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Original Article

Ten-year surveillance and epidemiological patterns of measles and rubella: A study in the Babol County

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Abstract

Background: The trend of measles and rubella has changed over the last two decades, with the increase in vaccination coverage and the establishment of the surveillance system. This study aimed to demonstrate the current status of the surveillance system and the epidemiological trend of measles and rubella.

Methods: This cross-sectional study retrospectively investigated the status of the surveillance system and the epidemiological patterns of measles and rubella in Babol Mazandaran, during 2014-2023. The study included 348 patients diagnosed with rubella and measles (suspected and definite). Their information was obtained and analyzed from the health department's information registration system.

Results: Out of 348 suspected cases (272 suspected cases of rubella and 76 suspected cases of measles), 2 cases were identified as rubella and 1 case as confirmed measles. 108 (31.03%) cases of suspected cases were in the age group below one year and 153(43.97%) cases were in the age group of 1 to 6 years. The age-specific incidence has decreased with increasing age ($p < 0.001$), and the incidence of suspected cases has increased from 2014 to 2023 ($p < 0.001$). The proportion of appropriate laboratory sample collection before and after COVID-19 was 100%. However, the source of infection remained unknown for all confirmed cases.

Conclusion: The quality of data, timeliness, and sensitivity of the health surveillance system in the region under study are acceptable. However, continuous training for healthcare providers and upgrading the equipment and facilities at the regional level are needed to maintain and improve this situation.

Keywords: Measles, Rubella, Surveillance system, Data base management systems.

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Viral infectious diseases are among the most important public health problems, especially in developing countries (1). Measles and rubella, which are generally considered childhood diseases, are two examples (2). The estimated number of measles cases in 2022 was 9,232,300 worldwide (3). Despite the availability of a safe and affordable vaccine, measles continues to cause significant illness and death worldwide. Approximately 136,000 patients died from measles in 2022, with the majority being children under the age of five (3, 4). In 2022, despite the availability of an effective vaccine against rubella, 19 countries have not yet used the rubella vaccine, and about 50% of countries have not yet succeeded in eliminating rubella (5). The symptoms of rubella in children and adults are usually mild and occur with less severity, making it challenging for the surveillance system to spot rubella cases effectively (6, 7). Measles is a highly contagious and febrile disease, one of the symptoms of which is maculopapular rashes that can be seen on the face and body of a person with the disease (8, 9). Rubella is an infectious disease that often causes a rash and mild fever in children and adults (10, 11).

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However, if contracted by pregnant women, especially in the first months of pregnancy, it can lead to miscarriage, fetal death, stillbirth, and congenital complications (10, 11). In the last two decades, with the increase in vaccination coverage and the establishment of a surveillance system to monitor the progress of these two diseases in many countries, the pattern of measles and rubella has changed, so the cases of these diseases have decreased significantly. Also, a higher proportion of cases occur in teenagers and adults (7, 12). In Italy, the incidence of measles and rubella has decreased, and the vaccination coverage in the country has reached over 90% for the first and second doses of measles and the first dose of rubella (13). The highest incidence of measles has been reported in the age group of 15-39 years. Between 2016 and 2020, 199 cases of measles, two cases of rubella, and one case of congenital rubella syndrome were reported in Canada. Forty per cent of these cases were brought in from outside the country (imported cases), and the average age of reported measles cases was 17 years. In 2021, 91.5% of two-year-old children in Canada received at least one dose of the measles and rubella vaccine (14, 15).

According to the Ministry of Health, Treatment and Medical Education statistics, in 2022, 214 measles cases were reported in Iran, half of which were non-Iranians (16). In the past two decades, Iran has seen a 91% decrease in confirmed measles cases (17). In the current program of the Ministry of Health of Iran, vaccination against measles, rubella, and mumps is done in two doses (12 and 18 months old) by measles, mumps and rubella (MMR) vaccine (18). The coverage rate of MMR vaccination in Iran is high, and in 2022, the coverage level of the first dose was 99%, and the second dose was 98% (19). The measles and rubella surveillance system in Iran has been integrated to eliminate measles and rubella in the country, and it is working in the form of the maculopapular rash and fever surveillance system. Based on the national protocol, immediate reporting of fever and maculopapular rash cases is mandatory; it is also necessary to report zero cases to higher levels. The current surveillance system requires that samples (blood, urine, and throat) be taken from all cases with maculopapular rash and fever.

