

Between mandatory vaccination and the COVID-19 pandemic: effects on the vaccination coverage trend in a province of Southern Italy

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Abstract. *Background and aim:* Although vaccination is considered an extraordinarily effective and safe tool for the prevention of infectious diseases, from 2013 to 2016 CVs at national level showed a downward trend, falling well below the 95% threshold recommended by the WHO to limit the circulation of viruses and bacteria in the community and to obtain the so-called herd effect in addition to the protection of individual vaccinated individuals. The aim of the study was to assess vaccination coverage data following the introduction of Law 119/2017 and in like to COVID-19 pandemic the impact on vaccination coverage. *Methods:* The study was conducted from 1 October 2019 to 1 October 2022, using the OnVac programme. *Results:* The analysis of the coverage rates of hexavalent vaccination during the entire study period shows that there was an increase in vaccinations during the two-year period 2020-2021, followed by a drastic decrease down to values below 95%. where variable coverage was noted between the two genders with higher percentages in the female sex. Contrary to expectations, 2021 did not allow the recovery of the defaulting cohorts, with a drop in coverage much higher than in previous years (with values approaching the values of 2008), not only for polio, diphtheria and tetanus, but also for measles, mumps, rubella, chicken pox and HPV, effectively getting worse over the previous decade. *Conclusions:* immunization challenges need to be addressed to ensure that every child, adolescent or patient at risk is immunized, especially but not only for COVID-19. (www.actabiomedica.it)

Key words: mandatory, vaccination, vaccination coverage, COVID-19, pandemic

Introduction

In Italy the Vaccination Calendar (1) is a document that contains the main indications for the different vaccinations based on age and health status and gathers proposals for the ideal vaccination schedule on the basis of scientific evidence. The document is the result of the collaboration between experts dealing with vaccinations and primary care for children and adults belonging to the Italian Society of Hygiene and Preventive Medicine, the Italian Society of pediatrics', the Italian Federation of Pediatricians, and the Italian

Federation of General Practitioners. This document also lists the vaccinations that have become mandatory, indicating their scientifically established times of administration to give the body the chance to respond appropriately. In 2019, the fourth edition of the Vaccination Calendar was published, which included several new features. The calendar proposed the vaccination against meningococcus B in adolescence, the use of ACWY anti-meningococcal vaccine for individuals as young as one year old across all regions, the extension of the HPV vaccine offer up to 25-year-olds women at their first cervical screening and to women treated

for precancerous lesions. The document also recommended to gradually lower the age at which the flu vaccine is offered for free from age 65, first to 60 and then to 50, as well as to children aged 6 months to 6 years. In addition to these updates, some priorities of particular importance are emphasized in the document, such as the vaccination of pregnant women against flu and whooping cough (dTpa). These two vaccinations can be lifesaving for both mother and baby, given the considerable risk associated with these diseases if contracted early in life or during pregnancy. It is, therefore, essential to share information and recommendations with the scientific societies of Gynecology and Obstetrics and Pediatrics to ensure that pregnant women are properly informed about the risks of these diseases and the possibility of effective prevention. It is also necessary to work to lay the foundations for future collaborations with other medical scientific societies in order to develop tailored vaccination protocols that increase adherence to vaccinations in groups at risk for disease.

In Italy, the Vaccine Calendar, included in the National Vaccine Prevention Plan (PNPV) (2) 2017-2021 was included in the DPCM on the Essential Levels of Care (LEA) (3).

Subsequently, The Vaccines Decree, which later became Law 119/2017 (4), made ten vaccinations compulsory for children under the age of 16 and strongly recommended four to be actively offered free of charge.

In the PNPV 2017-2021, anti-papilloma virus (HPV) vaccinations in 11-year-olds and anti-meningococcal tetravalent ACWY in adolescents are also indicated as being on active offer and free of charge.

The mandatory nature of measles, rubella, mumps and chickenpox vaccinations is subject to review every three years on the basis of epidemiological data and vaccination coverage achieved. Additionally, the following vaccinations are actively offered free of charge by the Regions and Autonomous Provinces, without any vaccination obligation: anti-meningococcal B, anti-meningococcal C, anti-pneumococcal and anti-rotavirus.

The PNPV 2017-2021 also provides for vaccination to be offered to different categories of people on the basis of the existence of certain risk conditions, such as diabetes mellitus, MICI, and HIV.

