken to stop them.

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Measles still spreads in Europe: who is responsible for the failure to vaccinate?

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Citation style for this article:
Citation style for this article: Lopalco PL, Martin R. Measles still spreads in Europe: who is responsible for the failure to vaccinate?. Euro Surveill. 2010;15(17):pii=19557. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19557

This article has been published on 29 April 2010

It is not a secret that the goal of eliminating measles and rubella in Europe will not be met by the targeted year 2010. Over the past 10-12 years, national and international public health authorities have conducted extraordinary efforts that have led to a dramatic reduction in reported measles cases in the World Health Organization (WHO) European Region from 200,000 in 1994, to almost 30,000 in 2003 and 7,411 in 2009 [1]. Nevertheless, measles is still spreading in Europe and there is no time for complacency.

The European Union (EU) countries are still experiencing the highest burden; according to WHO data, some of the lowest vaccination coverage against measles are found in Western Europe where, over the past two years, 96% of measles cases in the Region were reported [1]. According to the annual reports of the EUVAC.NET, a surveillance community network for vaccine preventable diseases, children still die from measles and its complications in the EU and many cases with severe complications are reported every year [2].

No sophisticated epidemiological methods are needed to figure out the reason for this: measles immunisation coverage has fallen below the recommended 95% (for first dose at sub-national level) in many western European countries and vaccination coverage levels for the second dose of measles-mumps-rubella (MMR) vaccine are even lower. Also, many children are not immunised in accordance with the national immunisation schedules but instead they are immunised late.

Consequently, large pockets of susceptible population have been accumulating in many EU countries. When such pockets are concentrated in the same geographical area or belong to the same population group, outbreaks occur earlier and easier. Why are these pockets increasing? While they consist of populations that share the common characteristic of being unimmunised, the reasons for this vary. They may include limited or difficult access to services for vulnerable or high-risk populations, cultural or religious beliefs, vaccine hesitancy due to vaccine safety concerns, and complacency whereby immunisation is considered a low priority with no real perceived risk of vaccine preventable diseases. The latter is a result of low knowledge and awareness of the means of transmission and severity of the disease. For some, the perceived disadvantages, drawbacks and inconvenience associated with vaccination can overrule the benefits.

Measles is not only a vaccine-preventable disease; it is somehow a predictable disease. It is one of the most infectious diseases and outbreaks have to be expected when vaccine coverage levels in populations fall below 95% for a certain period. Thus it comes as no surprise that we are observing several outbreaks every year in many European geographical areas and that measles has become endemic again in some countries.

The tool and strategy for eliminating measles and rubella is there and works: MMR vaccination is safe, effective and extremely cost-saving. Nonetheless it seems that delivery of vaccination through existing healthcare systems do not achieve the expected coverage needed for elimination.

Three articles related to measles elimination efforts in Poland are presented in this issue: first, H Orlikova *et al*. describe an outbreak in a Roma community in Lubelskie province [3], secondly, the issue includes a review of the outbreaks reported in Poland in 2008-09 highlighting that the majority of these occurred in Roma communities, by J Rogalska *et al* [4]. Finally, P Stefanoff *et al*. [5] describe a study performed during a vaccination campaign in a Roma community, reporting the challenges faced in achieving high vaccination uptake within that community.

Actually, measles outbreaks have been often described in Roma communities. The large outbreak currently occurring in Bulgaria involves mainly Roma people [6]. This is similar to the outbreak in Romania, 2005-2006 [7]. However, emphasising the linkage between outbreaks and Roma populations suggests that measles is only of concern to the EU's marginalised and minority population groups. It is therefore important to note that (i) the overall number of Roma cases represents a small proportion of the region-wide European burden; and (ii) outbreaks occurring in minority groups are easier to identify, describe and publicise. For the same reasons, during the past, outbreaks within other ethnic or religious communities have received considerable coverage in the scientific literature and mass media [8-10]; (iii) some of these communities are highly mobile which allows spread of the virus through vast areas of Europe.

Therefore, we should not only look for the presence of measles among the Roma population in Europe. As reported in the article by P Stefanoff *et al.*, the current health system does not identify and reach the entire population needing immunisation. As such, the responsibility for measles and rubella outbreaks in Europe, though it may be difficult to accept, lies with us, the public health authorities. With the success of immunisation programmes over the decades, we have forgotten how serious and costly measles and rubella disease can be. The benefit and risk analysis has shifted to focus on the vaccine and not the disease.

It is us, the health authorities, that either fail to put in place all the required infrastructure and effort to implement effective MMR vaccination campaigns, or do not pro-actively campaign to meet the needs of the region's un- and under-immunised children.

It is us, doctors and nurses, who are not fully convinced about the value of MMR vaccination; ignoring the fact that some of our young patients will suffer severe disease, complications, disability or even death because we did not vaccinate them.

It is us, parents of young children, who think we have control over our children's susceptibility to an infectious virus and expose our daughter or son to an unnecessary risk of a potentially severe or fatal disease.

Finally, it is us, vaccination experts that need to remain focussed on the measles and rubella elimination goal at a time when the introduction and promotion of new and underutilised vaccines, while extremely important contributions, compete for our attention. We must recognise that without maintaining the achievements made to date, and unless we remain vigilant against measles and rubella, diphtheria and poliomyelitis, the new vaccines we have so much hope for, will not achieve their potential.

While we will not meet the measles elimination goal in 2010, it does not mean that the goal is not worth striving for and it is feasible, as demonstrated by the experience in the Americas, where the last endemic measles case was reported in 2002.

The European Region needs to show renewed commitment to the goal of eliminating measles and do its best to reach it as soon as possible. For the sake of future generations, it is our duty to make this happen. We must collectively note where we can improve our response, improve our decision-making, be more diligent in tackling the real issues that face the un- and underimmunised, and continue to attract financial resources to make sure that measles becomes a disease of the past.

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Outbreak of poliomyelitis in Tajikistan in 2010: risk for importation and impact on polio surveillance in Europe?

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Citation style for this article:
Citation style for this article: World Health Organization Country Office Tajikistan, WHO Regional Office for Europe, European Centre for Disease Prevention and Control. Outbreak of poliomyelitis in Tajikistan in 2010: risk for importation and impact on polio surveillance in Europe?. Euro Surveill. 2010;15(17):pii=19558. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19558

This article has been published on 29 April 2010

On 23 April 2010, the World Health Organisation announced the confirmation of wild poliovirus serotype 1 (WPV1) in seven samples from children with Acute Flaccid Paralysis in Tajikistan, in the context of a multi-district cluster starting in December 2009. As of 28 April, 32 of 171 reported cases were laboratory-confirmed and most closely related to virus from Uttar Pradesh, India. This outbreak demonstrates the high risk that still exists for importation of wild poliovirus into polio-free regions.

On 23 April 2010, the World Health Organisation announced the confirmation of wild poliovirus serotype 1 (WPV1) in seven samples obtained from children with Acute Flaccid Paralysis (AFP) detected in Tajikistan in the context of a multi-district AFP cluster staring in December 2009.

Poliomyelitis (polio) was eliminated in the WHO European Region and the Region was certified polio-free in 2002. Since then, considerable efforts of national authorities and of the international public health community have sustained the polio-free status for the 880 million population of the Region. The last indigenous case of wild poliovirus infection in the WHO European Region was reported in Turkey in 1998 [1]. However, poliovirus imported from polio endemic countries remains a threat. In 1996, following migration resulting from the opening of borders in 1992, Albania reported 138 laboratory confirmed cases of WPV1 infection, including 16 deaths, with 24 confirmed polio cases detected in the bordering United Nations administered Province of Kosovo [2]. The main age group affected was the group of 10 to 34 years-old which accounted for 79% of cases and the lowest incidence was reported among children aged one to nine years. Among those with known vaccination status, 93% had received at least three doses of oral polio vaccine (OPV). The last outbreak in the EU, due to imported WPV3, occurred in the Netherlands in 1992 and 1993 in a community objecting to vaccination [3]. A total of 71 individuals were paralysed and two deaths were reported. The last cases of imported wild poliovirus in the WHO European Region were reported in 2001. These occurrences were associated with WPV1 originating from India, with three Roma children in Bulgaria and one non-paralytic case in Georgia [4]. These cases related to importation did not result in indigenous transmission, defined by the WHO as uninterrupted transmission occurring for more than 12 months.

Tajikistan, with a 6.6 million population, is one of the five Central Asian Republics and borders Uzbekistan, Kyrgyzstan, China and Afghanistan. Two outbreaks of polio were registered in Tajikistan in the 1990s, with 111 and 26 cases of poliomyelitis reported to the WHO in 1991 and 1994, respectively [5]. The last clinically confirmed case of poliomyelitis observed in Tajikistan was in 1997 [1,6].

The reported vaccine coverage with three doses of OPV in Tajikistan in 2008 was 87% [7], which is below the WHO target of over 90% [8]. In 2007, the national health authorities in Tajikistan conducted an immunisation campaign against polio, targeting children less than three years old in the areas bordering Afghanistan.

At the beginning of April 2010, the WHO Country Office in Tajikistan was informed of an increase in AFP cases in multiple contiguous districts. On average, Tajikistan reports 35-40 AFP cases annually with peaks in July and October. As of 28 April, the Ministry of Health of Tajikistan reported 171 AFP cases to WHO, with a sharp increase in the past two weeks, including 12 deaths and 32 cases of laboratory confirmed WPV1 infection; the tests were conducted at the WHO regional reference laboratory for polio, based at the Chumakov Institute of Poliomyelitis and Viral Encephalitis, Moscow, Russian Federation [9]. Genetic sequencing has determined that the poliovirus is most closely related to virus from

Uttar Pradesh, India. 136 (80%) of the AFP cases were in children aged under five years (age range 0-17 years). Cases were mainly reported from districts bordering Afghanistan and Uzbekistan. The Uzbek national authorities are investigating three cases of AFP.

Following the confirmation of WPV1 in Tajikistan, three rounds of nationwide immunisation with monovalent OPV type 1 are planned for all children aged five years or younger (1.1 million children) with a two week interval between each round, starting the first round on 4 May. In addition, there are ongoing efforts to strengthen AFP surveillance. Upon the request of the Ministry of Health of Tajikistan, WHO deployed a multi-disciplinary team of clinical, epidemiological, and virological experts, to investigate the event and assist national authorities in planning and implementing the necessary public health measures. WPV1 and WPV3 activity is currently recorded in Afghanistan. As of 20 April, Afghanistan reported eight cases of poliomyelitis (one WPV1 and seven WPV3) for the year 2010. The onset of disease in the most recent case was on 8 April. Since 2002, no cases of wild poliovirus infection have been detected in northern Afghanistan, areas with recognised high quality AFP surveillance. Pakistan reported 13 cases of polio due to WPV1 and WPV3 so far in 2010 [8]. Polio is still endemic in four countries worldwide; besides Afghanistan and Pakistan these are India and Nigeria [8].

The movement of Tajik nationals in the European Union (EU) is limited as less than 2,200 Schengen visas were issued in 2009. Considering these small numbers of Tajik nationals coming to the Schengen area, the risk of spread of WPV1 associated with the ongoing outbreak in Tajikistan within the EU is considered to be limited. However, importation of cases cannot be excluded, and high levels of vaccine coverage with three doses of polio vaccine are needed to ensure that importation into the EU will not occur. Pockets of susceptible populations do exist in the EU and the risk of disease in these groups is high if the virus is introduced in these communities. Avoiding complacency and maintaining good AFP and/or enterovirus surveillance in the EU to comply with WHO targets is of utmost importance to prevent WPV importation and further spread, particularly considering that 90% of cases associated with WPV infection do not have clinical symptoms. The need to maintain vigilance, implement adequate measures to detect and prevent re-importation of polio into polio-free regions is also stressed in a paper by H Nokleby *et al.* in this issue of *Eurosurveillance* [10].

While AFP surveillance is considered the gold standard for certification purposes, other surveillance strategies and sources of data have been accepted by the WHO European Regional Certification Commission of the Eradication of Poliomyelitis that enable the detection, rapid reporting, and investigation of any paralytic polio cases. This applies to countries that have been non-endemic for a long time, with high levels of sanitation and strong health systems. Accepted alternative surveillance strategies include enterovirus surveillance and/or environmental surveillance for polioviruses. Member states of the WHO European Region conduct a combination of AFP, enterovirus, and/or environmental surveillance. Forty-three of the 53 member states in the WHO European Region conduct AFP surveillance, including 23 of the 29 EU/EEA countries (Liechtenstein is not reporting to WHO), 41 have implemented enhanced enterovirus surveillance while seven are doing environmental surveillance through sewage systems.

A region is certified as polio-free if no indigenous poliomyelitis cases are identified for a period of more than three years in the presence of high quality, certification-standard surveillance. The current outbreak in Tajikistan represents the first introduction of wild poliovirus in the WHO European Region since it has been certified polio-free in 2002. Therefore, strong measures are needed to protect the status. The present situation calls for strong political and financial commitment from all member states to ensure the WHO European Region sustains its polio-free status and that global eradication of polio will be reached by 2012.

Although the Region is considered at high-risk for importation of wild poliovirus due to ongoing global travel, trade, and migration, especially with the four polio endemic countries, the current poliomyelitis outbreak in Tajikistan does not substantially affect the risk for further spread to the EU Member States at this time. It is important to note that WHO does not recommend restrictions on international travel and trade in case of the detection of wild poliovirus but emphasizes that standard recommendations regarding vaccination of travellers to and from a polio-affected country apply until a polio outbreak is interrupted.