These samples are collected at the same time the cases are reported to higher levels, and with the coordination of the city health center headquarters, the samples are then sent to the selected national laboratory, which is located in the National Laboratory of Virology, Faculty of Health at Tehran University of Medical Sciences (20). The measles and rubella surveillance system plays a vital role in their elimination by tracking the epidemiological pattern of these two diseases (21, 22). In recent years, the disruptions caused by the COVID-19 pandemic have had a significant impact on the measles and rubella elimination program, causing under-reporting of cases, delays in diagnosis and treatment, gaps in vaccination coverage, and a decrease in the accuracy and quality of the measles and rubella surveillance system data (21). A weak surveillance system and inadequate response in any region can increase the risk of contracting these two diseases in that population, so this study aimed to show the state of the surveillance system and the epidemiological pattern of measles and rubella in Babol in 10 years (2014-2023) to describe and analyze the current situation and provide practical suggestions to improve the conditions.

Methods

Study design: This cross-sectional study retrospectively investigated the status of the surveillance system and the epidemiological pattern of measles and rubella in Babol City, Mazandaran, in a ten-year period from the beginning of 2014 to the end of 2023. After obtaining the code of ethics under the number IR.MUBABOL.HRI.REC.1402.211, and receiving a letter of introduction from the Vice-Chancellery for Research and Technology of the university, as well as making the necessary coordination with the Vice-Chancellery of Health of the university and obtaining the required permits, the data were provided to the researchers. The personal information of patients was kept confidential. The Ministry of Health's national guidelines for measles and rubella surveillance were used to assess the status of the surveillance system (23).

The study population: The study included 348 patients diagnosed with rubella and measles (suspected or definite) from January 2014 to December 2023 in the centers affiliated with Babol University of Medical Sciences. The sampling method used in this study was a total population sampling.

Measles and rubella case definition: According to the instructions of the Ministry of Health's surveillance system for eliminating measles and rubella, any case with fever and maculopapular skin rash must be reported to the health authorities immediately and considered a suspicious case. Therefore, all suspected cases should be classified into one of four groups: definitive laboratory confirmed, clinically confirmed, epidemiologically relevant, and ruled out. A laboratory-confirmed case is a case that meets the clinical definition and is confirmed by the laboratory in terms of measles/rubella IgM. A clinically confirmed case is a case that meets the clinical definition, but there is not enough blood sample (blood sample of at least 1 ml for newborns and at least 5 ml for others) for serological confirmation. In addition, the case of suspected measles/rubella with an inappropriate blood sample (insufficient sample volume, failure to follow the cold chain in sample transfer, failure to use appropriate containers for sending the sample, contamination of the sample, failure to label the sample, lack of proper packaging, etc.) that has an epidemiological connection with a confirmed laboratory case is considered as an epidemiologically confirmed case of measles/rubella, a suspected case whose response to a negative serum sample is reported or does not match the clinical and epidemiological definition is considered ruled out (23).

Variables: To analyze the epidemiological pattern, we investigated the demographic characteristics such as age, gender, and nationality, as well as the residence status (urban or rural), vaccination history, clinical symptoms (including fever, cough, enlarged lymph nodes, rhinorrhea, redness of the conjunctiva, joint pain, joint swelling) and hospitalization.

We also investigated possible sources of infection, travel history in the month before and after the appearance of the skin rash, contact with suspected or confirmed cases, contact with pregnant women during the incubation period or symptoms of the disease, and whether the patient is pregnant. The final classification of the disease (ruled out, laboratory/clinical/epidemiological confirmed) and the temporal pattern of infection (month, year) were also considered. This study used data quality, timeliness, and usefulness indicators to evaluate the surveillance system's status (table 1).

Data quality indicates the completeness and validity of the data recorded in the surveillance system, timeliness indicates the speed (time interval) between steps in the surveillance system, and usefulness means the ability of the surveillance system of the region to meet the standards of the Ministry of Health, Treatment and Medical Education of Iran (including data quality, timeliness, sensitivity, collection of appropriate laboratory samples and identification of the source of infection).

Data source: The information needed for the study was taken from the health department of Babol County's information registration system.

Data analysis: SPSS 21 software was used for data analysis. To present descriptive statistics for quantitative variables, mean and standard deviation are reported if the data is normally distributed; otherwise, the median and interquartile range are used. For qualitative variables, frequency and percentage are also reported. Also, the trend of suspected measles and rubella cases between the mentioned years was analyzed using the Cochran-Armitage-Trend Test. Excel 2016 software was used to draw graphs. Also, a significance level ($P<0.05$) was considered in all statistical tests.

