Rubella serosurvey of pregnant women in Albania: high seroprevalence and implications for prevention

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Abstract

Rubella virus (RV) represents a notable pathogen on a global scale, leading to a relatively harmless illness referred to as rubella. In Albania, rubella has been recognized as an endemic disease since the early years, largely due to inadequate vaccination efforts and the virus's ability to spread rapidly through different interactions. Pregnant women who were not immunized against the rubella virus faced dire consequences, often leading to severe outcomes for their infants, including various congenital conditions such as Congenital Rubella Syndrome. The objective of this research is to conduct a serological surveillance of rubella in Albania between December 2023 and May 2024, examining IgG levels in serum samples and evaluating the overall immunological profile related to rubella infections. The study was conducted at the Institute of Public Health, Tirana where a total of 750 pregnant women from different cities were analyzed. Antirubella IgG antibodies were found in 716 pregnant women examined. The findings indicate that the prevalence of seropositivity reaches 95.46% in instances where antibody levels are at 10 UI/ml, whereas the rate of sero-negativity for IgG is recorded at 4.53% under the same antibody concentration. Updating vaccination initiatives is crucial to ensure that campaigns fulfill their designated aims. Special attention should be given to sero-negative pregnant women, who require tailored preventive measures and thorough health education concerning rubella transmission and the sequelae associated with congenital rubella syndrome. Given the public health significance of Rubella, it is imperative that our nation's public health institutions thoroughly evaluate and determine the necessity of ongoing surveillance within the Albanian population, as well as enhance vaccination initiatives and immunization programs.

Keywords: Rubella, seroprevalence, IgG antibodies, vaccination, CRS

1. Introduction

The rubella virus, a member of the Togaviridae family, features a positive-sense RNA genome that is approximately 10 kilobases in length. This virus is responsible for rubella, also known

as German Measles (Pratyush et al., 2021; Parkman, 1996). The infection is typically characterized by a maculopapular rash and posterior cervical lymphadenopathy. Furthermore, rubella infection during pregnancy, particularly in the first trimester, poses significant risks, potentially resulting in congenital rubella syndrome (CRS) (Bloom *et al.*, 2005). CRS can lead to a range of serious complications in infants, such as cardiac defects, cataracts, hearing loss, microcephaly, and hemolytic anemia (Yazigi et al., 2016). The worldwide effort to mitigate rubella has made significant strides, primarily through vaccination campaigns, public education, and advancements in diagnostic methodologies such as ELISA, Reverse Transcriptase-PCR, and HIA. Nevertheless, rubella persists in certain regions despite the availability of effective vaccines. Enhancing socio-economic factors and health literacy may contribute to improved vaccination rates. The World Health Organization (WHO) has outlined specific goals for rubella elimination, which include comprehensive surveillance, monitoring, and vaccination of the population (WHO 2020). From 2021 to 2022, the percentage of WHO member states that adopted rubella vaccination increased from 68% to 90%, and the global rate of vaccinated infants rose from 40% to 68% (Ou, et al., 2024). Investigations into surveillance practices in Albania have been conducted more recently and are characterized by periodic assessments. The assessment of rubella epidemic incidences spanned from 1964 to 2000. Significant circulation of rubella infections was observed in 1969, 1985, and 1994, which was linked to the lack of monitoring initiatives for the vaccination process (Kakarriqi et al., 2002). The results obtained from serological surveillance of this virus provide a basis for evaluating the strides made towards its eradication. According to the national immunization schedule in Albania, the live attenuated viral vaccine is compulsory for children between the ages of 12 and 18 months. After 1994, It has been advised that infants at the age of 18 months receive a second dose of the measles-rubella vaccine (Kakarriqi et al., 2002). Nonetheless, postpartum booster vaccinations for women are not conducted systematically.