Acknowledgements

The authors acknowledge the Ministry of Health of Tajikistan for actions taken in response to the ongoing polio outbreak and for cooperation with the Global Polio Eradication Initiative.

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Protection against poliomyelitis in Europe

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Citation style for this article:
Citation style for this article: Nokleby H, De Carvalho Gomes H, Johansen K, Kreidl P. Protection against poliomyelitis in Europe. Euro Surveill. 2010;15(17):pii=19556. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19556

This article has been published on 29 April 2010

The reappearance of circulating wild poliovirus type 1 (WPV 1) in Tajikistan is the first outbreak from imported wild poliovirus since the World Health Organization (WHO) European Region was declared polio-free in 2002. The risk of poliomyelitis importation to the European Union and European Economic Area countries has probably not increased, but the current outbreak is a reminder that high vaccination coverage, monitoring of protective immunity and maintaining surveillance are important to sustain the present polio-free situation.

Poliomyelitis (polio) is an acute, communicable disease caused by one of three wild-type poliovirus serotypes (WPV types 1-3), or by vaccine associated paralytic polio (VAPP) caused by the live, oral vaccine (OPV). It is characterised by symptoms of varying degree of severity, from subclinical or non-specific disease to rapid onset of acute flaccid paralysis (AFP). The polioviruses are spread mostly by the faecal – oral route. Before vaccination was introduced, most children were exposed to wild-type poliovirus. Of the persons infected, 1:100 to 1:1,000 develop paralytic polio, depending on age, and with the lowest incidence in the very young. It has been discussed that a genetic factor in the host could play a role in why only some individuals develop paralytic poliomyelitis [1].

The first polio vaccine, an inactivated polio vaccine (IPV), became available in 1955. The number of polio cases decreased rapidly in countries introducing the vaccine. Trivalent live attenuated oral polio vaccine (OPV) was launched in 1963. The OPV elicits mucosal immunity, which makes it more efficient in stopping the spread of virus than IPV. The OPV is also easier to apply as no injections are needed, and the need for educated healthcare personnel is limited. The Global Polio Eradication Initiative (GPEI) was launched by World Health Organization (WHO) in 1988, with the goal of eradicating polio before the year 2000 [2]. The GPEI was based on the availability and use of OPV, making large immunisation campaigns in countries with limited financial and healthcare resources possible, even though the need to maintain an adequate cold chain to avoid potency loss has been a challenge in many countries.

Use of OPV contains a small risk of polio-like disease caused by one of the three Sabin vaccine-related poliovirus serotypes; vaccine associated paralytic polio (VAPP). VAPP is seen after about one of one million vaccinations, most often in immunocompromised individuals. Through replication and spread in a susceptible population, the vaccine virus may gradually change into a vaccine-derived poliovirus (VDPV) and regain virulence (Table 1). Outbreaks caused by circulating vaccine-derived virus have been reported from several countries worldwide, with eg 153 paralytic cases reported from Nigeria (VDPV2) in 2009 [3]. To avoid this risk most European countries now use only IPV in their vaccination programs [4].

The Global Polio Eradication Initiative

The GPEI has had an enormous impact on the number of polio cases in the world. The total number of cases decreased from an estimated 350,000 in 1988 to less than 2,000 cases in 2009, and the number of polio endemic countries from 125 to four. The criteria for declaring a single country or a whole WHO region polio-free include reporting of zero indigenous polio cases for at least three years, and a documented surveillance system good enough to discover potential cases. The WHO Region of the Americas was declared polio-free in 1994, the Western Pacific Region in 2000 and the European Region in 2002 [5].

In spite of the large decrease in the number of polio cases the goal of global eradication has been difficult to reach. Wild poliovirus type 2 has not been detected since 1999, but types 1 and 3 are both circulating, and are still endemic in Pakistan, Afghanistan, Nigeria, and India. In the first three countries the main problem has been lack of immunisation, due to local vaccination opposition as in the case of Nigeria [6] or immunisation problems in areas of conflict. In India outbreaks with poliovirus 1 and 3 have continued in spite of very high vaccination coverage. The most probable explanation in India is that the OPV has not been sufficiently immunogenic in some population groups. Monovalent type 1 and 3 polio vaccines provide better immunogenicity [7], and in 2009 an almost as immunogenic bivalent vaccine against types 1 and 3 was introduced (Table 2). The number of cases and affected areas in India has recently been reduced due to these efforts.

Imported infections from the four still endemic countries have been observed in many parts of the world, and in Africa virus circulation has been re-established in some countries that have been polio-free for many years, mostly due to importation from Nigeria since polio again became endemic there in 2003 [8]. However, the general situation has improved recently, with only 71 notified cases in 2010 compared with 328 cases at the same time in 2009 [9].

The current outbreak in Tajikistan - an important reminder for the European Union (EU)/European Economic Area (EEA)

The present outbreak of polio from a polio serotype 1 virus in Tajikistan is described in another article in this issue of *Eurosurveillance* [10]. For the EU/ EEA countries this outbreak does probably not change the current risk of polio importation, as there is already much travel between the four large polio-endemic countries and the EU/EEA. However, the situation in Tajikistan is a reminder that importation of poliovirus to polio-free regions may happen at any time as long as polio virus is circulating in the world. In many European countries there may be population pockets with lower vaccination coverage, where introduction of poliovirus can lead to reestablishment of virus circulation. Earlier outbreaks, such as in the Netherlands in 1992, have shown that this may happen, even in countries with high general vaccination coverage [11].

Polio surveillance has several elements, AFP surveillance being one of them. Enhanced enterovirus surveillance is accepted by WHO as an alternative in countries that have been polio-free for years. Moreover, measuring of vaccination coverage and monitoring of protective immunity in the population are tools for controlling whether immunisation efforts lead to the expected result. Another element is checking for poliovirus in the environment, usually done in the form of sewage sampling. Checking defined sewage systems for wild or vaccine-derived poliovirus is performed routinely in seven EU countries and helps to quantify the current risk of virus importation in each country.

The change from OPV to IPV reduces the risk of disease caused by VPDV. WHO still considers use of OPV necessary to control polio in countries where the disease is still endemic or circulation is re-established. Regardless of that, several Indian paediatricians have advocated IPV also in India and trials are currently underway in less privileged populations [12]. Encouraging countries to change to IPV when possible will reduce the risk for VAPP for everybody.

High vaccination coverage in all parts of the population is the most important part of polio protection in Europe. Good surveillance, including enhanced enterovirus or AFP surveillance, vaccination coverage and population immunity, will help us discover weaknesses in the system or eventual importation of poliovirus, and make us able to implement the necessary measures to avoid re-establishment of polio circulation in a timely manner.

As long as poliovirus is circulating anywhere in the world it may easily be imported to polio-free regions. High vaccination coverage, including booster doses of IPV for persons travelling to polio endemic countries, and enhanced surveillance to detect imported cases early is necessary to avoid re-established circulation in other countries.

Table 1

Polioviruses that cause paralytic disease

WPV	Wild poliovirus serotype 1, 2 and 3
VPV	Virus identical to the oral polio vaccine (OPV) virus serotype 1, 2 and 3
VDPV	Vaccine-derived poliovirus serotype 1, 2 and 3, vaccine-like virus, but gene sequence differing more than 1% from the vaccine virus
cVDPV	Circulating VDPV

Table 2

Vaccines against poliomyelitis

IPV	Trivalent inactivated polio vaccine, used in most industrialised countries
OPV	Trivalent live oral attenuated polio vaccine, used for polio control and eradication in most of the world
mOPV1 and mOPV3	Monovalent oral vaccines against poliovirus serotype 1 or 3, used in India and some other endemic areas
bOPV	Bivalent oral vaccine against poliovirus serotype 1 and 3, recently introduced in India, Pakistan and Nigeria

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Ongoing mumps outbreak in a student population with high vaccination coverage, Netherlands, 2010

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Citation style for this article:
Citation style for this article: Whelan J, van Binnendijk R, Greenland K, Fanoy E, Khargi M, Yap K, Boot H, Veltman N, Swaan C, van der Bij A, de Melker H, Hahné S. Ongoing mumps outbreak in a student population with high vaccination coverage, Netherlands, 2010. Euro Surveill. 2010;15(17):pii=19554. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19554

This article has been published on 29 April 2010

Since December 2009, mumps incidence has increased in the Netherlands. As of 20 April 2010, 172 cases have been notified on the basis of laboratory confirmation or linkage to a laboratory-confirmed case. Of these, 112 were students, the majority of whom had been vaccinated (81%). Although outbreaks in vaccinated populations have been described before, risk factors for exposure and susceptibility, and dose-dependent vaccine effectiveness in a student population of this nature are relatively unknown.

Background

Mumps has been a notifiable disease in the Netherlands since 2009. Notification criteria include at least one related symptom (acute onset of painful swelling of the parotid or other salivary glands, orchitis or meningitis) and laboratory confirmation of infection or an epidemiological link to a laboratory-confirmed case [1]. The measles-mumps-rubella (MMR) vaccine containing the Jeryl Lynn mumps virus strain was introduced in the Netherlands in 1987. Vaccination is recommended, with a two dose schedule at the age of 14 months and nine years. In 2007 and 2009, an epidemic (genotype D) occurred in a socio-geographically clustered, Dutch reformed protestant community with low vaccination coverage [2]. Nationally however, vaccine coverage with two doses has been consistently above 93% [3]. Despite this, an outbreak of mumps occurred among vaccinated national and international students at a particular school in 2004 [4]. A resurgence of mumps has been observed in vaccinated populations in countries worldwide since 2004 [5].

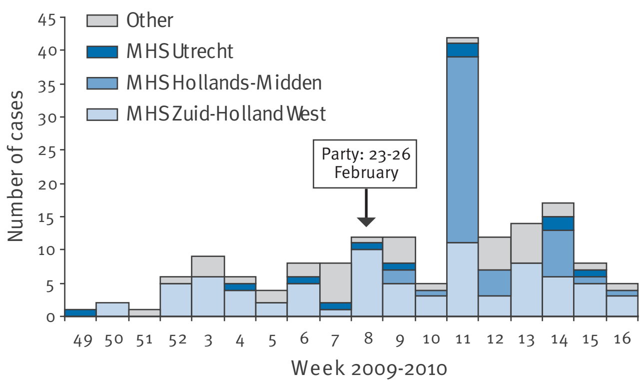
Descriptive epidemiology

In the 11 months from January to November 2009, 65 cases of mumps were reported to the National Institute for Public Health and Environment (RIVM) in the Netherlands. Between 1 December 2009 and 20 April 2010, 172 notifications of mumps cases were received (Figure 1), of whom 24% became ill in late February (week 11) 2010. Seventy-nine of the cases were from the Municipal Health Service (MHS) Zuid-Holland West (including the city of Delft), 44 were from MHS Hollands-Midden (including the city of Leiden) and accounted for the majority of cases in week 11, 11 were reported in MHS Utrecht, and an additional 38 cases were reported from other regions across the Netherlands. The median age was 21 years (range: four to 46 years) and 58% (n=99) were male. Most of the patients had mild symptoms, but 14 (9%) reported some complication, which in 12 cases was orchitis (12% of men). One person was hospitalised for one night due to severe symptoms but had no complications. Routinely collected notification data revealed that a large proportion of cases (n=112, 65%) were students. A further 11 cases were contacts of students.

Twenty-seven student-cases (24% of cases) reported attending a student party (attended by over 2,000

Figure 1

Mumps cases by week of onset of illness, the Netherlands, December 2009–April 2010 (n=172)



MHS: Municipal Health Service.
Report date: 20 April 2010.

students) held in mid-February (week 8) over four days and nights in a building of the Leiden student's association. The students suspected this to be the source of infection. Given the incubation period of mumps is typically 16 to 18 days, this would coincide with the surge in cases seen in week 11 in MHS Hollands-Midden. Some attended the party for one night only (mainly students from Delft and Utrecht), but the majority from Leiden attended for three or four days and nights in succession. An outbreak investigation into risk factors for acquisition of mumps by the MHS in Leiden, Delft and Utrecht is currently underway in collaboration with the Centre for Infectious Disease Control of RIVM.

