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Assessment of immunity to the measles virus through the detection of IgG antibodies

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Measles is a highly contagious viral infection that can lead to severe complications. The aim of this study was to evaluate immunity of the target population against the measles virus by assessing the presence of IgG antibodies. A total of 176 individuals were tested using the ELISA method. Fourteen participants (7.95%) were found to be non-immune, primarily from the 1976–1981 and 1982–1987 birth cohorts. The highest proportion of seronegative individuals (17.4%) was observed among those with unknown vaccination status. No significant differences were found between sexes. Most participants were from Kaunas, which also accounted for the majority of seronegative cases.

Keywords: measles, IgG antibodies, serological detection

INTRODUCTION

Measles is a highly contagious, acute, air-borne viral infection that can affect individuals of all age groups (Moss, 2017). It is caused by a virus, a member of the genus *Morbillivirus*, which, despite its relatively simple structure, is highly effective at spreading within the human body (Sato et al., 2012). The virus primarily targets immune cells, impairing their function and weakening the host's ability to fight infections (Amurri et al., 2022). In response, the immune system produces IgG antibodies. These antibodies provide protection by recognising, binding to, and neutralising the virus (Cooper, 2015; Vassilev et al., 2017). The World Health Organization (WHO) recommends a two-dose schedule of the measles vaccine. However, vaccination remains suboptimal. Factors contributing to under-vaccination include social determinants and challenges within healthcare delivery systems. The persistence and recurrence of measles cases suggest that a portion of the population remains either unvaccinated or has received only a single dose. Furthermore, disparities in vaccination coverage between countries of different income levels underscore the need to improve access to healthcare services (Patel et al., 2020).

In recent years, despite significant progress in reducing measles incidence and mortality through universal vaccination, outbreaks have increased globally. The European region recorded a peak in 2018, with countries such Germany, Greece, Ukraine, France, and Italy experiencing substantial outbreaks (WHO, 2019; Angelo et al., 2019). In Lithuania, 834 measles cases were reported in 2019, marking the largest outbreak in the past decade (NVSC, 2025). During that period, Lithuania ranked among the European countries with the highest number of measles cases per million inhabitants (Valinčiūtė, Schäfer, 2020). Due to decline in herd immunity, in many European countries, the situation worsened again in 2024 (Bassetti et al., 2025).

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The aim of this study was to evaluate the status of immunity of a selected population in Lithuania against the measles virus by assessing the presence of IgG antibodies and identifying potential immunity gaps across different age groups and vaccination backgrounds. Such data are crucial for informing public health strategies, enhancing surveillance, and preventing future outbreaks through timely vaccination and targeted interventions.

MATERIALS AND METHODS

A total of 176 individuals participated in the measles IgG antibody testing. The study included voluntary participants who wished to determine whether their immune system retained memory against the measles virus. To support the analysis, participants completed an anonymous questionnaire collecting information on age, sex, place of residence, history of measles infection, presence of measles-related symptoms, measles cases among family members, and the number of measles vaccine doses received throughout their lifetime.

The detection of IgG antibodies was carried out using an enzyme-linked immunosorbent assay (ELISA) with the Measles Virus IgG ELISA kit (Demeditec Diagnostics GmbH, Germany), following the manufacturer's instructions. Absorbance was measured spectrophotometrically at 450 nm with a reference wavelength of 620 nm, using a Multiskan FC plate reader (Thermo Scientific, China). Results were interpreted based on the sample values (expressed in units) and according to the manufacturer's guidelines. A result was considered positive if the absorbance value exceeded 11 units. Values between 9 and 11 units were interpreted as borderline, while results below 9 units were considered negative.

The collected data were analysed using Microsoft Excel. For the age group analysis, participants were categorised into eight birth cohorts: before 1963, 1964–1969, 1970–1975, 1976–1981, 1982–1987, 1988–1993, 1994–1999, and 2000–2006. For vaccination status analysis, individuals were grouped into four categories: not vaccinated, received one dose, two doses, and unknown vaccination status. In the analysis of geographical distribution, participants were classified by their place of residence to identify regional patterns of measles immunity. To determine whether the obtained data were statistically reliable, the Chi-square (χ^2) test was used. A p-value of less than 0.05 was considered statistically significant, indicating a meaningful association between the analysed variables.

