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Catch-up vaccination campaign in children between 6 and 8 years old during COVID-19 pandemic: The experience in a COVID hub in Milan, Italy



Matteo Mancarella^{a,1,*}, Federica Natarelli^{a,1}, Caterina Bertolini^b, Antonino Zagari^c,
Maria Enrica Bettinelli^{a,b}, Silvana Castaldi^{a,d}

^a Dept. Biomedical Sciences for Health, University of Milan, 20133 Milan, Italy

^b Vaccination Unit, ASST Fatebenefratelli Sacco, 20157 Milan, Italy

^c Direzione Socio-Sanitaria, ASST Fatebenefratelli-Sacco, 20157 Milan, Italy

^d IRCCS Fondazione Ca' Granda - Ospedale Maggiore Policlinico, 20122 Milan, Italy

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ABSTRACT

Background: COVID-19 has led to disruption in routine immunization programs around the world. Effective strategies need to be developed to address the decline in vaccine coverage to avoid preventable disease outbreaks. Our study reports a 4-days campaign for the catching-up of missed vaccinations in children aged between 6 and 8 years, in Milan, Italy.

Methods: The catch-up vaccination campaign (21st–24th of September 2021) involved children born in 2013, 2014 and 2015. These cohorts, if not already immunized, received the fourth dose of the Diphtheria-Tetanus-acellular Pertussis and Poliomyelitis vaccination (DTaPP4), the second dose of the Measles-Mumps and Rubella vaccination (MMR2) and Chickenpox, according to the Italian vaccine schedule.

Results: 3,943 letters were sent to children with a missing vaccination. 1,315 children, 33% of expected, were vaccinated during the campaign. The 2015 cohort was the one that benefited most from the initiative, 955 children were vaccinated for a total of 1,864 doses administered. This has led to a significant increase of 20.0 percentage points (p.p.) in vaccination coverages for the fourth dose of DTaPP and the second dose of MMR. 214 children for the 2014 cohort and 146 for the 2013 cohort were vaccinated during the following days, these cohorts have been already called previously therefore the participation in the campaign and consequently the increase in vaccination coverages were less substantial.

Conclusions: This experience has demonstrated that a mass vaccination campaign could be a useful tool in catch-up strategies, even during the pandemic. It should be part of a bigger immunization program strategy that also includes efforts to simultaneously strengthen routine immunization services. With the appropriate organizational improvements, this initiative could pave the way for future successful campaigns involving different age groups and vaccinations.

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1. Introduction

Coronavirus disease 2019 (COVID-19) with acute respiratory disease and potentially severe pneumonia has resulted in unimaginable consequence to public health and loss of human life [1].

* Corresponding author at: Dept. Biomedical Sciences for Health, University of Milan, 20133 Milan, Italy.

E-mail addresses: matteo.mancarella@unimi.it (M. Mancarella), federica.natarelli@unimi.it (F. Natarelli), caterina.bertolini@asst-fbf-sacco.it (C. Bertolini), antonino.zagari@asst-fbf-sacco.it (A. Zagari), maria.bettinelli@unimi.it (M. Enrica Bettinelli), silvana.castaldi@unimi.it (S. Castaldi).

¹ Equally cofirst authors.

Between 2020 and 2021, there have been more than 360 million confirmed cases of COVID-19 [2] with dramatic impact on morbidity, disability and deaths. A reduction in the accessibility of non-COVID patients to healthcare services has been the side effect of the COVID-19 outbreak, having potential consequences to the health of the population in the short and long term [3,4]. Huge indirect effects on health-care systems are recorded around the world, especially with regards to the routine child immunization services [5,6,7]. Decline in vaccine coverage rates, even for short periods, can lead to an increase in vaccine-preventable disease outbreaks, which could put additional pressure on health systems [8].

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All over the world vaccination coverage in 2020 have declined due to the pandemic restriction measures and the reorganization of health services [5]. The increase of personnel shifted to the COVID-19 wards has resulted in the closure of many vaccination centers and subsequently in the reduction of the preventive services, particularly in the first phase of the epidemic. Furthermore, the fear of contagion has led many parents to postpone scheduled vaccinations for themselves and their children [9,10]. Globally, in 2020, it has been estimated that 30 million of third-dose Diphtheria-Tetanus-Pertussis (DTP3) and 27.2 million of first-dose Measles-containing vaccine (MCV1) were missed [11]. Compared to expected doses delivered in the absence of the COVID-19 pandemic, it has been observed a relative reduction of 7.7% for DTP3 (vaccine coverage: 76.7%) and of 7.9% (vaccine coverage: 78.9%) for MCV1 [11]. Although the estimates on the doses not administered are variable according to the methodology applied in different studies, there is no doubt that throughout the world there has been a decrease in vaccination coverage especially in South-East Asia and Eastern Mediterranean regions [6,7,11].

