COVID-19

Childhood immunization coverage during the COVID-19 pandemic in the province of Siracusa, Italy

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Keywords

COVID-19 pandemic • Childhood immunization • Vaccine coverage • Vaccine-preventable diseases • Catch-up programmes

Summary

Introduction. *The COVID-19 pandemic has severely impacted routine immunization activities and a decline in vaccination coverage has been documented around the world. The aim of this study was to assess the impact of the direct and indirect effects of the COVID-19 pandemic on routine childhood vaccination coverage in the Province of Siracusa, Italy.*

Methods. *We compared 2020 and 2019 vaccination coverage by age group and vaccine type. Results were considered statistically significant at a two-tailed p-value ≤ 0.05.*

Results. *Our findings show that vaccination coverage rates for mandatory and recommended vaccinations decreased in 2020 compared with the previous year (range from -1.4% to -7.8%). Anti-rotavirus vaccination increased (+4.8%, as compared to 2019), while the reductions observed for polio vaccination (hexavalent) and human papillomavirus vaccination in males were not statistically significant. The reduction did not hit the population in the same manner, with the greater decreases observed for children aged > 24 months compared to the younger (-5.7% vs -2.2%) and for booster doses compared to the primary vaccinations (-6.4% vs -2.6%).*

Conclusions. *This study found that vaccination coverage of routine childhood immunisations was negatively affected during the COVID-19 pandemic in the Province of Siracusa. It is of huge importance to put in place some catch-up programs to ensure vaccinations at the earliest of individuals who missed immunization during the pandemic.*

Introduction

Childhood vaccination is one of the most important public health achievements in history and a cornerstone for the prevention of communicable infectious diseases. Routine immunizations of pregnant women, adults, elderly persons, patients with chronic conditions and higher risk, are also essential [1-5].

Although the direct health impact of the COVID-19 pandemic, caused by the new SARS-CoV-2 virus, on child health is generally low [6], the true impact on the paediatric population may lie in its indirect health impacts. The COVID-19 pandemic has severely impacted routine immunization activities and a decline in vaccination coverage has been documented around the world, regardless the economic status of the countries, rich and poor, developed and developing [7-9]. More than half of the countries in which data were available have reported moderate to severe disruptions, or total suspension of vaccination services during March-April 2020. Several countries postponed immunization campaigns in the first five months of the pandemic, including: measles vaccine, polio vaccine, meningococcal conjugated A vaccine, yellow fever vaccine, typhoid vaccine, cholera vaccine and tetanus-diphtheria vaccine [7-9]. According to WHO data, during the pandemic, global vaccine coverage (VC) has dropped from 86% in 2019 to 83% in 2020; an estimated of 23 million children under the age of one year did not receive basic vaccines, which is the highest number since 2009; the number of completely unvaccinated children increased by 3.4 million in 2020; only 19 vaccine introductions were reported in 2020, less than half of any year in the past two decades; 1.6 million more girls were not fully protected against human papillomavirus (HPV) in 2020, compared to the previous year [10, 11]. Immunization coverage has dropped also among adults [12]. The re-organization of health services on one hand, including the shift of health personnel to deal with increasing numbers of COVID-19 patients; the public health measures to mitigate the epidemic and the fear of contracting the infection on the other hand, have led to interrupt, delay and replan of a large number of vaccinations [13].

When immunization programs are stopped or interrupted for any reason, we may observe an increasing number of vaccine-preventable infections and related deaths, because of an increase in susceptible individuals to diseases that were controlled or even eliminated. Specifically, maternal and child health could be most affected by this problem, and this situation will represent a particular threat for low- and middle-income Countries for battling the pandemic alongside pre-existing challenges, including efforts to control vaccine-preventable diseases (VPDs) [14-16].

For this reason, interim guidelines warning about the risk of VPD outbreaks have been published, which could cause further pressure on health services [17-20].

Italy was the first country outside China to experience the impact of the COVID-19 pandemic and one of the worst-affected countries in the first months of the pandemic. The first case of SARS-CoV-2 infection was reported on 20 February and the disease quickly spread across the north of the country [21]. Italy adopted a generalized lockdown on March 12 and gradually resumed all activities from May 4 to June 15 [22].