Table 1. Performance indicators of the measles and rubella surveillance system based on the standards of the Ministry of Health, Treatment and Medical Education of Iran

Attributes	Measurement	Calculation	Goal (2022)
Data Quality (completeness)	Proportion of complete records of measles and rubella surveillance system Variables including date of birth, sex, nationality, place of the report, date of onset of rash, date of diagnosis, date of sample collection, history of travel, date of receipt of the sample by the laboratory, date of laboratory response, history of immunization against measles and rubella - date of last vaccination, and the date of onset of fever are of higher importance and were investigated.	The Number of fully reported cases / total reported cases *100	≥95% (23)
Timeliness	the interval between taking the sample and the time the laboratory receives it	The Number of serum samples that have reached the national reference laboratory within five days after collection / total sample received in the national laboratory * 100	≥95% (23)

Attributes	Measurement	Calculation	Goal (2022)
	the interval between reporting a case to higher levels and investigating the case	Proportion of all cases of maculopapular rash and fever that have been investigated within 48 hours after reporting.	≥95% (23)
	The time between receipt of the sample by the laboratory to getting an answer from the reference laboratory	The Number of results sent by the national reference laboratory within four days or less after receiving the sample/total number of samples received by the laboratory * 100	≥95% (23)
	The time interval between finding a case and reporting it to the university/County/the center for communicable diseases	Number of cases reported 48 hours or less after detection / Total number of cases reported for the period under review * 100	≥95% (23)
Usefulness	Collecting proper laboratory samples	Suspicious cases with suitable blood samples/ total suspicious cases * 100	≥95% (23)
	Infection source (Autochthonous, Imported, and contact with an Imported Case)	The percentage of confirmed cases that are classified according to the source of infection into Autochthonous, Imported or contact with Imported cases / total confirmed cases * 100	≥90% (23)
Sensitivity	The proportion of suspicious cases that were rejected	Suspected cases rejected in a one-year period/ area population * 100,000	≥ 3 per hundred thousand population every year (23)

Results

In the period between 2014 and the end of 2023, 348 suspected cases were reported by the measles and rubella disease surveillance system (272 cases of rubella and 76 cases of measles), of which 345 cases were ruled out, 2 cases were confirmed rubella and 1 case was classified as definite measles. The average age of suspected cases of the studied subjects was 4.82±8.20 years, and the median and interquartile range (IQR) was 1.00 (0.00-6.75). 108 (31.03%) of suspected cases were in the age group below one year, and 153 (43.97%) cases were in the age group of 1 to 6 years; among the suspected cases, 185 (53.16%) cases were males. However, all definite cases of measles and rubella were females. Also, 216 (62.07%) cases were from rural areas, but all definite cases were from the county. 41 (11.78%) suspected cases of these two diseases were admitted to the hospital, and all the admitted cases recovered. 4 (1.15%) of the suspected cases had a travel history before the onset of rash (7 to 21 days) (table 2).

The clinical characteristics of suspected cases are shown in figure 1. maculopapular skin rash, fever and rhinorrhea had the highest frequency, respectively. The research findings showed that the highest and lowest incidence rates of suspected cases in males were 11.57 and 2.49 per hundred thousand population, corresponding to the years 2021 and 2020, respectively. In females, the highest and lowest rates of suspected cases were 12.24 and 2.32 per hundred thousand population, corresponding to 2022 and 2014, respectively. The incidence of suspicious cases in males and females increased, which was statistically significant. The rate of incidence of suspected cases of these two diseases during the studied years was on average, 9.73

in rural areas and 3.94 in urban areas per 100,000 population. Incidence rate of suspicious cases in two groups living in rural and urban areas has increased over ten years, and this increase was statistically significant in both groups (table 3). Also, the incidence of measles in all the years of the study except 2021 was zero, and it was equal to 0.18 per hundred thousand population that year. The incidence of rubella was also zero in all years except 2014 and 2024, and the incidence of measles cases in 2014 and 2023 was equal to 0.19 and 0.17 per hundred thousand people, respectively.

Table 2. Demographic characteristics and records of suspected measles and rubella cases in Babol County in the studied years (2014-2023)

Variable	Variable sub-groups	Frequency (Percent)
Age	<1 year old	108 (31.03)
	1 to 6 years old	153 (43.97)
	7 to 12 years old	55 (15.80)
	13 to 17 years old	13 (3.74)
	≥18 years old	19 (5.46)
Gender	Male	185 (53.16)
	Female	163 (46.84)
Residential status	Rural	216 (62.07)
	Urban	132 (37.93)
Nationality	Iranian	347 (99.71)
	Non-Iranian	1 (0.29)
Vaccination	Yes	211 (60.63)
	No	126 (36.21)
	Unknown	11 (3.16)
Source of report	Governmental	307 (88.22)
	Private	41 (11.78)
Hospitalization	Yes	41 (11.78)
	No	307 (88.22)
Exposure to suspected or confirmed case	Yes	8 (2.30)
	No	316 (90.80)
	Unknown	24 (6.90)
Exposure to pregnant women	Yes	3 (0.86)
	No	345 (99.14)
Travel history before the rash	Yes	4 (1.15)
	No	344 (98.85)
Travel history after the rash	Yes	0 (0.00)
	No	348 (100)
Laboratory result	Ruled out	337 (96.83)
	Vaccinal measles (ruled out)	6 (1.72)
	Vaccinal rubella (ruled out)	1 (0.29)
	Vaccinal measles and rubella (ruled out)	1 (0.29)
	Measles positive (definite)	1 (0.29)
	rubella positive (definite)	2 (0.58)

