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ORIGINAL RESEARCH

Rubella Seropositivity and Associated Factors Among Young Female Adults in Bangladesh: A Cross-Sectional Study

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Purpose: A cross-sectional study was conducted among young female adults aged 18 to 24 years in Bangladesh to assess rubella IgG seropositivity and associated factors.

Methods: Data were collected on participants' sociodemographic and family characteristics, residency and age during 2014 Measles-Rubella campaign, and rubella vaccination history. Blood samples were collected and tested for rubella virus-specific immunoglobulin G (IgG) antibodies (rubella IgG) using chemiluminescence immunoassay.

Results: Of the 250 young female adults aged 18–24 years, 87.20% (95% CI: 83.06%–91.34%) were seropositive for rubella IgG: 89.47% among the vaccinated, 85.93% among the non-vaccinated, and 88.54% among those with unknown vaccination history. Seropositivity was not significantly associated with reported rubella vaccination history. Titer levels were significantly higher in seropositive participants without a vaccination history (Median 66.75 IU/mL; interquartile range (IQR): 42.53–98.47) than those with a history (Median 37.30 IU/mL; IQR: 29.70–65.60). Compared with those from rural locations, participants from urban locations had significantly lower odds of seropositivity (Odds Ratio 0.33; 95% CI: 0.12–0.92; p = 0.035).

Conclusion: A relatively high prevalence of rubella IgG seropositivity was detected. However, approximately one in ten participants remained susceptible to rubella infection during pregnancy and at risk of related adverse outcomes, including congenital rubella syndrome. Seropositivity was not associated with rubella vaccination history suggesting endemic transmission of the rubella virus. The low proportion of participants with a known vaccination history indicates gaps in vaccination documentation. Therefore, well-recorded vaccination histories and strengthened surveillance systems should be developed.

Keywords: antibodies, viral, rubella vaccine, young adult, community health planning

Introduction

Rubella is a highly contagious viral disease with vertical transmission that leads to serious adverse outcomes, including miscarriage, stillbirth, or a constellation of severe birth defects known as congenital rubella syndrome (CRS), especially from maternal infections during early pregnancy.[1,2] Rubella and CRS can be prevented using available, safe, and cost-effective vaccines.[3] In 2012, the World Health Organization (WHO) and partners set global goals to eliminate rubella and CRS by improving access to vaccines and promoting their widespread use.[4] In the same year, Bangladesh introduced a combined measles and rubella (MR) vaccine in the routine immunization program with a single dose for children aged 9 months, and then in 2015, a second dose for children aged 15 months was recommended.[5] Additionally, Bangladesh conducted an MR vaccination "Catch-up Campaign" in 2014 (hereafter referred to as the 2014 MR campaign), targeting children and adolescents aged from 9 months to 14 years. The campaign achieved an overall coverage rate of 90%, with rates varying between 83% and 94% across administrative divisions.[6] In 2018, Bangladesh was verified to have controlled rubella and CRS, and in 2019, the country adopted the revised goal of eliminating rubella by 2023.[7]

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The rubella vaccine is well known for its efficacy in preventing the disease and is recommended globally.[8,9] However, in 2023, the national coverage rate for the first dose of the rubella vaccine in children aged 9 months was 88.6% in Bangladesh[10] and the number of clinically confirmed CRS cases increased from 89 in 2015 to 236 in 2023.[11] Such evidence indicates problems with rubella prevention through vaccination in both children and reproductive-aged pregnant women. A 2014 study in Bangladesh found that 68.9% of women aged 16 to 25 years without a history of rubella vaccination were seropositive for rubella virus-specific Immunoglobulin G (IgG) antibodies (hereafter referred to as rubella IgG), and that after receiving a single dose of rubella vaccine, all of the seronegative women (100%) developed immunity.[12]

Immunity to rubella infection can be determined by the presence of rubella IgG, which indicates past exposure to the virus, either through infection or vaccination, and usually demonstrates lifetime efficacy, making it an important marker for assessing immunity status.[3,13] Although there is no definitive test to distinguish rubella IgG from vaccination and infection, the evaluation of rubella immunity is crucial to identify the magnitude of susceptibility among reproductive-age women who are at risk of rubella infection during early pregnancy and the associated adverse outcomes, including having newborns with CRS.[14]

A review of rubella serosurveillance showed that previous studies used various immunoassays, including enzyme-linked immunosorbent assay (ELISA), chemiluminescence immunoassay (CLIA) and chemiluminescent microparticle immunoassay (CMIA), to detect rubella IgG seropositivity in blood samples.[15] The prevalence of rubella seropositivity depends on vaccination policies, campaigns and coverages as well as the magnitude of rubella infection, and can vary across geographical regions, between rural and urban locations, and based on other socio-demographic factors.[6,16–18] Therefore, we aimed to assess the prevalence of rubella seropositivity and its associated factors in relation to the 2014 MR campaign and the geographical distribution among young female adults aged 18 to 24 years in Bangladesh. The findings of this study provide insights into the status of rubella immunity among young female adults highlighting the need for targeted rubella vaccination policies.

