

IMPLEMENTATION OF THE PREVENTIVE VACCINATION PROGRAM AGAINST MEASLES, MUMPS, AND RUBELLA (MMR) ON THE EXAMPLE OF A SELECTED CLINIC IN THE CITY OF KRAKOW

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Authors' contribution:

A. Study design/planning • B. Data collection/entry • C. Data analysis/statistics • D. Data interpretation • E. Preparation of manuscript • F. Literature analysis/search • G. Funds collection

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ABSTRACT

Aim of the study: The study aimed to examine the measles-mumps-rubella (MMR) vaccination coverage with the full vaccination schedule (two doses) in children aged 9 and 10 years, and the vaccination rate with the first dose in children aged three years, in the selected Primary Health Care facility.

Material and methods: This is an ecological study, conducted by analysis of medical records. We researched the vaccination coverage of children aged 3, 9, and 10 years in each year between 2010 and 2019 and studied the data of 1610 children. Data were collected from vaccination records and annual vaccination coverage reports. The statistical analysis was done by using the chi-square and Kendall's tau tests.

Results: The percentage of nine-year-olds vaccinated with a second dose of MMR between 2010 and 2019 was 55% on average ($n = 913$) and 86% ($n = 855$) in the group of one-year-old children. The number of nine- and 10-year-olds not vaccinated with any single dose of MMR did not increase significantly and oscillated between 0-2%. The average percentage of three-year-olds vaccinated with the first dose of MMR over a 10-year period was 95% ($n = 1057$). In 2019, however, the number of vaccinated children fell below 90% (86%), and the number of unvaccinated children more than doubled compared to 2018.

Conclusions: A second dose of MMR vaccine in the studied group is often administered later than recommended in the immunisation schedule. The percentage of vaccinated 10-year-olds usually does not exceed 90%. There has been an increase in the number of unvaccinated children, mostly three-year-olds.

Key words: vaccination, MMR, vaccine calendar.

INTRODUCTION

Measles is a viral illness transmitted by droplets or airborne with a high infective potential. Swelling of the parotid glands, commonly called mumps, is also caused by the virus and spread by the droplets. Similarly, rubella is a viral illness transmitted by the droplets. Children are the most prone to contract these three different viruses. The long-term complications vary from mild to dangerous or even death [1-3]. The World Health Organisation (WHO) reported that 82,596 people suffered from measles in the European region in 2018 and 72 died [1]. With the aim of preventing the negative health implications, immunisation against the indicated illnesses has been carried out in many countries for years.

In Poland, vaccinations against measles, mumps, and rubella have been compulsory since 2004 [4]. For this purpose, a combination vaccine called MMR

(measles-mumps-rubella) is used. The immunisation schedule requires a child to receive two doses of MMR. Children should be vaccinated with the first dose once they are between 13 and 14 months old. This is to be followed by a second dose (booster) when they are 10 years old [5].

In 2019 the National Institute of Public Health in Poland published data about childhood vaccination coverage in the previous year – 2018. A drop in the number of two-year-old children vaccinated with the MMR was observed between 2009 and 2018 on a nationwide scale. The vaccination coverage was 84% in 2009 but only 74% in 2018. Across the whole group of 10-year-olds (born 2009) about 73.9% received the second dose of MMR in 2018, and among 11-year-olds (born 2008) it was 92.4% [6].

In the Małopolskie voivodeship, MMR vaccine coverage was 91.2% in children aged three years.

In comparison, diphtheria and tetanus vaccination coverage among three-year-olds was 96.8% in 2018, meaning 3.2% of them were not vaccinated [6].

Due to an increase in the number of measles outbreaks in Europe, new guidelines were introduced in 2019, and the second dose is now to be administered when children are six years old. It is believed to provide higher immunity against measles, mumps, and rubella [1, 5].

The anti-vaccination movements have a significant impact on social perception of vaccines and might be responsible for influencing parents' decision about vaccinations [2].

Due to the article written by A. Wakefield in 1998, the MMR vaccine was associated with a higher occurrence of inflammatory bowel disease and autism. Although Wakefield's paper has been discredited by a great deal of scientific evidence, parents' concerns about the MMR vaccine are still ongoing [1, 2, 7]. Other potential causes of negative attitudes towards vaccination leading to rejection of them include low health literacy, limited trust in the health system, and belief in the Big Pharma conspiracy theory [8].

AIM OF THE STUDY

The aim of the study was to examine the MMR vaccination coverage with the full vaccination schedule (two doses) in children aged 9 and 10 years as well as the vaccination rate with the first dose in children aged three years in the selected Primary Health Care facility.