Table 3. The number, percentage, and incidence rate of suspected cases of measles, rubella, definite measles, and definite rubella in Babol by gender, residential area, and total in the studied years (2014-2023)

Year of the study	Total		Ruled out cases (sensitivity)		Male		Female		Urban		Rural	
	Number (percent)	incidence	Number (percent)	incidence	Number (percent)	incidence	Number (percent)	incidence	Number (percent)	incidence	Number (percent)	incidence
2014	13 (3.74)	2.51	12 (3.48)	2.32	7 (3.78)	2.71	6 (3.68)	2.32	2 (1.52)	0.64	11 (5.09)	5.32
2015	45 (12.93)	8.58	45 (13.04)	8.58	23 (12.43)	8.77	22 (13.50)	8.39	15 (11.36)	4.76	30 (13.89)	14.30
2016	17 (4.89)	3.20	17 (4.93)	3.20	9 (4.86)	3.38	8 (4.91)	3.01	5 (3.79)	1.57	12 (5.56)	5.64
2017	48 (13.79)	8.90	48 (13.91)	8.90	24 (12.97)	8.90	24 (14.72)	8.90	14 (10.61)	4.33	34 (15.74)	15.76
2018	27 (7.76)	4.94	27 (7.83)	4.94	15 (8.11)	5.49	12 (7.36)	4.39	13 (9.85)	3.96	14 (6.48)	6.40
2019	22 (6.32)	3.97	22 (6.38)	3.97	13 (7.03)	4.69	9 (5.52)	3.25	10 (7.58)	3.01	12 (5.56)	5.41
2020	15 (4.31)	2.67	15 (4.35)	2.67	7 (3.78)	2.49	8 (4.91)	2.85	2 (1.52)	0.59	13 (6.02)	5.78
2021	50 (14.37)	8.76	49 (14.20)	8.76	33 (17.84)	11.57	17 (10.43)	5.96	32 (24.24)	9.35	18 (8.33)	7.89
2022	52 (14.94)	8.99	52 (15.07)	8.59	31 (16.76)	10.72	21 (12.88)	7.26	20 (15.15)	5.76	32 (14.81)	13.84
2023	59 (16.95)	10.03	58 (16.81)	9.86	23 (12.43)	7.82	36 (22.09)	12.24	19 (14.39)	5.38	40 (18.52)	17.00
Total	348 (100)	6.26	345 (100)	6.20	185 (100)	6.65	163 (100)	5.86	132 (100)	3.94	216 (100)	9.73
P. trend	<0.001		<0.001		0.004		0.003		<0.001		0.025	

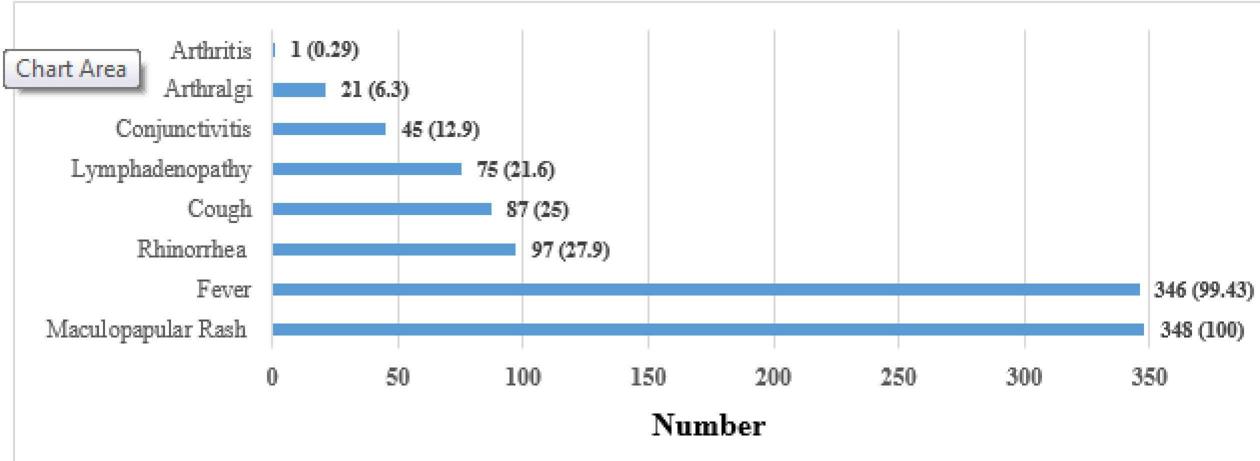

Figure 1. Clinical characteristics of suspected cases of measles and rubella in the studied years (2014-2023)

