New Microbiologica, 45, 2, 115-123, 2022, ISSN 1121-7138

FULL PAPER

The Italian Mandatory Notification System: An Important Public Health Tool For Continuous Monitoring Of Infectious Diseases

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SUMMARY

Infectious diseases still register significant morbidity and mortality worldwide. Surveillance through a mandatory notification system allows the continuous analysis of the situation even at a local level and its importance has been highlighted by the recent COVID-19 pandemic. This paper aimed to outline the importance of the mandatory notification system as a Public Health tool in the continuous monitoring of infectious diseases. To this aim, we carried out a cross-sectional study examining the notifications reported in the Italian territory of Messina, Sicily, in the period 2001-2020. The institutional websites were examined and the notification data were used to obtain the incidences. Overall, a significant reduction of the incidence notification trend was observed. Chickenpox was by far the most notified infectious disease, followed by scabies, pediculosis, and brucellosis. Outbreaks of brucellosis, measles and hepatitis A occurred. All the diseases decreased over time, except syphilis, for which a significant increase was observed. Surveillance of infectious diseases through a mandatory notification system remains a bulwark of public health despite underreporting. Our study reflects the situation of a typical high-income area, although some unexpected criticisms are highlighted. Continuous information about correct behaviors through education campaigns are crucial in order to improve the situation.

Keywords: mandatory notifications, infectious diseases, surveillance, public health

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Received June 01, 2021 *Accepted* March 30, 2022

INTRODUCTION

Despite progress in their prevention, diagnosis and treatment, infectious diseases still have a significant burden of morbidity and mortality globally (Global Burden of Disease, 2017). These diseases are spread all over the world, but in low-middle income countries they represent the first cause of death, especially among children, with lower respiratory infections being the deadliest, followed by infectious diarrheas and, in third and fourth places, tuberculosis (TB) and HIV/AIDS infection (World Health Organization, 2020). However, even in high-income countries, infectious diseases are an important concern, especially due to the onset of reemerging diseases such as TB or syphilis (Floyd *et al.*, 2018; Spiteri *et al.*, 2019) and the spread of antimicrobial-resistant bacteria, with important clinical and economic consequences for patients and public health (Zhen *et al.*, 2019; Ceylan *et al.*, 2020). Finally, the recent COVID-19 pandemic, with previous Middle-East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS), are the best examples of the risk represented by the onset of new viral infections (Guarner, 2020).

To minimize the burden of infectious disease morbidity and mortality, surveillance is surely one of the most important public health weapons. National surveillance systems allow continuous examination of the epidemiological burden and the trend of important infections at a local level (Lee *et al.*, 2011). In Italy, this surveillance consists of the mandatory reporting by physicians of all probable and/or confirmed cases of infectious diseases. Ministerial Decree of 15 December 1990 groups the diseases in five classes

Key words:
HPV, Self-collected, Vaginal specimens, Cervical samples, Pre-analytical.

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and establishes times and ways to make the notification (Ministero della Salute, 1990). Until 2018, all notifications converged into the online routine surveillance system for infectious diseases. Specifically, local General Practitioners (GPs), Primary Care Pediatricians (PCPs) or hospital physicians made notifications to local Hygiene and Public Health services of the Local Health Units (LHUs) that, after the report, adopted all prophylaxis measures to protect public health. Then, the information from the local level reached the central (Ministry of Health, Higher Institute of Health, in Italian ISS) and international (European Union, World Health Organization) levels. In 2019, the New Italian System for Reporting Infectious Diseases (PREMAL) was created. The new system is completely online, uses ICD9-CM coding for disease classification, and can include new emerging or emergency syndromes. Nowadays, in addition to PREMAL, some specific surveillance systems are present at the central level, including those for legionellosis, influenza, measles and congenital rubella, acute viral hepatitis and sexually transmitted diseases (Ministero della Salute, 2019; Epicentro, 2021a).