The forthcoming rubella serosurveillance study targeting pregnant women in Albania takes place between December 2023 and May 2024. This research will assess the immunological profiles related to rubella infections. By analyzing specific antibodies, such as IgG and IgM, in blood samples, the study seeks to determine whether individuals have experienced prior infections, which would indicate immunity to the rubella virus, and to identify any new cases of infection. This study is also related to the fulfillment of specific objectives such as to assess the prevalence of Rubella infections in Albania, to identify the most effective preventive strategies for these infections among pregnant women and to evaluate the incidence of Rubella virus infections. The achievement of these objectives, coupled with the reduction of the risk associated with Rubella virus infection in this demographic, is crucial in determining whether to establish a new healthcare policy for additional vaccinations in this specific group or to continue with the existing program.

The interpretation of the results at the end will help us understand how the conclusions are related to the application of preventive measures against rubella virus infection. This research will contribute to the findings of similar studies carried out in various regions of Albania, focusing on the seroprevalence of rubella, thereby facilitating a more comprehensive understanding of the overall immunity levels across the nation.

2. Materials and Methods

2.1 Materials

For the diagnosis of rubella, it is essential to collect a blood sample within a timeframe that begins three days after the onset of the maculopapular rash and extends to the 28th day. Conversely, to evaluate immunity to the virus, samples may be collected at any time. A seroprevalence study, conducted between December 2023 and February 2024, involved the collection of 750 blood samples from pregnant women in 12 distinct cities of Albania. These

samples were obtained from consultative centers as well as maternity wards. However, the study is not without its limitations, including the use of a convenience sampling method, which may introduce the possibility of selection bias. There exists a disproportionate distribution of samples, where districts with larger populations are associated with a higher quantity of samples. This inequality stems from the assumption that more substantial results can be obtained in these densely populated regions.

2.2 Methodology

Blood samples ranging from 3 to 5 ml were collected from each pregnant woman, with each sample placed in a tube labeled with a unique identifying barcode. Upon arrival at the laboratory, the samples underwent centrifugation for five minutes at a speed of 3000 rpm, allowing for the extraction of serum containing antibodies. The presence of IgG antibodies was subsequently assessed using the ELISA method at the National Rubella-Measles Laboratory, Institute of Public Health, employing the NovaLisa IgG kit. Antigen fixation materials were utilized, along with reagents for the development of the reaction. The results were interpreted based on colorimetric changes, with readings taken using the Thermo Scientific Multiskan™ EX spectrophotometer, which is capable of analyzing absorbance and fluorescence signals within a wavelength range of 400 nm to 750 nm. Samples exhibiting IgG levels against rubella exceeding 10 IU/ml were deemed significant, while those with levels below this threshold were disregarded.

2.3 Data analysis

Data analysis was performed with the SPSS statistical program, and Microsoft Excel was used for the creation of graphs. Variables were articulated in terms of absolute and relative frequencies, with the chi-square test applied for variable comparison within the study. The Kolmogorov-Smirnov test was implemented to evaluate age distribution. A p-value of ≤0.05 was considered statistically significant. Moreover, tables and graphs were employed to effectively visualize the data.

3. Results

The examination conducted at the district level across 12 districts reveals the distribution of samples designated for analysis, as presented in Table 1. This table indicates an unequal allocation of samples, with districts exhibiting larger populations corresponding to a greater number of samples. This disparity arises from the premise that a more robust outcome can be achieved in these more populous areas.

Table 1. The number of samples taken for each district and their percentage.

Region	Number	(Percentage) %
Durrës	59	7.9
Shkodër	59	7.9
Elbasan	96	12.8
Korcë	54	7.2
Vlorë	43	5.7
Fier	88	11.7
Lezhë	65	8.7
Kukës	35	4.6
Berat	47	6.26
Peshkopi	59	7.86
Gjirokastër	18	2.4
Tiranë	127	16.93
Total	750	100

Age distribution of pregnant women

The study, involving 750 pregnant women, revealed an average age of 28 years inTable 2. The ages of participants ranged from a minimum of 15 years to a maximum of 45 years. The standard deviation was calculated to be 6.4, while the variance stood at 42.2. Furthermore, the 95% confidence interval was determined to be 27 for the lower limit and 28 for the upper limit, with a margin of error of 0.4.