In 2012, the Sicilian region, created the 'Vaccine Calendar for Life' with the D.A. 0820/12, modifying

and integrating the previous regional Vaccine Calendar dating back to 2010 (5,6).

The Vaccinal Calendar for Life of Sicily expands the vaccination offer, being in fact one of the most up-to-date and richest in terms of active and free offer in the European and international panorama.

In January 2020, the World Health Organization (WHO) reported that Chinese health authorities had identified a novel coronavirus strain never isolated in humans: 2019-nCoV, which was then named severe acute respiratory syndrome from coronavirus-2 (SARS-CoV-2) (7). The virus was associated with an outbreak of pneumonia cases, recorded as of 31 December 2019, in the central Chinese city of Wuhan, and it quickly spread around the world, leading to about 660 million confirmed cases since the start of the pandemic (data as of 28 December 2022) and to 6,682,619 deaths worldwide [Johns Hopkins University (JHU) (8)]. In Italy, the number of confirmed cases, as of December 2022, was 25.021.606 with 183.936 deaths attributable to COVID-19 infections [Johns Hopkins University (JHU) (8)].

The aim of the study was to assess vaccination coverage data following the introduction of Law 119/2017 and to evaluate the impact of the COVID-19 on vaccination coverage.

Material and methods

The study was conducted between 1 October 2019 and 1 October 2022 with the aim of prospectively collecting vaccination coverage data from the L.H.U. 5 of Messina for the three-year period 2019-2022, gathering data for cohorts between 2001 and 2022, using the OnVac programme. This programme is an integrated system for all vaccinations that allows remote access and registration of individual vaccination events including those administered by general practitioners (GPs), family pediatricians (PLS) and emergency room personnel.

Results

The data shown in figure 1 demonstrate how at time 0, 1 October 2019, with regard to the vaccinations

included in the hexavalent (4 doses) the value of vaccination coverage exceeded 90%. However, when examining the same vaccination but with 5 doses, the coverage drops to 20%.

HPV vaccination coverage appears to be drastically low with only 15% vaccinated with at least one dose (Figure 2).

The anti-MPR vaccination coverage data exceed 85% (one dose), below the cutoff indicated in the PNPV 2017-2021, equal to 95%. Even lower is the varicella vaccination coverage with one dose (about 68%) (Figure 3)

Only 62.67% of the sample concluded the complete vaccination cycle for 13 valent pneumococcus (Figure 4), while the vaccination coverage for hepatitis

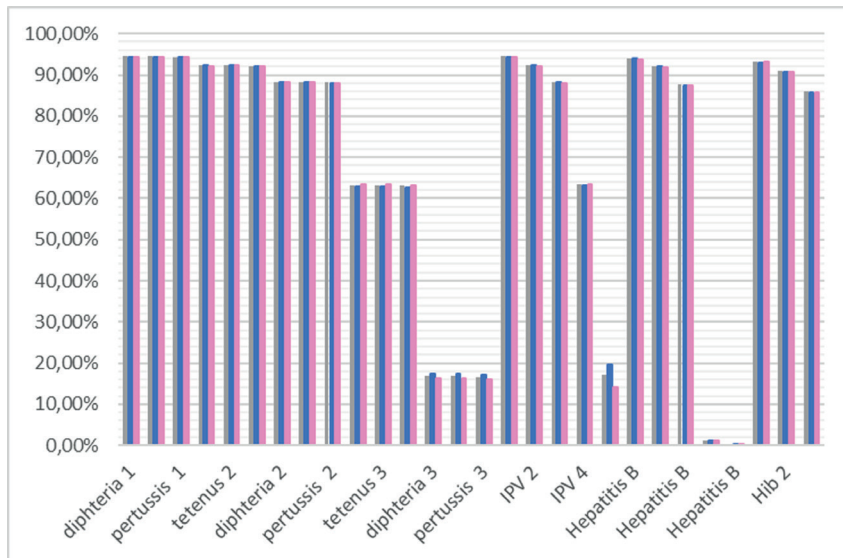


Figure 1. VC for hexavalent in one vaccination for cohort 2001-2019 on the first October 2019 by number of doses and by sex in Messina city. The blue column refer to male population, instead the pink one to female population.

