Original article

A descriptive analysis of COVID-19 associated mortality in Parma province: Concordance between official national mortality register provided by ISTAT (National Institute of Statistics) and local ADS (Automated Data System) real-time surveillance flow

Rosanna Giordano[1], Elisa Mariani[1], Giulia Paini[1,2], Licia Veronesi[3]

[1]Department of Public Health, Local health Authority Parma, Parma, Italy; [2]School of Specialization in Hygiene and Preventive Medicine, University of Parma, Parma, Italy; [3]Department of Medicine and Surgery, Laboratory of Hygiene and Public Health, University of Parma, Parma, Italy

Abstract. *Background and aim:* The Public Health Department of the Parma Local Health Authority (AUSL) has implemented a computerized system called ADS (Automated Data System) to collect data on COVID-19 cases and related deaths, as required by the Emilia-Romagna Region and the Italian Ministry of Health, to improve the daily flow of real-time information. However, official mortality data for all causes was collected even from the National Institute of Statistics (ISTAT) through death forms that were completed by certifying doctors in each municipality. This analysis aims to verify the agreement between the data collected by ISTAT and the data collected by ADS. *Methods:* The study period went from January 1st to December 31st, 2021. The population under observation consisted of residents in the province of Parma who died due to COVID-19, as identified through the ISTAT and/or ADS data flow. *Results:* In 2021, a total of 448 deaths due to COVID-19 were reported in the Parma Province, with a median age of 83 years. The ADS system identified 408 of these deaths, whereas ISTAT certified only 347. Three hundred and seven deaths were identified by both flows. *Conclusions:* The survey suggests that the ADS surveillance system may have overestimated the COVID-19 mortality data compared to the ISTAT flow. The ADS has been valuable in the immediate response to emergencies, providing a more sensitive system that prioritizes the precautionary principle and enables decisions aimed at minimizing risks for vulnerable populations. However, it is not recommended for routine surveillance, as it is less reliable compared to the ISTAT flow. (www.actabiomedica.it)

Key words: COVID-19, mortality, surveillance, informative flow, ISTAT

Introduction

On March 11, 2020, after assessing the levels of spread and severity of the SARS-CoV-2 infection, the World Health Organization (WHO) declared the COVID-19 outbreak a global pandemic.

Globally, as of 24 July 2023, there have been 768,653,968 confirmed cases of COVID-19, including 6,953,483 deaths, reported to WHO. As of 30 June 2023, a total of 13,492,099,754 vaccine doses have been administered (1).

Italy was the first European country to experience the intense spread of the SARS-CoV-2 virus. From 3 January 2020 to 24 July 2023, there have been 25,912,481 confirmed cases of COVID-19 with 191,012 deaths, reported to WHO, with a peak observed in March and April 2020 (2-4). Of these deaths, 39.26% occurred in 2020, 32.74% in 2021 (a total of 62,528 deaths, of which about 8,000 were associated with a diagnosis made in 2020), 24.81% in 2022, and 3.20% in 2023. As of 11 June 2023, a total of 150,317,622 vaccine doses have been administered (5).

In 2021, there was a decrease in the total number of deaths from all causes compared to the previous year, although they remained at very high levels: 709,035 deaths, 37 thousand less than in 2020 (-5.0%) but 63 thousand more than the 2015-2019 average (+9.8%) (6). With regards to age groups, the increase in deaths in the population aged 80 and over was the most significant contributor to the excess mortality of 2021, accounting for 72% of the excess mortality. In total, 455,170 people aged 80 and over died (about 46 thousand more than the average for the five years 2015-2019). The increase in mortality in the 65-79 age group explained a further 21% of the excess deaths, with an increase of over 13 thousand deaths (for a total of 177,937 deaths in 2021) compared to the average of the years 2015-2019 (7).

Monitoring the pandemic at the national and international levels is of paramount importance (8-13). Since the early stages of the COVID-19 pandemic declaration, the Ministry of Health requested that the Regional Health Services provide the number of daily COVID-19-related deaths. To meet this demand, the Emilia-Romagna Collective Prevention and Public Health Sector requested the Local Health Authorities (AUSLs - Aziende Unità Sanitarie Locali) to provide a daily flow of information regarding the number of swab tests carried out, COVID-19 cases, and COVID-19 deaths. To collect these data, the Department of Public Health of the AUSL of Parma implemented a real-time computerized system called "ADS" (Automated Data System). According to this system, a COVID-19-related death was recorded and communicated if the patient who died had been currently registered as a "COVID-19 case" or had a positive swab at the time of death or was not considered "recovered".