Materials and Methods

Study Design and Setting

A cross-sectional seroprevalence study was conducted in Bangladesh from 15 May to 10 July 2024 among young female adults aged 18 to 24 years. To obtain a representative sample of young female adults from diverse geographical origins across the country, we selected garment factory workers living in residential areas near large garment factories located in the Dhaka, Gazipur and Narayanganj districts in central Bangladesh. The Garment sector in Bangladesh employs over 4 million workers, primarily rural migrants from almost all 64 districts, with approximately 60% females.[19] As of 2018, approximately 3,856 garment factories were in operation, 82% of which were located in the three adjacent districts: Dhaka (38%), Gazipur (29%) and Narayanganj (15%).[20] Therefore, the garment factory workers in these districts were considered most suitable for sampling. We selected four factory zones across the three selected districts: two in Dhaka (Mirpur and Savar), one in Gazipur (Tongi) and one in Narayanganj (Adamjee).

Study Sample and Sample Size

We recruited young female adults aged 18 to 24 years,[21] as they were a part of the target population of the 2014 MR campaign and representing reproductive-age women at risk of rubella infection during pregnancy. We kept the lower limit of the age at 18 years to minimize the recall bias. Focusing on this cohort allowed us to specifically assess rubella seropositivity in the group that directly benefited from the campaign. Therefore, the inclusion criteria for the study sample were young female adults aged 18 to 24 years, employed in a garment factory at enrolment, and willing to participate in both structured interviews and blood sample collection. Those who were pregnant, had language barriers, or had serious illnesses or disabilities were excluded.

The sample size was calculated using a precision formula based on an approximately 80% prevalence of rubella seropositivity among reproductive-age women aged between 16 and 25 years in Bangladesh from a previous systematic

review.[22] Considering a 95% confidence interval, 5% acceptable error, and 2% estimated equivocal test results, a sample of 250 young adults was required.

Data Collection

Residential hotspots with large numbers of factory workers were identified in each selected zone. Subsequently, during factory days off or in the evening after returning from work, a household was approached by a research team consisting of one male and one female trained research assistant and an experienced medical technician. The eligibility criteria were checked, and if eligible, the participants were informed of the study objectives and procedures. Obtaining written consent, participants were interviewed face-to-face, and blood samples were collected. Interview data from the participants consisted of sociodemographic and family characteristics, information on the participants during the 2014 MR campaign, and rubella vaccination history. Sociodemographic and family characteristics included participants' current age, education level, marital status, status of having a child, current district of residency, division of origin, location in the division of origin, household size, and parents' education and occupation. Information on participants during the 2014 MR campaign included the district of residency, division of residency, location of residency, and age at that time.

After the interview, 3-mL venous blood was collected from the participants using EDTA tubes, following standard medical precautions, and stored with appropriate labelling and maintenance of a proper cold chain. Next households were visited to identify eligible participants until the required sample size was reached. The number of participants chosen from each district depended on the density of garment factories, which was approximately half in Dhaka, followed by Gazipur and Narayanganj.

Laboratory Methods

Serum samples were transported to the laboratory at the Department of Virology, Bangabandhu Sheikh Mujib Medical University (BSMMU) in Dhaka, Bangladesh. Rubella IgG was analyzed using LIAISON® Rubella IgG II assay (DiaSorin S.p.A., Saluggia (VC), Italy), which uses chemiluminescence immunoassay (CLIA) technology. Rubella IgG was measured in international units per milliliter (IU/mL). According to the manufacturer's instructions, the titers were determined between 0.2 and 350 IU/mL. A cut-off value of 10 IU/mL for the rubella IgG titer is internationally recommended as the threshold for a positive result.[23] Equivocal test result was considered as negative based on the guideline of the Centers for Disease Control and Prevention (CDC).[24] Therefore, in this study, titer levels ≥10 IU/mL and <10 IU/mL were used to classify positive and negative results, respectively.

Statistical Analysis

The data were analyzed using R statistical software version 4.4.2 (R Core Team, Vienna, Austria; 2024). All continuous variables were tested for normality using the Shapiro–Wilk test, and the median and interquartile range (IQR) were used if the data were not normally distributed. The characteristics of the participants, geographical distribution, and prevalence of seropositivity were analyzed descriptively as the number and/or percentage or median with IQR. Rubella IgG titers in seropositive participants were compared between those with and those without a history of rubella vaccination.