It is important to mention the COVID-19 integrated surveillance system, which continuously and systematically collects all cases of SARS-CoV-2 infection confirmed by molecular diagnosis performed by various regional reference laboratories across Italy. The system was established with Circular no. 1997 of 22 January 2020 and is coordinated at the top by the Department of Infectious Diseases of the ISS, even if each Region/Autonomous Province has one or more local coordinators. At the local level, all suspect COVID-19 cases (both isolated at home or hospitalized) are confirmed by SARS-CoV-2 molecular diagnostic testing. Confirmed cases are then notified by physicians to the LHUs, where the regional coordinator uploads them to a specific IT platform created by the ISS. Finally, the central Department of Infectious Diseases processes and analyses the notification data and makes them available to ensure monitoring of the epidemic across the country. Besides this main information flow, in Italy we have another important source of information about the COVID-19 epidemic: the Civil Protection (CP), which daily collects information on all aspects of COVID-19 infection (total number of positive tests, deaths, hospitalizations and intensive care admissions) throughout Italy. Data collected by CP are aggregated, as opposed to those collected by the ISS, which are individual-level data including demographic information, clinical conditions and comorbidities. Actually, aggregated data have the great advantage of being faster and easier to collect, but individual-level data allow more detailed and accurate analyses (Epicentro, 2020c).

However, it is well known that most surveillance and notification systems are affected by the phenomenon of underreporting, and this certainly masks the real incidence of disease. Nevertheless, an efficient surveillance and a valid notification system are vital for public health and to control outbreaks (Gibbons *et al.*, 2014).

This paper aimed to outline the importance of the mandatory notification system as a Public Health tool in the continuous monitoring of infectious diseases, tracking their trend in a Southern Italian territory and drawing a picture of the burden still represented by these diseases in an area of a high-income country, allowing evaluation of the most important criticisms concerning most public health efforts.

MATERIALS AND METHODS

We carried out a cross-sectional study examining all infectious disease notifications made in the twenty-year period 2001-2020 in the Italian province of Messina (613,887 residents in the year 2020). The health of the whole province is administered by Provincial Health Agency no. 5 (ASP 5), which is divided into eight districts, one of these being the Metropolitan city of Messina. The notifications made by physicians are managed by the Public Health, Epidemiology and Preventive Medicine Unit of the Messina ASP 5 Prevention Department, which has the task of transferring the information to the IT platforms of the general and specific institutional websites. We used the notification data to obtain disease incidences, considering the resident population year by year. Statistical processing was performed using version 10 of StatSoft® software and a t-test was used to assess significance.

RESULTS

In the considered period, the provincial resident population decreased by 7.3%, from 662,450 in 2001 to 613,887 in 2020. Just over a third (37.0% in 2020) of the residents lived in the metropolitan city of Messina. *Table 1* presents details of incidence rates of such notifications.

Overall, a significant reduction of the incidence notification trend was observed, with a decrease of 92.2% ($P<0.0001$). *Table 2* reports the total cases and the relative average incidence rates of the notified infectious diseases.

Grouping the diseases according to their transmission modes and/or clinical characteristics, we evaluated the notification trend of exanthematous/pediatric diseases (measles, mumps, rubella, chickenpox, pertussis and scarlet fever), foodborne diseases (brucellosis, non-typhoidal salmonellosis, food poisoning, typhoid fever, hepatitis A and botulism), arthropod-borne/parasitic diseases (scabies, pediculosis, rickettsiosis, visceral Leishmaniasis and malaria), re-emerging diseases (tuberculosis, syphilis),

Table 1 - *Resident population, notified cases of infectious diseases and incidence rates from 2001 to 2020*

Year	*Resident population*	*Notified cases of infectious diseases*	*Incidence rate/100,000*
2001	663,450	1,649	248.5
2002	661,708	1,315	198.7
2003	659,513	1,244	188.6
2004	658,924	1,112	168.8
2005	657,785	932	141.7
2006	655,640	825	125.8
2007	653,861	535	81.8
2008	654,032	538	82.3
2009	654,601	328	50.1
2010	653,810	472	72.2
2011	653,737	225	34.4
2012	649,320	209	32.2
2013	648,062	286	44.1
2014	648,371	220	33.9
2015	645,296	126	19.5
2016	640,675	253	39.5
2017	636,653	279	43.8
2018	631,297	225	35.6
2019	626,876	161	25.7
2020	613,887	129	21.0

viral and bacterial meningo-encephalitis and others (acute hepatitis B and tetanus). *Figure 1* shows the trends of all the above-mentioned diseases.