A survey conducted by the Ministry of Health in Italy (18th November 2021) indicates that a decrease in vaccination activities was detected in almost all Local Health Units (LHU) [10]. In Italy, the Ministry of Health periodically issues the National Immunization Prevention Plan (PNPV), a guidance document for immunization policies intended to be of technical support to Regions and which defines vaccines that have to be actively offered free-of-charge to target populations in Italy [12]. The immunization plan is implemented on a local level by the LHU according to regional guidelines. The establishment of the 2017–2019 edition of the PNPV extended the number of mandatory vaccines from four to 10 vaccines for children aged 0–16 years [13]. Vaccinations against pertussis, measles-mumps-rubella (MMR), varicella and *Haemophilus influenzae* (Hib) were added as mandatory vaccines (mandatory vaccines were diphtheria, tetanus, hepatitis B and polio) in the national immunization schedule [14]. A not negligible decline has been observed with regards to the first vaccinations of newborn with percentages below the threshold that guarantees herd immunity (95%) [13], however the reduction has been noted in all age groups. Taking into account the pre-school children between 5 and 6 years, it has been found a decrease of 2.7 percentage points of the fourth dose of the Diphtheria-Tetanus-acellular Pertussis and Poliomyelitis (DTaPP4) vaccination rate (85.92% in 2020 vs 88.62% in 2019) and of 1.76 percentage points for the second dose of the Measles-Mumps and Rubella vaccination (MMR2) (85.82% in 2020 vs 87.58% in 2019) [10].

Our study reports the experience of a 4 days of massive vaccination carried-out in Milan LHU in Italy in order to catch-up missed vaccinations in children aged between 6 and 8 years by the ASST Fatebenefratelli-Sacco. The ASST are public health organizations with hospital and community services trusts.

2. Materials and Methods

2.1. Selection and invitation of cohorts

The management of the preventive services is assigned by the Milan LHU to three different ASST. The ASST has the institutional mandate of providing health services to all population and ensuring the Essential Levels of Assistance (LEA) [15] with the resources of the Region. The Metropolitan area of Milan is divided into 9 districts called municipalities, ASST “Fatebenefratelli-Sacco” covers the municipalities number 1, 2, 3, 4 and 8 which coincide with the area with the highest population density (754,649 inhabitants).

The catch-up vaccination campaign was named “Mettili un vaccino in cartella” (“Put a vaccine in your schoolbag”) and involved

children between 6 and 8 years old born in 2013, 2014 and 2015 living in districts 1, 2, 3, 4 and 8. According to the national vaccine schedule [13], children born in 2015 should receive DTaPP4, MMR2 and Chickenpox vaccine in 2021, at the age of 6. This campaign represents a way to balance the slowdown in routine vaccinations during the COVID-19 pandemic in the current year. Conversely, the children born in 2013 and 2014 have the opportunity to catch up missed vaccinations that they should have received in previous years.

In July 2021 were extracted from the regional immunization registry (SI AVR) all the names of those born in 2015, 2013 and 2014 not vaccinated with MMR2 and DTaPP4. This first list was then compared with the names of individuals currently resident in Milan and assigned to the ASST Fatebenefratelli-Sacco, provided by the resident population registry database of the same cohort of birth. The non-resident subjects were excluded.

A letter was sent to all those who were not vaccinated with a leaflet explaining the importance of the immunizations and the invitation to the massive catch-up days. The first sending counted 3,739 letters.

The subjects without any information registered on the individual certificate of immunization status have been contacted by telephone by the immunization services and then, if resulting in missed vaccinations, invited to the massive catch-up days through letter. A total of 3,943 letters were sent (Fig. 1).

2.2. Setting of the campaign

The campaign was set up by the ASST Fatebenefratelli Sacco between the 21st and the 24th of September 2021 in “La Fabbrica del Vapore”, a space of the Municipality of Milan, which has been used as a COVID-19 vaccination hub from April to October 2021. The general layout was composed by different areas: reception, acceptance, anamnesis, inoculation and observation. The organization of the activities has been structured respecting the standards [16] already required for anti-COVID vaccinations to prevent possible contagion and to guarantee interpersonal distancing. In particular, internal and external routes were clear and as linear as possible to ensure two different ways of entry and exit. At the entrance there was a body temperature detector while disinfection stations were provided in each area.