Factors associated with the seropositive and seronegative groups were analyzed using univariable analysis and multivariable logistic regression. Differences in the medians between groups were tested for significance using the Wilcoxon rank-sum test, and proportions between groups were tested using Fisher's Exact Test, with or without simulation, as appropriate. Variables with a p-value <0.2 from univariable analysis were included in the initial regression model and checked for multicollinearity using generalized variance inflation factor (GVIF) analysis. The division of origin was omitted from the model because of multicollinearity. Firth's penalized likelihood approach[25] was used in the multivariable logistic regression model to handle variables with a "zero" cell count or small datasets to enhance the goodness of fit and improve model stability. Statistical significance was set at $p < 0.05$, with 95% confidence interval (CI).

Results

Overall, 250 young female adults aged 18 to 24 years were recruited, approximately half were working and residing in the Dhaka district (54.00%), followed by the Gazipur district (30.40%), and the Narayanganj district (15.60%). The median current age of participants was 21.04 years (IQR: 19.18–23.05), while the median of their age during the 2014 MR campaign was 10.73 years (IQR: 8.86–12.74). These participants came from 54 of the 64 (84.38%) districts of Bangladesh (Figure 1), representing all eight administrative divisions (Dhaka, Barisal, Chittagong, Rangpur, Mymensingh, Sylhet, Rajshahi, and Khulna) of the country.

Of the 250 participants, 32 were seronegative (12.80%; 95% CI: 8.66%–16.94%) and 218 were seropositive (87.20%; 95% CI: 83.06%–91.34%) for rubella IgG. Table 1 shows the sociodemographic characteristics of seronegative and seropositive participants. Seropositivity varied significantly by educational level ($p = 0.02$), with the highest prevalence observed among participants who had completed grade 10 or higher (97.73%). A significant difference was also observed between the groups based on the participants' division of origin ($p = 0.031$) and location in the division of origin ($p = 0.035$). Participants from the Khulna division had the highest seropositivity rate (100.00%), whereas those from the Barisal division had the lowest (72.97%). A higher seropositivity rate was observed in participants from rural locations (89.09%) than in those from urban locations (73.33%). No statistically significant differences were observed in the participants' current age, marital status, status of having a child, or current district of residency.

The family characteristics of participants with seropositive and seronegative rubella IgG test results are presented in Table 2. Significant differences were observed in household size and mother's education between seropositive and seronegative participants. Information on the residency and age of the participants during the 2014 MR campaign was not associated with their rubella IgG serological status (Table 3). However, the rate of seropositivity varied remarkably across the division of residency during the 2014 MR campaign, ranging between 74.19% and 100.00%.

Seropositivity by vaccination history showed 89.47% among the vaccinated, 85.93% among the non-vaccinated, and 88.54% among those with unknown vaccination history, with no significant association observed ($p = 0.913$), and the prevalence of seronegative findings ranged from 10.53% to 14.07%, regardless of rubella vaccination history (Figure 2). Rubella IgG titers among 218 seropositive participants ranged from 13.30 IU/mL to 350.00 IU/mL, with a median titer level of 63.70 IU/mL (IQR: 39.45–98.72). The titers of seropositive participants stratified by their rubella vaccination history ($n = 133$, unknown history excluded) are shown in Figure 3. The distribution of titers in participants with no vaccination history was wider than that in participants with a vaccination history. A significant difference was observed between the titer levels of vaccinated and non-vaccinated group of seropositive participants ($p = 0.017$) with their median titer levels being 37.30 IU/mL (IQR: 29.70–65.60) and 66.75 IU/mL (IQR: 42.52–98.47), respectively.

Factors associated with rubella IgG seropositivity determined using multivariable logistic regression are shown in Table 4. Living in an urban location in the division of origin was associated with seropositivity. Those who lived in an urban location had significantly lower odds of rubella seropositivity compared to those living in a rural location (odds ratio 0.33; 95% CI: 0.12–0.92; $p = 0.035$). Other significant factors identified in the univariable analysis were not significant in the logistic regression analysis.

Discussion

Nearly nine in ten young female adults in Bangladesh had rubella IgG seropositivity. Seropositivity was not significantly associated with a history of rubella vaccination; however, rubella IgG titer levels in those without a history of vaccination were approximately double the levels in those with a history of vaccination. The division of residency during the 2014 MR campaign was not significantly associated with seropositivity. However, location in the division of origin was significantly associated with seropositivity in logistic regression analysis.