Alongside this information flow, official mortality data for all causes have been collected by the Italian National Institute of Statistics (ISTAT). These data were compiled by certifying doctors according to the International Classification of Diseases – ICD-10 (codes U07.1 or U07.2). In the province of Parma, ISTAT death certifications were uploaded to the Mortality Register with a delay of at least one month, as all the certifications of the previous month needed to be collected first. This explains why the ISTAT flow could not be used during the COVID-19 health emergency, as it did not provide information on deaths in a timely enough manner for health management. ADS was preferred because it was immediate, albeit inevitably less robust. Otherwise, given this organization, it could be difficult to differentiate deaths likely caused by COVID-19 ('due to') from deaths coinciding with COVID-19 ('together with') (14).

The primary objective of this retrospective observational study was to verify the concordance between the ISTAT flow (the official reference for mortality statistics) and the ADS flow to improve surveillance and management of the COVID-19 health situation, as well as future emergent spreading pathogens such as influenza viruses, through enhancements to the ADS computerized system.

The second objective was to analyze the characteristics of subjects classified differently by the two reporting systems.

Methods

The investigation period for this retrospective non-interventional study was from January 1st, 2021 to December 31st, 2021. We chose this timeframe because, at that time, data collection through the ADS management system was fully operational, allowing us to collect data in the most reliable possible way. The data were extracted from weekly records already present at AUSL and treated with preventive consultation from the AUSL Privacy Commissioner.

The study investigated all subjects living in the province of Parma who died of COVID-19 in 2021, including (a) those who were registered in the ISTAT flow but not in the ADS one, (b) those who were registered in the ADS flow but not in the ISTAT flow, and (c) those who were registered in both. A total of 448 subjects were investigated.

We examined the computerized surveillance tabs in the ADS application and collected the following data in anonymous records: gender, age, date of death, COVID-19 vaccination status, the time between COVID-19 vaccination and death, date of execution of the latest diagnostic swab, the reason for the execution of the diagnostic swab, and cause of death according to the ISTAT flow. We categorized the variable "swab's reason" into the following categories: ER access (patient having a swab performed when accessing the Emergency Room for symptoms not related to COVID-19); case contact; hospitalization (patient having a swab performed while being hospitalized for reasons other than COVID-19); screening (patient having a screening swab performed routinely on risk categories such as health workers), and symptoms (patient having a swab performed because of symptoms attributable to COVID-19).

Firstly, we performed a descriptive analysis of the examined population regarding age, gender, COVID-19 vaccination status, and causes of death. We calculated averages, medians, and frequencies as appropriate. To meet our primary objective, we calculated the percentage of concordance between the two flows (the official ISTAT data and the ADS data). To achieve our secondary objective, we then evaluated the distribution of the considered variables in the concordant and non-concordant populations. We applied the Chi-square test for this comparison, with a significance level of 5%. All the data used for the analysis were previously anonymized and aggregated. We conducted all statistical analyses using IBM SPSS 28.0.

Results

The characteristics of the study population are shown in Table 1: 208 subjects were female (46.4%) and 240 were male (53.6%), with an average age of 81 years (80 for males and 82 for females) and a median age of 83 years for both.

Seventy-seven percent of the subjects in the study were not vaccinated against COVID-19 (Table 2); among the 105 vaccinated subjects, the median of days between the last administered vaccine dose and death was 137 days.

The total number of deaths associated with COVID-19 in the ADS flow was 408, whereas the total number of deaths associated with COVID-19 in the ISTAT flow was 347 (Figure 1). The agreement between the two flows (ADS real-time surveillance vs officially validated ISTAT flow) was 69%: among the 448 deaths considered, 307 were recorded in both flows. Out of the 141 deaths that did not agree because they were only present in one of the two flows, 101 were only present in the ADS flow, and 40 were only present in the ISTAT flow.