MATERIAL AND METHODS

The study was conducted in the Med-All Medical Centre in Krakow, which provides primary health care including a paediatric outpatient clinic. Most of the children under the care of practice were residents of Krakow (98.7%).

This is an ecological study that belongs to the group of analytical observational studies. It was conducted by analysing medical records. Overall, the data of 1610 children born between 2000 and 2016 were analysed. The data were collected from 392 vaccination records of children born in 2016, 2010, and 2009, who were 3, 9, or 10 years old, respectively, in 2019. All other data of children born in 2000-2008 and 2011-2015 were collected from annual vaccination coverage reports.

The data were analysed over the 10-year period from 2010 to 2019. Children under the age of six years, who were vaccinated with the second dose of MMR in 2019, were not included in the sample group due to the lack of a reference point to previous years. However, children under the age of 11 years (but over 10 years old) were included in the sample group due to the nu-

merous missed vaccinations in children who were subject to vaccination in a given year. In addition, the number of three-year-olds vaccinated with a single dose of MMR vaccine was analysed. This vaccination should have taken place between the age of 13 and 14 months.

The analysis was carried out and the results were developed in MS Excel (Microsoft) and R statistical package version 3.3.2.

The chi-square test was used to check the significance of differences in the number of children vaccinated with the full vaccination schedule (two doses) at the age of nine and 10 years. The correlation between the number of three-year-olds vaccinated with the first dose and individual years was tested using Kendall's tau test. The level of statistical significance was $p < 0.05$.

RESULTS

The analysis of the MMR vaccine coverage in the researched group was divided into two parts. First, the situation of older children who were subject to the mandatory second dose is presented (Table 1, Figure 1), followed by children aged three years, who should have been vaccinated with the first dose (Table 2, Figure 2).

The percentage of nine-year-olds vaccinated with the second dose of MMR over the 10-year period (2010-2019) was 55% on average ($n = 913$). The lowest percentage of children vaccinated with the second dose ($< 45\%$) occurred in 2016 and 2017. The highest level of coverage among nine-year-olds was observed in 2012; however, it did not exceed 70% (69.23%).

The average percentage of vaccination coverage in the group of 10-year-olds was 86% over the 10-year period ($n = 855$) (Table 1), and in the five analysed years it exceeded 90%. However, the vaccination coverage was not greater than 95%, which is the herd immunity threshold [1].

The lowest level of vaccinated 10-year-olds was recorded in 2010 and 2011 (75%).

The number of 9 and 10-year olds not vaccinated with any single dose of MMR did not increase significantly and oscillated between 0 and 2% during the analysed 10-year period.

At the age of 10 years there were still children with only one dose of MMR vaccine, but it is not possible to identify clear statistical trends (Figure 1).

Aggregating data in the form of summing up the observations for all the analysed years in terms of the nine- and 10-year-olds vaccinated with two doses of MMR allows us to state that the MMR vaccine coverage in the researched groups of nine- and 10-year-olds depends on age ($p < 0.001$) (Table 2).

The number of fully vaccinated 10-year-olds is therefore statistically significantly higher than the number of fully vaccinated nine-year-olds (Table 3).

Table 1. Nine- and 10-year-olds vaccinated with MMR from 2010 to 2019

Year	9-year-olds				10-year-olds			
	Unvaccinated n (%)	1 dose n (%)	2 doses n (%)	Total (n)	Unvaccinated n (%)	1 dose n (%)	2 doses n (%)	Total (n)
2010	3 (4.11)	23 (31.51)	47 (64.38)	73	0 (0)	16 (25)	48 (75)	64
2011	1 (1.32)	38 (50)	37 (48.68)	76	0 (0)	17 (24.64)	52 (75.36)	69
2012	0 (0)	28 (30.77)	63 (69.23)	91	0 (0)	7 (9.59)	66 (90.41)	73
2013	1 (1.25)	30 (37.5)	49 (61.25)	80	0 (0)	7 (7.69)	84 (92.31)	91
2014	0 (0)	24 (32.43)	50 (67.57)	74	0 (0)	8 (9.64)	75 (90.36)	83
2015	1 (1.05)	45 (47.37)	49 (51.58)	95	0 (0)	7 (9.09)	70 (90.91)	77
2016	1 (0.96)	66 (63.46)	37 (35.58)	104	1 (1.06)	9 (9.57)	84 (89.36)	94
2017	1 (1)	57 (57)	42 (42)	100	1 (0.97)	15 (14.56)	87 (84.47)	103
2018	2 (1.85)	56 (51.85)	50 (46.3)	108	0 (0)	9 (9.47)	86 (90.53)	95
2019	2 (1.79)	39 (34.82)	71 (63.39)	112	2 (1.89)	17 (16.04)	87 (82.08)	106