Microbiological findings

The clinical diagnosis of notified cases was laboratory-confirmed by at least one method in 46% of cases (n=79): by detection of a mumps-specific IgM antibody response in 20% of cases (n=32), by detection of mumps virus RNA in 30% (n=48), and/or by cultivation of mumps virus in 10% (n=16). Where there was no laboratory confirmation, an epidemiological link to a laboratory-confirmed case was established in 45% of cases (n=78). Five cases did not meet notification criteria because they were linked epidemiologically to an index case, but laboratory confirmation of that index case was not established at the time of notification. The remaining ten cases reportedly met the notification

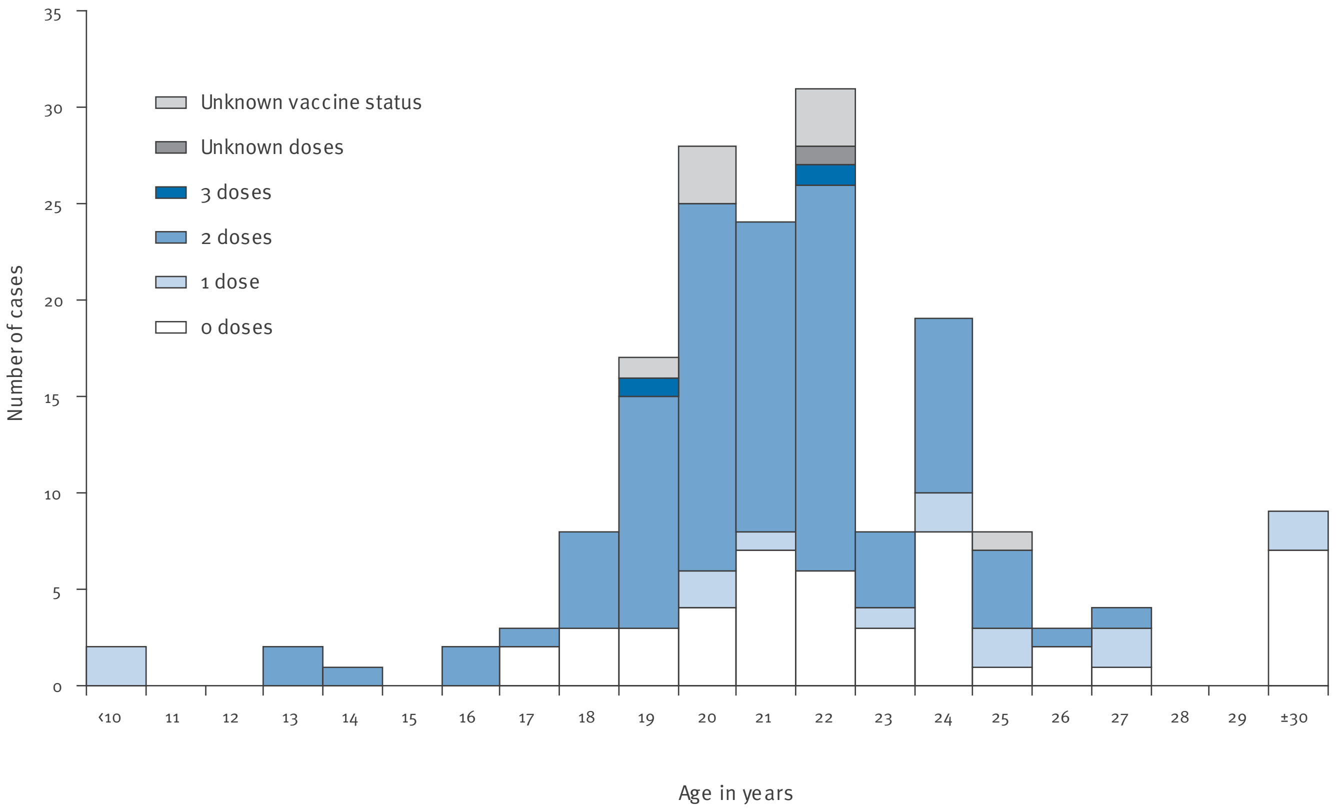
Table

Vaccination status of cases reported as students and others, The Netherlands, December 2009–April 2010 (n=164)

Vaccination status of respondents	Not reported to be students		Reported as students		Total	
	n	%	n	%	n	%
At least one dose	**29**	**50**	**85**	**81**	**114**	**70**
1 dose	8	14	6	6	14	9
2 doses	21	36	77	73	98	60
3 doses	0	0	2	2	2	1
Vaccinated with unknown number of doses	**0**	**0**	**1**	**1**	**1**	**1**
Unvaccinated	**29**	**50**	**20**	**19**	**49**	**30**
Total	**58**	**100**	**106**	**100**	**164**	**100**

Figure 2

Mumps cases by age and vaccination status, the Netherlands, December 2009–April 2010 (n=172)



Report date: 20 April 2010.

criteria, but reasons for notification were incomplete or missing (n=6%). Genotyping of isolated mumps viruses revealed that the outbreak strain belonged to the G5 lineage.

Vaccination status of cases

Reported vaccination coverage among cases, particularly among the students, was high (Table). Of the 164 for whom vaccine status was known, 115 (70%) were vaccinated and 100 (61%) had received at least two mumps vaccinations. Among the 106 students for whom vaccine status was known, 85 (81%) were vaccinated at least once, and 79 of them were vaccinated at least twice.

Age and vaccination status of cases are presented in Figure 2.

Discussion

Mumps outbreaks among vaccinated populations are reported world-wide [5-7]. Clinical attack rates are generally lower in vaccinated populations (indicating a protective effect), but there is growing evidence of waning immunity over time, [8-10] leading to secondary vaccine failure [4,10-12]. The majority of cases in this outbreak were students aged 18 to 24 years, of whom 73% had received at least two mumps vaccinations. The clustering of cases among students (in Leiden and to a lesser extent in Delft and Utrecht) suggests that intensive social contact during the four-day party may have facilitated transmission. Shared living facilities among members of the students' association, and the close contact environment of routine college life are also likely contributing risk factors [13,14].

In accordance with recommendations from the World Health Organization [15], most countries now offer a two-dose vaccine schedule for mumps. In the Netherlands, all birth cohorts since 1982 have been offered two vaccine doses. Exceptionally, there is a suggestion that those born in 1986 and 1987 (now aged 23), were offered three doses of MMR at the age of 14 months, four years and nine years [16], but this remains to be confirmed. Dutch children are older when they receive the second vaccine dose (at age nine years) compared to those in the United Kingdom, the United States and Canada, where it is given at four to six years of age. Boosting of the immune response by circulating wildtype virus is unlikely as mumps has not been widespread in the Netherlands except for a restricted outbreak within the religious community a few years previously [2]. Primary vaccine failure is possible but a post-vaccination seroprevalence of 93.2% has been shown in children under the age of three years in the Netherlands [17]. In addition to the intensive social contact implicated in this outbreak, the fact that it occurred among the oldest vaccinated cohorts in the Netherlands who received two vaccine doses makes secondary vaccine failure more plausible.

Careful investigation will be required to establish the relationship between increasing age on the one hand, and incidence rates, severity and post-exposure disease susceptibility on the other. Comparison of pre- and post-exposure antibody titres in a longitudinal study could give clues about correlates for protection against mumps virus infection, as this is not well understood for persons who have received two doses of the mumps vaccine. Antigenic differences between the Jeryl Lynn vaccine strain (genotype A) and the viral strain in this and other outbreaks (genotype G) have also previously been implicated [11], but recent data suggests a good degree of serologic cross-immunity between Jeryl Lynn and other genotypes [18].

Current outbreak response measures concentrate on gathering good surveillance data, and students in the cities affected by this mumps outbreak who are not fully vaccinated (i.e. with two doses of MMR) are advised to complete their MMR vaccination. In response to an ongoing outbreak in the United States among a population of young adults (age 7-18 years) with a similar high vaccination coverage, public health officials in New York have been offering a third dose of MMR vaccine in some schools since January 2010 [12]. The lower incidence of mumps in the Netherlands among those born in 1986 who may have received three vaccine doses in childhood is certainly interesting in this respect, but further investigation is required to confirm this.

On assessment, the risk of a large national outbreak in the Netherlands is considered to be low because of high overall vaccine coverage and the clustered nature of student social life. Offering a third vaccine dose is not planned at present. With the cooperation of the municipal health services and the students' associations, we intend to conduct further research to better understand the risk factors associated with mumps exposure and susceptibility, and dose-related vaccine effectiveness.

Acknowledgements

We would like to thank patients, clinicians, staff of laboratories and of municipal health services, and students for their contribution to generating the information reported in this manuscript.

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Spotlight on measles 2010: A measles outbreak in a Roma population in Pulawy, eastern Poland, June to August 2009

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Citation style for this article:
Citation style for this article: Orlikova H, Rogalska J, Kazanowska-Zielinska E, Jankowski T, Slodzinski J, Kess B, Stefanoff P. Spotlight on measles 2010: A measles outbreak in a Roma population in Pulawy, eastern Poland, June to August 2009. Euro Surveill. 2010;15(17):pii=19550. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19550

This article has been published on 29 April 2010

We describe a local indigenous outbreak of measles in a susceptible Roma community, which occurred in Pulawy, a town of 50,000 citizens in the Lubelskie province (eastern Poland) during summer 2009. From 22 June to 30 August 2009, 32 measles cases were reported, and additionally nine possible cases were actively identified. A mass immunisation campaign was organised to stop measles transmission in the Roma community. Active surveillance of rash-febrile illnesses allowed documentation of the impact of mass immunisation in preventing further measles spread in the Roma community, and the surrounding population of Pulawy.

Outbreak notification

Between 26 June and 21 July 2009, 14 measles cases were reported by physicians to the public health authority in Lubelskie province, Poland. All affected persons were from a Roma community living in the town of Pulawy. No measles cases had been registered during the previous decade until 2008, when six cases were notified in the same Roma community in Pulawy.

The investigation suggested common exposure between the first reported cases. The index case was a Roma resident of Pulawy. On 20 June he returned from the city of Lodz, where he had been was in contact with a Roma person who had recently returned from England with rash illness (this case had not been reported to the Polish national surveillance). On 22 June he developed typical symptoms of measles, subsequently confirmed serologically, and was admitted to hospital on 26 June.

Outbreak investigation

An outbreak investigation team was formed comprising epidemiologists and public health officers at district, regional and national level.

Case definitions were set up as follows:

- Possible case: each person who resided in the town of Pulawy after 15 June 2009 and who developed febrile illness with rash;
- Probable case: each person, who fulfilled the criteria of a possible case, and for whom an epidemiological link to a confirmed case was ascertained;
- Confirmed case: each person who fulfilled the criteria of a possible case, and in whom measles was confirmed by serological (ELISA IgM) or virologal test (virus isolation or PCR).

Active case finding was implemented simultaneously. We reviewed the medical documentation from all primary healthcare facilities in Pulawy since mid-June retrospectively, to search for cases of rash-like illness, which could indicate undiagnosed measles transmission occurring inside or outside the Roma community. Beginning from 10 August 2009, enhanced surveillance was set up, requesting primary healthcare and hospital physicians to report all new rash-febrile cases, and to send weekly reports including all suspected cases or zero reporting.

Outbreak description

From 22 June until 30 August 2009, 41 cases were registered, of whom 32 (78%) were reported through the routine surveillance, and nine were actively found. According to the case definition, eight (19%) of the 41 cases were classified as confirmed, 24 (59%) as probable and nine (22%) as possible. The shape of the epidemic curve (Figure 1) indicated person-to-person propagation, with several transmission chains.

Of 41 registered cases, 35 (85%) were of Roma ethnicity, residing in two localities in Pulawy inhabited by the local Roma community. In addition, one occupational case was reported in a Polish hospital nurse working in the department of infectious diseases of the district hospital in Pulawy. A further five non-Roma cases were notified, all of whom were actively found and classified as possible cases.

Among the 32 confirmed or probable cases, 13 (41%) were female (Figure 2). The mean age was 12 years (range: three months to 49 years) and the median age was 12 years. Four infants (12%) and nine adults (28%) were among the 32.

Twenty two of 32 (69%) patients were hospitalised in the department of infectious diseases at district hospital in Pulawy and the others were treated in primary healthcare. Practically all 32 confirmed or probable cases developed typical erythematous maculopapular rash, fever >38 °C and cough. Most of the patients had Koplik spots, coryza and conjunctivitis. Four cases, all of them unvaccinated, of whom one was classified as confirmed and three as probable, experienced severe complications; namely, three patients had pneumonia and one infant had myocarditis, encephalitis and pneumonia. All patients recovered and no fatal cases were registered. The nine cases that were classified as possible cases had very mild symptoms with rash and fever, and none of them were hospitalised.

Laboratory results

Biological samples from eight cases were tested in the laboratory, and all were confirmed as measles-positive at the National Reference Laboratory for Measles and Rubella of the National Institute of Public Health in Warsaw, three serologically (ELISA IgM-positive) and five by detection of measles virus (one through virus isolation, five through PCR testing). Genotype D4 isolate Pulawy.POL/28.09 was confirmed from two cases, detected at the World Health Organisation's European Regional Reference Laboratory for Measles and Rubella at the Robert Koch Institute in Berlin.