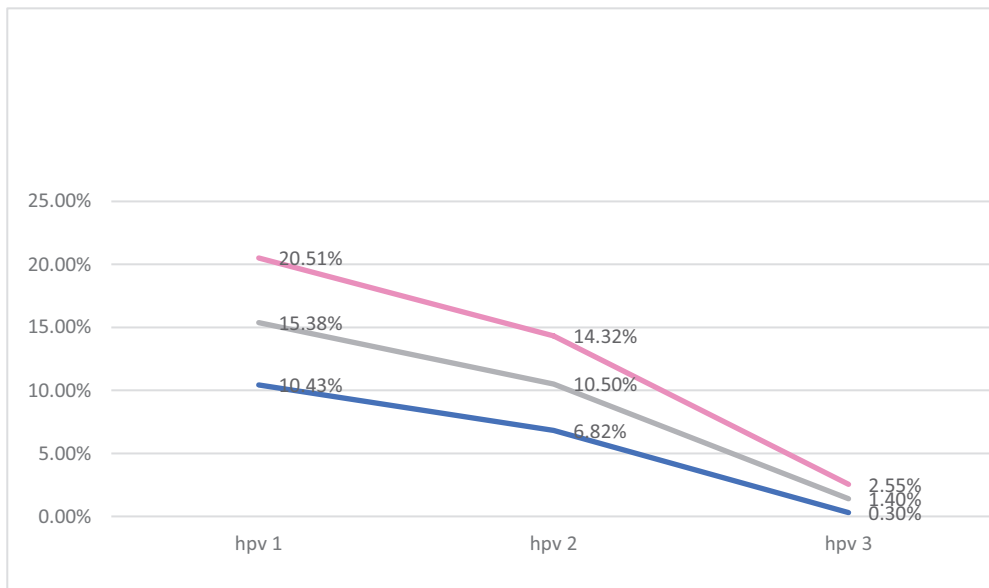


Figure 2. CV for HPV vaccination for cohort 2001-2019 on the first October 2019 by number of doses and by sex in Messina city. The blue column refers to male population, instead the pink one to female population. The gray column refers to the entire population involved

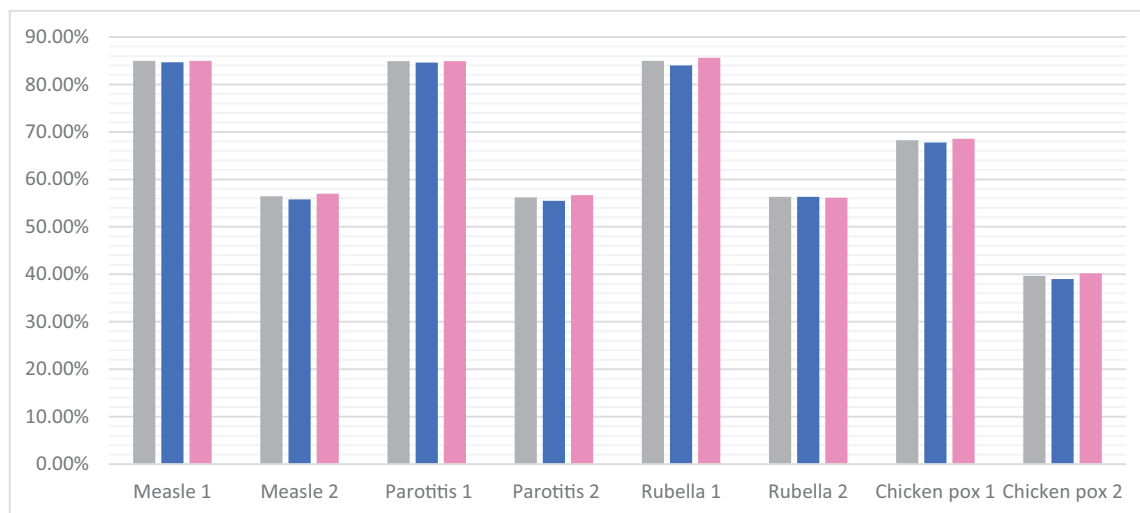


Figure 3. Vaccination coverage for MMRV in the 2001-2019 cohorts by total number of doses (province of Messina) (grey) and by gender (blue and pink). The blue column refers to male population, instead the pink one to female population. The gray column refers to the entire population involved