The Italian vaccination policy provides for the following 10 mandatory routine immunisations for children aged 0-16: poliovirus, diphtheria, tetanus, hepatitis B, pertussis, *Haemophilus influenzae* type b, measles, rubella, mumps, and chicken pox (the anti-varicella – chicken pox – vaccine is mandatory only for children born from 2017 onwards). Furthermore, the vaccinations against human papillomavirus (HPV), meningococcus serotype B (Men B) and serotypes A, C, W135, Y (Men ACW135Y) are recommended in children and in adolescents, as well as herpes zoster and pneumococcus (PNC) for the population over 65 years [23, 24]. These vaccinations are offered actively and free of charge by the Italian National Health Service.

In this study, we aimed to assess the impact of the direct and indirect effects of the COVID-19 pandemic on routine childhood vaccine coverage in the Province of Siracusa, an area with 386,071 inhabitants situated in south-east of Sicily, Italy, according to different birth cohorts and vaccine types.

Material and methods

Vaccination coverage data were extracted from the official records of Epidemiology Unit of the Health Department of Provincial Health Authority of Siracusa, that routinely collects data on all administered vaccines. To estimate changes in vaccine coverage, we calculated absolute differences between 2019 and 2020 coverage rates.

We used the birth cohorts, population, target age group, number of doses and year of administration as showed in Table I. We used polio and measles vaccination as the usual proxy for the hexavalent (polio, diphtheria, tetanus, hepatitis B, pertussis, *Haemophilus influenzae* type b) and quadrivalent (measles, rubella, mumps and chicken pox) or trivalent (measles, rubella, mumps) vaccinations, respectively, since these vaccines are administered in six-in-one and four-in-one or three-in-one vaccine formulations in Italy. Data are reported for birth cohort and a complete vaccination cycle, regardless of the schedule adopted and the vaccine type administered. As for polio, measles, men B, men ACW135Y and PNC vaccination, we used the available data at 24 months of age (even though these vaccines are administered with different timing in the first two years of life according to Italian immunization) comparing vaccine coverage rates for the years 2019 (administered from January to December 2019 to the 2017 cohort) and 2020 (administered from January to December 2020 to the 2018 cohort).

Polio with diphtheria, tetanus, pertussis and measles with rubella, mumps (and chicken pox, not mandatory for children born before the 2017) vaccinations are boosted at 6, mandatorily. We used data on polio and measles vaccinations in 2020 (VC 2020) to the 2013 cohort (7 years old), as well as data on vaccinations administered through the year 2019 (VC 2019) to the 2012 cohorts (7 years old).

Vaccination against rotavirus is administered in the first year of life, therefore we compared vaccine coverage rates at the 12-month timepoint (VC 2019 for the 2018 cohort and VC 2020 for the 2019 cohort). Regarding anti-HPV vaccination, we used the full-cycle coverage for 14-year-old (2005 cohort in 2019, 2006 cohort in 2020) since it is offered during the 12th year of life.

We performed a statistical analysis at 12 months (for rotavirus vaccination; cohort 2018 and 2019) and 24 months (polio, measles, men B, men ACW135Y/men C vaccinations; cohort 2017 and 2018), 7 years (polio and measles booster doses; cohort 2012 and 2013) and 13 years (HPV; cohort 2006 and 2007) for mandatory and recommended vaccinations. The Chi-square test was executed on proportions for the years 2020 vs. 2019.

Analysis findings were considered statistically significant at a two-tailed p-value ≤ 0.05.

Results

The 2019 and 2020 level of vaccine coverage rates for mandatory and recommended vaccinations are reported in Table II and in Table III respectively. For each vaccine-preventable disease, cohort and year of administration, we reported the vaccine coverage, the number of vaccinated (in the numerator, extracted from official records of Epidemiology Unit) and the eligible population (in the denominator, according to Istat data, Italian National Statistical Institute).

With reference to the mandatory childhood immunisations, in 2020, 24-month coverage rates were 86.7% for polio (hexavalent vaccine), 87.2% for measles (quadrivalent vaccine), representing -1.4% (not statistically significant) and -3.8% decreases, respectively, as compared to 2019. By 7 years of age (booster doses), immunisation coverage was 77.3% for polio and 77.1% for measles, representing a -7.8% and -5.0%, respectively, compared to 2019 (Tab. II).