Vaccination status of cases

From a total of 32 confirmed or probable cases, 28 were not previously immunised, including five infants (between three and 13 months) who were not vaccinated because of young age. Only one, a 1.5-year-old boy, was previously vaccinated (three months before onset) with one dose of measles-containing vaccine. Three persons received their first dose during the mass

Figure 1

Measles cases by day of onset (two-day intervals) and by classification, Pulawy, 2009 (n=41)

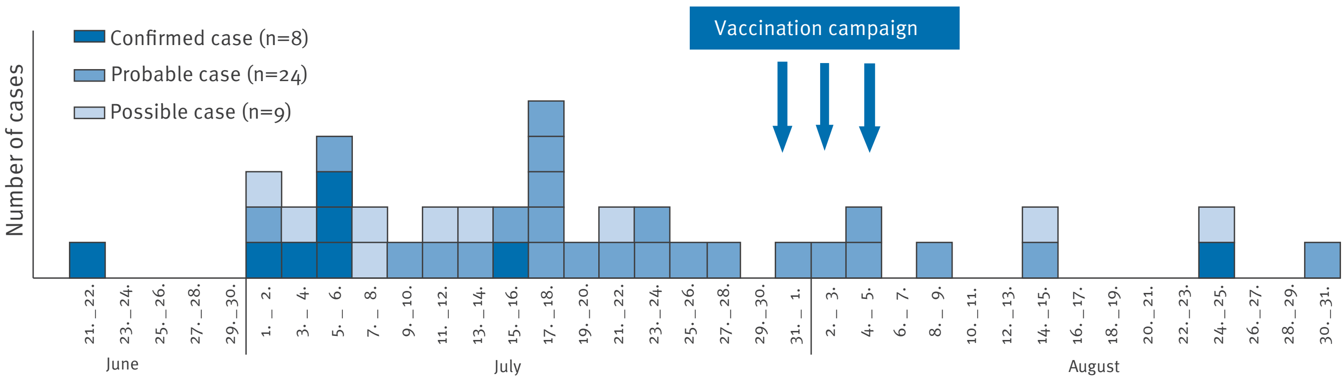
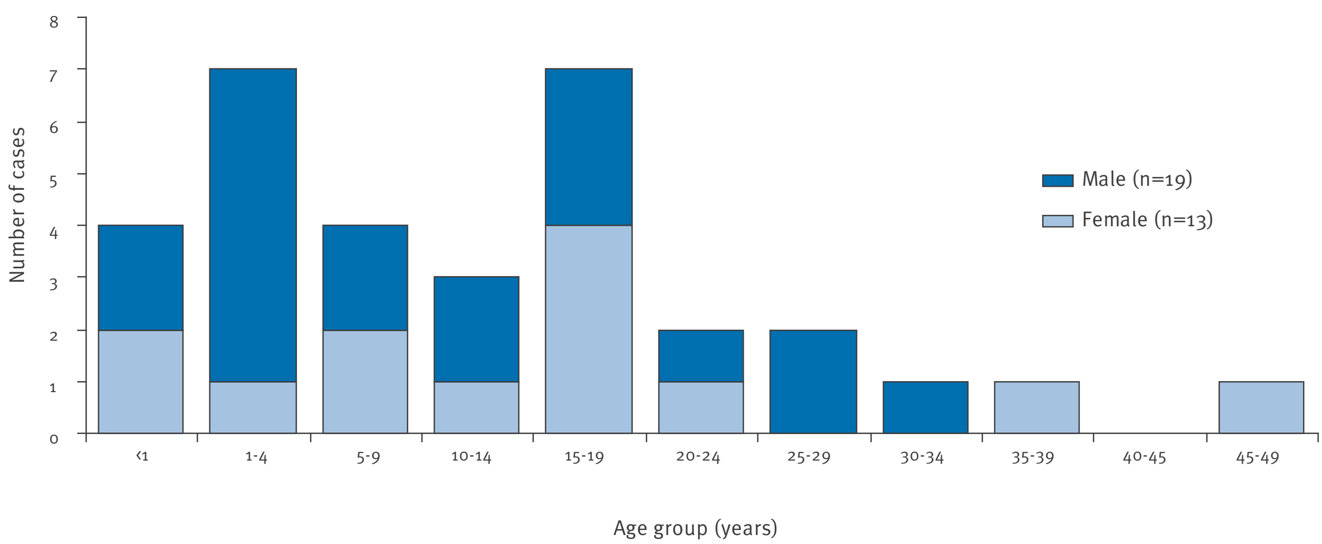


Figure 2

Confirmed and probable cases of measles by age group and gender, Pulawy, 2009 (n=32)



vaccination campaign that was initiated as a control measure to interrupt the spread of the outbreak. They had onset of measles four to five days after the vaccine administration (Figure 3). Among the nine possible cases, seven were previously vaccinated.

Control measures

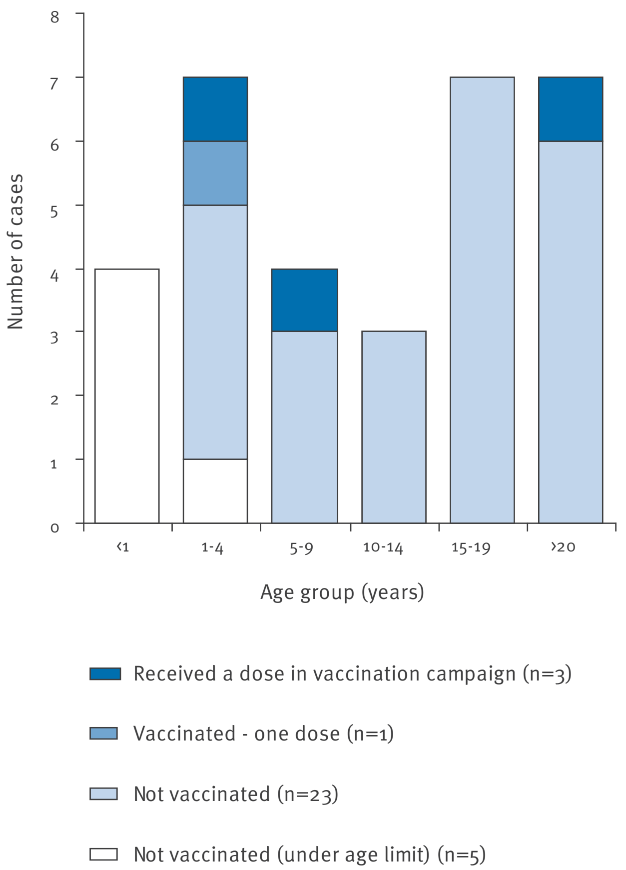
As a response to stop the spread of the measles outbreak, the district sanitary inspectorate in Pulawy, with the support from regional sanitary inspectorate in Lublin and the National Institute of Public Health, organised a mass vaccination campaign. It was directed to the Roma residents of Pulawy, between the ages of nine months and 60 years. The invitation to the mass immunisation in Polish language was disseminated to the Roma community leaders, and through primary health units in Pulawy. It was held at a primary healthcare centre in the proximity of the Roma community, on 31 July, and on 3 and 4 August. From around 300 Roma registered at the municipality of Pulawy, 195 (102 individuals under the age of 20 years and 93 adults) attended the vaccination point and 138 (55 individuals under the age of 20 years and 83 adults) received a dose of combined measles, mumps and rubella (MMR) vaccine [1]. The reasons for exclusion of some attendants from vaccination were the following: a documented full previous vaccination (n=16), young age under nine months (n=3), pregnancy (n=3), breastfeeding shortly after delivery (n=1), confirmed or probable measles in summer 2009 or documented laboratory-confirmed measles ealier (n=22), acute measles diagnosed during the campaign (n=2), temporary contraindication due to an acute febille illness (n=9), and waiting for an attestation of contraindication (n=1).

Ongoing active febrile-rash illnesses surveillance was continued in all medical centers in Pulawy following the identification of the first case, until twice the maximum incubation period after the onset date of the last case. The district sanitary inspectorate in Pulawy informed local healthcare professionals about the outbreak and ongoing control measures. An article summarising the outbreak and control measures undertaken was published in the national surveillance bulletin. The public was provided with up-to-date information via local websites and press articles.

The regional sanitary inspectorate in Lublin implemented investigation of the Roma communities in Lubelskie province with regards to their vaccination status, and offering immunisation to all unvaccinated and incompletely vaccinated individuals or contacts of measles cases. For example, on 17 and 19 August 2009, 45 Roma were vaccinated with MMR vaccine in a focus area of measles in Opole Lubelskie and Poniatowa. A recommendation was issued to check the vaccination status of all 10-year-old school children in Pulawy at the beginning of the new school year.

Figure 3

Vaccination status of confirmed and probable measles cases by age-group, Pulawy, 2009 (n=32)



Discussion and conclusions

This outbreak has been the largest indigenous cluster of measles in the past decade in Poland, affecting one tenth of the local Roma community. Infants, children and adults had measles and several patients had severe complications.

In addition to the standard procedures (treatment and isolation of cases, contact tracing, offering of post-exposure vaccination until 72 hours after the contact), we implemented active case finding and organised a mass immunisation campaign as a response to this outbreak [1]. Moreover, vaccination coverage, size and age distribution of the Roma population in Pulawy was assessed, as described in a parallel article [2].

Factors that facilitated the spread of infection in the susceptible Roma population were low prior vaccination uptake, high contagiousness of measles, infection transmission lasting from between two and four days before to four days after rash onset, questionable home isolation of cases and numerous contacts inside the community. Children and adults fell ill, as described in other countries [3-5]. Several infants experienced measles at an age below the limit for the first vaccine dose in the national immunisation schedule. We observed several waves of propagation within the community. The herd immunity in the local Roma population was insufficient to stop the outbreak. Interruption of indigenous measles transmission is considered one of the criteria for elimination [6].

The targeted mass immunisation was efficient in limiting measles transmission. Only five cases occurred after the campaign in the Roma community. Among them were three patients with onset of disease four to five days after administration of the vaccine. They had received their first dose during the campaign and were probably vaccinated during the incubation period. Two children with onset of disease after the campaign had not previously been immunised, one because of young age (under six months-old) and the other was referred to a neurologist and an allergist to verify the contraindication, but his parents did not take the child to see the specialists.

One additional case that occurred after the campaign targeted only to Roma, was the occupational infection of the hospital nurse reported in routine surveillance. This case could have been avoided if the nurse had been previously vaccinated. Ensuring that healthcare workers are adequately protected is a key requirement to prevent healthcare-associated measles infections [7].

All nine cases identified through the active surveillance, four were of Roma ethnicity and five non-Roma, were classified as possible cases. All nine had mild symptoms and were treated in an outpatient clinic. Most of them were found retrospectively. Seven of the possible cases had previously been vaccinated against measles, of whom six with one dose, and none were laboratory-tested for measles. It is therefore possible, that they may have had a different febrile-rash disease not necessarily caused by measles virus. Nevertheless, active case finding and inclusion of possible cases was useful in order to assess how far the outbreak might have spread. The active surveillance helped us in documenting that the mass vaccination effectively stopped transmission in the Roma community and that the non-Roma population was not or just marginally affected.

Based on the above evidence, we can conclude that due to high vaccination coverage in Poland's general population, large-scale spread of measles outside the Roma community was avoided. According to the official statistics for 2008, the vaccination coverage for the combined MMR vaccine was 98.4% for the first dose administered at the age of 13-15 months, and 97.2% for the second dose given at the age of 10 years [8].

Poland belongs to the countries with moderate incidence of indigenous measles, with 0.1-0.3 cases per 100,000 population in the years 2006 to 2008 [9,10]. Fourteen percent of all cases in 2008 were imported [10]. In the current indigenous outbreak, the index case was infected in June 2009 when staying in the city of Lodz, where several measles cases were registered at the time [11]. The epidemiological investigation revealed contact with a person with a rash illness recently returned from England. This person was neither reported to the surveillance system nor identified by the index case, so remains unknown and no details regarding the travel history were obtained.
Only eight cases were laboratory-tested for measles during the outbreak, which is a quarter of the cases reported in routine surveillance and a third of the hospitalised ones. The proportion of laboratory-tested patients should be higher in the phase of measles elimination. However, samples were taken and confirmed from patients in almost every chain of transmission in the outbreak. The genotype D4 virus isolate Pulawy.POL/28.09, detected in the current outbreak, was identical with the isolates Wroclaw.POL/13.09 and Lodz.POL/27.09 in Poland and Hamburg.DEU/03.09 in North-West Germany from spring 2009 and differed by 1 nt from the sequence of the isolate Enfield.GBR/14.07 circulating in England [11]. The Pulawy strain also shows sequence identity (100%) to the virus detected in the current epidemic in Bulgaria [Regional Reference Laboratory WHO EURO, RKI, personal communication].

Several outbreaks of measles have been reported in many European countries within the past years, in particular in susceptible population groups such as orthodox Jewish communities [12], religious schools [13], anthroposophic communities [14,15], traveller communities [16,17] and in regional or national outbreaks involving a large proportion of Roma/Sinti [18], Roma migrant or indigenous populations [3,4]. Measles clusters in susceptible communities are a considerable public health problem. To reach the goal of measles elimination in Poland and other European countries, a stronger commitment by decision makers to improve vaccination coverage in all sections of the population is needed. Regional and national elimination strategies need to include steps to assess the accumulation of susceptible individuals and interrupt indigenous transmission [19].

Causes of low vaccination uptake must be defined. In the case of Roma communities we should consider factors that may contribute to the low vaccination coverage that was observed for example in Pulawy [2]. The reasons could be varied, such as socio-economical and cultural differences, level of education, language barriers, discrimination [20] or low awareness of vaccination as a preventive measure. Where there is limited access to healthcare, this must be improved. By organising the vaccination campaign in Pulawy, we have learned that for a public health intervention in the Roma population to be successful, it must be tailored and supported by Roma family and community leaders.

Education of public health and healthcare professionals must continue in the phase of measles elimination [21], and laboratory testing of febrile-rash illnesses is essential.

Recommendations

1. Cooperation between local administrative authorities, social workers in contact with the Roma, primary healthcare workers and public health professionals is necessary in reaching Roma communities to prepare and implement public health interventions including suplementary immunisation activities.
2. Offering immunisation against measles to unvaccinated inhabitants in Pulawy and other towns in which inadequately vaccinated populations have been identified could prevent further outbreaks.
3. Surveillance of febrile-rash illnesses should be enhanced by enforcing laboratory testing of all suspected measles cases to document measles elimination in the present situation in Poland.