Exanthematous/pediatric diseases

Among these diseases, chickenpox was by far the most notified, with, however, a significant reduction of 99.0% from 2001 to 2020. In the first six years (2001-2006) a very high number of cases were notified, with two important outbreaks in 2001 and 2004 (incidence rates of 136.8 and 115.9/100,000 inhabitants). Later, the notification rate declined significantly, with a decrease of 97.8% from 2006 to 2020. In the second decade (2010-2020), three outbreaks occurred in 2010, 2013 and 2017 but the incidence rates were much lower and equal to 31.2, 17.0 and 20.3/100,000 inhabitants, respectively). Measles was characterized by two important outbreaks in 2010 and in 2017-2018 with incidence rates of 14.2 and 15.1/100,000 inhabitants. Only one rubella outbreak was reported in 2008, with 123 notified cases and an incidence rate of 18.8/100,000 inhabitants. Women were affected in 52.2% of cases, of which 50.0% and 27.2% belonged to the 15-24 and 25-64 age groups, respectively. Four unvaccinated pregnant women contracted rubella, but all in the 2nd trimester and in all cases with laboratory confirmation of rubella infection. Three new-borns resulted negative to IgM search and PCR while one of them was positive only for IgM without development of signs and symptoms of the disease. In the last eight years (2013-2020), only one rubella case was notified in 2017. No important outbreaks of mumps and pertussis occurred during the studied period, in which a small number of cases were equally distributed. The average incidence rate of pertussis halved in the second decade (0.5/100,000) compared to the first (1.1/100,000). Almost all (96.2%) notified cases concerned children, 36.1% of whom were unvaccinated. Among these, 30.8% were aged <1 year and 7.7% were foreigners from Asian countries, especially China and India; the reasons for non-vaccination in the remaining 61.5% are unknown. However, 58.3% of notified cases occurred in vaccinated subjects, while for 5.6% the immunization status was unknown. Concerning the age groups, 0-14 was by far the most frequent one for measles, mumps, chickenpox, pertussis and scarlet fever, for rubella an important percentage (35.9%) concerned the 15-24 group. No differences were reported concerning gender.

Table 2 - *Total cases and average incidence rates of notified infectious diseases in the twenty-year period 2001-2020.*

Infectious diseases	*Total number of notified cases*	*Average incidence rate/100,000*
Chickenpox	4,817	36.7 ± 40.9
Scabies	1,009	7.7 ± 8.3
Pediculosis	913	6.9 ±7.8
Brucellosis	884	6.8 ± 7.0
Tubercolosis	491	3.8 ± 1.0
Non-typhoidal salmonellosis	468	3.6 ± 2.7
Scarlet fever	412	3.1 ± 2.6
Measles	311	2.4 ± 3.9
Food poisoning	278	2.1 ± 3.4
Rickettsiosis	247	1.9 ± 1.5
Rubella	221	1.7 ± 4.1
Infective diarrhea	147	1.1 ± 1.3
Syphilis	121	0.9 ± 0.6
Typhoid fever	113	0.9 ± 0.9
Mumps	107	0.8 ± 0.9
Whooping cough	105	0.8 ± 1.1
Bacterial meningitis	103	0.8 ± 0.5
Acute viral meningitis	90	0.7 ± 0.5
Hepatitis A	83	0.6 ± 0.8
Dermatophytosis	75	0.6 ± 0.9
Hepatitis B	70	0.5 ± 0.4
Non-tuberculous mycobacteriosis	43	0.4 ± 0.3
Visceral leishmaniasis	35	0.3 ± 0.3
Legionellosis	24	0.2 ± 0.3
Malaria	16	0.1 ± 0.1
Tetanus	11	0.1 ± 0.1