According to ISTAT, 101 out of 408 deaths reported by ADS were not confirmed as COVID-19-related deaths. These 101 deaths were codified by ISTAT as shown in Figure 2, which displays all the causes of death for the 448 subjects in the study. Cardiovascular, respiratory, and cancer diseases were responsible for 60 out of the 101 deaths (59.4%). The

Table 1. Age of the deceased COVID-19 cases in the province of Parma in 2021

	N. subjects (%)	Mean age	Median age	Minimum age	Maximum age
Male	240 (*53.6)*	80	82	41	101
Female	208 (*46.4*)	82	83.5	46	99
Total	448 (*100*)	81	83	41	101

Table 2. Distribution of vaccinated subjects by age group in the population of deceased individuals under examination

Age groups	Vaccinated subjects with at least one dose	Not vaccinated subjects
0-59 years (%)	1 (*6%*)	16 (*94%*)
60 years over (%)	104 (*24%*)	327 (*76%*)
Total (%)	105 (*23%*)	343 (*77%*)

term "other causes" 24/101 (23.8%) refers to gastrointestinal diseases, kidney diseases, and neuropsychiatric and endocrinological diseases; the remaining deaths (2.3%) were attributable to traumatic causes. On the other hand, the 40 subjects listed in the ISTAT mortality register but not in the ADS records (classified as death due to COVID-19) were patients who had previously been recorded in ADS as COVID-19 cases but, at the time of their death, they had recovered and tested negative for the virus. Despite their negative results, the certifying doctor still believed that the cause of death should be attributable to COVID-19.

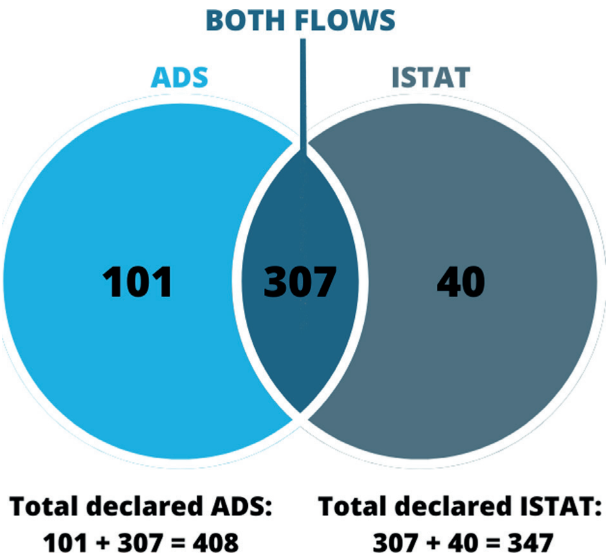

Figure 1. Concordance between ADS and ISTAT data on COVID-19 diagnosis.

The secondary objective was to assess the distribution of the variables among the discordant groups (101 deaths only in ADS and 40 deaths only in ISTAT) compared to the concordant group (307 deaths). Due to the limited number of vaccinated subjects in our population (Table 2), it was not feasible to evaluate the distribution based on the vaccination status. Therefore, our focus was concentrated on analyzing the distribution of the variable "*reason for diagnostic swab*" as an indicator of COVID-19 status.

No statistically significant differences were observed for the 40 subjects identified solely through the ISTAT dataset (Table 3) except for the category of swabs performed for "screening" purposes. Among the 40 individuals who died solely according to the ISTAT data, 20.5% had undergone diagnostic swabs as a part of a screening program, compared to 8% in the concordant group (p: 0.012).

Among the 101 individuals who died from COVID-19 only according to the ADS dataset, several significant differences were observed in the distribution of reasons for undergoing a diagnostic swab, compared to the concordant group (Table 4). Specifically, 16% of these individuals had undergone the swab at the emergency room for reasons unrelated to COVID-19, while the concordant group had a significantly lower percentage of 3.9% ($p < 0.001$). Additionally, 55% of the ADS-only group had performed the swab during their hospital stay for reasons other than COVID-19, in contrast to the concordant group with 19.6% ($p < 0.001$).