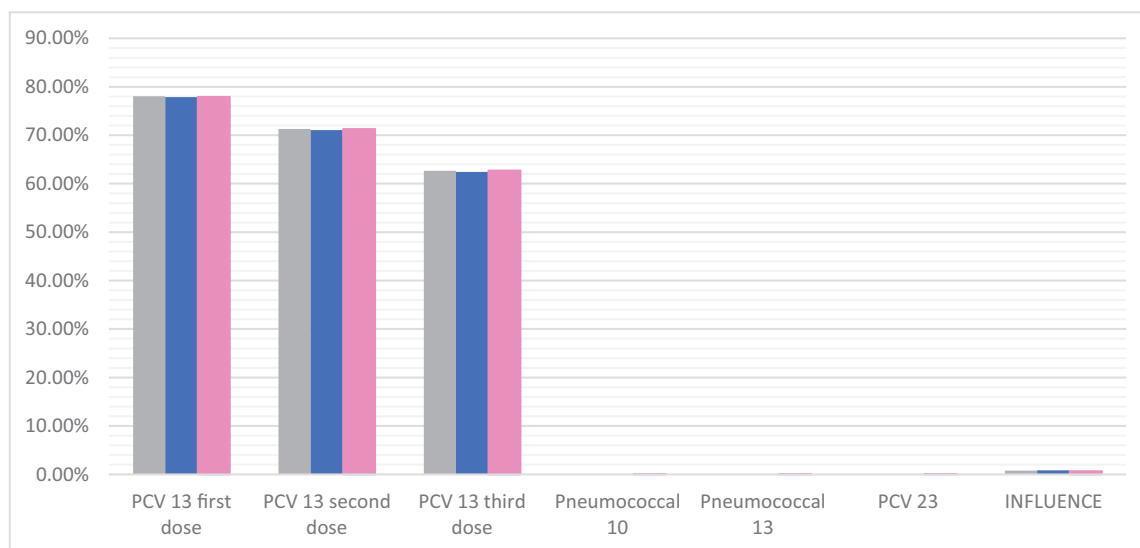


Figure 4. Vaccination coverage for pneumococcus and flu in the 2001-2019 cohorts by number of doses (province of Messina). The blue column refers to male population, instead the pink one to female population. The gray column refers to the entire population involved.

and tuberculosis, in the cohort of patients investigated, reached 0.4% and 1.2% respectively.

In the second year of the study (12 months), an increase in the vaccination coverage assessed was observed, with values above the cut-off for poliomyelitis

vaccination, for DTP and for Haemophilus influenzae type B (Figure 5).

At time 1 (12 months), vaccination coverage was higher than in 2019, both in the male and female populations.