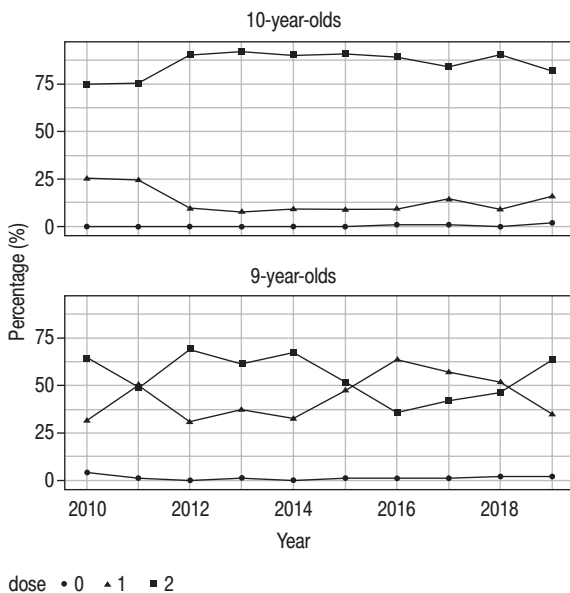


Figure 1. Trends in MMR vaccination coverage of 9- and 10-year-olds from 2010 to 2019

Table 3. Basic MMR vaccination in 3-year-olds from 2010 to 2019

Age (years)	Uncompleted vaccination n (%)	Completed vaccination n (%)	Total (n)
2010	1 (1.18)	84 (98.82)	85
2011	0 (0)	77 (100)	77
2012	2 (2.44)	80 (97.56)	82
2013	3 (2.21)	133 (97.79)	136
2014	5 (5.68)	83 (94.32)	88
2015	6 (4.88)	117 (95.12)	123
2016	8 (5.93)	127 (94.07)	135
2017	6 (5.88)	96 (94.12)	102
2018	7 (6.48)	101 (93.52)	108
2019	17 (14.05)	104 (85.95)	121

Table 2. Results of chi-square test after aggregating data of 9- and 10-year-olds (completed and uncompleted vaccination)

Age (years)	Uncompleted vaccination n (%)	Completed vaccination n (%)	Total (n)
9	418 (45.78)	495 (54.22)	913
10	116 (13.57)	739 (86.43)	855

$\chi^2 = 215.85, df = 1, p < 0.001$

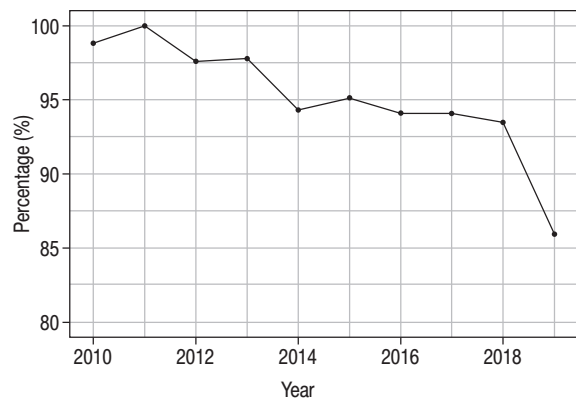


Figure 2. Trends in MMR vaccination in 3-year-olds from 2010 to 2019

The average percentage of three-year-olds vaccinated with the first dose of MMR over the 10-year period was 95% ($n = 1057$). However, in 2019, the number of vaccinated children fell below 90% (86%), which means the number of unvaccinated children more than doubled compared to 2018 (Figure 2). In the previous years, vaccination coverage with the first dose exceeded 90%.

Furthermore, a 10-year analysis of children under the care of the selected clinic indicates a decrease in the number of three-year-olds vaccinated with the first dose of MMR. Kendall's tau test proves the existence of a strong monotonic relationship between the

number of vaccinated children and the year of vaccination ($r = -0.822$, $p < 0.001$).

In summary, there is a systematic increase in the number of children unvaccinated with the first dose in the researched clinic.

DISCUSSION

An important factor to consider is herd immunity, which is established when the level of vaccination coverage in the population is above 95%. People who are not vaccinated for various reasons and those who, despite vaccination, have not developed long-term immunity to the pathogens in question will still be protected due to the limited transmission of microorganisms in such a population [3, 9, 10]. Lasting resistance to measles, mumps, and rubella will be achieved after being vaccinated with two doses. Despite the Global Vaccine Action Plan (GVAP) implemented by the WHO, an increased incidence of measles was registered in 2018 [1].