Acknowledgements

We thank all those involved in the outbreak investigation and vaccination campaign for good cooperation (State Regional Sanitary Inspectorate in Lublin and State District Sanitary Inspectorate in Pulawy, Local Administrative Authority in Pulawy and general practioner B. Goscimska and all nurses W. Gorska, J. Polak, T. Skorek). We would like to acknowledge A. Zielinski for his supervision regarding vaccination campaign. We thank kindly S. Santibanez and A. Mankertz from the WHO European Regional Reference Laboratory for Measles and Rubella at the Robert Koch Institute in Berlin for detailed virological analysis and A. Makowka who performed virus isolation and PCR testing at the Department of Virology in the National Institute of Public Health in Warsaw.

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Spotlight on measles 2010: An epidemiological overview of measles outbreaks in Poland in relation to the measles elimination goal

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Citation style for this article:
Citation style for this article: Rogalska J, Santibanez S, Mankertz A, Makowka A, Szenborn L, Stefanoff P. Spotlight on measles 2010: An epidemiological overview of measles outbreaks in Poland in relation to the measles elimination goal. Euro Surveill. 2010;15(17):pii=19549. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19549

This article has been published on 29 April 2010

The objective of this study was to describe transmission chains of measles observed in Poland during 2008-2009. A decade ago, the incidence of measles in Poland declined and approached one case per million inhabitants one of the World Health Organization's criteria for measles elimination. Following a period of very few reported measles cases (2003 to 2005), an increase in incidence was observed in 2006. Since then, the incidence has constantly exceeded one case per million inhabitants. Of 214 measles cases reported in 2008 and 2009 in Poland, 164 (77%) were linked to 19 distinct outbreaks, with 79% of cases belonging to the Roma ethnic group. Outbreaks in the non-Roma Polish population had different dynamics compared to those in the Roma population. On average, measles outbreaks in Roma communities involved 10 individuals, seven of whom were unvaccinated, while outbreaks in the non-Roma Polish population involved five individuals, half of whom were incompletely vaccinated. The majority of outbreaks in Roma communities were related to importation of virus from the United Kingdom. In six outbreaks, the epidemiologic investigation was confirmed by identification of genotype D4 closely related to measles viruses detected in the United Kingdom and Germany. Our data indicate that Poland is approaching measles elimination, but measles virus circulation is still sustained in a vulnerable population. More efforts are needed to integrate the Roma ethnic group into the Polish healthcare system and innovative measures to reach vulnerable groups should be explored.

Background

In 1998 Poland implemented a measles elimination programme, coordinated by the World Health Organization (WHO) Regional Office for Europe. It requires monitoring consecutive stages of the elimination by tracking secondary outbreak cases, genotyping of detected measles viruses (MV) and serological testing of all suspected cases of measles [1].

Measles has been a notifiable disease in Poland since 1919. National case-based notification was initiated in 1996 and WHO case definitions [2] have been adopted. Since 2005, the case classification of the European Union [3] has been used. The first dose of the monovalent measles vaccine for children aged 13-15 months was introduced in Poland in 1975, and the second dose for seven year old children was implemented in 1991. In 2005 the monovalent measles vaccine was replaced by the combined measles-mumps-rubella (MMR) vaccine, administered at the age of 13-15 months and 10 years.

Poland belongs to the European countries with moderate incidence of measles [4,5]. Following the introduction of routine immunisation, the incidence of measles has decreased. From 2003 to 2005 the number of locally acquired cases in Poland was below the elimination threshold of one case per million inhabitants. Since 2006 the measles incidence has increased and remained continuously above this elimination indicator (Figure 1) [6]. In 2006, measles cases were mostly related to importation of MV-D4, whereas MV-D6 was detected in 2007. In 2008-2009 a substantial increase in the frequency of outbreak-related cases was observed, often related to importation.

The vaccine coverage in Poland with MMR vaccine remains well above the target of >95% for the first dose of measles vaccine (MCV1), another WHO marker for measles elimination [7]. Coverage with the first dose of MMR vaccine in three-year-olds in 2008 was 98.4%, and for two doses of MMR in eleven-year-olds it was 97.2%. Information on measles vaccine coverage in ethnic groups such as the Roma ethnic minority is not available in Poland.

The objective of this study was to describe the patterns of chains of transmission investigated in Poland between 1999 and 2009, with special focus on 2008-2009, in relation to the measles elimination goal.

Methods

In the present study, measles cases reported within the Polish enhanced measles surveillance between 1999 and 2009 were investigated. Physicians were required to report all suspected measles cases to the local health departments and to obtain samples for confirmatory IgM testing. The information collected during case investigation included demographic characteristics, vaccination status, and clinical and laboratory data. Although not routinely collected in the national surveillance system, the ethnic background

Figure 1

Secular trends of measles incidence in Poland, 1966-2009

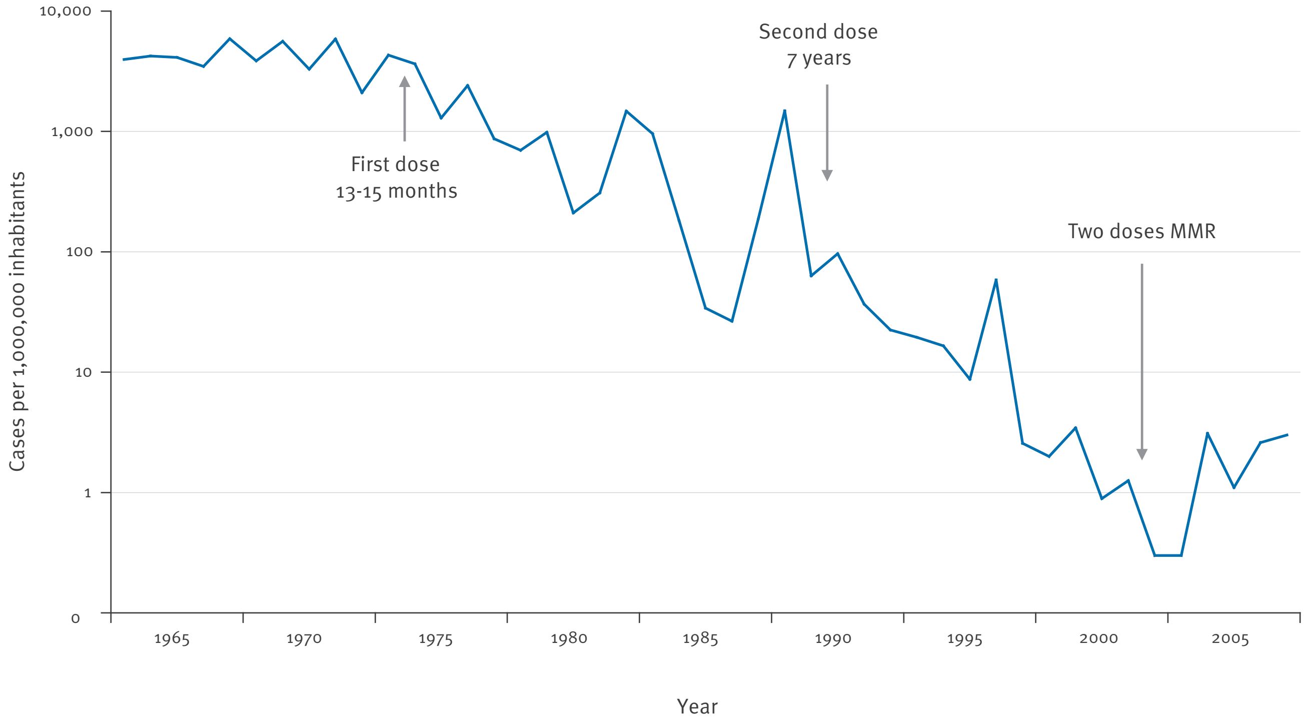
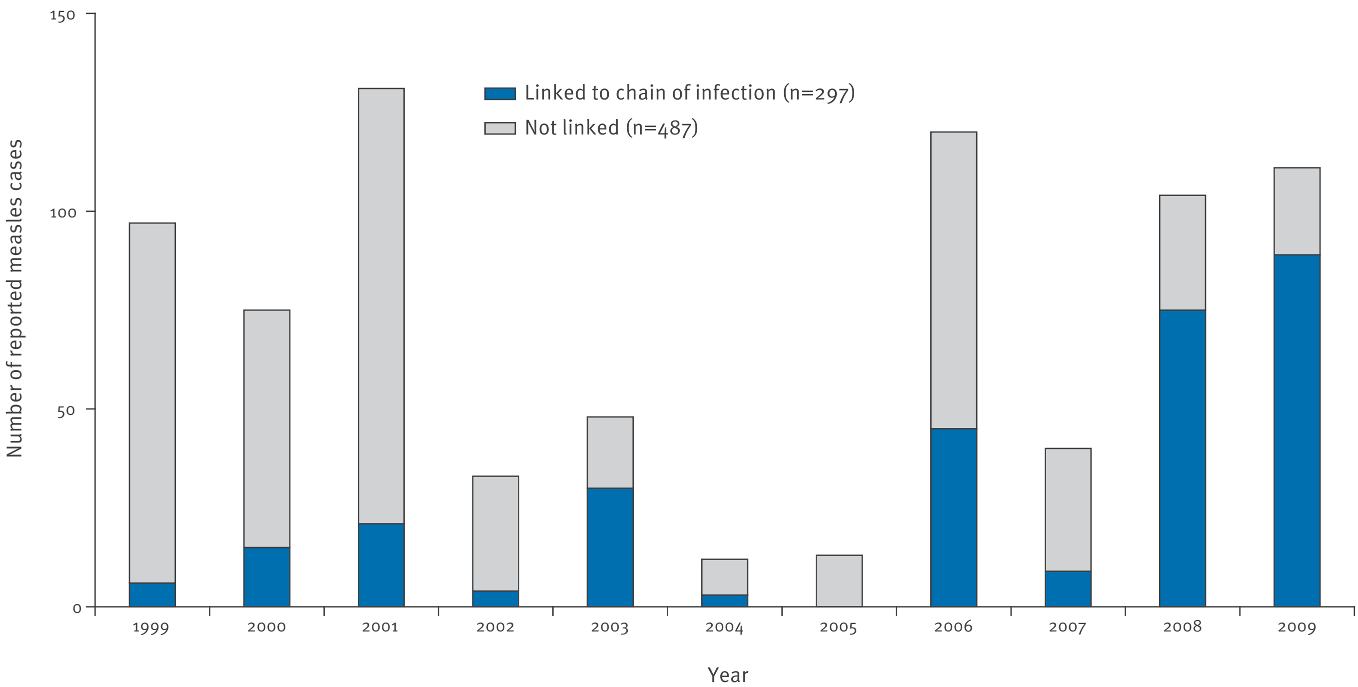


Figure 2

Number of reported measles cases, including those which could be linked to transmission chain, Poland, 1999-2009 (n=784)



of reported measles cases was recorded. Contact tracing is routinely undertaken, especially for unvaccinated and exposed individuals. Serological testing and detection of measles virus RNA are performed in the National Reference Laboratory at the National Institute of Public Health. Measles virus-containing samples are sent to the WHO Regional Reference Laboratory for Measles and Rubella (Robert Koch Institute, Berlin) for genotyping.

For the present study, we defined an imported outbreak as resulting from importation of measles virus by a person arriving from abroad who was exposed and developed symptoms outside Poland, and subsequently was the source of documented local transmission to other cases linked to the outbreak. If available, genotyping results were used for confirmation of importation-related transmission chains.

Measles case reports from 1999 to 2009 are described. Measles cases with an established link to the infection transmission chain (outbreak cases) in 2008-2009 are described in more detail to determine the role of disease importation and outbreak patterns.

Results

Over time, an increasing proportion of measles cases could be linked to identified chains of transmission in Poland (Figure 2), from 6% in 1999 to 80% in 2009. Of 569 cases of measles reported between 1999 and 2007, 133 (23%) were linked to outbreaks. In 2008 and 2009, this proportion was higher, with 77% reported measles cases linked to outbreaks.

During 2008 and 2009, 19 measles outbreaks with 164 cases were reported in Poland. Seven outbreaks were due to importation of the disease from the United Kingdom (UK), and 12 involved only indigenous transmission. Outbreaks in that period were reported from nine of the 16 provinces of Poland. One of the 164 outbreak cases, excluded from further analysis, occurred in a Ukrainian citizen who arrived in Poland in February 2009. He contracted measles while staying in a hospital where an outbreak occurred.

Fifty-three percent of cases in 2008 and 2009 were female and 90.2% of the patients were residents of urban areas. Cases were seen in all age groups, although adults aged over 19 years were predominantly affected (45 cases, 27.4%). One hundred and thirty patients (79.3%) were admitted to hospital. The proportion of hospitalised cases was highest in children aged five to nine years (90.9%). Seventy-nine percent of all outbreak-related cases during 2008 and 2009 occurred among the Roma ethnic group.

Important differences were observed between the outbreaks among the Roma community and those occurring in non-Roma Polish population (Table).