Our study found 87.20% seropositivity in young female adults aged 18 to 24 years. The seropositivity in our study was higher than that reported in a systematic review among reproductive-age women aged 16 to 25 years in Bangladesh (80.50%) before the introduction of the rubella vaccine in 2012[22] and a prevalence study conducted in 2014 (68.90%).[12] The findings from Bangladesh differed from a 2017 report on women aged 15 to 49 years in Korea, where the MR

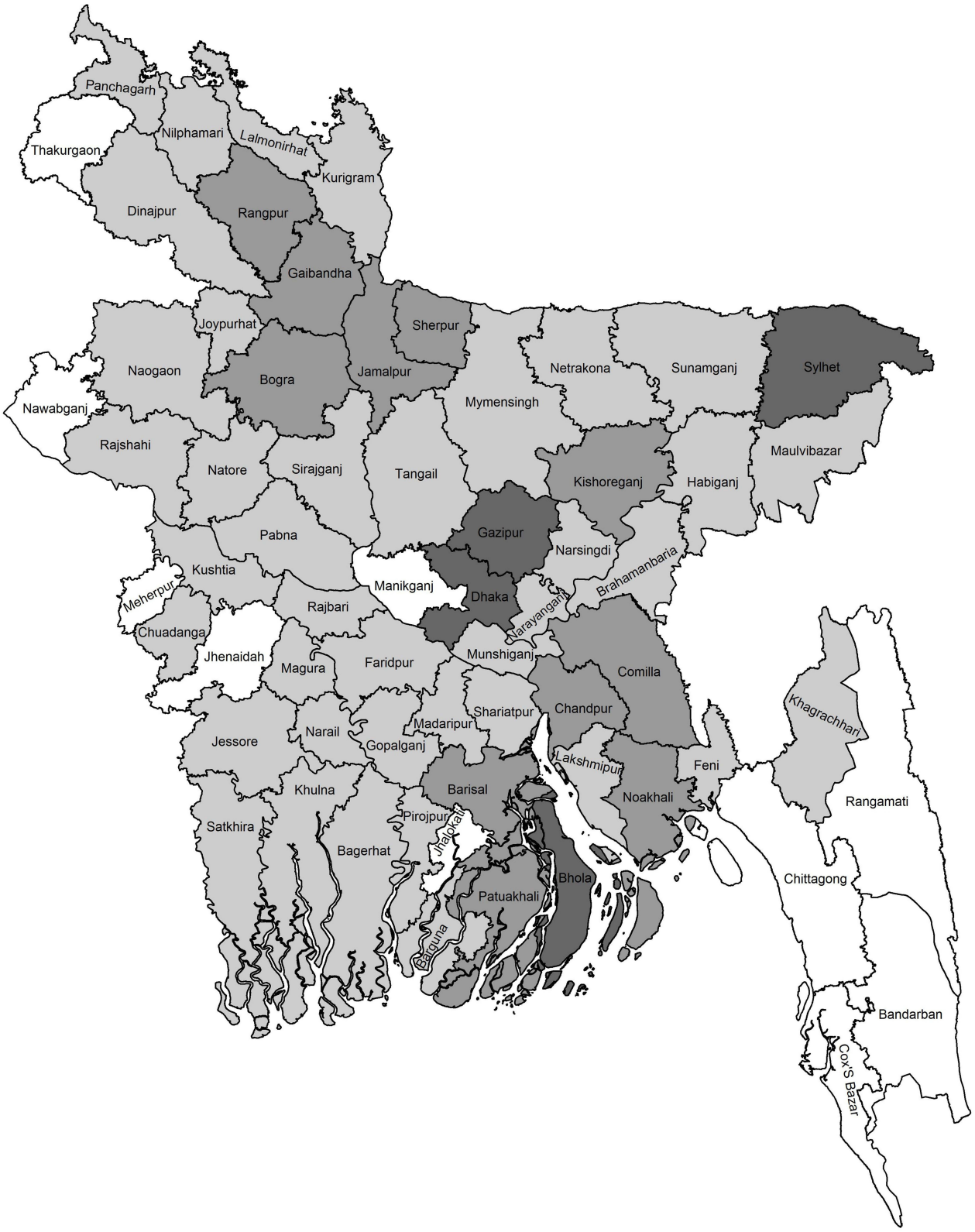

Figure 1 District map of Bangladesh representing the number of participants who were living in different districts during 2014 MR campaign.