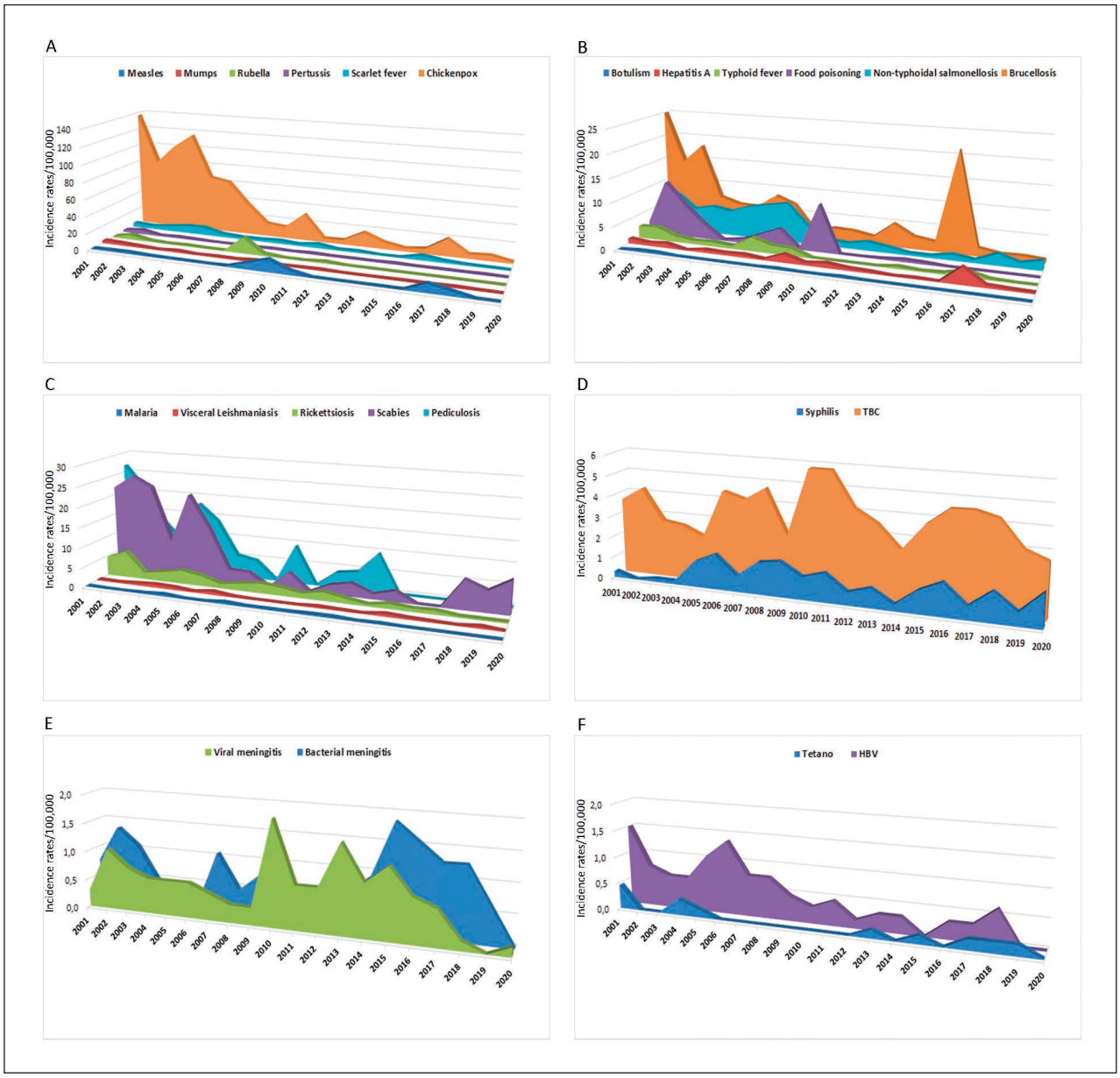

Figure 1. *Trends of all notified infectious diseases grouped according to their transmission modes and/or clinical characteristics: A) Exanthematous/pediatric diseases; B) Foodborne diseases; C) Arthropod-borne/parasitic diseases; D) Re-emerging diseases; E) Bacterial and viral meningitis; F) Other diseases.*

Foodborne diseases

The most notified foodborne disease by far was brucellosis, for which, however, a decrease of 97.0% was recorded. While in the first three years (2001-2003) the incidence rates were 25.0, 14.4 and 18.0/100,000 inhabitants, a progressive decrease was recorded until 2015. In 2016, an important outbreak with 137 notified cases (IR 21.4/100,000 inhabitants) occurred. After this peak, only a few cases were reported in 2017-2020. Non-typhoid salmonellosis cases were constantly notified, without major epidemic outbreaks over the entire period, but with a reduction from the first decade (388 notified cases), to the second one (only 80 cases). Food poisoning and typhoid fever followed a very similar trend, with significant differences between the two decades. Specifically, in the first decade, 272 cases of food poisoning were notified, compared to only 6 cases in the second one, while for typhoid fever, the cases were 98 *vs.* 15. Hepatitis A was constantly reported, with few notified cases, but an outbreak (IR:3.5/100,000 inhabitants) was reported in 2017 in a population made up in most cases by men (89.3%) belonging to the 25-64 age group (76.7%). Finally, botulism was present with only six cases over the entire period.