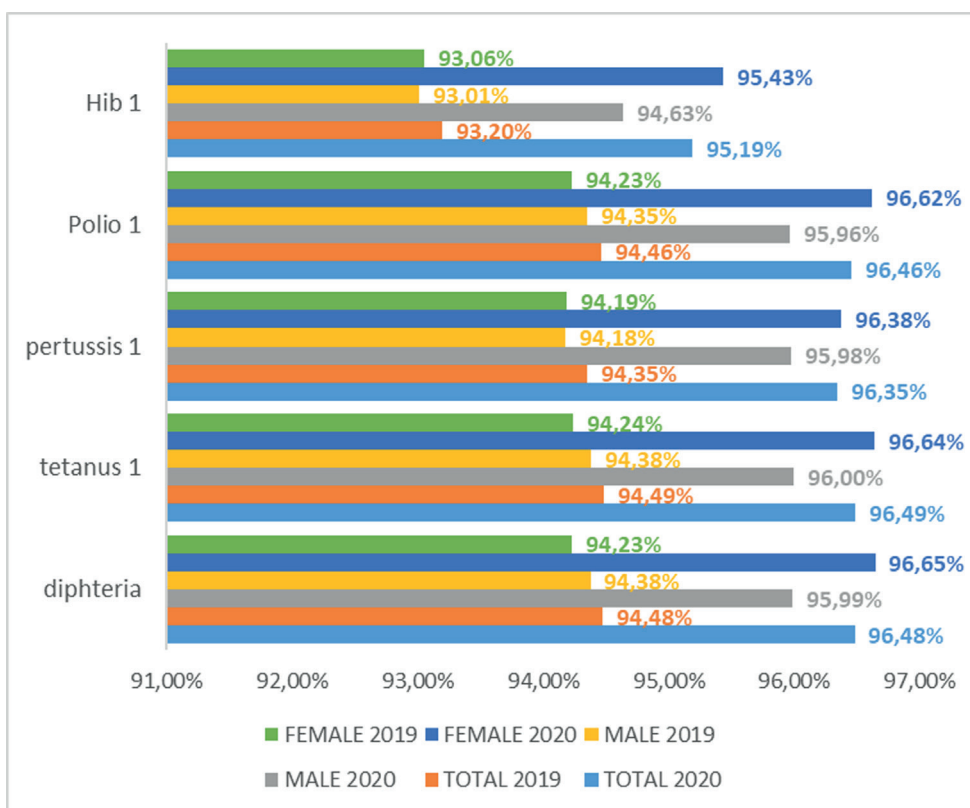


Figure 5. Increase in vaccination coverage in the 2001-2019 cohorts by number of doses (province of Messina).

Table 1. Comparison of vaccination coverage for PCV 13, PPV 23 and flu vaccinations in the two-year period 2019-2020

	TOTAL 2020	TOTAL 2019	MALE 2020	MALE 2019	FEMALE 2020	FEMALE 2019
PCV 13 1st DOSE	80.04%	0.01%	79.55%	0.01%	80.27%	0.01%
PCV 13 2nd DOSE	73.92%	11.40%	73.41%	11.39%	74.19%	11.36%
PCV 13 3rd DOSE	61.07%	78.04%	60.43%	77.86%	61.52%	77.94%
PCV 10	0.03%	71.28%	0.03%	71.04%	0.03%	71.27%
PPV 23	0.09%	0.03%	0.09%	0.03%	0.09%	0.03%
FLU	1.16%	0.09%	1.25%	0.09%	1.05%	0.09%

Vaccination coverage for flu reached 1.16%, while anti-pneumococcal vaccination with conjugate vaccine reached values equal to 61.07% unlike that of the polysaccharide vaccine which did not exceed 0.09% . The higher number of administrations in 2020 compared to previous years should be highlighted (Table 1).

In 2020 vaccination coverage were lower than 2019 (Figure 6)

The analysis of the coverage rates of hexavalent vaccination (Figure 7) during the entire study period shows that there was an increase in vaccinations during the two-year period 2020-2021, followed by a drastic decrease down to values below 95%. where variable coverage was noted between the two genders with higher percentages in the female sex (Figure 8).

With regard to flu vaccination coverage, the values are below the threshold indicated by the PNPV (75%

Results

VACCINATION COVERAGE OF LHU OF MESSINA ON 31/12/2020

2 AND 3 YEARS (COHORT 2017-2018)

VACCINATION	VC (%)	Age	VC (%)	Age
Rotavirus	56.4	24 months	-	-
Hexavalent	90.9	24 months	93 (3 DOSES)	36 months
MMR and chickenpox	88.2	24 months	90.9 (88.3 CHICKENPOX)	36 months
PCV	97.2	24 months	88.9	36 months
MEN B	88.2	24 months	88.1	36 months
MEN ACWY	73.1	24 months	73.6	36 months

15 YEARS (COHORT 2005)

VACCINATION	VC (%)
Tdap-IPV	92.8 (3 DOSES)
MMR and chickenpox (1° DOSE)	92
MMR and chickenpox (2° DOSE)	82
MEN C	51
MEN ACW _{135Y}	39.7

5-6 YEARS OF AGE (COHORT 2014)

VACCINATION	VC (%)
DPT-IPV	94.3 (3 DOSES)
MMR and chickenpox (2° DOSE)	60.9 53.4



Figure 6. Vaccination coverage by age on December, 31 2020.