The findings revealed that the highest number of suspected cases, 44 (12.64%) with an incidence rate of 0.8 per 100,000 population, occurred in June, while the lowest number, 16 (4.60%) cases with an incidence of 0.29 per 100,000 population, was in December. There was a general decreasing trend, with the rate of suspected cases dropping from 0.51 per hundred thousand in April to 0.44 per hundred thousand in March ($p<0.001$) (figure 2). Over the years studied, there was an average of 6.26 suspected cases per one hundred thousand population in the county for these two diseases.

Figure 3, displays the trend of suspected measles and rubella cases from 2014 to 2023. The highest number of suspected cases was in 2023, with 10.03 per 100,000 , while the lowest was in 2014, with 2.51 per 100,000 population. The incidence of suspected cases increased throughout the study years, and based on the Cochran-Armitage trend test, this increase was statistically significant ($p<0.001$). The findings of the research showed that the age-specific incidence decreased with increasing age, and the Cochran Armitage trend test showed that this decreasing trend was statistically significant ($p<0.001$).

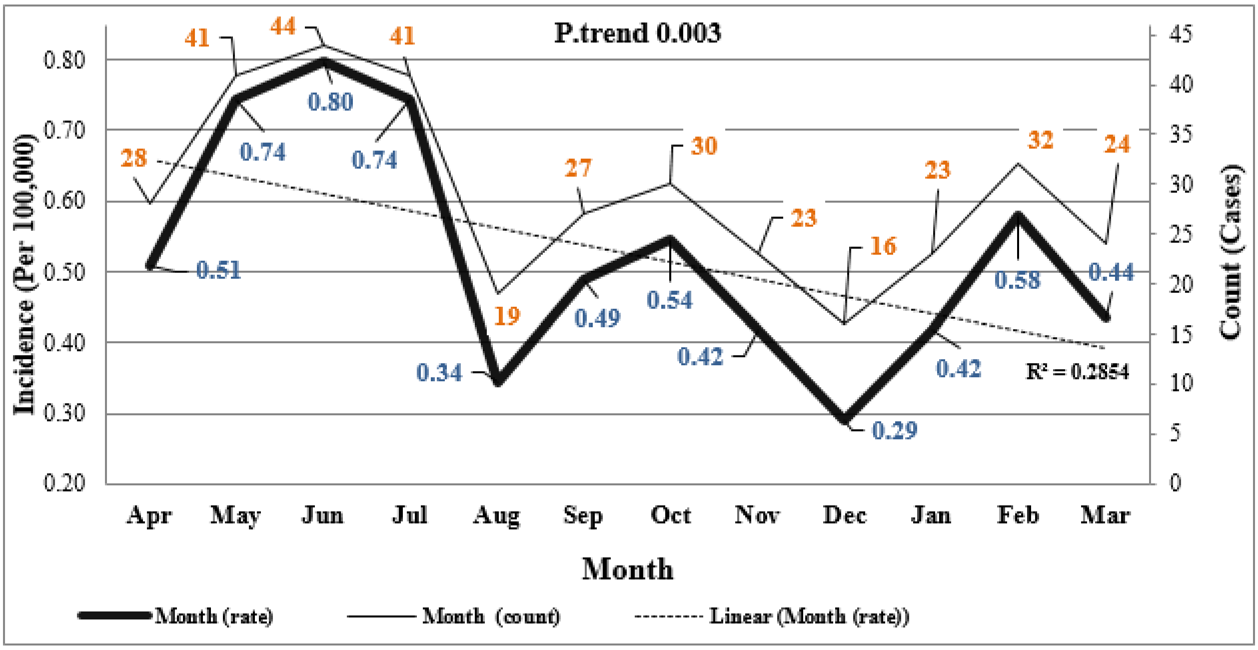

Figure 2. Trend of the number and incidence rate of suspected cases of measles and rubella in one hundred thousand population of Babol during the studied years according to month (2014-2023)