Arthropod-borne/parasitic diseases

Scabies and pediculosis were by far the most notified and they were predominantly present on the first decade (2001-2010) with an average IR of 12.0 and 12.4 compared to 1.9 and 3.0/100,000 inhabitants on the second one. However, while only 6 cases of pediculosis were notified in 2018-2020 (percentage decrease of 99.4%), scabies reported a lower percentage decrease (64.8%) and a consistent recurrence in 2018-2020 with 130 cases of which 59.3% occurred in men and 87% in Italians. In general, the average age was 35.1 ± 23.7 years old and, according to the age groups, 23.7% occurred in 0-14, 14.9% in 15-24, 46.5% in 25-64 and 14.9% in >64. Among resident foreigners and excluding the cases recorded in irregular migrants that landed numerous on our coasts during 2014-2018, 81.3% occurred in men (average age 22.6 ± 13.2). Based on age, 25.0% occurred in 0-14, 43.8% in 15-24 and 31.3% in 25-64. Rickettsiosis is endemically present in our territory but it recorded a significant reduction (percentage decrease 93.5%) comparing the average IR of the two decades (2.9 vs 0.9/100,000). Few cases, without any difference between the two decades, were notified for visceral leishmaniasis and malaria (all import cases).

Re-emerging diseases

Tuberculosis and syphilis were constantly notified and the average IR of the two decades remain overlapping for both the diseases (3.7 vs 3.9/100,000 and 0.9 vs 1.0/100,000 respectively). However, while for TBC a percentage decrease of 33.3% was recorded from 2001 to 2020, syphilis cases had a percentage increase of 400% with 8.3% of all cases notified in last year.

Bacterial and viral meningitis

Meningitis, with the same frequency for bacterial and viral forms, were constantly notified. However, an increase for the bacterial form was observed in the period 2014-2019 of which, according to the etiology, 29.2% were pneumococcal, 27.1% was caused by *Klebsiella pneumoniae*, 16.7% were meningococcal and 4.2% were secondary to *Haemophylus influenzae* infection; in 22.8% the etiology was unknown (*Figure 2*). The forms caused by *K. pneumoniae* occurred in subjects aged 25-64 years old for 73.2%.

Other diseases

Only few cases of acute Hepatitis B were notified, which interested men for 72.9% and the age group 25-64 years old in the 80.0%. A reduction of IR was