With reference to the recommended childhood immunisations, in 2020, 24-month coverage was 54.0% for Men B (-4.6% as compared to 2019), 61.7% for Men ACW135Y/C (-5.6% as compared to 2019), 83.5% for PNC vaccine (-2.4%, as compared to 2019), and 45.0% for rotavirus (+4.8%, as compared to 2019). Regarding HPV vaccination, in 2020, overall coverage was 41.7% (-4.3% compared to 2019), in female was 51.3% (-4.8%) and in male was 33.0% (-3.4%) (Tab. III).

Interestingly, we observed a significant increase for rotavirus vaccinations in 2020 compared to 2019 (+5.4%).

Tab. I. VDP, birth cohort, population, target group, number of doses and year of administration of vaccinations to assess the vaccine coverage.

VDP	Mandatory/ Recommended	Birth cohort	Eligible population§	Target age group	Number of doses	Year of vaccine administration (1st January - 31st December)
Rotavirus	Recommended	2018	3090	12 months	2*	2019
		2019	2989			2020
Polio, Measles, Men B, Men ACW135Y/Men C	Mandatory	2017	3155	24 months	3 for polio and 3 (or 4) for Men B; 1 for measles and Men ACW135Y/C	2019
	Recommended	2018	3090			2020
Polio, Measles	Mandatory	2012	3605	7 years	4 for polio; 2 for measles	2019
		2013	3408			2020
HPV	Recommended	2005	3909	14 years	2	2019
		2006	3890			2020

§ Data from www.demoistat.it. * The vaccination course of the vaccine used in the Province of Siracusa consists of two doses. VPD: vaccine-preventable disease. Men B, ACW135Y and C: *Neisseria meningitidis* serogroups B, ACW135Y and C; PNC: *Streptococcus pneumoniae*; HPV: human papillomavirus.

Tab. II. Vaccine coverage (VC) rates (%) registered for mandatory vaccinations, at 24 months and 7 years of age, stratified by vaccine type and year of administration, along.

With the percentage differences between the 2019 and 2020 rates in the Province of Siracusa.

Target age group	VDP	VC Rates (%) by Year of Vaccine Administration		% Difference (2020 *vs* 2019)	*p*-Value *
		2019	2020		
24 months	Polio	88.05 (2778/3155)	86.70 (2679/3090)	-1.4	0.11
	Measles	90.94 (2869/3155)	87.15 (2693/3090)	-3.8	< 0.001
7 years	Polio	85.10 (3068/3605)	77.26 (2633/3408)	-7.8	< 0.001
	Measles	82.14 (2961/3605)	77.11 (2628/3408)	-5.0	< 0.001

* Chi-square test (2020 vs 2019); VC: vaccination coverage; VPD: vaccine-preventable disease.

Tab. III. Vaccine coverage (VC) rates (%) registered for recommended vaccinations at 12 months, 24 months. and 14 years of age, stratified by vaccine type and year of administration, along with the percentage differences between the 2019 and 2020 rates in in the Province of Siracusa.

Target age group	VDP	VC Rates (%) by Year of Vaccine Administration		% Difference (2020 *vs* 2019)	*p*-Value *
		2019	2020		
12 months	Rotavirus	40.23 (1243/3134)	45.00 (1345/2988)	+4.8	< 0.001
24 months	Men B	58.61 (1849/3155)	54.01 (1669/3090)	-4.6	< 0.001
	Men ACW135Y Men C	67.29 (2123/3155)	61.68 (1906/3090)	-5.6	< 0.001
	PNC	85.86 (2709/3155)	83.50 (2580/3090)	-2.4	< 0.001
14 years	HPV	45.95 (1796/3909)	41.67 (1621/3890)	-4.3	< 0.001
	HPV females	56.12 (1059/1887)	51.30 (945/1842)	-4.8	< 0.01
	HPV (males)	36.45 (737/2022)	33.01 (676/2048)	-3.4	< 0.05

* Chi-square test (2020 *vs* 2019); Men B, ACW135Y and C: *Neisseria meningitidis* serogroups B, ACW135Y and C; PNC: *Streptococcus pneumoniae*; HPV: human papillomavirus; VC: vaccine coveragevaccination coverage; VPD: vaccine-preventable disease.