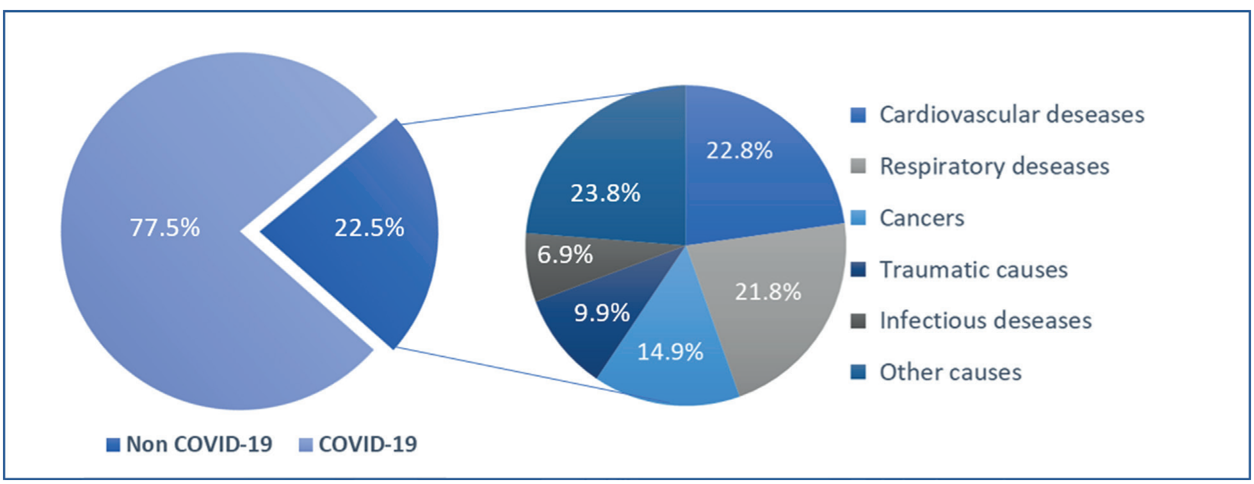

Figure 2. ISTAT distribution of causes of death in the total population considered (448 deaths).

Table 3. Comparison analysis between the 40 deceased individuals recorded exclusively in the ISTAT form and the 307 deceased individuals who were present in both datasets

REASON FOR THE DIAGNOSTIC SWAB	Subjects deceased (n. 40)		Subjects deceased (n. 307)		Chi-square test *p**
	n.	%	n.	%	
Access to the ER	2	*5.1*	12	*3.9*	0.74
Case contact	8	*20.5*	53	*17.3*	0.08
Hospitalization	5	*12.8*	60	*19.6*	0.28
Screening	8	*20.5*	24	*7.8*	0.012
Symptoms	17	*41*	158	*51.3*	0.28

*Chi-square Test not significant (except for SCREENING, p=0.012)

Table 4. Comparison analysis between the 101 deceased individuals listed in the ADS dataset and the 307 deceased individuals present in both datasets

REASON FOR THE DIAGNOSTIC SWAB	Subjects deceased (n. 101) - ADS only		Subjects deceased (n. 307)		Chi-square test *p*
	n.	%	n.	%	
Access to the ER	16	*16*	12	*3.9*	<0.001
Case contact	7	*7*	53	*17.3*	0.011
Hospitalization	55	*55*	60	*19.6*	<0.001
Screening	15	*14*	24	*7.8*	0.037
Symptoms	8	*8*	158	*51.3*	< 0.001

The swab was taken as part of a screening program by 14% of the ADS-only group, compared to 7.8% of the concordant group ($p < 0.037$). Finally, only 8% of the 101 subjects in the ADS-only group had undergone the swab due to symptoms attributable to COVID-19, whereas the concordant group had a significantly higher percentage of 51% ($p < 0.001$), along with 41% of the 40 subjects registered solely in the ISTAT dataset.

Conclusions

In Italy, COVID-19 mortality had the greatest impact on the elderly population. The impact was particularly severe for those aged 80 and above, accounting for 72% of the excess mortality, whereas 21% was attributed to the age group of 65-79 years (3). In our study, it was found that more than 50% of the deceased individuals were above the age of 83.

The study period was limited to 2021 when the first vaccines were approved and administered. Within our group of subjects who died due to COVID-19 or were found to have COVID-19, the percentage of individuals vaccinated with at least one dose was very low (23%). Among these vaccinated individuals, the average time elapsed between the last dose and death was over 4 months (137 days), aligning with current knowledge (8) suggesting a decline in vaccine-induced protection after this period.