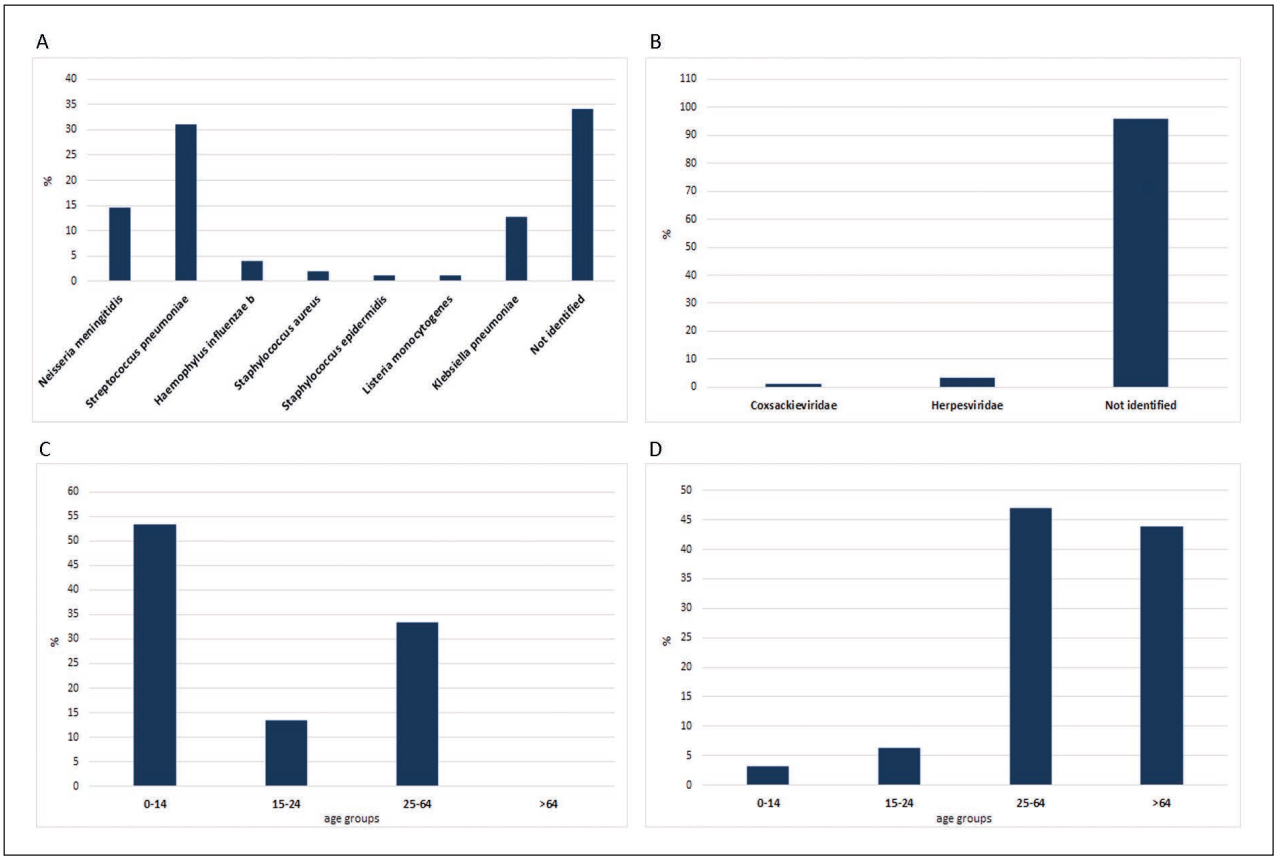

Figure 2. *Bacterial and viral meningitis characteristics: A) Etiology of bacterial forms; B) Etiology of viral forms; C) Age groups of meningococcal meningitis; D) Age groups of pneumococcal meningitis.*

recorded over the period (IR 0.8 in the first decade vs. 0.2 in the second one). Eleven tetanus cases were overall notified (IR 0.1/100,000 in both decades), which interested women for 63.6% and the age group >65 years old in 100.0%. A lethal rate of 36.4% was reported.

DISCUSSION

Surveillance still represents one of the main Public Health tools in the prevention of infectious diseases and the mandatory notification system is the cornerstone of this control process (Simonsen *et al.*, 2016). Indeed, infectious diseases are still burdened by a high rate of morbidity and mortality worldwide and the incidence rates of some of them are alarming even in the high-income world despite the progresses recently reached. This feature is due to several factors such as the increased longevity in industrialized countries that has led to a high number of subjects who, due to immunosenescence, are more susceptible to acquire infectious diseases and develop life-threatening complications. Moreover, the improvement in healthcare has increased the immune-compromised subjects, including oncologic, transplant patients, diabetics, HIV-positive, and individuals making immunosuppressive therapies. In addition, changes in lifestyles have increased the transmission of infective agents in populations previously at low risk. The spread of the injection drugs in the recent past increased the transmission of HIV, Hepatitis B and C. The spread of some eating habits (raw fish and ethnic food) expanded the distribution of parasitic agents. Finally, travelling and migration increase allow the spread of infections from undeveloped countries to high-income countries.

The importance of an organized notification system coordinating the surveillance of infectious diseases has been widely shown by the COVID-19 pandemic. The constant and systematic collection of COVID-19 cases is one of the most important tool in the integrated control of the disease because it allows to highlight the real epidemiological situation and to make decision about actions to be taken to control the spread of the infection. Surveillance system have been widely used worldwide as cornerstone in the fight against COVID-19 pandemic (de Lusignan *et al.*, 2020; Ibrahim, 2020; Sakib *et al.*, 2020; Adebisi *et al.*, 2021).

Apart from the current situation given by the COVID-19 pandemic, Italy currently shows a typical situation of a high-income country characterized by a massive reduction of the infectious diseases burden due to the improvement in life quality and in the healthcare provided to population. According to the National Institute of Statistics (ISTAT), before the COVID-19 pandemic, infectious diseases were eighth among all causes of death (Istituto Nazionale di Statistica, 2018), although the morbidity rates are still not negligible for some of them. However, from our analysis some criticisms have arisen to which attention must be paid by public health to improve the health condition of the community.