Discussion

Vaccine coverage of routine childhood immunisations was negatively affected during the COVID-19 pandemic in the Province of Siracusa. The reduction did not hit the population in the same manner, with the greater decreases observed for children aged > 24 months compared to the younger (-5.7% vs -2.2%) and for booster doses compared to the primary vaccinations (-6.4% vs -2.6%). Moreover, our data show that vaccine coverage rates for mandatory vaccinations decreased in 2020 compared with the previous year (range from -1.4 % to -7.8%), while recommended vaccinations ranged from +4.8% to -5.6%. Since the introduction of compulsory vaccination in 2017, the vaccine coverage progressively increased in Italy [25-27]. Nevertheless, during the pandemic, a significant drop in vaccinations coverage was observed [28-31]. According to a survey launched by the Ministry of Health, vaccination activity has slowed down throughout Italy, even if with regional differences [32-34]. The relocation of health personnel involved in this service to support the management of the pandemic is the most important reason for this slowdown (more than 33% throughout the national territory). In addition to this, about one out of four vaccination centres has recorded a reduction or even a suspension of vaccination activities because of the measures of social isolation and distancing. According to the survey, the reduction in vaccinations did not affect the entire population in the same manner, but mainly concerned the pediatric group aged > 1 year, to a lesser extent the adult population, because a priority was given to the basic courses and to the most susceptible groups during the emergency context. Above all, the immunization with the greatest decline in coverage rate among the pediatric population was that against HPV. To a lesser extent, a decrease was also observed for DTaP (polio booster dose) and men B immunizations.

A decline in immunizations could endanger the 90-95% vaccination coverage target that is necessary for herd immunity against diseases such as measles, mumps, and whooping cough. In such circumstances, an increased risk of resurgence of vaccine-preventable diseases that were controlled or eliminated in children who missed vaccinations during the pandemic is expected, thereby posing a twofold challenge to public health systems, with possible dramatic effects especially in the LMCI's countries [14, 35].

Despite a decrease in vaccine coverage rates, we did not register an increase in vaccine-preventable disease outbreaks in the Province of Siracusa in 2020. In the year 2020, 1 case of measles was reported compared to 3 cases in 2019; 6 cases of chicken pox in 2020 to 17 cases in 2019; no case of meningococcal and pneumococcal infection in 2020 vs 2 cases in 2019. Probably, at least in the short-term, the impact of the pandemic on possible vaccine-preventable disease outbreaks have been balanced by public health measures (personal protective equipment, hand hygiene, quarantine/isolation, physical distancing), which likely prevented the spread of other respiratory diseases as well. Similar data have registered in the rest of Italy, where no increase in outbreaks due to vaccine-preventable diseases has recorded [30, 36, 37]. Other countries reported a slight reduction in vaccine-preventable diseases rates [38-40].

Several factors are associated with the reduction in vaccine coverage in the Province of Siracusa, as the same in the rest of the world: public actions to contain the spread of infection (lockdown, isolation, quarantine and other infection control measures), relocation oh health personnel involved in vaccination activity to deal with the pandemic, and also parental concerns about potentially exposing their children to COVID-19 during well child visits [41-43].

Measure to prevent the spread of infections have been implemented in all vaccination centres of Provincial Agency of Health of Siracusa: physical distancing, environmental sanitation, room ventilation, wearing of the face masks, hand hygiene, telephone appointment, detection of body temperature, different time slots to increase availability, optimisation of spaces dedicated to vaccine administration and active search for new locations.

Our findings demonstrate that an attempt was correctly made to give priority to the infants and to primary cycles. As matter of fact, our data show that the effect of pandemic on vaccine coverage was less pronounced in infants compared to toddlers, since the medical staff of the vaccination centres of the local health authority of Siracusa prioritized age group over another within the childhood vaccinations with active call for these categories of patients.

Consistent with national data, we found an increase of vaccine coverage of anti-rotavirus vaccination [27, 30]. We hypothesize that this finding may be explained, at least in part, by the greater attention given to the infants, as mentioned above, and the fear of exposing children to the possible consequence of rotavirus infection, such as severe dehydration and hospitalization, in a critical period for the healthcare facilities.