RESULTS AND DISCUSSION

Analysis of the ELISA results showed that 84.66% of participants (149/176) tested positive for IgG antibodies against the measles virus, while 7.39% (13/176) had borderline results and were recommended for retesting. The remaining 7.95% (14/176) tested negative for measles-specific IgG antibodies. The 84.66% immunity rate observed in this study falls short of the herd immunity threshold, which is estimated to range between 89% and 94% (Moss, 2017). This suboptimal immunity level may increase the risk of future measles outbreaks within the population. Therefore, particular attention was given to the analysis of negative results to evaluate potential risk factors and their impact on the segment of the population lacking sufficient immunity.

The analysis revealed that the highest proportions of individuals lacking measles immunity were found in 1976–1981 and 1982–1987 age groups (Figure), in which 16.6% tested negative in each. In contrast, full immunity was observed among individuals born between 1964 and 1975. The association between the age group and negative ELISA results was statistically significant (p = 0.0022), indicating that measles immunity varies notably by birth cohort. Similar findings were reported in Japan, where population immunity in adults aged 20–49 remained below the herd immunity threshold despite high overall vaccination coverage (Kinoshita, Nishiura, 2017).

It is important to emphasise that borderline IgG results are inconclusive and may indicate insufficient antibody levels to provide effective

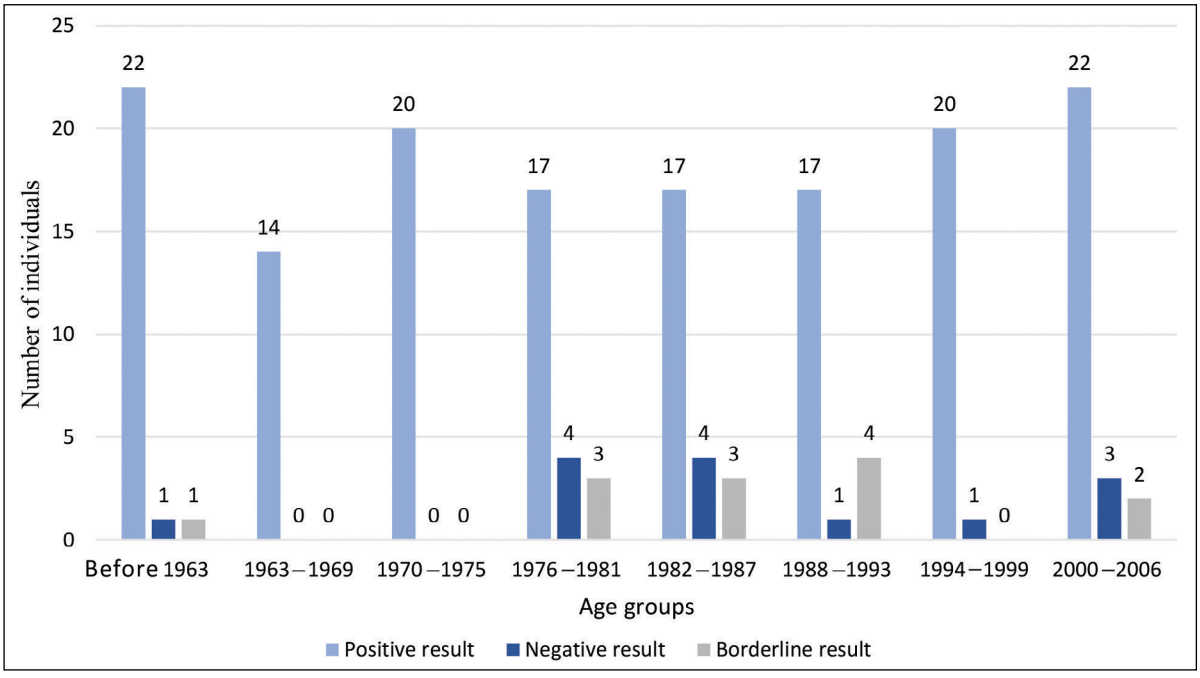

Figure. Seroprevalence of measles IgG antibodies by age groups

protection against measles. This could be due to historical vaccination practices: from 1964 to 1988, individuals in Lithuania typically received only a single dose of the measles vaccine (NVSC, 2023), which often failed to induce a robust and long-lasting immune memory (Patel, Tobin, 2025). As a result, a larger proportion of individuals born during this period may lack adequate levels of measles-specific IgG antibodies. In contrast, the introduction of a second measles vaccine dose in 1988 (NVSC, 2023) significantly improved long-term immunity (Patel, Tobin, 2025). However, incomplete vaccination coverage in later decades may still contribute to immunity gaps in some individuals.