In line with national and international situation, the reduction is due to an improvement of vaccination offer and coverage that brought down the IR of all the vaccine-preventable diseases, especially measles, rubella, mumps pertussis and, more recently, chickenpox (Ministero della Salute, 2020a; Gori *et al.*, 2020). Indeed, the difference observed in chickenpox IR is due to a low acceptance rate of its relative vaccination that, in the first studied years, in Italy it was not included in the trivalent MMR vaccine causing a vaccination coverage lower than the other diseases (Epicentro, 2020a). Measles notification trend was characterized by two outbreaks, of which the last (2017-2018) concerned the whole country (Andrianou *et al.*, 2019; Palamara *et al.*, 2018). The outbreak followed a decrease in vaccination rates that induced to turn into mandatory the previously optional MMRV vaccinations by a specific law (L 119/2017) (Ministero della Salute, 2017; Di Pietro *et al.*, 2019). Only one outbreak of rubella and any of mumps were recorded during the whole period. These diseases involved by far children (0-14 years old), except for rubella that occurred in adolescent and young adults in more than one-third of cases (35.9%), underlining the potential risk for women in fertile age that could get the disease during pregnancy with serious complications for unborn. In order to maintaining the incidence of congenital rubella to less than 1 case per 100,000 live newborns, in Italy is active from 2003 a specific program, named "National Plan for the Eradication of Measles and Congenital Rubella" (in Italian PNEMoRC) which is also aimed to the elimination of measles by stopping its indigenous transmission (Ministero della Salute, 2003). Pertussis was a not frequently notified disease, thanks to the consolidated and efficacy use of hexavalent vaccine which, by a single administration, protects for six different diseases including tetanus, diphtheria, poliomyelitis and HBV that are mandatory in Italy for a long time (Epicentro, 2021b). Despite pertussis was not compulsory before the 2017, it enjoyed the benefits of the other co-administered mandatory vaccinations and this led to a good vaccination coverage. The cases notified in vaccinated subjects were partly due to an uncompleted cycle (missed booster dose recommended in the fifth-sixth year of life) especially for cases occurred in adolescents (Ministero della Salute, 2020b). Moreover, in Italy, a booster dose during the third trimester of pregnancy, aimed to passively protect newborn, is strongly recommended. To inform women to get vaccinated, a role could be played by midwifes highlighting the importance to improve the knowledge of this healthcare catego-

ry (Visalli *et al.*, 2021). Despite the significant goals achieved in the fight against these vaccine-preventable diseases, a continuous health education of population is necessary to counteract vaccine hesitancy, spread globally (Facciolà *et al.*, 2019).

Foodborne diseases were constantly present and brucellosis was the fourth most notified disease despite a decrease over time. As opposed to the northern and central national territories that recently acquired the qualification of "officially free territory" (Ministero della Salute, 2020b), the disease is endemic in our territory in both animals and humans. The human outbreak that occurred in 2016 was linked to the consumption of contaminated local cheese due to the endemic persistence of infected animals, especially sheep and goats, bred by small-scale farmers eluding official veterinary checks (Facciolà *et al.*, 2018). To improve this situation, it will be indispensable either to increase public awareness regarding the consumption of unchecked milk and derivatives and/or to improve official control measures and eradication efforts with vaccination of all susceptible animals. This goal could benefit from cooperation between human and veterinary health services. Despite the reduction, the persistent notification of other foodborne diseases and, in particular, non-typhoid salmonellosis must be highlighted. Moreover, the presence of typhoid fever and hepatitis A (IR 0.9 vs 0.6/100.000) should be stressed, since it could be closely related to local habits of consuming raw or undercooked seafood (especially mussels), bred in a city lake area, occasionally contaminated by sewage in past years. However, concerning the outbreak of hepatitis A that occurred in 2017, the composition of the affected sample and the simultaneous presence of epidemic outbreaks worldwide and in other parts of Italy confirmed a different origin, linked to at-risk sexual habits, almost exclusively occurring among men having sex with men (MSM) (Mauro *et al.*, 2019; Aulicino *et al.*, 2020). Correct nutritional education, avoiding raw/undercooked food, and continuous sexual education talking about diseases traditionally not considered as sexual transmitted diseases, are crucial in order to improve the epidemiology of these pathologies.

Parasitic and arthropod-borne diseases, some still endemic in our territory, such as rickettsiosis, were in constant decline, with the exception of scabies, which was the second-most-notified disease. A re-emergence in cases was observed in 2018-2020, mainly in young Italian adult men. Since only very few cases occurred in the same family group, this could be explained by assuming a possible sexual origin (Salavastru et al., 2017; Amato *et al.*, 2019) and by the persistence of some pockets of poverty in the city area. Overall, we must emphasize the huge gap existing between Italians and resident foreigners, specifying that in the "foreigner" category we did not consider cases occurring in irregular migrants who landed on our coasts in 2014-2018 (Visalli *et al.*, 2020).