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Table 1 Socio-Demographic Characteristics of the Participants with Seropositive and Seronegative Test Results for Rubella IgG

Variable	Rubella Seropositivity (N = 250)		P-value
	No (N = 32) n (%)	Yes (N = 218) n (%)	
Current age (years), Median (IQR)	20.75 (18.96–22.80)	21.13 (19.27–23.05)	0.597
Age group			0.261
18 to 19 years	14 (17.3)	67 (82.7)	
20 to 21 years	6 (8.3)	66 (91.7)	
22 to 24 years	12 (12.4)	85 (87.6)	
Education level			0.020
Grade 5 and below	16 (18.60)	70 (81.40)	
Grade 6 to 9	15 (12.50)	105 (87.50)	
Grade 10 and above	1 (2.27)	43 (97.73)	
Marital status			1.000
Never married	10 (12.05)	73 (87.95)	
Ever married	22 (13.17)	145 (86.83)	
Status of having a child	(N = 22)	(N = 145)	1.000
Do not have a child	8 (12.69)	55 (87.30)	
Have a child	14 (13.46)	90 (86.54)	
Current district of residency			0.783
Dhaka	16 (11.85)	119 (88.15)	
Gazipur	10 (13.16)	66 (86.84)	
Narayanganj	6 (15.38)	33 (84.62)	
Division of origin			0.031
Dhaka	6 (13.33)	39 (86.67)	
Barisal	10 (27.03)	27 (72.97)	
Chittagong	6 (17.65)	28 (82.35)	
Khulna	0 (0.00)	16 (100.00)	
Mymensingh	1 (3.45)	28 (96.55)	
Rajshahi	1 (3.70)	26 (96.30)	
Rangpur	3 (9.09)	30 (90.91)	
Sylhet	5 (17.24)	24 (82.76)	
Location in the division of origin			0.035
Rural	24 (10.91)	196 (89.09)	
Urban	8 (26.67)	22 (73.33)	

vaccine was introduced to school-aged children in 2001, in which the overall seropositivity was 76.90% and a declining trend was observed over an eight-year period.[26]

There are no recommendations for target seropositivity rates among reproductive-age women to eliminate rubella infection and CRS. A low rate of seropositivity indicates a higher rate of susceptibility in the population, including reproductive-age women, leading to an increased risk of rubella infection during pregnancy and also CRS in the country.[27] Previous studies assessing seropositivity among reproductive-age women in different years following the introduction of the rubella vaccine showed variation across countries: 76.4% in Saudi Arabia,[28] 83.9% in Egypt,[29] and 87.2% in Thailand.[30] However, to optimize immunity in the population and eliminate rubella and CRS, the WHO recommends achieving and maintaining at least 95% coverage for two doses of rubella vaccination through routine and supplementary immunization programs, ensuring that coverage also reflects small geographical areas.[7]

In our study, we did not find a significant association between seropositivity and rubella vaccination history, which is supported by a literature review reporting an inconclusive association between rubella seroprevalence and previous vaccination status, varying from positive to negative to no association.[15] The fact that approximately one in ten young female adults remained rubella seronegative highlights shortcomings in the vaccination program, either due to non-

Table 2 Family Characteristics of the Participants with Seropositive and Seronegative Test Results for Rubella IgG

Variable	Rubella Seropositivity (N = 250)		P-value
	No (N = 32)* n (%)	Yes (N = 218)* n (%)	
Household size, Median (IQR)	4.00 (3.00–5.00)	3.00 (2.00–4.00)	0.009
Mother's education			0.034
No education	22 (15.17)	123 (84.83)	
Grade 1 to 5	6 (9.52)	57 (90.48)	
Grade 6 and above	0 (0.00)	23 (100.00)	
Father's education			0.229
No education	21 (15.91)	111 (84.09)	
Grade 1 to 5	5 (7.25)	64 (92.75)	
Grade 6 and above	3 (12.00)	22 (88.00)	
Mother's occupation			0.311
Unpaid housewife	27 (13.71)	170 (86.29)	
Paid employee and worker	3 (6.98)	40 (93.02)	
Father's occupation			0.528
Day laborers	5 (20.83)	19 (79.17)	
Employee	3 (10.71)	25 (89.29)	
Farmer	6 (9.84)	55 (90.16)	
Self-employed	9 (11.11)	72 (88.89)	
Transport worker	6 (18.18)	27 (81.82)	

Notes: *Participants answered 'Don't know' were omitted.

vaccination or vaccine inefficacy. The 2014 MR campaign administered a single dose, regardless of prior vaccination history.[6] The efficacy of rubella vaccination is well established, with a single dose achieving seroconversion rates of at least 95% among clinically confirmed non-immune adolescent girls and young female adults with no prior vaccination history.[12,31] Nevertheless, its effectiveness still depends on proper storage and maintenance of the cold chain.[32] Therefore, the findings of this study suggest a potential gap in achieving herd immunity through vaccination. The low reported rubella vaccination history in our study population may have resulted from unrecognized types of prior vaccination, forgotten vaccination history, or actual non-vaccination due to an inadequate vaccination recording systems in the country. Addressing this gap remains a critical challenge, highlighting the need for an enhanced efforts to strengthen national immunization strategies.