Table

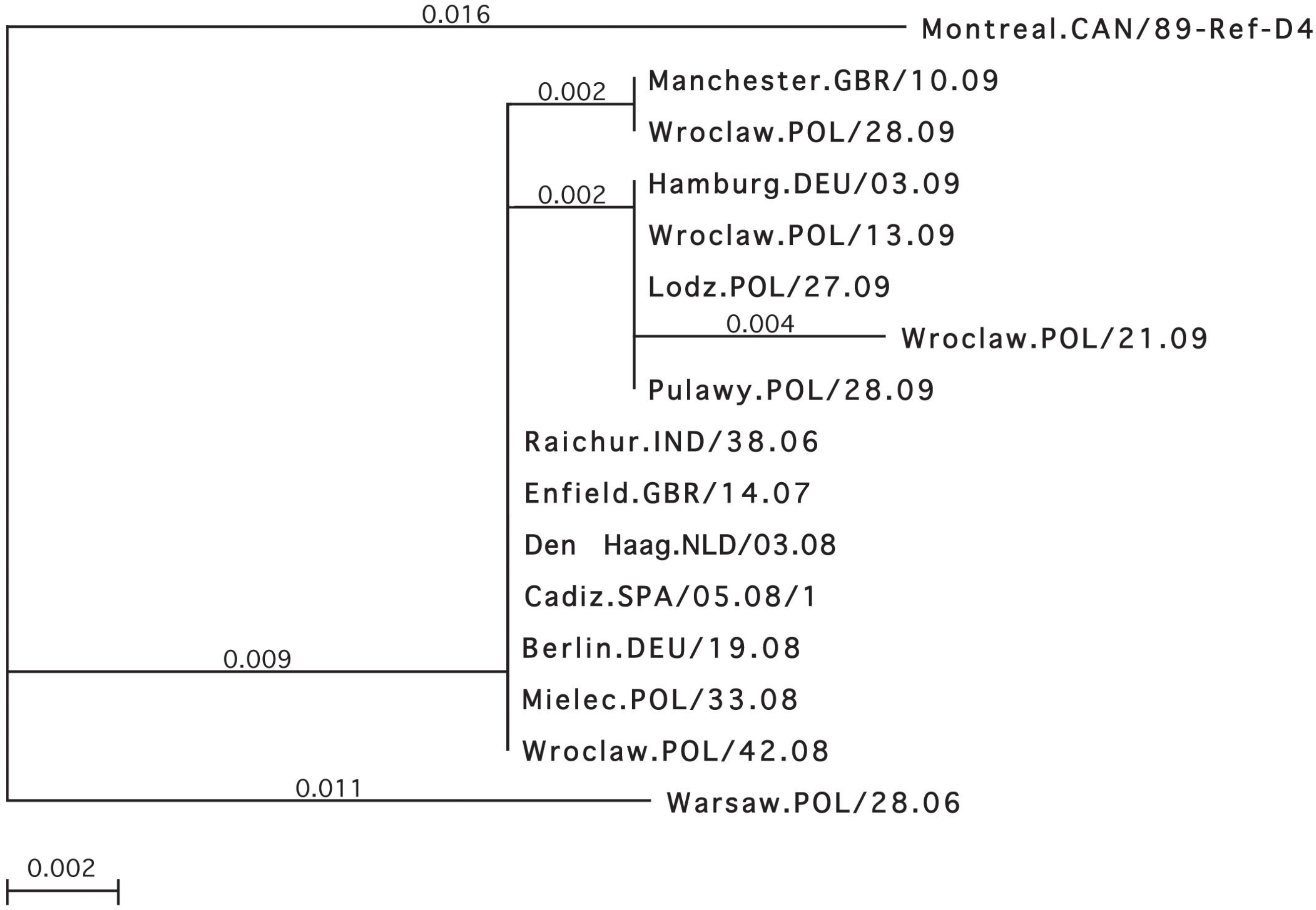
Characteristics of cases linked to chain of transmission, Poland, 2008-2009 (n=163)

Characteristic	Roma		Non-Roma Polish population		Total	
	N	%	N	%	N	%
Number of outbreaks	13	68.4	6	31.6	19	100.0
Number of cases	126	77.3	37	22.7	163	100.0
Sex						
Female	64	50.8	23	62.2	87	53.4
Male	62	49.2	14	37.8	76	46.6
Confirmation of cases						
Laboratory-confirmed	72	57.1	35	94.6	107	65.6
Epidemiologically linked	54	42.9	2	5.4	56	34.4
Vaccination status						
Vaccinated according to age	18	14.3	12	32.4	30	18.4
Incompletely vaccinated	91	72.2	18	48.6	109	66.9
Unknown vaccination status	17	13.5	7	19.0	24	14.7
Importation status (number of outbreaks)						
Import-related	7 (68 cases)	53.8 (54.0)	1 (3 cases)	16.7 (8.1)	8 (71 cases)	42.1 (43.6)
Local	6 (58 cases)	46.2 (46.0)	5 (34 cases)	83.3 (91.9)	11 (92 cases)	57.9 (56.4)
Generations of transmission identified (number of outbreaks)						
1-2	9	69.2	4	66.7	13	68.4
3 or more	4	30.8	2	33.3	6	31.6
D4 genotype identified	4 (19 cases)	30.8 (15.1%)	2 (2 cases)	33.3 (5.4)	6 (21 cases)	31.6 (12.9)

Outbreaks among Roma were considerably larger with an average of 10 cases, who were mostly unvaccinated (72% of outbreak cases), while outbreaks in the non-Roma Polish population involved an average of five cases, with 48% of outbreak cases incompletely vaccinated. The majority of outbreaks in Roma communities were related to importation of virus from the UK. In six outbreaks, measles virus genotyping identified a genotype D4 strain that was most closely related to viruses from the UK and Germany. Figure 3 presents the exact genetic relationship between viruses isolated from outbreak cases in 2008 and 2009 to closely related strains isolated in other countries. Laboratory testing was performed more often for cases from the non-Roma Polish

Figure 3

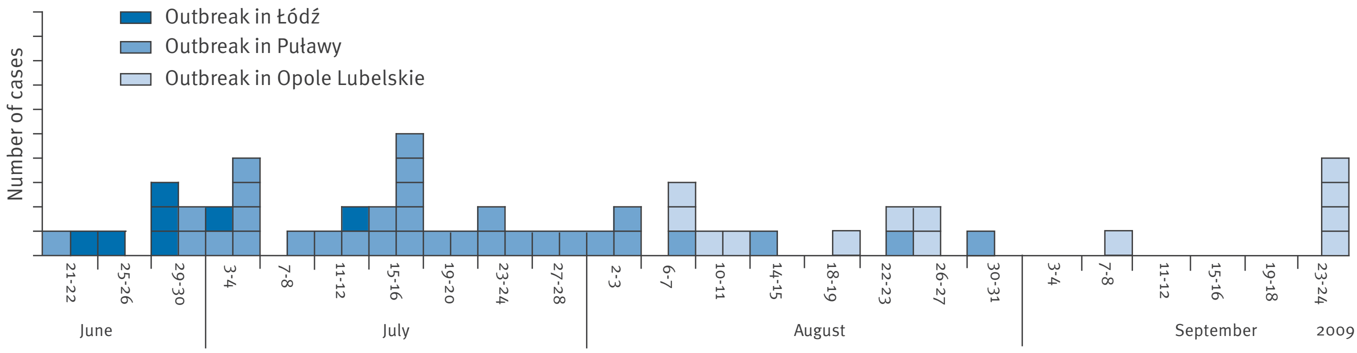
Phylogenetic analysis of measles viruses of genotype D4 detected from 2006 to 2009 in Poland and other European countries



The phylogenetic tree is based on a 456 nt sequence encoding the carboxyterminus of the nucleoprotein. It includes all measles strains identified in Poland in 2006-2009 and world strains most closely related to them.
Method: Neighbor Joining; Best Tree; tie breaking = Systematic.
Distance: Tamura-Nei; Gamma correction = Off; Gaps distributed proportionally.
Source: Robert Koch Institute, Berlin, Germany.

Figure 4

Number of reported measles cases by week of illness onset, Poland, 2009



population (94%) than for cases from the Roma community (57%). Based on the dates recorded for onset of disease, the same proportion of outbreaks recorded up to four generations of transmission among the Roma and non-Roma Polish population.

In some cases, separate outbreaks could be linked by detailed epidemiological and molecular investigation. From August to October 2008 two outbreaks occurred in Mielec and Wroclaw, which are approximately 400 km apart. A total of 32 cases were recorded from those two outbreaks in Roma communities, and both could be linked to the strain Enfield/GBR/14.07 (Accession No. EF600554) of measles virus genotype D4. The index cases were among families with young children returning from London, UK. In the same period numerous importations from England, confirmed by the detection of the Enfield strain, were notified in several other European countries (Figure 3), i.e. the Netherlands (Den Haag.NLD/03.08, GenBank Accession No. EU585844), Spain (Cadiz.SPA/05.08/1, GenBank Accession No. EU982301) and Germany (Berlin.DEU/19.08).

From June to October 2009, 54 cases were linked to three outbreaks in Roma communities living in different towns (Figure 4). The first outbreak with seven measles cases was reported in the city of Lodz. Subsequently, 47 measles cases were reported in the city of Pulawy and Opole Lubelskie in Lubelskie province. The outbreaks in Lodz and Pulawy were linked by epidemiological investigation and measles virus genotyping, since the measles virus detected in Lodz and Pulawy was identical to the strain Hamburg/DEU/03.09(D4) observed in northwest Germany in the first quarter of 2009. The outbreak in Opole Lubelskie was linked to the Pulawy outbreak by an epidemiological link, and no samples were collected for genotyping.

Discussion

Measles outbreaks have recently been described in many European countries. Large outbreaks were reported in 2008 and 2009 in France [8], Switzerland [9], and Bulgaria [10].

WHO defined measles elimination as a situation in a large geographical area in which endemic transmission of measles virus cannot occur and imported measles cases do not initiate sustained transmission [11]. Despite public health efforts and maintaining high levels of vaccination coverage, outbreaks due to measles virus importation continue to occur in Poland. Similarly as in other European countries, herd immunity has not been achieved despite a national measles vaccination coverage above 95%. This failure is possibly related to the existence of specific vulnerable populations, who are often not reached by the public health services regarding vaccination. Common causes of limited access to public health services may involve particular attitudes or beliefs of these populations [12-14].

There could be several reasons for the increased proportion of cases for which a chain of infection could be traced in 2008 and 2009, compared with the previous period. On the one hand, local public health officers may have been investigating the epidemiological links more efficiently during the recent years. When approaching the measles elimination phase, it becomes more important to monitor infection chains and, if necessary, to intervene. On the other hand, well defined outbreaks were identified in 2008 and 2009 with several cases occurring in the same households. This rather indicates an appearance of pockets of unvaccinated persons, who are sustaining measles transmission, possibly in relation to anti-immunisation beliefs, or poor access to healthcare.

Similar to other European countries, Poland has not succeeded in controlling measles enough to reach one case per million inhabitants, one of the WHO criteria for measles elimination. In recent years, most outbreaks in Poland were detected in ethnic minorities and were often related to measles importation from the United Kingdom or Germany. Currently, the emphasis of measles elimination activities should be directed to immunising all sections of the population that are not adequately protected. Considering that ethnic minorities are often marginalised and discriminated against, we need to better understand the health problems, attitudes and beliefs of these communities. An assessment performed during a large outbreak in August 2009, revealed limited access to healthcare and low life expectancy of a settled Roma community [15]. Both in Roma and in the non-Roma Polish population, a considerable proportion of unvaccinated cases in the under 19-year-olds indicates the need to address at least some high-risk groups in Poland. The best approach would be to focus on healthcare workers and persons working in crowded environments like schools, universities or airports.

Genetic characterisation of detected measles viruses has been done in Poland continuously since 2006 [16]. Molecular and epidemiological investigation of the recent outbreaks revealed five independent transmission chains with a duration of under three months. Genetic data demonstrated a close relationship of four of the five distinct subvariants of genotype D4 identified in Poland to viruses of western Europe (GenBank Accession No. EF600554, EU585844, EU982301, GQ370461) from where they were imported, and to a virus from India (GenBank Accession No. EU812270) considered to be the source of the recent European D4 viruses [Regional Reference Laboratory WHO EURO, Robert Koch Institute, personal communication]. The present analyses document that Poland has made progress on its way to reach the elimination goal for measles virus in the WHO European region. Considering increasing airline travel, and anti-vaccination beliefs, continuous efforts are necessary to maintain a high vaccination status of the Polish population, and implement innovative measures to reach vulnerable groups.

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Mass immunisation campaign in a Roma settled community created an opportunity to estimate its size and measles vaccination uptake, Poland, 2009

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Citation style for this article:
Citation style for this article: Stefanoff P, Orlikova H, Rogalska J, Kazanowska-Zielinska E, Slodzinski J. Mass immunisation campaign in a Roma settled community created an opportunity to estimate its size and measles vaccination uptake, Poland, 2009. Euro Surveill. 2010;15(17):pii=19552. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19552

This article has been published on 29 April 2010

During a mass immunisation campaign following an outbreak of measles in a Roma community settled in the town of Pulawy, Poland, we performed an estimation of the size of this Roma population and an assessment of its vaccination uptake. We obtained a list of Roma residing in Pulawy from the local municipality and estimated using a simple capture-recapture formula that Pulawy had 377 Roma residents (43% under 20 years old), which was 27% more than the 295 registered at the municipality. During the vaccination campaign, demographic information was recorded that could be linked to information from the municipality list as well as to prior immunisation status. Among the people whose data were recorded during the vaccination campaign, 14% were not registered at the primary healthcare centres, and were therefore deprived of access to healthcare. Among 102 screened subjects under the age of 20 years, 51% were vaccinated according to schedule. Vaccine uptake for the first dose of measles-containing vaccine was 56% (54/96) and for the second dose 37% (18/49). The present study indicates the need to get a better demographic overview of Roma communities living in Poland and to understand the barriers limiting their access to healthcare and social services. Organisation of catch-up immunisations of this vulnerable population is necessary.