The WHO recommends that all routine vaccinations be administered as scheduled, even during the COVID-19 pandemic. Routine immunization sessions should continue, using special measures and precautions, to the extent possible and as permitted within the local COVID-19 response context. This includes routine immunization for infants, children, adolescents, pregnant women, high-risk groups, and adult healthcare providers [44, 45]. Any interrupted immunization services should be resumed, and catch-up vaccinations offered as quickly as possible [46, 47].

Our findings are consistent with other available reports in Italy during the pandemic [30, 32], in which we observe similar outcomes for almost all vaccine coverage rates differences, even if with different magnitude, except for HPV vaccination among males and Men ACW135Y. Our data are also consistent with data reported for Sicily, that show similar trends in vaccine coverage rates reduction [27].

The main strength of our study is first its originality since, to the best of our knowledge, it is the only study

that assess the impact of COVID-19 pandemic on vaccine coverage at local level in Italy. In our opinion, this is very useful to better understand the reasons for the reduction in vaccine coverage in a specific local context and above all to establish tailored catch-up programs for missed vaccinations more effectively. The local data can also allow to evaluate the actual staff of the vaccination services, that even before the pandemic, were not rarely understaffed, and lacking in some skills, such an effective communication to a wider public in the complex environment surrounding vaccinations [48]. Increasing society complexity is presenting new challenges for vaccines, including vaccine hesitancy and misinformation of vaccine safety and effectiveness in the mainstream media and social media, which require specific skills. National policies that aim at halting the circulation of false information about vaccines on social media are welcome, but also solutions to improve the communication strategy locally are extremely important [49, 50].

Conversely, several limitations that merits discussion were detected in our study. To begin with, evaluating the vaccine coverage at 24 months, we did not analyse the potential delay in the administration of some vaccines, such as hexavalent or quadrivalent, which should be administered within the first year of life or at the beginning of the second year of life, respectively, according to the immunization calendar. Second, social determinants such level of the education, family income, social isolation, geographic location or ethnic minorities, were not evaluated due to insufficient data availability [51]. It is likely the COVID-19 pandemic has exacerbated the adverse effects of some social determinants on vaccination uptake behaviours *e.g.*, employment, poverty, healthcare access, food insecurity, education, etc. It's well known that these determinants are associated, among other things, with lower vaccine coverage rates [51, 52]. Third, vaccine hesitancy is one of the top threats to public health and while it is as old as vaccination itself, the nature of the challenge continues to shift with the social landscape [53]. Today, in the era of COVID-19, vaccine hesitancy and the "infodemic" it fuels are key drivers of under-vaccination across the globe [54-57]. In this study vaccine hesitancy has not been investigated.

Conclusion

Childhood vaccination remains paramount: all children should receive all scheduled vaccinations according to their age, with priority given for completion of all primary series vaccines, with no interruption of scheduled sessions [58]. Timely vaccination is key to maintaining population immunity against vaccine-preventable diseases, ensuring populations are fully protected against life-threatening illnesses as early as possible, and preventing large outbreaks of vaccine-preventable diseases, particularly for diseases such as measles for which a high coverage is required to prevent outbreaks.

It is vital to put in place a catch-up vaccination strategy to ensure vaccinations at the earliest of individuals who missed immunization during the pandemic, also with the involvement of primary care pediatricians in the direct administration of vaccination, going beyond any disparities in access driven by any social determinants, like education, income, ethnicity, location, social networks.

Our findings indicate that vaccine coverage of routine childhood immunisations was negatively affected during the COVID-19 pandemic in the Province of Siracusa, similar to what has been noted nationally and in other countries. Three mandatory and four recommended pediatric vaccinations slowed down during the epidemic waves in 2020; one mandatory vaccination and one recommended vaccination remain unchanged; lastly, one recommended vaccination increased significantly. These data are consistent with other available reports in Italy.

Further research is needed to follow-up the evolution of the vaccine coverage of the cohorts under investigation and the possible implications on spread of vaccine-preventable diseases.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

FC: conceptualization, methodology, statistical analysis, writing and original draft preparation.
FC, EDP, CR: acquisition of data.
FC, FB, EDP, MLC: formal analysis and interpretation of data.
FC, FB: writing, review and editing.
FC, EDP, MLC: supervision and project administration.
All authors have read and agreed to the submitted version of the manuscript.

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