We detected immunity titers in participants without a vaccination history, likely due to prior rubella infection, as supported by a previous literature review.[15] This is also supported by a WHO report of clinically confirmed 182 rubella cases[33] and 236 CRS cases in Bangladesh in 2023.[11] In addition, the incidence of rubella infection is underestimated globally because of asymptomatic or mild symptoms, limited access to healthcare, and inadequate surveillance and reporting systems.[34,35] Our finding of double IgG titers in those without a vaccination history compared to those with a history aligned with previous reports that observed significantly higher antibody responses from natural infection than from vaccination.[36,37] Rubella IgG seropositivity indicates immunity against rubella either from a prior infection or vaccination.[3] Without vaccination, the detection of seropositivity suggests endemic transmission of the disease among study participants.[15]

Division of residency during the 2014 MR campaign, was not significantly associated with seropositivity in both the univariable and multivariable analysis. In contrast, division of residency has been shown to be associated with rubella seroprevalence in Korea and the Democratic Republic of the Congo.[26,38] This could be due to the smaller sample sizes in each division in our study compared to those two studies, which limited the statistical ability to detect positive cases, as well as differences in how geographic regions were defined. When comparing division-level seropositivity in this study with vaccination coverage reported during the 2014 MR campaign, about half of the divisions showed approximate

Table 3 Residency and Age of Participants During the 2014 MR Campaign with Seropositive and Seronegative Test Results for Rubella IgG

Variables	Rubella Seropositivity (N = 250)		P-value
	No (N = 32) n (%)	Yes (N = 218) n (%)	
Division of residency during 2014 MR campaign			0.062
Dhaka	10 (12.66)	69 (87.34)	
Barisal	8 (25.81)	23 (74.19)	
Chittagong	7 (24.14)	22 (75.86)	
Khulna	0 (0.00)	14 (100.00)	
Mymensingh	1 (4.17)	23 (95.83)	
Rajshahi	1 (4.55)	21 (95.45)	
Rangpur	2 (7.41)	25 (92.59)	
Sylhet	3 (12.50)	21 (87.50)	
Location of residency during 2014 MR campaign			0.828
Rural	23 (12.37)	163 (87.63)	
Urban	9 (14.06)	55 (85.94)	
Age (years) during 2014 MR campaign, median (IQR)	10.41 (8.58–12.50)	10.83 (8.97–12.74)	0.540
Age group during 2014 MR campaign			0.486
7 to 9 years	15 (15.63)	81 (84.37)	
10 to 12 years	9 (9.68)	84 (90.32)	
13 to 14 years	8 (13.11)	53 (86.89)	

percentages, whereas the others displayed discrepancies with either lower or higher seropositivity than expected.[6] Despite this, location in the division of origin showed a significant association with seropositivity, similar to studies conducted in Ethiopia and Turkey.[17,39] However, we found higher seropositivity in rural locations, consistent with the Turkish study,