Table 2. Statistical data analyzed

Sample size	750
Minimum age	15
Maximum age	45
Mean	28.2
95% CI for mean	27.8 - 28.6
Median	28.0
Variance	42.2
Standard deviation	6.4

The data presented in Table 3 indicates that the age group of 26 to 35 years is the most represented, comprising 390 women, which accounts for 52% of the total population (confidence interval: 51.6% – 52.4%). In contrast, the age group of 15 to 24 years constitutes 37.3% with 280 women (confidence interval: 36.9% – 37.7%). The least represented group is that of 36 to 45 years, which includes 80 women, making up 10.7% (confidence interval: 10.3% – 11.1%).

Table 3. Classification of cases taken in the study based on age group

Age (years)	Number	Percentage	CI % 95%
15 - 25	280	37.3	37.3 (36.9-37.7)
26 - 35	390	52	52 (51.6 – 52.4)
36 - 45	80	10.7	10.7 (10.3 – 11.1)
Total	750	100	-

Clinical signs

Common indicators of rubella infection in patients include the presence of a maculopapular rash and swollen regional lymph nodes. The findings indicate that a significant proportion of the subjects, specifically 75% (568 women), exhibited no clinical symptoms. Additionally, a subset of the participants reported experiencing vaginal ulcers, accounting for 8.53% (64 women), while 5.46% (41 women) expressed discomfort during sexual intercourse.

Table 4. Symptoms during pregnancy

Symptoms	Number	%
Maculopapular rash	13	1.73
Regional lymphonodule	25	3.33
Leukocyte shape deviation	39	5.2
Vaginal ulcers	64	8.53
Pain during sexual intercourse	41	5.46
No clinical symptoms	568	75.73
Total	750	100

A limited number of patients have exhibited regional lymph-nodules and alterations in leukocyte morphology, as illustrated in Table 4. Concurrently, other comparable research

indicates that the predominant symptoms include chills, lymphadenopathy, erythema, arthralgia, and rhinorrhea (Alaoui *et al.*, 2023). A commonality between both studies is the occurrence of lymphadenopathy, which is reported at 3.33% in Albania and 72.2% in the referenced study.

Distribution of rubella IgG antibodies

Timely detection and intervention are vital in preventing both mortality and the transmission of diseases among newborns whose mothers have experienced obstetric issues. Therefore, it is imperative that mothers with a history of obstetric complications are systematically screened for rubella, facilitating appropriate diagnosis and prompt case management (Ramana *et al.*, 2013). In this context, an ELISA assay was conducted to evaluate the immune status by measuring IgG levels.

The data derived from the analysis of serial samples across various regions in Albania, as illustrated in Table 5, indicates the presence of positive IgG antibodies in the blood, as well as negative values that signify their absence. Furthermore, the cut-off value is included, which serves to distinguish between positive and negative outcomes, thereby indicating whether an individual has encountered the rubella virus or has been vaccinated, thus confirming the presence of rubella IgG antibodies.