The nationwide vaccination coverage with two doses of MMR vaccine according to the immunisation schedule stands at 73.9% for nine-year-olds and 92.4% for 10-year-olds. However, in the Małopolskie voivodeship the rates are 73.8% for children aged nine years and 91.5% for 10-year-olds (data obtained in 2018) [6]. The significant differences in the percentages of vaccinated children between both age groups are the result of the fact that parents often do not vaccinate their children in the scheduled year but postpone the vaccination appointment.

As a comparison, the childhood vaccination coverage in the United Kingdom in 2018, was 94.5% for the first dose of MMR and 86.4% for the second one. The 10-year trend in 2008-2018 indicates an increase in vaccine coverage for the second dose of MMR in the British population despite a slight decrease in the years 2016 to 2018 (88% in 2016 and 86.4% in 2018) [11].

The data for Greater London were lower than in the other parts of the country. Only 76.3% of Londoners received a second dose of MMR vaccine [11].

In the above study, the level of vaccination coverage with the second dose of MMR among nine-year-old patients in the selected Primary Health Care facility in Krakow is also lower (46.3%) than in the whole country (73.9%) or in the region (73.8%).

The situation improves in the group of children a year older (10-year-olds). The vaccination coverage was 92.4% nationwide, 91.5% in the Małopolskie voivodeship, and 90.53% in the studied population in the selected Primary Health Care facility [6]. Nevertheless, patients in the researched population have lower vaccination coverage in comparison to national or regional levels.

In regard to vaccination coverage with the first dose of MMR vaccine in children aged three years, the

nationwide coverage in 2018 was 96% and 95.4% in the Małopolskie voivodeship [6]. In the studied population, the percentage of children receiving the first dose of the MMR vaccine was 93.5%. The level of vaccination coverage in the Polish population is therefore higher than in the studied population.

Despite a nine-year trend of vaccination coverage with the first dose of MMR vaccine above 90%, a two-fold increase (14.5%) in the number of unvaccinated three-year-old children was observed in 2019 (Table 2). Over the last 10 years, there has been a growth in the number of children not receiving any dose of the MMR vaccine in the studied population (Figure 2) as well as in the national population [6]. The consequence of decreased coverage with the MMR vaccine is an increase in the incidence rate of the measles, mumps, and rubella [1].

There was a three-fold increase in the incidence of measles, which mainly affected unvaccinated persons in Poland in 2016 [12, 13], while in 2017 a two-fold decrease was observed, but in 2018 another rise in measles cases was recorded [14]. According to a study conducted by Korczyńska and Rogalska, over 2000 cases of mumps were registered in 2014, and the majority of the sick children were not vaccinated or had only one dose of vaccine [15]. According to Sun *et al.*, children vaccinated with only one dose of MMR vaccine were still at risk of viral infection in comparison to children immunised with the two doses of MMR vaccine [16]. Therefore, it is important to monitor childhood vaccination coverage and to educate parents on the necessity of receiving a second dose of MMR vaccine.

The reasons why parents do not report to a clinic to vaccinate their children with the MMR vaccine are commonly not documented in vaccination records; therefore, they were not identified in the studied population.

Dońska *et al.* state that apart from a lack of trust for healthcare workers, the other reasons behind rejection of vaccinations include religious and personal beliefs, uncertainty regarding vaccine safety, and the sense of a lack of information [8]. Słopiecka and Kwiecień point out that mass media, information chaos, and celebrities promoting a natural lifestyle and avoidance of vaccinations negatively influence people's attitude towards vaccination [17].

According to Kochman and Rudzińska, inadequate health education of parents is a major factor for their decision to not vaccinate their children. Researchers prove that a thorough education translates into more vaccinated children. In the institutions where extensive health education is provided, the percentage of vaccinated children exceeded the level of those vaccinated in the national population [18]. Information obtained from medical staff has the greatest impact on changing a parent's decision about vaccinations,

according to the research by Gańczyk *et al.* [19]. The style of communication also has a significant impact on parents' perception of vaccinations [2]. It seems, therefore, that it is necessary to conduct long-term educational activities about vaccinations in order to increase the number of vaccinated children and thus obtain the aforementioned herd immunity.

CONCLUSIONS

A relatively low percentage (60%) of children in a given year received the compulsory second dose of MMR vaccine in the researched clinic. A second dose is therefore often given later than it should be.

The percentage of vaccinated 10-year-olds in the studied population rarely exceeded 90%.

In 2019, there was a sudden rise in the number of three-year-olds failing to receive the MMR vaccine in the researched population. This trend can be a part of an increasing nationwide trend in the number of unvaccinated children.

Due to the increase in the number of unvaccinated children, there is a need to raise awareness among parents about the necessity of vaccinations.

Disclosure

The authors declare no conflict of interest.

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