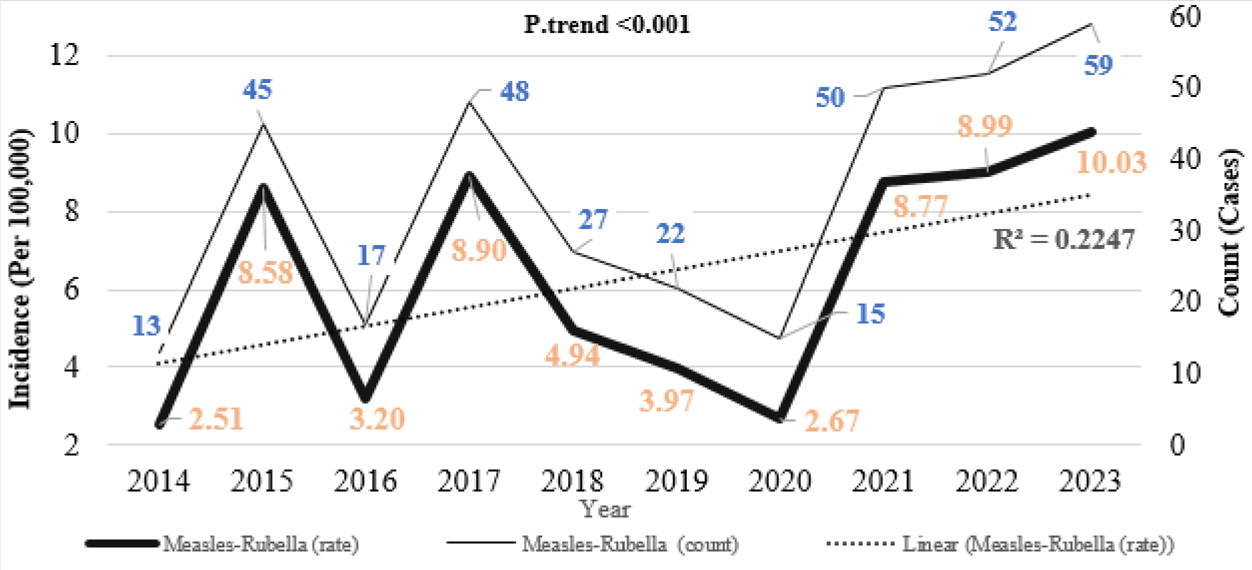

Figure 3. The trend of the number and incidence rate of suspected measles and rubella cases in the 100,000 population of Babol during the years under study (2014-2023)

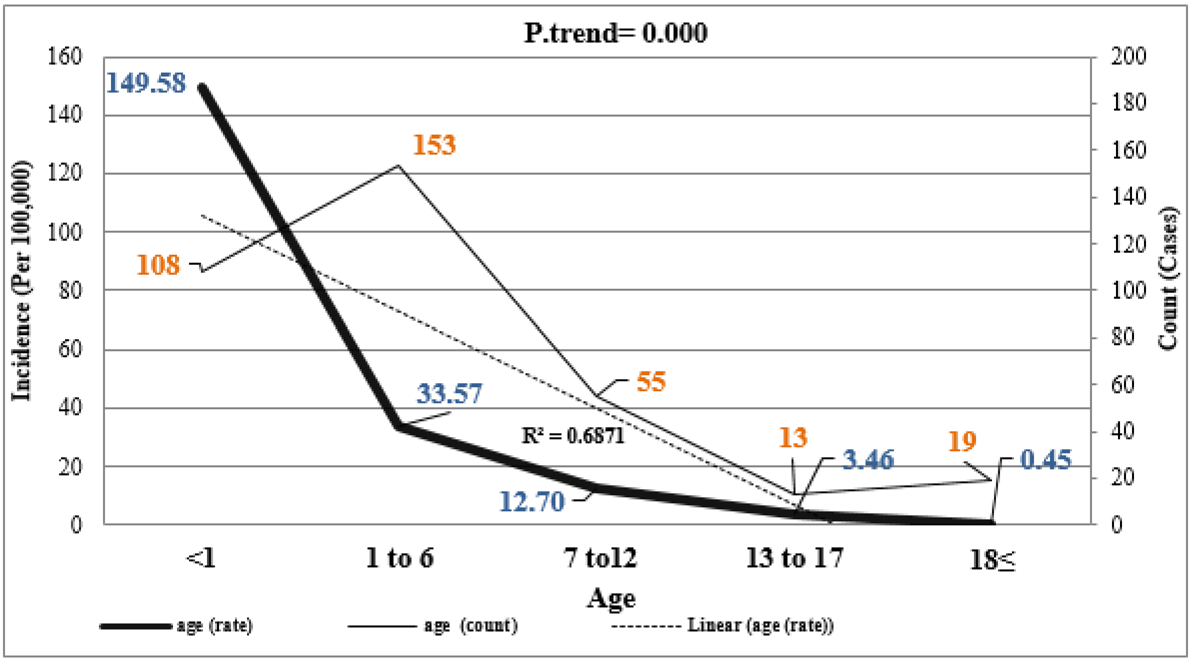

Figure 4. Trend of the number and incidence rate of suspected cases of measles and rubella in 100,000 population of Babol during the studied years according to age (2014-2023)