Tuberculosis and syphilis are considered re-emerging diseases in high-income countries for several reasons, such as the spread of HIV-infection, the occurrence of migration, the spread of alcoholism and, in marginalized subjects, difficulty in access to healthcare (Sotgiu *et al.*, 2016; Stamm *et al.*, 2016). In our province, TBC was always present in the considered twenty-year period, with increases linked to the presence of resident and irregular foreigners (Facciolà *et al.*, 2020). In foreigners, poor living conditions, social inequalities and the occurrence of hard and underpaid work could have re-activated a latent TB infection. Syphilis was the only infectious disease that showed a very high percentage increase over time (+400%), especially in young men. This finding could probably be linked to a general decrease in awareness of sexual infections reported in different settings, especially in young and very young people and in MSM (Arando *et al.*, 2019; Visalli *et al.*, 2019). Moreover, the possible role played by the spread of Pre-Exposure Prophylaxis (PrEP) for HIV prevention in the transmission of other sexually transmitted infections (STIs) has been evaluated (Traeger *et al.*, 2019; Ong *et al.*, 2019). These findings suggest the need to increase awareness of STIs and to spread a culture of prevention, especially in young people and the MSM group, which are the most vulnerable population groups, through continuous health education campaigns carried out in schools and in specific category associations (gay communities).

Although reports of meningitis decreased over time, a number of the bacterial forms (in particular by *K. pneumoniae*) occurred more frequently. This agent causes different types of community-acquired and healthcare-associated infections, including pneumonia, bloodstream infection, surgical site infections, liver abscess and meningitis. *K. pneumoniae* meningitis is grouped in 3 forms: metastatic meningitis (particularly from liver abscess), post-neurosurgical procedures for brain lesions or head injuries, and primary or spontaneous meningitis, especially among elderly patients or those with concomitant immunocompromised conditions (Yu *et al.*, 2015). In our study, the cases were mostly hospital-acquired infections linked to neurosurgical procedures. Meningococcal and pneumococcal forms were evenly distributed over time but, thanks to the general increase in meningococcus B and tetravalent (A,C,Y,W-135) vaccination coverage (Epicentro, 2020b), a constant decrease is expected over the next few years. A critical limit of these results is the frequent lack of information about the etiologic agent (due to previous antibiotic therapy) and, again, the lack of serological typing of meningococcal strains.

Finally, acute HBV infections affected mainly men

aged 25-64, a group including sexually active and unvaccinated subjects. The absence of cases in the 0-14 age group highlights the efficacy of vaccination included in the hexavalent vaccine (Di Pietro *et al.*, 2019). Despite the few cases of tetanus, all notified among subjects over 64 years of age, and the high lethality observed, is it advisable to provide a vaccination booster.

CONCLUSIONS

Surveillance of infectious diseases through mandatory notifications remains a cornerstone of public health, despite the limit represented by the widespread phenomenon of underreporting. However, we determined that the propensity of physicians to notify cases of infectious diseases and the decreasing trend remained more or less constant over time even in 2020, when a significant reduction due to the COVID-19 pandemic was expected. Moreover, especially concerning severe infections requiring hospitalization (e.g., TB, meningitis, tetanus), notification is one of the mandatory tasks of the medical staff, and therefore we assume that we can be sure of the real incidence of these pathologies. Furthermore, to make notification systems more and more effective and accurate, some new Information Technology (IT) systems, such as machine learning techniques, have been developed in recent years and used in many fields of medicine. Machine learning is a part of IT with the potential to change all aspects of epidemiology, and offers epidemiologists new tools to deal with problems for which classical methods are not properly indicated. For example, Support Vector Machines (SVMs) have been used to predict the incidence of several infectious diseases, including dengue (Althouse *et al.*, 2011) and influenza-like illness (Signorini *et al.*, 2011). In addition, one type of sequential ensemble filtering, the ensemble adjustment Kalman filter, has been used to predict seasonal influenza outbreaks (Shaman *et al.*, 2012), to recreate the transmission modality of the 2014–2015 Ebola epidemic in Sierra Leone (Yang *et al.*, 2015), and to retrospectively forecast cases of West Nile virus (De Felice *et al.*, 2017) and respiratory syncytial virus (Reis *et al.*, 2016). Finally, many studies have used machine learning platforms to forecast the epidemiology of the COVID-19 pandemic (Gao *et al.*, 2020; Saba *et al.*, 2021; Xiong *et al.*, 2022).

In conclusion, our study describes the situation in a high-income country, but some critical issues have been highlighted. Specifically, attention must be focused on incorrect local eating habits linked to foodborne diseases. Moreover, the significant increase in syphilis or in diseases for which sexual intercourse could be assumed, requires greater dissemination of correct information on this issue in at-risk categories. Finally, easy access to all forms of healthcare and the fight against social inequalities should be the cornerstone of all public health policies.

Conflicts of interest

The authors declare that there are no conflicts of interest.

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