The issue of abortion was examined among the surveyed women, revealing that a certain proportion had undergone the procedure at various points in time. According to the data, approximately 27% of women reported never having an abortion (24.07 – 29.93, CI 95%), while the majority, constituting 37%, indicated that they had experienced an abortion at some unspecified time (34.07 – 39.93, CI 95%). Additionally, 35% of the participants may have had more than two abortions (32.07 – 37.93, CI 95%). An examination of the abortions conducted led to a classification of their types, showing that spontaneous abortions accounted for 56.48% (309 women) and interrupted abortions for 43.51% (238 women). The interrupted abortions were further divided into two categories: the first category includes terminations at the request of the individual, driven by various reasons such as financial, health, and social issues, with 204 women (85.71%) in this group; the second category consists of terminations requested for medical reasons, which involve the diagnosis or worsening of congenital or hereditary diseases, as well as cases where the mother's health is endangered, comprising 34 women (14.28%). The occurrence of abortions is not restricted to a defined time frame; instead, it varies significantly. In the data reviewed, 44 women (8%) had abortions within a span of fewer than five years, whereas 218 women (39.78%) fell within the five to ten-year range. The largest group, consisting of 285 women (52.1%), had abortions after a period longer than ten years. This trend, particularly the higher incidence of abortions occurring after ten years, can be linked to the socio-economic conditions of the respective time.

The analysis reveals a seropositivity rate of 95.46% (95% CI: 93.37 – 97.55, p<0.05) and a receptivity rate of 4.53% (95% CI: 2.44 – 6.62, p<0.05). The statistical evaluation of the results from the serial samples determined a total margin of error of 2.09, which will assist in calculating the upper and lower limits for each respective value, where the margin of error is ± 2.09, SD= 29.24 and the χ^2 value is 83.68. Similar studies examined IgG antibody seroprevalence among pregnant women. Reports indicate susceptibility rates of 11.3 percent and 9.8 percent. Additionally, various studies conducted across multiple countries have documented seroprevalence rates ranging from 58 percent to 98 percent. Notably, specific findings include seropositivity rates of 88.7% in Meknes, Morocco in 2015 (Sbiti et al., 2017)), 90.2% in Barat, Morocco (Belefquih et al., 2013)), 79.7% in Tunisia (Hannachi et al., 2011)), 85% in Canada (Gilbert et al., 2017), 58.4% in China (Zhou et al., 2017), 97.2% in Brazil (Moura et al., 2015),

94.1% in Spain (Vilajelua et al., 2015), 94.4% in Norway (Regine et al., 2014), and 85% in Togo (Mounerou et al., 2015).

Table 5. Distribution of rubella IgG antibodies in relation to the reproductive history of pregnant women

Region	Positive IgG	CI 95%	Negative IgG	CI 95%	Total
Durrës	59	100 (100-100)	0	-	59
Shkodër	59	100 (100-100)	0	-	59
Elbasan	92	95,8(93.71-97.89)	4	2,01 - 6,19	96
Korçë	48	88,8(86.11-90.89)	6	9,01 - 13,19	54
Vlorë	39	90.7(88.61-92.79)	4	7,21 - 11,39	43
Fier	88	100 (100-100)	0	-	88
Lezhë	65	100 (100-100)	0	-	65
Kukës	33	94.2(92.11-96.29)	2	3,61 - 7,79	35
Berat	46	97.8(95.71-99.89)	1	0,03 - 4,21	47
Dibër	45	76.2 (74.11-78.29)	14	21,6 - 25,79	59
Gjirokastër	15	83.3(80.91-85.39)	3	14,51 - 18,69	18
Tiranë	127	100 (100-100)	0	-	127
Totali	716	95.46(93.37-97.55)	34	2,44 - 6,62	750

Reproductive data	Nr	Pecentage
Spontaneous abortion	309	56.48%
Intermittent abortion	238	43.51%
Medical requested abortion	34	14.28%
Personal requested abortion	204	85.71%

Time (years)	Nr	%
<5	44	8
5 - 10	218	39.78
>10	285	52.1

Table 6. Seroprevalence for positive and negative cases

	Nr	Total number	Percentage

Seroprevalence of positive cases	716	750	95.46%
Seroprevalence of negative cases	34	750	4.53%

Immunological profile of the study

Assessing the immunological profile related to rubella infection is essential for understanding the prevalence of rubella within a population. This evaluation plays a crucial role in mitigating the incidence of rubella among pregnant women and implementing appropriate preventive strategies. Consequently, it is advisable to conduct early screenings for pregnant women to evaluate their immunity levels and ascertain their rubella serostatus.