Regarding surveillance system data quality, the completeness index for 13 variables mentioned in table 1, in the period before the start of the COVID-19 pandemic, was (n=172). After the start of the COVID-19 pandemic, it became (n=176). Eight variables were completely collected among the suspected cases in the pre-COVID period. Still, the variables of diagnosis date (99.41%), sample collection date (98.83%), sample receipt date by the reference laboratory (98.25%), the response date of the reference laboratory (98.25%), and the date of fever onset (98.83%) were not collected completely. In the period after the COVID-19 pandemic, this index was equal to 100% for all variables. The timeliness of the surveillance system was examined using the indicators mentioned in table 1 in the period before the COVID-19 pandemic and after the COVID-19 pandemic. All indicators in the two time periods were higher than the goal of the Ministry of Health set in 2022 (table 4). The usefulness of the surveillance system was evaluated using the indicators in Table 1 in the period before and after COVID-19. The appropriate laboratory sample collection index before and after the COVID-19 period was equal to 100%. However, the source of infection for none of the definite cases (2 cases of rubella and 1 case of measles) was identified. Also, the sensitivity of the measles and rubella surveillance system in the region was investigated; the highest sensitivity rate was related to 2023 (10.03 per hundred thousand), and the lowest sensitivity rate was related to 2014 (2.51 per hundred thousand) (table 4).

Table 4. Timeliness of the measles and rubella disease care system in the period before and after COVID-19

Indicators of the timeliness of the surveillance system	Before the COVID-19 pandemic [a]			After the COVID-19 pandemic [b]			Set goal at 2022
	Median (IQR) Day	Min & Max	The ratio of suspicious cases with a minimum set target (days) to total suspicious cases	Median (IQR) Day	Min & Max	The ratio of suspicious cases with a minimum set target (days) to total suspicious cases	
The time between the preparation of the sample in the laboratory of the health deputy and the receipt of the sample by the reference laboratory	1 (1-1)	(0-4)	100%	1 (1-1)	(0-4)	100%	≥ 95%
The interval between the receipt of the sample by the reference laboratory and the response of the reference laboratory	2 (1-3)	(0-5)	98.21%	2 (1-3)	(0-16)	95.45%	≥ 95%
The interval between case reporting to higher levels and case investigation	0 (0-0)	(0-2)	100%	0 (0-0)	(0-2)	100%	≥ 95%
The interval between case identification and reporting to the university/county/infectious disease center	0 (0-0)	0 (0-6)	98.83%	0 (0-0)	(0-2)	100%	≥ 95%

a) The period from January 1, 2014, to December 31, 2019, was considered before the start of the COVID-19 pandemic.
b) The period from January 1, 2020, to December 31, 2023, was considered to be after the start of the COVID-19 pandemic.

Discussion

The study results revealed that the highest number of suspected cases occurred in children aged one year or younger and those aged one to six. The trend of identifying suspicious cases was generally increasing, but a sharp drop was seen in the year of the start of the COVID-19 pandemic (2020). The surveillance system's status was evaluated based on data quality, timeliness, and usefulness before and after COVID-19. The data quality in the two investigated periods was at a good level and improved in the post-COVID period. The surveillance system was highly timely in both periods and despite a slight drop after COVID-19, it remained at a high level. The usefulness of the surveillance system, which means meeting the national goals, was at a high level in all the investigated variables except the identification of the source of infection. The source of infection was not determined in any of the definite cases.

The data analysis revealed that the highest number of suspicious cases occurred in children aged less than one year and one to six years, with a decreasing trend as age increased. Despite the decline in cases of these two diseases and the upward shift in age groups in many areas, children under five years old still have the highest incidence of measles and rubella (24, 25). In many parts of Iran, the cases of these two diseases have drastically decreased due to high vaccination coverage and an effective surveillance system. Cases of these diseases are now sporadic in different age groups. Both regional and national surveillance systems are sensitive to the incidence of maculopapular rashes in children of this age group due to previous health issues related to these diseases. As a result, most suspected cases in the region are related to these two age groups.

The study's results indicated an increase in suspicious cases over ten years, with a sharp decline in 2020. Similar to our research, the trend of measles and rubella cases in Japan, China, and Germany sharply decreased in 2020 (26-28). Also, the studies conducted in countries of the European Union and the United Kingdom and the African countries of the World Health Organization, showed a decrease in confirmed cases in 2020 (29, 30). The transmission route of measles and rubella is very similar to that of COVID-19, and actions such as closing borders and travel restrictions, physical distancing, closing schools and kindergartens, and using masks can affect the incidence of these two diseases. The decrease in the number of cases of these two diseases can partly be attributed to the weakening of the surveillance system for airborne and droplet infections. This weakening is due to incorrect diagnosis, reduced laboratory capacity, possible delays in announcing results, and low case reporting caused by the large volume of COVID-19 patients in hospitals and the lack of prioritization of these two diseases. The sharp decrease in the first months of the pandemic was mainly a result of the surveillance system's weaknesses.