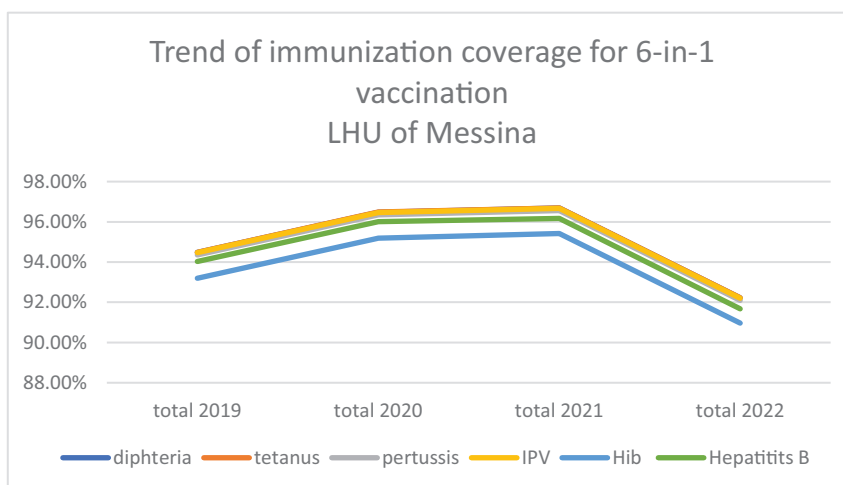


Figure 7. Trend of vaccination coverage for the hexavalent in one vaccination in the province of Messina.

minimum achievable goal). Lower coverage values are observed for 13-valent and 23-valent pneumococcal vaccination in all years studied (Figure 9 and Table 2).

With regard to vaccination for measles, mumps, rubella and varicella, the values shown are always below 95% (Figure 10).

Discussion and conclusions

The primary objective of the research project was to evaluate vaccination coverage (VC) in the Messina health district in the general population. Vaccination coverage is, in fact, the indicator par excellence

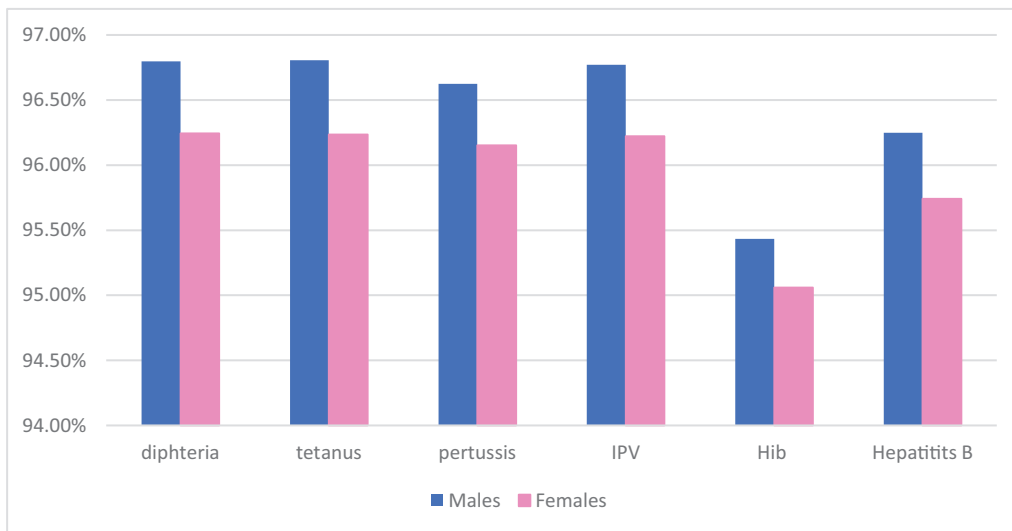


Figure 8. Difference of vaccination coverage by sex in 2022. The blue column refers to male population, instead the pink one to female population involved.

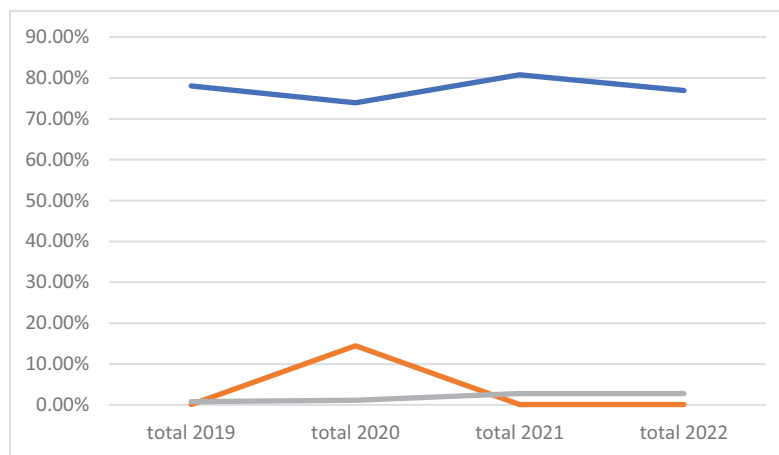


Figure 9. Trend of immunization coverage for PCV 13 (grey), PPV23 (orange) and flu (blue).