In the 0-59 age group, corresponding to those vaccinated later in 2021 as they were considered at lower risk, 94% of the deceased individuals were not vaccinated, contrasting with 76% in the age group of 60 and above.

The Local Health Authority implemented the ADS surveillance system after the initial months of the pandemic. The primary objective was to promptly identify COVID-19 patients and deaths associated with COVID-19, enabling local management of the epidemic, and providing daily updated data as required by the regional health authority. This decision was made because the ISTAT flow, which is more accurate in determining causes of death, was not suitable for describing a rapidly evolving and changing phenomenon due to delays in recording events.

However, the ADS flow lacked clinical or coroner value in certifying the cause of death, resulting in an area of uncertainty that can only be addressed through retrospective data analysis.

At the end of 2021, it became apparent that the ADS data, compared to the ISTAT data, were overestimating the number of deaths attributed to COVID-19. This observation confirmed the previous hypothesis that real-time systems based on positive samples may overestimate COVID-19-related deaths. When considering the ISTAT records of 448 subjects classified as deaths with or due to COVID-19 (as shown in Figure 2), it was found that 26.6% of them, according to ISTAT classification, had died from other causes. On the other hand, when ISTAT official mortality data became available, it was discovered that a small portion of deaths had not been recognized as COVID-19-associated by ADS, possibly due to the absence of a "positive swab" close to the time of death. Conversely, the certifying doctors, when completing the mortality forms, had identified a causal link between COVID-19 and the deaths.

In the group of deceased individuals present in the ADS dataset but not in the ISTAT dataset, 71% of them had undergone diagnostic swabs upon accessing the emergency room and for hospitalization due to reasons unrelated to COVID-19. Hospital protocols required the execution of a nasal swab for the detection of SARS-CoV-2 upon admission, regardless of the presence of symptoms attributable to this pathology, to protect the health of patients and healthcare workers. In these cases, the detection of the infection was incidental, and the doctors, when completing the ISTAT death certificates, did not consider it necessary to attribute the deaths to COVID-19. Additionally, the percentage of subjects who had undergone diagnostic swabs due to symptoms in the group of deceased individuals solely present in the ADS dataset (8%) was much lower compared to the percentage observed in the group of subjects present in both datasets (51%) or the ISTAT solely flow (41%).

Regarding the group of 40 deceased individuals present in the ISTAT flow only (Table 3), the most significant difference in the reason for carrying out the diagnostic swab between this group and the subjects present in both flows was the execution within screening programs (20.5% vs 8% with $p < 0.05$), while the execution of the swab for symptoms was similar with a non-significant difference (41% vs 51%).

This study has several limitations. Firstly, it only considers data from the year 2021. Expanding the investigation to include data from 2022 would increase the sample size and reduce the uncertainty associated with a tracking methodology developed during an emergency period. Additionally, the study did not utilize individual clinical records and could not thoroughly analyze death certificates. Therefore, it serves as a starting point for further research and investigations.

The primary objective of the ADS surveillance system was to promptly identify both COVID-19 patients and COVID-19-related deaths, aiming to minimize the impact of viral transmission on the population, particularly among vulnerable individuals (15). The implementation of the ADS system facilitated the timely management of the pandemic in the Parma area, enabling daily monitoring and immediate public health interventions. Therefore, the system's crucial requirement was sensitivity in detecting cases. On the other hand, the certification of causes of death by ISTAT allows for a more comprehensive analysis of the factors contributing to each death. Additionally, it enables national and international comparisons, which will play a vital role in studying the events and outcomes of the COVID-19 pandemic.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement, etc.) that might pose a conflict of interest in connection with the submitted article.

Ethic Committee: not applicable

Authors Contribution: RG, EM, LV: conception and design of the study; RG, EM, GP acquisition of the data, RG, EM, GP, LV analysis and interpretation of the data; RG, EM, GP, LV drafting the article and revising it critically. RG, EM, GP, and LV approved the version to be published.