The appointments were scheduled every 6 min from 8:00 am to 4:00 pm. Depending on the number of appointments, vaccinations were organized in 10–15 immunization-lines where anamnesis and administration were carried out, with about 70 vaccinations per line. The health care personnel consisted of 30 operators per day, of which at least 3 are medical doctors and all the remaining nurses. Administrative staff and volunteers of Civil Protection were also involved to support the activities, particularly reception.

2.3. Vaccines employed

All age groups were vaccinated with a combined diphtheria, tetanus, acellular pertussis (adsorbed) and inactivated poliomyelitis vaccine, for the fourth dose of DTaPP immunization. A combined measles, mumps and rubella vaccine live, attenuated was used for the second dose of MMR. Measles, mumps, rubella and varicella virus vaccine live (MMRV) was proposed to those who had no evidence of chickenpox infection according to the past infectious history, as reported by the parents. The other vaccines envisaged under the PNPV, were also available in case of other missed immunizations.

The need for vaccines was calculated based on the number of letters sent.

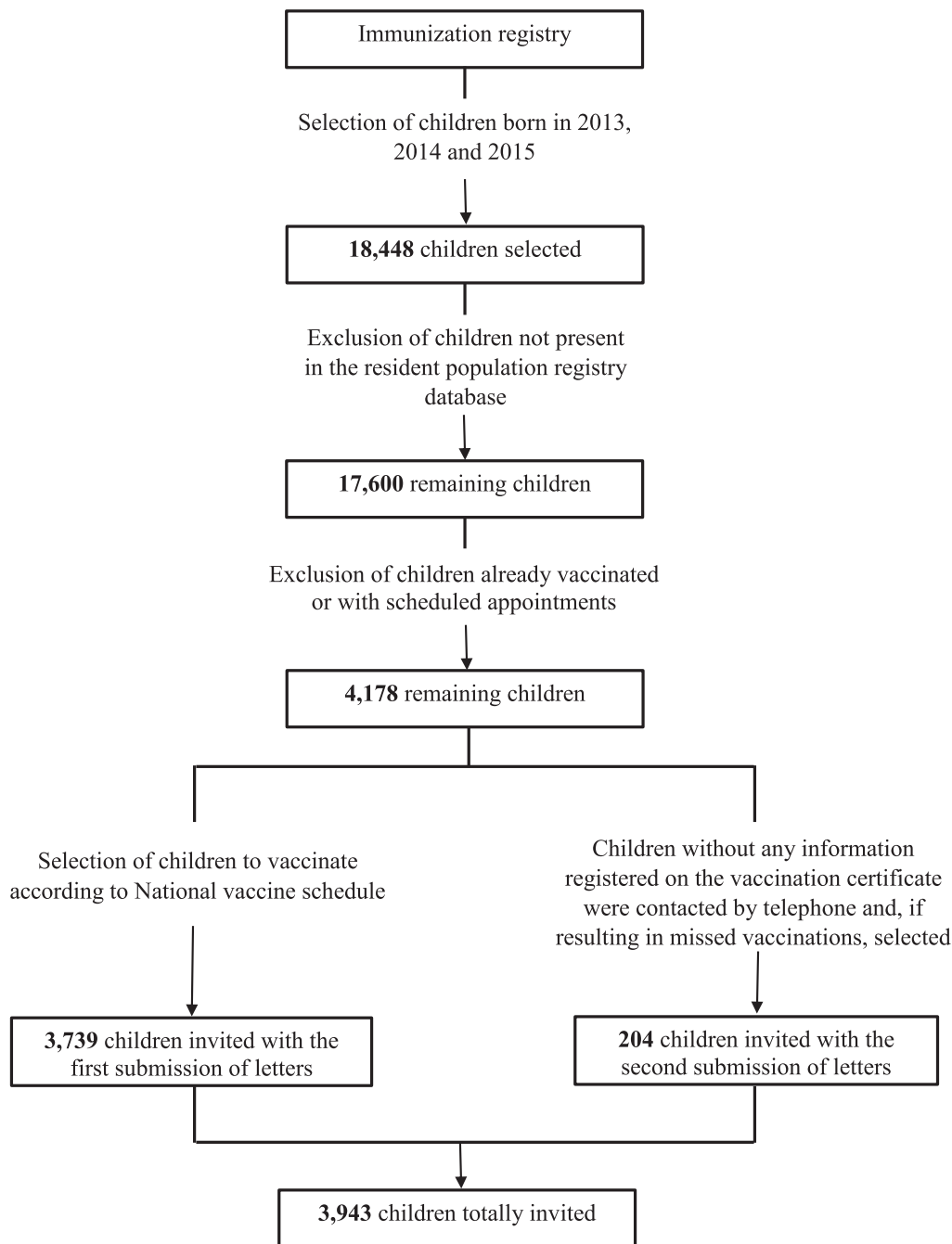


Fig. 1. Selection process of the children invited to the catch-up days.

3. Results

The response to the invitation letters and the consequent participation in the immunization campaign varied according to the age group ranging from 13% for the cohort of 2013 to 48% for the cohort of 2015.

3.1. Cohort 2015

Children born in 2015 resident in the municipalities considered were 5,879, including 2,759 and 2,805 children needed to be vaccinated for DTaPP4 and MMR2, respectively. The immunization coverage before the start of the catch-up campaign was 53.1% for DTaPP4 and 52.3% for MMR2. 955 children were vaccinated during

the first and the second vaccination days dedicated to this cohort and 1,864 vaccines were administered globally. There has been a significant increase of 20.0 percentage points (p.p.) in immunization coverages for DTaPP4 and MMR2 (Table 1).

3.2. Cohort 2014

6,098 children aged between 6 and 7 years old (cohort 2014) were present in the resident population registry and over the 82% of them was already vaccinated (Table 1) while 1,068 and 1,079 children needed to be vaccinated with DTaPP4 and MMR2, respectively. This cohort had been already called previously therefore the participation in the campaign and consequently the increase in immunization coverage were less substantial than the