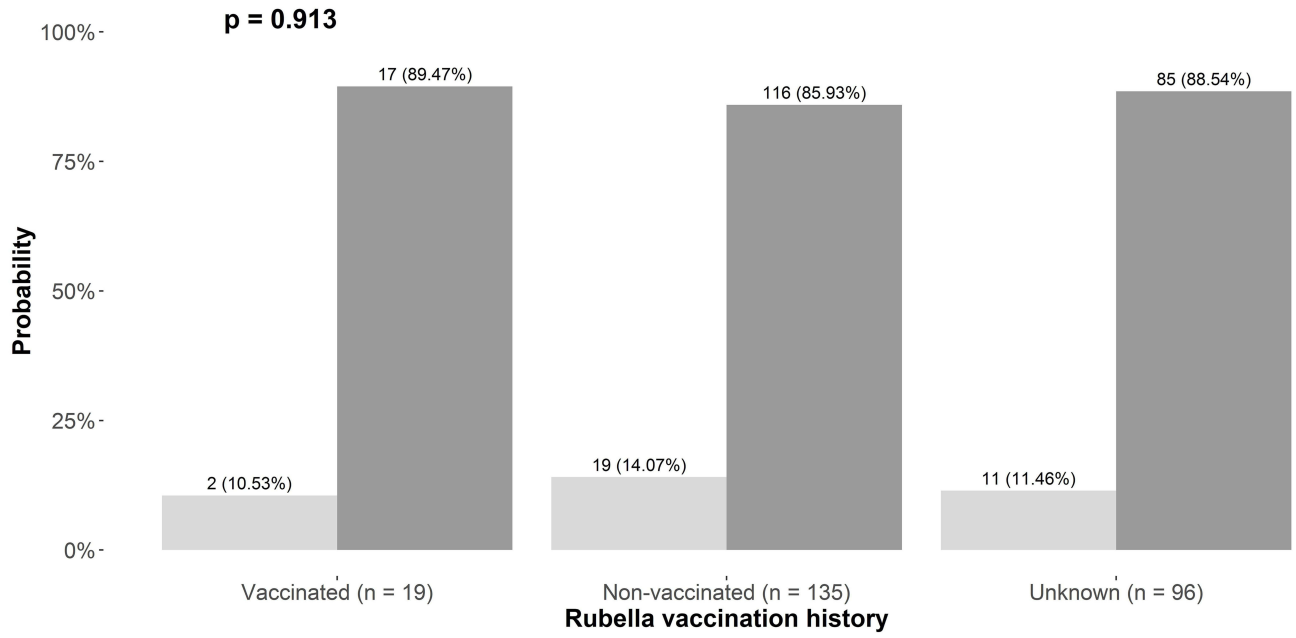

Figure 2 Percentage of rubella IgG seronegative (light grey) and seropositive (dark grey) participants stratified by their rubella vaccination history.

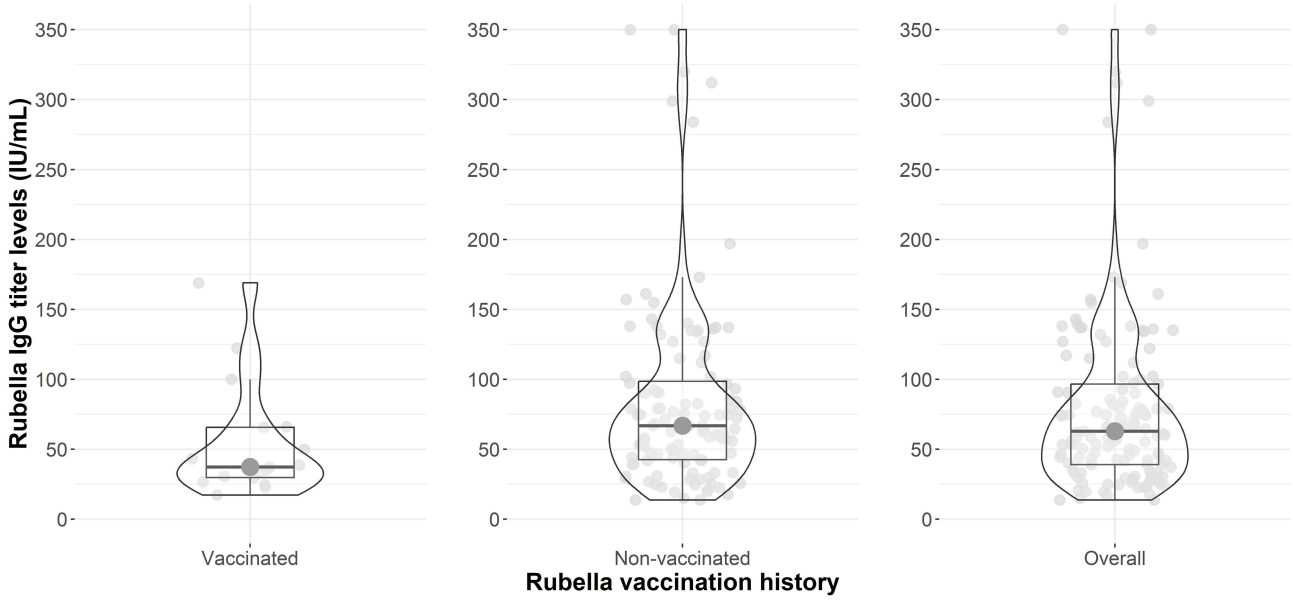

Figure 3 Rubella IgG titer levels among seropositive participants with a known rubella vaccination history.

while the Ethiopian study showed higher seropositivity in urban locations. These variations may stem from differing classifications of rural and urban areas across countries. Furthermore, many participants originally from rural locations had migrated to urban locations, complicating the determination of when and where immunity was acquired. Women with higher education were significantly more likely to be seropositive in the univariable analysis, but this association