Table 2. VC trend in the three-year period 2019-2022 by sex and by type of vaccine.

	MALES				FEMALES			
	2019	2020	2021	2022	2019	2020	2021	2022
FLU	77,86%	73,41%	80,74%	76,74%	77,94%	74,19%	80,51%	76,93%
PCV-13	0,09%	14,30%	0,09%	0,09%	0,09%	14,58%	0,09%	0,09%
PPV-23	0,88%	1,25%	2,85%	2,85%	0,69%	1,05%	2,67%	2,67%

of vaccination strategies since it provides information on their actual implementation on the territory and on the efficiency of the vaccination system (9).

Before examining the results of our research, it is only right to give an overview of the time situation in which it took place and to specify some basic concepts

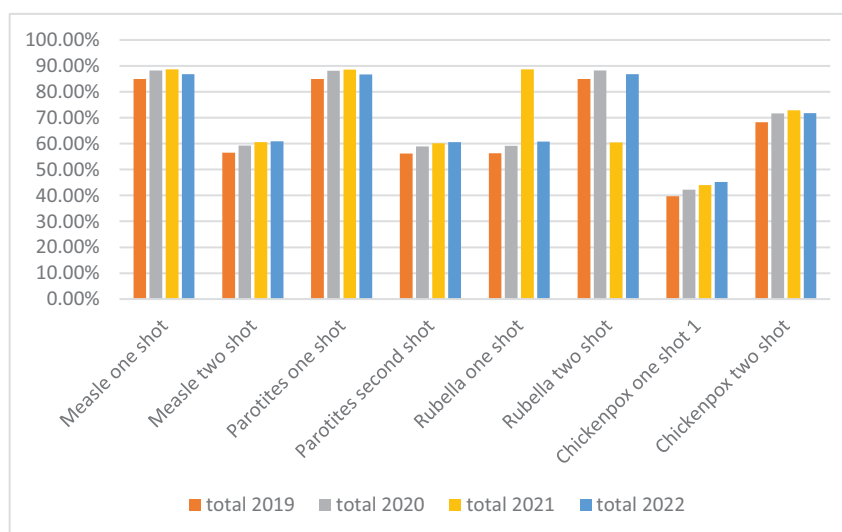


Figure 10. Trend VC in the period 2019-2022 for MMR and chickenpox.

in understanding what is reported. In Italy the Istituto Superiore di Sanità is the institution in charge of monitoring CVs by requesting data from the regional health departments.

Although vaccination is considered an extraordinarily effective and safe tool for the prevention of infectious diseases, from 2013 to 2016 CVs at national level showed a downward trend, falling well below the 95% threshold recommended by the World Health Organisation (WHO) to limit the circulation of viruses and bacteria in the community and to obtain the so-called herd effect in addition to the protection of individual vaccinated individuals. This terminology is used to refer to 'the reduction of infection or disease in the non-immunised fraction as a result of immunising a part of the population', as opposed to the term 'herd immunity' defined by John TJ and Samuel R (10) as 'the proportion of subjects with immunity in a given population'. Herd immunity is, therefore, the population-wide consequence of acquired immunity among certain individuals that can reduce the risk of infection among susceptible individuals.

Due to the decline in vaccination coverage and the consequent increase in infectious diseases, which had previously almost disappeared, Law 119/2017 was enacted, which introduced compulsory immunization for children under the age of 16 with regard to ten vaccinations (4). Its implementation had a significant impact on vaccination coverage data showing a clear reversal of

the trend already in the first year of its entry into force, a phenomenon confirmed in the following years.

In our study we highlighted that the SARS-CoV-2 pandemic of 2020 had a high impact on VC data, which, due to the population's fear of contagion and social containment measures, led many citizens to postpone planned vaccinations for themselves and/or their children. A further cause of the reduction in VC was probably due to the reduction in the provision of the service by the health authorities, which were forced, due to the shortage of health personnel, to reprogramme the staffing plans of the prevention departments by finding dedicated personnel from these departments to deal with the emergency (11). These data are comparable with international ones such as indicated by MaDonald et. Al (12).

The latest national and regional vaccination coverage data are updated to 31 December 2020 and show a profile of assimilability with the vaccination coverage data recorded in this study in the Messina health district in the three-year period investigated 2019-2022 (9).