Background

From 2003 to 2005, Poland was approaching the World Health Organisation's measles elimination target, with the recorded incidence of locally-acquired cases below one per million inhabitants. In 2008 and 2009, several measles outbreaks were notified in Poland, many of which were related to cases imported from United Kingdom [1]. Also in other European countries, an increase in measles incidence was observed in those years, mainly due to ongoing transmission among different vulnerable populations [2-4].

Vaccination against measles is mandatory and free of charge in Poland. Since 1975 the first dose of monovalent measles vaccine had been recommended at the age of 13-15 months, and in 1991 a recommendation for the second dose at the age of six years was introduced. Since 2004, the vaccine has been given as the combined measles-mumps-rubella (MMR) vaccine at the age of 13-15 months and 10 years. In 2008, the national vaccination coverage for measles for three year old children with the first dose was 98% and for 11 year-olds with the second dose 97% [5]. The vaccination coverage in high-risk groups or in any sub-populations in Poland is not routinely assessed.

From 22 June to 30 August 2009, an outbreak of measles with 41 registered cases occurred in a Roma community in the town of Pulawy in eastern Poland [6]. An interventional vaccination campaign was organised in the affected community in order to stop further spread of measles. The objective of the present study was to estimate the size and age distribution of the Roma population in Pulawy based on data collected during the mass immunisation, and to assess prior vaccination coverage against measles in the studied population.

Methods

To estimate the size of the Roma community in Pulawy, we obtained the list of Roma residents registered at the local administrative authority of the municipality of Pulawy (status: mid-July 2009), including the social security number (PESEL), name, surname, sex, date of birth and address of residence. According to Polish law, each person residing in a given location for a period exceeding two months has to be registered at the local municipality. Residents registered at the municipality are entitled to social benefits and have access to school and healthcare systems. The list from the municipality included the Roma ethnic status, which was additionally verified by the municipality administrators responsible for Roma ethnic minority.

During the vaccination campaign, which was organised at the beginning of August 2009, we recorded the demographic information, prior vaccination status, the registration rate at a primary healthcare centre and registration at the municipality. The immunisation campaign was organised at a local healthcare unit. It was advertised by social workers going from house to house within the Roma community, through newspaper and website advertisements in Polish language and through regional Roma leaders. During the campaign, immunisation was offered to Roma residents between the age of nine months and 60 years.

The capture-recapture method was used to estimate the population size and age distribution of the community. Because of high mobility of the Roma communities, it was assumed that only part of the Roma residents were registered at the local municipality. Therefore, the campaign was considered as an opportunity of re-capturing some of the persons who were not registered. The following standard formula was used for the calculation:

$$\text{Estimated Roma population} = \frac{\text{(Registered at municipality) x (Attending mass immunisation)}}{\text{Registered individuals attending mass immunisation}}$$

The immunisation status recorded during the vaccination campaign was further verified with actual documentation from general practitioners. Because of incomplete documentation for adults, which is true for all Polish citizens, the present analysis of vaccine uptake was limited to individuals under the age of 20 years.

Results

Description of the studied community

The capture-recapture assessment is summarised in Table 1. Altogether, 297 Roma (130 persons <20 years) were registered in the Pulawy municipality. From 195 attendants at the vaccination campaign, 156 (82 subjects <20 years) were registered. Based on our performed computation, the estimated size of Roma population in Pulawy was 377 persons (162 subjects <20 years), which was 27% more than the registered population.

The age-by-sex distribution of the estimated population of Roma residents was compared to the official statistics for the entire population of Poland (Figure 1). Altogether, 39 of 195 (20%) Roma attending the vaccination campaign were not registered in the municipality, including 20 of 102 persons under the age of 20 years (20%). In addition, 27 of 195 Roma (14%), including 20 of 102 under the age of 20 years (20%), were not registered in any of the primary healthcare facilities in Pulawy.

Sporadic unstructured interviews with members of the studied community indicated that it was common practice for young people or families with children to live for several weeks to several months with relatives in another community in Poland or abroad.

Assessment of vaccination coverage

In total, 102 persons under the age of 20 years attended the vaccination campaign. Five were younger than 13 months, which constitutes the age limit of the first vaccination according to the national schedule and were therefore excluded from the denominator. Vaccine uptake for the first dose was 56% (54/97) and for the second dose 37% (18/49) (Table 2).

Among the screened subjects under the age of 20 years, 51% were vaccinated according to the national schedule (Figure 2). Considering the previously estimated size of the Roma population under 20 years of age, this would mean that 83 persons in the studied population were insufficiently vaccinated.

Table 1

Estimation of Roma population size, Pulawy, Poland, July-August 2009

	Age (years)									Total
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	
Registered at municipality	63	67	49	40	43	26	4	4	1	**297**
Male	21	36	22	17	25	11	1	0	0	**133**
Female	42	31	27	23	18	15	3	4	1	**164**
Attending mass vaccination	50	52	26	24	19	24	0	0	0	**195**
Male	19	30	9	10	9	12	0	0	0	**89**
% registered	68	87	78	50	78	75	0	0	0	**75**
Female	31	22	17	14	10	12	0	0	0	**106**
% registered	84	77	77	93	90	92	0	0	0	**84**
Estimated Roma population	81	82	63	59	52	31	4	4	1	**377**
Male	31	42	28	34	32	15	1	0	0	**183**
Female	50	40	35	25	20	16	3	4	1	**194**

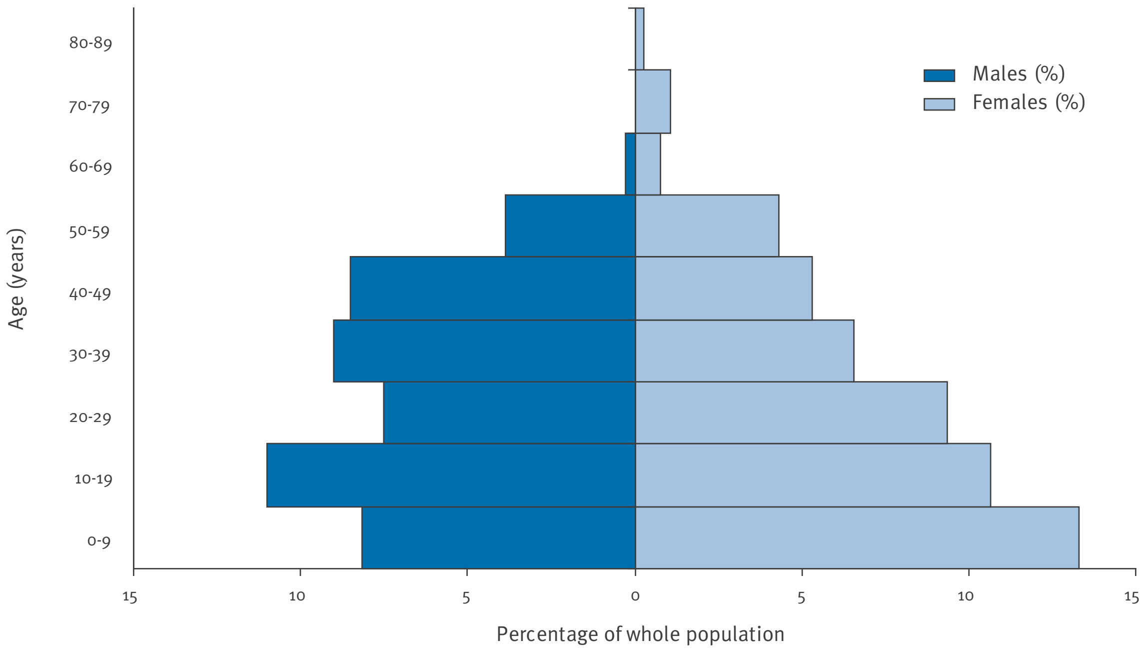
Discussion

One of the possible limitations of this study is the low representativeness of the evaluated Roma population. Roma communities greatly differ in terms of size and integration with the local population, and are usually quite mobile. We attempted to evaluate the population settled in a single town, which could be captured during a mass immunisation event. A considerable number of Roma residents attended the campaign because the event was organised in proximity to the Roma settlements and measles was recognised as a potentially severe disease after one of the early cases in this outbreak had developed serious complications [6]. In addition, persons aged 60 years and older were not captured during the mass immunisation, thus

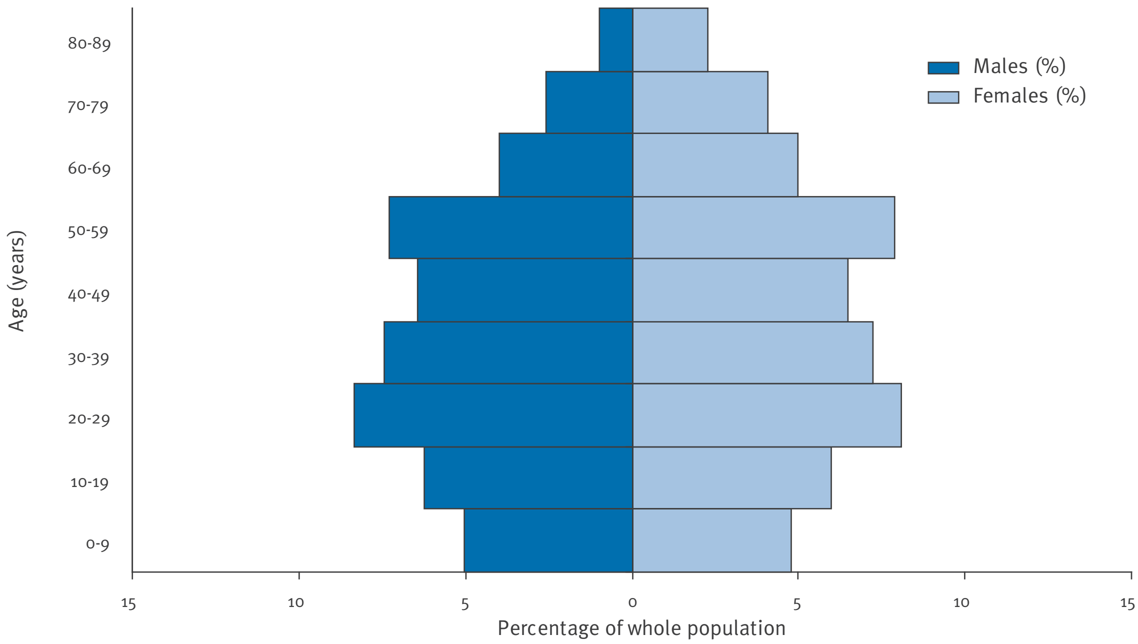
Figure 1

Age-by-sex distribution of the estimated Roma population of Pulawy (a), compared with the population of Poland as a whole (b), 2009

(a) Roma community in Pulawy, August 2009



(b) Polish population, census 30 June 2009



Note: The population older than 60 years was underestimated because they were not invited for the mass immunisation (recapture opportunity).

Table 2

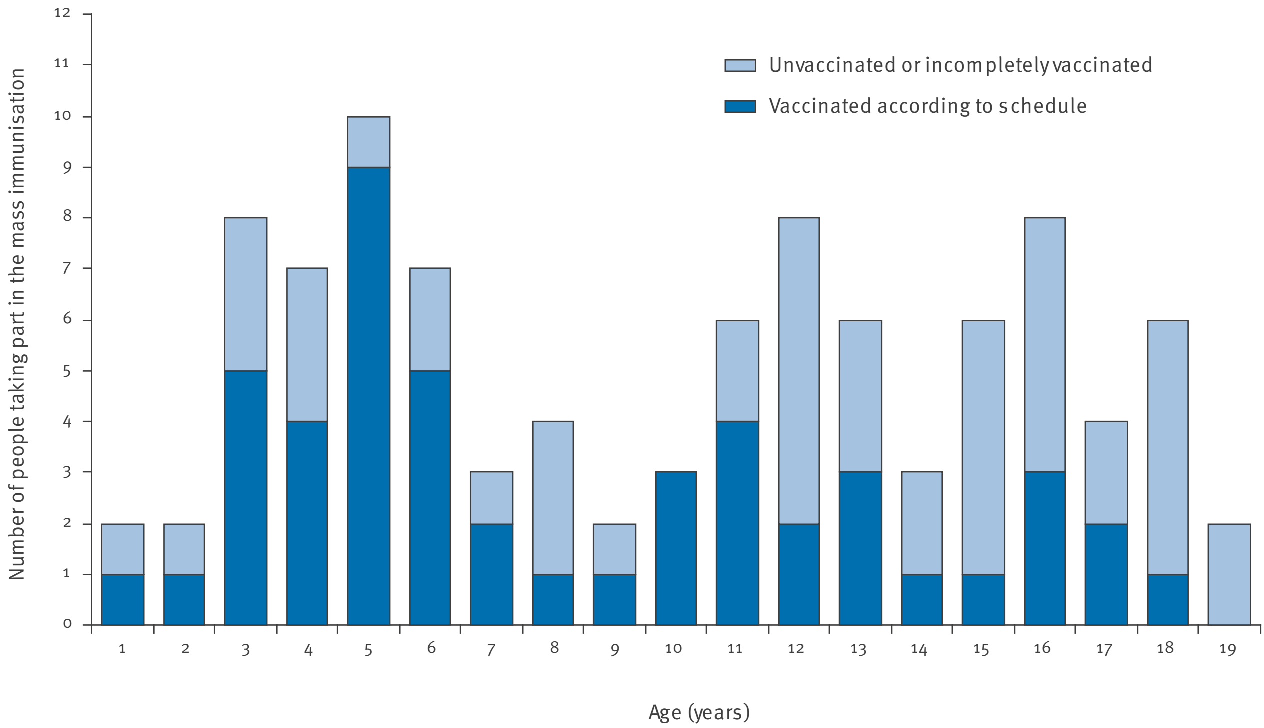
Immunisation status[a] of Roma residents under the age of 20 years, as recorded during mass vaccination campaign, Pulawy, Poland, July-August 2009 (n=102)