Table 1
Vaccination coverage for children born in 2013, 2014 and 2015 before and after the catch-up vaccination campaign.

Cohort	Coverage on the 20th of September 2021 (Before the start of the vaccination campaign)		Coverage on the 24th of September 2021 (After the vaccination campaign)		Total increase	
	DTaPP4	MMR2	DTaPP4	MMR2	DTaPP4	MMR2
2015	53.1%	52.3%	73.1%	72.3%	+20.0p.p.	+20.0p.p.
2014	82.5%	82.4%	85.7%	85.5%	+3.2p.p.	+3.1p.p.
2013	82.1%	82.2%	86.4%	86.6%	+4.3p.p.	+4.4p.p.

Abbreviations: DTaPP4 Fourth dose of Diphtheria-Tetanus-acellular Pertussis and Poliomyelitis vaccination; MMR2 Second dose of Measles-Mumps and Rubella vaccination; p.p. Percentage points.

cohort of 2015. 214 children have been vaccinated during the catch-up day with a total of 392 immunization registered.

3.3. Cohort 2013

Children born in 2013 resident in the municipalities considered were 6,741 and the vaccine coverages for DTaPP4 and MMR2 exceeded 82% (Table 1). In this cohort the children to be vaccinated were 1,156 for DTaPP4 and 1,151 for MMR2. 263 immunizations were conducted on 146 children during the catch-up vaccination day dedicated to this age group, a resume is shown in Table 2. This cohort had been already called several times so the impact on the campaign was little and so the increase in vaccine coverage due to the low participation compared to the children born in 2015.

3.4. Comparison with routine activities

We compared the activities carried out from the 21st to 24th of September with routine immunizations days in order to check if this modality was more effective.

Taking as a comparison the same time span of the previous week (14th–17th September), 45 vaccination lines were active at the ASST Fatebenefratelli-Sacco vaccination centres, which allowed for the vaccination of an average of 28 children per line.

The catch-up vaccination days in the COVID-19 vaccination hub, which took place simultaneously with the routine immunization activities carried out in the vaccination centres, saw an increase of 97% of children vaccinated, despite a 38% increase in vaccine lines (Table 3).

Table 2
Resume of the catch-up vaccination days conducted between the 21th and the 24th of September 2021.