Table 4 Factors Associated with Rubella Seropositivity in Multivariable Logistic Regression

Variables[a]	Crude OR (95% CI)	Adj. OR (95% CI)	p-value
Education (of participants)			
Grade 5 and below	Reference		
Grade 6 to 9	1.60 (0.74–3.44)	1.34 (0.56–3.21)	0.512
Grade 10 and above	9.83 (1.26–76.78)	3.11 (0.62–31.11)	0.183
Location in the division of origin			
Rural	Reference		
Urban	0.34 (0.14–0.84)	0.33 (0.12–0.92)	0.035
Household size	0.84 (0.71–0.99)	0.89 (0.73–1.08)	0.234
Mother's education			
No education	Reference		
Grade 1 to 5	1.61 (0.67–4.40)	1.18 (0.45–3.42)	0.748
Grade 6 and above	8.56 (1.11–1101.42)	4.38 (0.50–577.57)	0.222
Division of residency during 2014 MR campaign			
Dhaka	Reference		
Barisal	0.42 (0.15–1.18)	0.33 (0.10–1.05)	0.061
Chittagong	0.45 (0.16–1.34)	0.33 (0.09–1.15)	0.080
Khulna	4.38 (0.51–575.12)	1.90 (0.20–255.61)	0.644
Mymensingh	2.37 (0.51–22.76)	1.38 (0.26–14.04)	0.730
Rajshahi	2.17 (0.47–20.87)	0.90 (0.16–9.34)	0.914
Rangpur	1.54 (0.41–8.40)	0.83 (0.19–4.89)	0.817
Sylhet	0.93 (0.27–3.94)	0.92 (0.24–4.29)	0.912

Notes: [a]Division of origin was omitted from the model due to multicollinearity.
Abbreviations: Adj. OR, Adjusted odds ratio.

was not significant in the multivariable regression. The pattern of higher seropositivity among women with higher education in our study is consistent with findings from other studies conducted in Kenya[40] and India,[41] which may be explained by the greater likelihood of receiving rubella vaccine during school attendance.

To the best of our knowledge, this is the first study to assess rubella IgG seropositivity in the target population of the 2014 MR campaign in Bangladesh. Moreover, the young female adults in our study were representative of that population because their hometowns were located in 54 of 64 districts across all eight divisions in the country during the 2014 MR campaign. However, this study has some limitations. First, the study samples were not randomly selected, as no list of population existed, and we approached participants at their residence during factory days off or evenings, which may slightly affect responses if the day or time we approached them was not convenient for them. Second, rubella vaccination history was self-reported owing to the absence of a good-record system, which may have produced recall bias. Third, distribution of seropositivity encountered a zero-cell count for two of the variables; however, correction methods were used to reduce bias in parameter estimates. Fourth, our study sample focused on women of a certain age group, and the finding may not be generalized to other age groups. Finally, rural-to-urban migration may have a potential impact on participants' immunity status, but this was not analyzed in this study.

Conclusion

A relatively high prevalence of rubella IgG seropositivity was found among young female adults aged 18 to 24 years in Bangladesh. However, approximately one in ten participants remained non-immune and at risk of rubella infection during pregnancy. The absence of a significant association between vaccination history and seropositivity, along with higher IgG titers in the non-vaccinated group underscores the need of further investigation. The low rate of self-reported vaccination history highlights critical gaps in vaccination documentation. Well-recorded vaccination histories and strengthened surveillance system to monitor rubella infection should be developed in Bangladesh and other countries where rubella is endemic. Further research should explore rubella immunity gaps across age groups and assess both the prevalence of rubella infections and rubella vaccination coverage.

Abbreviations

CRS, congenital rubella syndrome; WHO, World Health Organization; MR, measles and rubella; IgG, immunoglobulin G; IU/mL, international units per milliliter. IQR, interquartile range; CI, confidence interval.

Data Sharing Statement

Data presented and discussed in this paper is available from the corresponding author upon request.

Ethical Considerations

The study was approved by the Human Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University, Thailand (REC number 66-441-18-1) and by the National Research Ethics Committee of the Bangladesh Medical Research Council (registration number56517122023). This work complies with the ethical standards of the relevant national and institutional committees with the Helsinki Declaration of 1975, as revised in 2008. Written informed consent was obtained from all participants before conducting structured interviews and collecting blood samples. Confidentiality of the data was maintained and access to the data was restricted to the researchers involved in this study. All identifiable participant information was removed from the dataset before analysis and then shared with the co-investigators. All participants who provided blood samples for testing rubella IgG were informed of their test results, and those with negative test results were advised to receive the rubella vaccine.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

Authors declared no competing interest.

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