The results of our study indicated that the sensitivity of the measles and rubella surveillance system remained high throughout the years of the study. The guideline provided by the World Health Organization in 2018 considered the minimum level of sensitivity in the country and province to be 2 per hundred thousand people (31). The regional surveillance system's sensitivity levelin all the years under review, even before 2018, was higher. The national guideline of Iran's measles and rubella surveillance system (compiled in 2022) considered the minimum sensitivity at the county level to be 3 per hundred thousand population (23). The findings of our study showed that the level of sensitivity in the years after the presentation of this guideline was much higher than the determined level. This shows the success of the surveillance system in finding suspected cases of these two diseases, as well as the surveillance system's ability to differentiate measles and rubella from other diseases that cause maculopapular rashes. The analysis of the regional measles and rubella surveillance system database showed that the quality of data (completeness) was at a high level in the pre-COVID period and improved in the post-COVID-19 period. The high quality of the data can be due to the fact that the staff of the region's measles and rubella surveillance system are well-trained and have sufficient knowledge. Similar to the results of our study, good data quality was reported in the two time periods before and after COVID-19 in Brazil, except for one variable during the COVID pandemic period, which was attributed to the adverse effects of the pandemic on the epidemiological surveillance and health system (32). Also, good data quality was seen at the level of mandatory reporting variables in Italy. Still, laboratory-related variables had low levels of completeness, which was mentioned to be a result of non-mandatory data filling and the existence of an inactive surveillance system for measles and rubella, which imposes an extra duty on doctors, hospitals, and laboratory workers (33). Contrary to the results of our study, the completeness of data in the measles surveillance system in South Africa was at a low level, the reason for which was the lack of understanding of healthcare workers about the need to provide complete details of suspected cases (34).

The results of our study showed that the timeliness of sending the samples to the reference laboratory, the reference laboratory's response, the case investigation, and the report to higher levels are at a surprisingly high level. Unlike the present study, the timeliness of sending samples in South Africa and Brazil was lower than that of the WHO target (32, 34). The reason for the lack of timeliness in sending the samples can be attributed to the lack of awareness of the health center staff about the laboratory-based nature of the surveillance system, as well as operational problems related to the transportation and receipt of samples. Similar to our study, the timeliness of the laboratory response in South Africa and Milan, Italy, had an acceptable level (higher than the WHO standard) (34, 35). The reason for this issue can be that the employees working in the national reference laboratory are more trained; these people have a higher understanding of the role of the laboratory in the surveillance system and its importance in eradicating measles and rubella, contrary to the results of our study, the response time of the reference laboratory in Ghana was at a low level, which was due to the lack of laboratory facilities to perform diagnostic tests (36). Also, contrary to our study, reporting to higher levels in Apulia, Italy, was low, attributed to low notification commitment among some doctors and employees (33).

The results showed that the region's measles and rubella surveillance system is efficient, and the surveillance system has reached all national and World Health Organization goals except for one goal. This shows the perceived importance of the current surveillance system at the national and regional levels. The index of collection of laboratory samples suitable for sending to the laboratory had the highest possible level; similar to our study, most of the northern regions of the country have a high level of collection of samples suitable for sending to the laboratory (37). The surveillance system determined the source of infection of none of the confirmed cases; the reason for this was that the cases occurred sporadically, and the cases did not have a history of contact with another suspected and confirmed case. Also, the two confirmed cases of the disease did not have a history of traveling to other areas before the appearance of the rash. Due to the lack of identification of the chain of infection, the surveillance system could not find the source of infection in the definite cases. In the present study, the registered data of the university's health department were used to evaluate the status of the surveillance system. This made us unable to obtain the opinion of the system's stakeholders to investigate the organization's internal problems. On the other hand, patient data has been recorded in the data registration system since 2014, and before that, the data was not recorded comprehensively.

The result of the research showed that the quality of data, timeliness, and sensitivity of the surveillance system of the region under study has an acceptable level, and the whole surveillance system has been evaluated as efficient based on the analysis of the regional health deputy database. However, to maintain this situation and improve the conditions, there is a need for continuous training of the surveillance system employees, as well as upgrading of equipment and facilities at the regional level. In addition to examining the data of the surveillance system on a broader and more prominent level, future studies can use the opinions of the beneficiaries, both providers and service recipients, to identify the weak points of the system with comprehensive and more detailed investigations and find solutions for eliminating the weaknesses of the system and turning it into a strong point.

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