Table 7. Adapted immunity toward rubella virus for each region

Region	Immune %	Suspicious %	Further observations
Durrës	7.86	-	-
Shkodër	7,86	-	-
Elbasan	12.26	0.53	-
Korçë	6.4	0.8	-
Vlorë	5.2	0.53	-
Fier	11.73	-	-
Lezhë	8.66	-	-
Kukës	4.4	0.26	-
Berat	6.13	0.13	-
Peshkopi	6	1.86	-
Gjirokastër	2	0.4	-
Tiranë	16.93	-	-
Total	95,45	4,53	-

To provide a comprehensive overview of the immunological status across the analyzed regions, the percentages of individuals with confirmed immunity and those with ambiguous results were computed. Individuals are classified as immune if they demonstrate the presence of immunoglobulin G for rubella following testing. The data indicates that all individuals tested in Durres, Shkodra, Fieri, Lezha, and Tirana are immune to the rubella virus. In contrast, the immunity levels in other regions are significantly lower, with Elbasan at 12.26%, Korça at 6.4%, Vlora at 5.2%, Kukës at 4.4%, Berat at 6.13%, Peshkopi at 6%, and Gjirokastër at 2%. The classification of cases as suspicious occurs when the antibody test for the rubella virus shows an absence of immunoglobulin G (IgG), meaning it is undetectable in the serum sample. This results in about 4.51% of cases being categorized as suspicious, which includes areas like Elbasan, Korçë, Vlorë, Kukës, Berat, Peshkopi, and Gjirokastër.

4. Discussion

The global public health community is increasingly focused on the elimination of congenital rubella and preventing of congenital rubella syndrome (CRS). To address these issues effectively, it is essential to conduct rubella screening for pregnant women and to ensure that the general population receives appropriate vaccination (WHO 2020).

This research primarily focuses on the immunological profile of the rubella virus across various regions of Albania. The findings indicate which areas exhibit a greater susceptibility for infants to develop Congenital Rubella Syndrome (CRS), particularly in cases where the mothers had no previous exposure to the virus. The study involved 750 pregnant women indicated an average age of 28 years, with the predominant age group being 26 to 35 years, which included 390 participants, representing 52% of the overall sample (confidence interval: 51.6% – 52.4%). The ages of the participants varied from a minimum of 15 years to a maximum of 45 years. Age has been recognized as a significant determinant of rubella seroprevalence, with

studies showing that immunity tends to decrease as individuals age (Hafsa et al., 2022; WHO, 2011). In parallel studies conducted in Morocco, the youngest participant was 17 years old, while the oldest was 44 years old, with an average age of 29 years (Alaoui *et al.*, 2023). Furthermore, similar research has shown that individuals under 20 years old constitute 0.77%, those aged 21-30 account for 72.4%, participants aged 31-40 represent 25.2%, and those over 40 years old make up the remaining 0.38% (Tripathy et al., 2021).

Concurrently, findings from studies in Albania spanning the 1990s to 2000 reveal that individuals aged 5 to 14 years represent 60-70% of the rubella cases documented in epidemic centers during the years 1969, 1985, and 1994. The subsequent age groups, namely those aged 1 to 4 years and 15 to 24 years, also contribute significantly to the case numbers. Furthermore, the age group of 25 to 44 years old accounts for about 1-2% of the reported rubella cases during this timeframe. The first age group, aged 1 to 5 years, was responsible for 80-90% of the annual incidence of rubella (Kakarriqi et al., 2002). This age-related incidence illustrates a unique aspect of rubella epidemiology in Albania, especially in contrast to many European nations that had not yet adopted vaccination strategies.