	Cohort 2015	Cohort 2014	Cohort 2013
N° of letters sent	1,983	860	1,100
N° of children vaccinated	955	214	146
N° of vaccines administered	933 DTaP-IPV 499 MMR 423 MMRV 7 VAR 1 HepB 1 DTaP-IPV-Hib-HepB	197 DTaP-IPV 101 MMR 85 MMRV 3 VAR 2 HepB 4 DTaP-IPV-Hib-HepB	128 DTaP-IPV IPV 88 MMR 35 MMRV 9 VAR 3 HepB
Total of vaccines administered	1,864	392	263

Abbreviations: DTaP-IPV Diphtheria, tetanus, acellular pertussis and inactivated poliovirus vaccine for children; MMR Measles, mumps, and rubella vaccine; MMRV Measles, mumps, rubella, and varicella vaccine; VAR Varicella vaccine; HepB Hepatitis B vaccine; DTaP-IPV-Hib-HepB DTaP, inactivated poliovirus, Haemophilus influenzae, and hepatitis B vaccine.

Table 3
Comparison between routine activities (14th–17th of September) and activities during the catch-up vaccination days at la Fabbrica Del Vapore and the vaccination centres (21st–24th of September).

	N° of vaccination lines	N° of children vaccinated	N° of vaccines administered
Only routine activities	45	1,235	2,132
Activities during the catch-up days	62	2,430	4,411
Total increase	+38%	+97%	+107%

4. Discussion

The COVID-19 pandemic is causing an unprecedented impact on the delivery of healthcare services at all levels, including routine childhood immunizations [17]. In the United States alone, it was estimated more than a 60% decline in MMR for children aged 2 to 8 years, and over a 60% decline in human papillomavirus (HPV) vaccination for adolescents aged 9 to 12 years from March-May of 2020 compared with March-May of 2019. [9].

The road to catch-up routine vaccination rates requires concerted efforts to raise awareness of the significance of childhood immunizations and to improve access to preventive services. It is fundamental to make parents conscious of the importance of preventable diseases vaccines by sharing information via active call programs, e-mails, newsletters, and social media from trusted institutional sources [18]. Besides, it is necessary to develop effective catch-up strategies and to increase the availability of vaccination access points to “meet people where they are”, for example by planning vaccination sites at schools, mobile vaccination clinics and massive vaccination days [9]. Therefore, as suggested by the Italian Prevention Plan 2020–2025, it is essential to foster greater interaction among all settings: school, work environment, community and health services. LHU could be the “super-setting” where it is easier to reach individuals to promote health and carry out prevention interventions and in which all stakeholders converge [19].

In circumstances where immunization services must be diminished or suspended, countries have taken extraordinary measures to recover children who missed vaccinations. In China, as an example, during the early stages of the COVID-19 epidemic, about 80% of the vaccination services were suspended. National Immunization Program (NIP) and non-NIP vaccine doses administered decreased by 80% and 90%, respectively, compared with doses administered before the COVID-19 pandemic. Three to six months of catch-up campaign, subsequently, was carried out and 94.4% of the nearly 90 million vaccine doses that had been delayed were caught up. Their strategy was based on informing parents of children at appropriate ages for vaccination through rural government officials, sub-district and community health service centres and on

implementing vaccination services, by increasing daily service hours and offering vaccination services during weekends [20].

Moreover, in these circumstances, WHO suggests, if no school-based immunization platform or school vaccination checks currently exist, considering whether such a platform can be implemented as a strategy to quickly close immunity gaps in the involved age groups [18]. In England, since before the pandemic, there are several projects that provide for the routine administration of vaccines in schools. Evidence shows that coverage of vaccinations for school-aged children is greater if delivered in a school setting compared to primary care [21,22].

The situation in Italy, and in Milan in particular, is not dissimilar from what happened in the rest of the world during the pandemic. 6-year-olds children, by way of an example, are a key age-group to assess the coverage of the DTaPP and MMR vaccinations over the years. Table 4 shows how the decline in vaccination coverage due to the COVID-19 pandemic has been evident in 2020 compared to the previous year.

The catch-up vaccination campaign “Mettili un vaccino in cartella” was carried out to raise vaccine coverage and to avoid outbreaks of preventable diseases. Approximately 13–48% of children with missed vaccinations was involved, leading to an important increase of vaccination coverage. Considering that the ideal target coverage to be achieved to ensure herd immunity should be 95% [13], catch-up strategies are still necessary. However, our vaccination campaign has not only allowed the coverage of 2019 to be reached but has considerably exceeded it (73.1% vs 63.5% for DTaPP4 and 72.3% vs 62.9% for MMR2) Table 1 and 4.