References

1. WHO Coronavirus (COVID-19) Available online: https://COVID-1919.who.int (Accessed August 2nd, 2023)
2. WHO Technical Advisory Group on COVID-19 Mortality Assessment. Available online: https://www.who.int/data/technical-advisory-group/COVID-19-mortality-assessment (Accessed August 2nd, 2023)
3. Settimo Rapporto prodotto congiuntamente dall'Istituto nazionale di statistica (ISTAT) e dall'Istituto Superiore di Sanità (ISS). https://www.ISTAT.it/it/files//2022/03/Report_ISS_ISTAT_2022_tab3.pdf (Accessed August 2nd, 2023)
4. Dorrucci M, Minelli G, Boros S, et al. Excess Mortality in Italy During the COVID-19 Pandemic: Assessing the Differences Between the First and the Second Wave, Year 2020. Front Public Health. 2021 Jul 16;9:669209. doi: 10.3389/fpubh.2021.669209.
5. WHO Coronavirus (COVID-19). Available online: https://COVID-1919.who.int/region/euro/country/it (Accessed August 2nd, 2023)

6. Ministero della Salute. Report Vaccini anti COVID-19. Available online: https://www.governo.it/it/csCOVID-1919/report-vaccini (Accessed on August 2nd, 2023.).
7. SARS-CoV-2 positive deaths surveillance Group. Available online: https://www.epicentro.iss.it/en/coronavirus/bollettino/Report-COVID-19-2019_10_january_2022.pdf (Accessed on January 2nd, 2023).
8. Gallo V, Chiodini P, Bruzzese D, et al. Comparing the COVID-19 pandemic in space and over time in Europe, using numbers of deaths, crude rates and adjusted mortality trend ratios. Scientific reports. Sci Rep. 2021 Aug 12; 11(1):16443. doi: 10.1038/s41598-021-95658-4.
9. Odone A, Delmonte D, Gaetti G, Signorelli C. Doubled mortality rate during the COVID-19 pandemic in Italy: quantifying what is not captured by surveillance. Public Health. 2021 Jan;190:108-115. doi: 10.1016/j.puhe.2020.11.016.
10. Signorelli C, Odone A, Gianfredi V, et al. COVID-19 mortality rate in nine high-income metropolitan regions. Acta Biomed. 2020;91(9-S):7-18. Published 2020 Jul 20. doi:10.23750/abm.v91i9-S.10134.
11. Veronesi L, Colucci ME, Pasquarella C, et al.. Virological surveillance of SARS-CoV-2 in an Italian northern area: comparison of Real-Time RT PCR cycle threshold (Ct) values in three epidemic periods. Acta Biomed 2020 Jul 20;91(9-S):19-21. doi: 10.23750/abm.v91i9-S.10138.
12. Mohieldin Mahgoub Ibrahim M, Colucci ME, Veronesi L, et al. Virological surveillance of SARS-CoV-2 in an Italian Northern area: differences in gender, age and Real Time RT PCR cycle threshold (Ct) values in three epidemic periods. Acta Biomed. 2021 Oct 7;92(S6):e2021457. doi: 10.23750/abm.v92iS6.12268.
13. Perotti P, Bertuccio P, Cacitti S, et al. Impact of the COVID-19 Pandemic on Total and Cause-Specific Mortality in Pavia, Northern Italy. Int J Environ Res Public Health. 2022;19(11):6498. Published 2022 May 26. doi:10.3390/ijerph19116498.
14. Lampl BMJ, Lang M, Jochem C, Leitzmann MF, Salzberger B. COVID or not COVID: attributing and reporting cause of death in a community cohort. Public Health. 2022 Apr;205:157-163. doi: 10.1016/j.puhe.2022.02.008.
15. Rosenbaum JE, Stillo M, Graves N, Rivera R. Timeliness of provisional United States mortality data releases during the COVID-19 pandemic: delays associated with electronic death registration system and weekly mortality. J Public Health Policy. 2021;42(4):536-549. doi:10.1057/s41271-021-00309-7.

Correspondence:

Received: 3 March 2023
Accepted: 4 August 2023

Licia Veronesi, MD
Laboratory of Hygiene and Public Health,
University of Parma
Via Volturno, 39, Parma, 43125 Italy
Phone: 0521 903794
E-mail: licia.veronesi@unipr.it
https://orcid.org/0000-0002-5399-2934