In detail, the national CV polio data, used as a proxy for the vaccinations contained in the hexavalent, indicate a reduction of almost one percentage point compared to the previous year with values of 94.02%. The Sicilian Region is in last place, with a coverage of 89.19%, in the national ranking. Data from the Messina Health District show a coverage of 90.9%.

At the national level, the drop in CVs was also recorded in relation to the first dose of measles vaccine, with a decrease of 1.79% compared to the previous year, and coverage of 92.70%. In the Sicilian Region, where CVs are close to 91%, the Messina health district shows lower values at both 24 and 36 months.

At the national level, there is a decrease in CVs for varicella of 90.28% in 2020, with a decrease of 0.22% compared to 2019, as well as for meningococcal B with a -2.68% on an annual basis and a threshold of 66.30%. At the regional level, vaccination coverage in 2020 will only reach 88.68%, while in the Messina district it will be close to 90%.

Anti-pneumococcal vaccination coverage is also decreasing -1.42% on an annual basis with the national threshold of 90.58 being reached. While at the regional level coverage is just 85%, at the provincial level it is 97.2%.

Regarding rotavirus, in contrast, there is an improvement in CVs with a year-on-year increase of +36.65% and the achievement of 62.80% in 2020. This increase is probably the result of the free vaccination offer for all newborns starting from the 2018 cohort. The Sicilian Region reached values of 59.83%, comparable to those of the Messina Health District (56.4%).

The study also analyzed the coverages of the other cohorts useful for monitoring the share of late vaccinated children, i.e. those who were non-compliant with the previous year's vaccination survey and who have been recovered.

The decrease in CV of the 2018 cohort was found in the analysis of CV data of the 2017 (36 months), 2014 (5-6 years) and 2005 (15 years) cohorts at both the national and regional levels. In the Messina health district (see figure) in contrast to the regional data, higher values were observed for pneumococcal vaccination at 36 months of age, for polio vaccination at 5-6 years of age and for measles and polio vaccination at 15 years of age.

We can therefore state that in the Messina district, vaccination coverage values remain stable and, at times, come close to or exceed national and regional values. It was not possible in the study to analyze the VC data of all cohorts in their entirety due to the fact that the OnVac system, which has been collecting data since the year 2000, has not been updated.

Finally, our data is like to the official global vaccination data published by WHO and UNICEF which report a drastic drop in the COVID-19 period (11).

Globally, the proportion of children who received three doses of diphtheria, tetanus, and pertussis (DTP3) vaccine decreased by 5 percentage points between 2019 and 2021, reaching 81%. The decline was due to many factors, including, an increase in the number of children living in countries where there are ongoing conflicts and/or with fragile contexts where access to vaccinations is often difficult, greater disinformation, the interruption of the supply service resulting from COVID-19, the hijacking of human resources for the management of the pandemic with the following reduction in the availability of the immunization service (12).

We also found a higher decline on VC of the adult respect to infant ones: this could be derived by the higher priority given to primary immunization series for infants such as indicated by other international data (12).

Contrary to expectations, 2021 did not allow the recovery of the defaulting cohorts, with a drop in coverage much higher than in previous years (with values approaching the values of 2008), not only for polio, diphtheria and tetanus, but also for measles, mumps, rubella, chicken pox and HPV, effectively getting worse over the previous decade. On the contrary, in some other studies a recover of vaccine rates was detected that could be related to different strategies such as encouraging health care workers to routinely order and deliver vaccines, using reminders and reminder tools, and emphasizing the importance of vaccination at public press conferences (13,14).

Thus, not only pandemic-related disruptions but also systemic immunization challenges need to be addressed to ensure that every child, adolescent or patient at risk is immunized, especially but not only for COVID-19 (15-17). So, it is important to implement catch-up programmes to reach unimmunised/under-immunised children.

A strength of our study was the use of a population-based repository that contains complete and timely information on all childhood immunizations, as well as the ability to use a denominator, which is an improvement over previous research. who only had access to data on vaccinated children.

We also included data on a variety of vaccines for early childhood and older age groups and an extended period to review coverage for different pandemic periods.

The results presented here do not infer causality, i.e. we cannot infer that the COVID-19 pandemic is the cause of the observed decrease in vaccination coverage, but that certainly the presence of multiple concomitant factors has led to a drastic decrease in recorded vaccination coverage in industrialized countries.

Ethic Committee: LHU of Messina, Protocol n. 75274, 4th June 2020

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