This campaign can be considered as an intensification of routine immunization that, as suggested by WHO, is referred to a spectrum of time-limited, intermittent activities used to administer routine vaccinations to under-vaccinated populations. In essence, it is a catch-up opportunity for children or eligible targeted population who are the usual target group for routine immunization services but have been missed or underserved during the year. Ideally, it should be part of a bigger immunization program strategy that also includes efforts to simultaneously strengthen routine immunization services for the long term. It would then serve as a bridge of providing immunity until routine immunization services are strengthened enough to sustainably provide routine services for the targeted communities [18].

There were several issues that affected the effectiveness of the initiative. First of all the selection of the subjects to be vaccinated due to databases and registry not completely updated regarding address, which is essential to send letters. This has led to the manual control of the names on different registries with a potential margin of error. The use of up-to-date and comprehensive databases would make the extraction of subjects’ names less cumbersome and more effective.

The involvement of the pediatrician could be strategic since they are a point of reference for families. In an era where infodemic could encourage vaccine-hesitancy, having little and clear information about the effectiveness of vaccinations, their timing and even-

Table 4
Vaccination coverage for 6-year-olds children assigned to the ASST Fatebenefratelli-Sacco on the same day (20th of September) in 2019, 2020 and 2021 respectively.

	2019 (Children born in 2013)	2020 (Children born in 2014)	2021 (Children born in 2015)
DTaPP4	63.5%	48.8%	53.1%
MMR2	62.9%	48.2%	52.3%

Abbreviations: DTaPP4 Fourth dose of Diphtheria-Tetanus-acellular Pertussis and Poliomyelitis vaccination; MMR2 Second dose of Measles-Mumps and Rubella vaccination.

tual contraindications or side effects from a trusted professional can make a difference [23].

Our study did not consider schools but several articles have shown that the involvement of schools can also have a positive impact both as a setting for pediatric vaccinations and as a place to raise awareness among children and their families about prevention. This aspect can be taken into account in the evaluation of future vaccination campaigns [24,25,26].

Sending letters to invite parents and children presented several weaknesses: this method greatly lengthens the times, and it is also not possible to determine who received the letter or not and who actually decided to join the campaign. This last point is essential to establish the actual number of appointments and to decide accordingly the provision of adequate staff and necessary vaccine doses.

The success of the patient recall intervention depends upon several factors, such as accuracy of contact information, completeness of vaccination records, viability of contact way, comprehensibility of the message, beliefs and attitudes about vaccinations, and access to immunization services [27]. In recent studies, text message showed the highest level of effectiveness as a single recall method for vaccination, although the communication method should be evaluated in every vaccination campaign according to the target population [28,29]. As an example, in the face of high vaccine hesitancy, interactive text messaging in which a parent could request further information via the message was more effective than a conventional notification that simply informed patients about the need for a vaccine [28].

A centralized management of reminder/recalls (using a unified Immunization Information System, like SIAVR) is more effective and cost-effective than a practice-based and self-administered approach [29]. The centralized approach based on immunization registries offers the potential to become the focal point of patient reminder systems by identifying the populations at risk, providing algorithms to determine who is eligible and systems to send letters or text message reminders [27].

For future initiatives the sending of text messages by mobile phone or e-mails could be considered together with the letters and as a reminder the day before the scheduled appointment. Moreover, parents should be able to confirm the appointment on a dedicated portal that also contains all possible frequent asked questions about vaccinations.

5. Conclusions

The current COVID-19 pandemic is still having an important impact on routine healthcare services including routine immunization activities, consequently, immunization rates have suffered a decline. It is important to set catch-up activities in order to prevent outbreaks of vaccine-preventable diseases.

The scientific literature does not report similar experiences of mass vaccination during COVID-19 pandemic in Italy, with the same modalities and target population. This first experience in a COVID-19 vaccination hub has demonstrated that mass vaccination campaign could be a useful tool in catch-up strategies, and with the appropriate organizational improvements, it could pave the way for future successful campaigns involving different age groups and vaccinations.

CRediT authorship contribution statement

Matteo Mancarella: Conceptualization, Writing – original draft, Visualization, Writing – review & editing. **Federica Natarelli:** Conceptualization, Writing – original draft, Visualization, Writing – review & editing. **Caterina Bertolini:** Conceptualization, Data curation, Resources. **Antonino Zagari:** Conceptualization, Methodol-

ogy, Supervision. **Maria Enrica Bettinelli:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Silvana Castaldi:** Conceptualization, Methodology, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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