The findings of the present research indicate that the overall seroprevalence of rubella IgG in the examined samples was 95.46%, accompanied by a receptivity rate of 4.53%. This data reflects a high level of past exposure to the rubella virus, either through natural infection or vaccination, resulting in the acquisition of protective immunity.
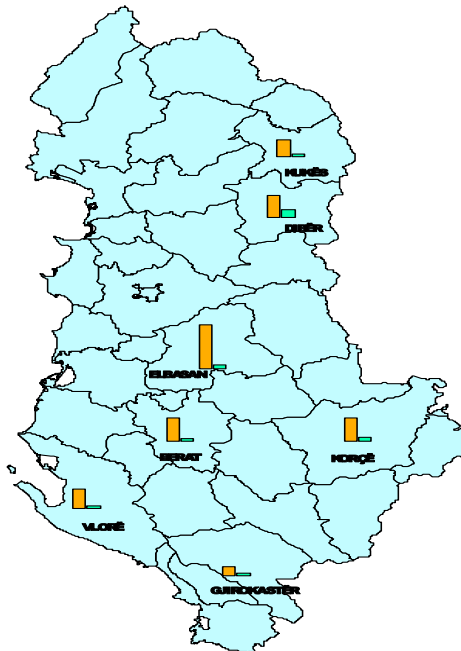

Figure 1. Geographical distribution of IgG negative and IgG positive cases in Albania

The results highlight that counties such as Elbasan, Korçë, Vlorë, Kukës, Berat, Dibër, and Gjirokastër are more susceptible to rubella infection. The MMR vaccine is effective in preventing rubella; however, the lack of IgG antibodies in these regions indicates that 4.53% of women are unvaccinated. This seronegative finding among 4.53% of the women may be due to either an incomplete immune response or a reduction in antibody levels over time.

Similar observations have been documented in other nations, such as Beijing, China (83%), Alberta, Canada (84%), and Rabat, Morocco (85.9%) (Meng et al., 2018; Lai et al., 2015; Hafsa *et al.*, 2022). Additionally, the seronegativity rate of 4.53% found in this study is lower than the average seronegativity reported for pregnant women in Finland and the Netherlands, as well as the 90% seroprevalence noted among pregnant women in Ontario (Hafsa et al., 2022; Pandolfi et al., 2009). Acute Rubella virus infection during the early stages of pregnancy has been associated with a range of complications, including spontaneous abortion and congenital defects referred to as Congenital Rubella Syndrome (Bloom et al., 2005; Lulandala et al., 2017).

Recent studies on rubella serosurveillance have been lacking; however, historical data indicate that such studies were crucial from 1964 to 2000. It is important to note that the assessment of the immune profile is a standard practice utilized to provide insights into the current epidemiological landscape of the country. Analyzing the epidemiological surveillance data from Albania during the years 1964 to 2000 reveals that the average annual incidence of reported rubella cases was 9.6, excluding the years 1968, 1969, 1985, 1993, 1994, 1996, 1998, and 2000. Notably, in the years 1965, 1967, 1971, and from 1976 to 1979, as well as in 1982, only 1-2 cases were reported, while the years 1980 and 1981 recorded no cases at all. These findings suggest that the low frequency of rubella virus indicates minimal circulation of the infection within Albania (Kakarriqi et al., 2002). Between the years 1964 and 2000, three significant epidemic occurrences can be identified (Kakarriqi et al., 2002): the first in 1969, which recorded 3,676 cases, resulting in an incidence rate of 180 cases per 100,000 individuals; the second in 1985, recognized as the most extensive outbreak, with 78,594 cases and an incidence rate of 3,080 cases per 100,000 individuals; and the third in 1994, which saw 3,432 reported cases, corresponding to an incidence of 106 cases per 100,000 individuals.