Year of birth	Age (years)	Number of prior doses					Total number of children	1-dose uptake	2-dose uptake
		0	1	2	3	Unknown			
2009	0	2[b]				1[b]	3[b]	-	-
2008	1	3[b]	1				4[b]	1 of 2	-
2007	2	1	1				2	1 of 2	-
2006	3	3	5				8	5 of 8	-
2005	4	2	4			1	7	4 of 7	-
2004	5	1	9				10	9 of 10	-
2003	6	1	5			1	7	5 of 7	-
2002	7	1	2				3	2 of 3	-
2001	8		1			3	4	1 of 4	-
2000	9		1			1	2	1 of 2	-
1999	10		2		1		3	3 of 3	1 of 3
1998	11		1	4		1	6	5 of 6	4 of 6
1997	12	2	1	1	1	3	8	3 of 8	2 of 8
1996	13		1	2	1	2	6	4 of 6	3 of 6
1995	14			1		2	3	1 of 3	1 of 3
1994	15	2	2	1		1	6	3 of 6	1 of 6
1993	16			3		5	8	3 of 8	3 of 8
1992	17	1		2		1	4	2 of 4	2 of 4
1991	18			1		5	6	1 of 6	1 of 6
1990	19					2	2	0 of 2	0 of 2
Total		**19**	**36**	**15**	**3**	**29**	**102**	**56%**	**37%**

[a] Immunisation status prior to any vaccinations received during the campaign.
[b] Children below legal age of first dose (12-15 months)

Figure 2

Vaccine uptake in the Roma population by age, Pulawy, Poland, July-August 2009 (n=97)



limiting the precision of estimates for older residents. Moreover, participation in the campaign was not independent of registration in the municipality. Therefore it is likely that the crucial assumption for the capture-recapture computation was not met.

We have no definite explanation why 20% of residents were not registered at the municipality. It could be explained by barriers to social services identified in previous studies, such as the high mobility of Roma communities, their stigmatisation, marginalisation and/or discrimination [6]. Another plausible explanation could be that several Roma residents from nearby communities may have come to Pulawy specifically to receive the vaccine injection. In any case, the present analysis illustrates that a considerable proportion of Roma are not officially registered, and therefore have limited access to social benefits including healthcare. Individuals who are not registered cannot find a legal job and cannot obtain health insurance. In theory everyone under the age of 18 years has free access to healthcare in Poland, irrespective of nationality and health insurance. The large number of attendants of the mass immunisation who were not registered in primary healthcare indicates, however, that those children did not have access to regular health checks, vaccination services or any kind of prophylactic programmes.

Another consequence of a substantial part of the Roma community not being registered could be underestimation of the size of the Roma population living in Poland. Lack of a good demographic overview of the local ethnic minorities makes it impossible to develop targeted social and public health programmes which would fit the needs of those vulnerable groups. According to the official national census data collected in 2002, 12,731 persons belonging to the Roma ethnic minority were living in Poland (0.033% of the population). This figure was mainly based on settled communities that the census could reach. The real number of Roma residents in Poland is probably higher, as illustrated in review published in 2000 [8]. The Roma ethnic group is the largest minority in several central and eastern European countries, comprising approximately seven million people [7]. In addition to a lack of research, interpretation of the literature is hampered by the absence of a standard definition of who is, and who is not, Roma [9].

The presented estimates indicate that the studied Roma population was young, with 61% of residents younger than 30 years. The demographic pyramid differs greatly from that of the overall population in Poland and the populations of most European countries. Because Roma communities have many children, they are good reservoirs for childhood infectious diseases. Access to healthcare and integration with health systems including immunisation programmes should be equal for all citizens of Poland irrespective of ethnicity.

An assessment of the measles vaccine uptake in the Roma population revealed a very low coverage with the second dose in the studied community. High vaccine uptake was observed in 5-7 year-olds, and 10-11 year-olds and may be related to health checks before entry to primary school (six-year-olds) and secondary school (12-year-olds).

The present findings are probably an indication of that the measles vaccination coverage among other Roma communities in Poland, and supposedly in other European countries may also be low. Populations with low vaccination coverage impede measles elimination in Europe. The current goal encompasses stopping transmission of indigenous measles by 2010 [10]. To reach this goal in Poland, a stronger commitment by decision makers to improve vaccination coverage in all sections of the population is needed and innovative measures to reach vulnerable groups should be explored.

Conclusions and Recommendations

1. We recommend an assessment of the size and vaccination status of Roma communities living in Poland to better integrate them in healthcare services including immunisation programmes. It will be necessary to approach Roma leaders and to understand the needs and motivations of this large ethnic minority.
2. Factors influencing low vaccination of Roma communities need to be assessed to better target health education campaigns.
3. Catch-up immunisations in Roma communities should be organised, including all age groups.

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Immunisations among school leavers: is there a place for measles-mumps-rubella vaccine?

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Citation style for this article:
Citation style for this article: Lashkari HP, El Bashir H. Immunisations among school leavers: is there a place for measles-mumps-rubella vaccine? . Euro Surveill. 2010;15(17):pii=19555. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19555

This article has been published on 29 April 2010

To ascertain measles-mumps-rubella (MMR) immunisation coverage among school leavers in an inner city London borough following a local MMR catch-up initiative, a questionnaire was sent to parents and guardians of adolescents who attended the 12 secondary schools in Haringey and were due for the school leavers' vaccination. The questionnaire enquired about previous history of MMR vaccination and a history of adverse events or contraindications to the vaccine. The electronic immunisation records of 400 children (30-35 students from each school) included in the catch up initiative were randomly selected. The childrens' school health records were manually compared with the electronic records. The mean age of the children was 14.7 years, and 224 (56%) were male. Of the 373 records examined prior to the local MMR catch-up initiative, 98 children (26%) had never received MMR, 173 (46.5%) had only had one dose, 100 (27%) had two doses, and two children had three doses of the vaccine. During the school leavers' MMR immunisation, 171 (43%) received a dose of MMR and the number of children immunised with two doses increased to 206 (55.3% versus 27% P<0.001), doubling the coverage. Offering MMR vaccination as part of the school leavers' immunisation is logistically convenient and it may limit the extent of outbreaks.

Introduction

In 1988 the measles-mumps-rubella (MMR) vaccine was introduced in the United Kingdom (UK) and offered to children aged 12-15 months (born after October 1987) [1]. A catch-up campaign for those who were born between 1983 and 1987 accompanied the launch. In 1994, a measles-rubella (MR) vaccine was offered to children born between January 1978 and March 1989 [1]. In October 1996 a second MMR dose was added at the same time as the preschool booster, with a catch-up for those born between January 1990 and March 1992. For the first decade following its introduction in the UK, the MMR vaccine uptake was high, reaching 90% in most areas. With the adverse publicity (from 1998 onwards), the national uptake of the vaccine has fallen to 81% (in children up to the age of two years) and to less than 60% in some areas of London [2]. In 2005, over 40,000 cases of mumps were reported to the Health Protection Agency; half of those cases were children in the age group from 15 to 19 years [3]. In 2006, 739 cases of measles were reported and 129 of those were between 10 and 19 years old [4].

Many studies have suggested that children and adolescents who had two doses of the MMR vaccine are better protected against measles, mumps and rubella compared with those who had only one dose of the vaccine [5-8]. Since 1990, the number of children born with congenital rubella has decreased and only 40 cases were reported for the period between 1991 and 2002 [9-11]. An uptake of 80% is required to prevent the circulation of rubella in the population. If the uptake is lower than that then the average age of infection rises, which leads to an increased risk for women of child bearing age [12].

In 2006, an increasing number of mumps cases were reported among secondary schools pupils in Haringey (North London). In an attempt to control the growing number of cases, we offered a catch-up dose of MMR to all adolescents who were leaving school in 2006 and had not previously had any or only one dose of the MMR vaccine.

Methods

A consent form which included a short questionnaire was sent to all parents and guardians of adolescents who attended the 12 secondary schools in Haringey and were due for the school leavers' vaccination, which includes diphtheria (low dose), tetanus, and inactivated polio vaccine (dT-IPV). The questionnaire enquired about previous history of MMR vaccination (number of doses and dates) and any history of adverse events or contraindications to the vaccine. If parents or guardians were unsure and there was no documentation of previous MMR vaccination in the child's school records, the vaccine was recommended. Those who consented to vaccination were given the MMR dose in school at the time of school leavers' vaccination. Immunisations in all secondary schools were conducted by school nurses. Immunisation records of those vaccinated were entered in the children services' electronic vaccination database that holds the vaccination records of children living in or attending a school in the borough.

Three months following the school MMR initiative, the electronic immunisation records of 400 students (30-35 from each school) born between 1 September 1990 and 31 August 1991 who were due for the school leaver's immunisation (dT-IPV) in 2006 were randomly selected. We then examined the records to ascertain firstly, the number of MMR doses given previously and secondly, if the student received a dose of MMR following the school leavers' vaccination initiative. Because of concerns over the completeness of electronic immunisation records, we also reviewed the childrens' school health records for ascertainment and validation of the MMR vaccine history.

Results

The mean age of children was 14.7 years and 224 (56%) were males. Based on information gathered from the school health and electronic immunisation records prior to the catch-up activity, 27 of 400 (8%) immunisation records were either missing or incomplete. Of the remaining 373 records, 98 (26%) had never received MMR vaccine, 173 (47%) had had one dose, 100 (27%) had had two doses, and two children had received three doses of the vaccine. During the school leavers' MMR vaccination a total of 173 (47%) children received a dose of MMR vaccine increasing the number of those who had a total of two doses to 206 (55.3% versus 27% P<0.001) (Table). The reasons for MMR vaccine refusal were not mentioned in the medical records.

Discussion

To our knowledge, no previous studies have looked at the feasibility and benefits of giving MMR immunisation as part of the school leavers' vaccination (as a catch-up initiative) for those who had received no or only one dose of MMR vaccine previously. The children in the study were born between 1990 and 1991 and hence a significant proportion had only one dose of MMR vaccine as they may have missed the second dose introduced in 1996. As one dose of the vaccine offers only 80-85% efficacy against mumps [13], a large number of children in this study are at risk of acquiring this disease. Moreover, part of the same group of children are also not fully protected against measles because of their incomplete vaccination [6]. This was clear from recent measles outbreaks where almost one in five cases were adults [14].

Following the school immunisation, the risk of these infections was reduced by more than twofold. However, the number of children who had two doses of MMR and could therefore be considered to have adequate protection against measles, mumps and rubella is still very low (55%). The low MMR uptake may explain the outbreaks of mumps among older school children and university students. This group might also have contributed indirectly, because of low herd immunity, to the increasing number of measles cases in younger age groups. Rubella has been eliminated from the United States (US) and Scandinavian countries except for occasional imported infections. In the UK, there is a danger of rubella infection in unvaccinated young women in the future due to earlier low uptake of MMR vaccine [11]. As some parents may be particularly reluctant to immunise very young children with MMR, they may be more willing to do so when the children are older and therefore more likely to accept such catch-up campaigns. Providing this vaccine in school and at the same time as the school leavers' immunisation is logistically convenient and it may limit the extent of mumps and measles outbreaks which may involve also younger children who are not fully vaccinated.

Some evidence of waning immunity was found, with the estimated vaccine effectiveness declining from 99% in 5-6 year old children to 86% in 11-12 year-olds during the large outbreak in the UK in 2004-2005 [15]. Waning immunity has been postulated as one of the contributing factors for the large mumps outbreak in 2005 in Canada because young adults in the age group of 18-24 year-olds would most commonly have received their most recent dose of mumps-containing vaccine six to 17 years previously [16,17]. Despite high coverage with two doses of mumps vaccine large outbreaks of mumps have been happened in the US [18]. If population immunity is already near the herd threshold, even negligible waning immunity, particularly when combined with increased exposure, could potentiate an outbreak [19].

Table

Coverage with measles-mumps-rubella vaccine among school leavers before and after catch-up immunisation at schools, North London, 2006 (n=400)

Number of MMR doses	Before school leavers' MMR vaccination Number (percentage ± 95% CI)	After school leavers' MMR vaccination Number (percentage ± 95% CI)	Change in number of vaccine doses
0	98 (26±4%)	33 (9±3%)	-66%
1	173 (47±5%)	132 (36±5%)	-24%
2	100 (27±4%)	206 (55±5%)	106%
Unknown	27	27	
> 2 doses	2 (0.5%)	2 (0.5%)	

CI: confidence interval; MMR: measles-mumps-rubella vaccine.

MMR vaccination for the school leavers will help to boost the herd immunity, but further studies are needed to establish the potential for waning of immunity in adolescents and young adults. Notwithstanding, every effort should be made to improve the MMR uptake in younger children who are at greater risk of the three diseases.

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