The analysis conducted concerning the objective of implementing preventative measures reveals a satisfactory outcome, demonstrating a significant level of awareness and vaccination coverage among the majority of the population, despite the random nature of the study. Numerous studies are actively promoting these initiatives through health education in schools and workplaces, aiming for the complete eradication of rubella (Terracciano *et al.*, 2020; Khandaker et al., 2014). The year 2013 saw a rubella outbreak in Tokyo, Japan, which was traced back to a workplace setting. To combat this public health issue, health authorities implemented a strategy that included the administration of a second dose of the MMR vaccine for children aged one year (Terracciano et al., 2020; Sugishita et al., 2014). Additionally, the vaccination campaign targeted suspected foreign individuals and pregnant women (Terracciano et al., 2020). In a separate study from Poland in 2021, it was found that around 50 rubella cases were reported, a decrease from the 98 cases recorded in 2020, indicating a downward trend in the disease's prevalence (Bogusz et al., 2023).

Despite ongoing skepticism regarding the advantages of vaccination, it is essential to implement vaccine awareness initiatives, particularly targeting unvaccinated multiparous women, to achieve the objective of eradicating RV. The World Health Organization advises that all seronegative multiparous pregnant women receive vaccination postpartum before their hospital discharge to attain a seroprevalence rate of 100%. However, this recommendation has not been realized in Albania. A significant obstacle is the absence of a robust communication strategy aimed at mitigating vaccine hesitancy among these pregnant women, which is vital for enhancing their participation in the vaccination program. It is advisable to monitor cases of rubella and congenital rubella to assess the effectiveness of the interventions and to detect any potential outbreaks. Health authorities are encouraged to ensure adequate immunization through mass vaccination campaigns targeting pregnant women of reproductive age, as well as routine vaccinations for children against rubella. Such vaccination efforts are crucial for preventing outbreaks in workplaces and educational institutions.

5. Conclusions

Congenital rubella represents a significant health concern that necessitates eradication efforts, particularly given the availability of a live attenuated vaccine for the prevention of this disease. It is essential for all women of reproductive age to be immunized. The prevalence of rubella immunity among pregnant women across twelve distinct regions in Albania is notably high, at 95.46%. The seroprevalence analysis for IgG positive cases indicated that 95.46% of the subjects tested positive, with a chi-square test yielding a statistic of 83.682 at a significance level of α=0.05. Conversely, the seroprevalence for IgG negative cases was found to be 4.53%, also assessed using the chi-square test, which produced the same statistic of 83.682 at α=0.05. Consequently, this indicates that a small proportion of the population remains unprotected against the rubella virus. This research demonstrated that the immunity rate in pregnant women exhibited a notable and gradual decrease correlated with advancing age. Subsequent studies ought to prioritize the examination of rubella IgG seroprevalence among older age cohorts to identify the most suitable age for a catch-up vaccination initiative.

The majority of individuals did not exhibit any clinical symptoms during pregnancy; however, many of these women had a prior history of vaginal ulcers, a prevalent manifestation associated with the rubella virus. According to TORCH analysis conducted in Albania, the regions of Dibër, Kukës, Korçë, Gjirokastra, Vlorë, Elbasan, and Berat are reported to lack IgG antibodies for rubella. This deficiency signifies an elevated risk of active infection in these areas, consequently increasing the likelihood of health complications for infants, including the potential for congenital rubella syndrome (CRS). Therefore, it is crucial to recognize the significance of vaccination awareness initiatives, especially targeting non-immunized multiparous and primiparous women. However, these efforts are currently lacking in implementation by health authorities. This research will extend into the future with ongoing periodic assessments of rubella seroprevalence among women, particularly those born prior to 1970-1980. Additionally, collaboration with the Institute of Public Health and the Ministry of Health will be pursued to facilitate vaccination awareness campaigns. Future goals will also encompass the recognition of individuals who present written proof of having received at least one dose of a live rubella virus-containing vaccine after the age of 12 months, along with laboratory confirmation of rubella immunity, as possessing adequate presumptive evidence of immunity to rubella.

Acknowledgments

Conflict of interests

The authors declare that they have no competing interests.

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