Analysis by sex and vaccination status revealed differences in seropositivity (Table 1). Among females, 82.0% tested positive for measles-specific IgG antibodies, 8.1% were seronegative, and 9.9% had borderline results. In comparison, 89.2% of males were seropositive, 7.7% seronegative, and 3.1% had borderline results. The differences in IgG antibody responses between males and females were not statistically significant ($\chi^2 = 2.85$, $p = 0.240$), indicating

Table 1. **Distribution of measles IgG antibody results by sex and vaccination status**

Group		Number of individuals		
		Positive result	Negative result	Borderline result
Sex	female	91	9	11
	male	58	5	2
Vaccination status	Not vaccinated	10	1	1
	1 vaccine dose	43	1	4
	2 vaccine doses	46	0	1
	Vaccination status unknown	50	12	7

no clear association between sex and measles immunity in this sample. It is important to note that the number of female participants was substantially higher than that of male participants, comprising 63.1% and 36.9% of the study population, respectively. This disparity in group sizes should be taken into account when interpreting the results, particularly in analyses involving sex-based comparisons.

Previous studies suggest that IgG antibody levels and measles incidence may differ between sex. For example, a study of Australian blood donors found higher antibody levels in female than male after adjusting for age (Williamson et al., 2024). Additionally, long-term epidemiological data from seven high-income countries indicated consistently higher measles incidence rates in males across most age groups, likely due to biological rather than behavioural factors (Green et al., 2022).

Regarding vaccination history, the highest proportion of negative results (17.4%) was observed among participants with unknown vaccination status (Table 1). Among those who received two vaccine doses, 97.9% were seropositive, while 89.6% of those with one dose and 83.3% of unvaccinated individuals showed seropositivity. A statistically significant association was found between vaccination status and immunity levels ($\chi^2 = 20.95$, $p = 0.0019$). These findings are consistent with other studies indicating that a single dose of measles vaccine provides approximately 92% effectiveness, while two doses increase protection to 95% (Hayman, 2018; Plans-Rubió, 2020). Before the introduction of vaccination, up to 90% of children acquired long-term immunity through natural infection (Hayman et al., 2017). However, in countries with high vaccination coverage, measles epidemiology has shifted: not only children, but also unvaccinated or partially vaccinated adults have become more susceptible (Bester, 2016). As measles prevalence decreases, opportunities for natural immunity acquisition are also reduced, potentially increasing the risk of future outbreaks (Hayman, 2018).

The distribution of participants by place of residence showed that the largest proportion came from Kaunas, which also recorded the highest number of negative results (13/152, 8.6%). Klaipėda had a notably smaller sample size ($n = 20$) and only one negative case (5.0%), while all participants from Vilnius, Marijampolė, and Panevėžys tested positive for measles-specific IgG antibodies (Table 2). Statistical analysis revealed no significant association between place of residence and the likelihood of being seronegative for measles ($\chi^2 = 0.66$, $p = 0.956$). However, the highly uneven distribution of participants, with the vast majority residing in Kaunas, limits the ability to make objective and accurate regional comparisons, as the small number of participants from other districts may not accurately represent the true measles immunity status in those areas and could bias the overall results.

According to the National Public Health Centre, Lithuania experienced a major measles outbreak in 2019, with the highest numbers of cases reported in Kaunas and Vilnius districts (NVSC, 2025). In subsequent years, incidence dropped sharply, with only sporadic cases detected between 2020 and 2025. The exceptionally high number of cases in 2019 is

Table 2. **Measles IgG antibody results by district of residence of participants**

District (population)	Number of individuals			Total
	Positive result	Negative result	Borderline result	
Kaunas (300 000)	128	13	11	152
Klaipėda (160 000)	17	1	2	20
Vilnius (600 000)	2	0	0	2
Marijampolė (36 000)	1	0	0	1
Panevėžys (85 000)	1	0	0	1

consistent with our findings of suboptimal herd immunity levels, particularly in Kaunas, indicating that localised immunity gaps may have contributed to the outbreak. Although recent incidence remains low, these immunity gaps could still facilitate outbreaks if measles is reintroduced.

CONCLUSIONS

This study demonstrated that a portion of the Lithuanian population remains susceptible to measles, with the highest susceptibility observed among individuals born between 1976 and 1987. The largest proportion of seronegative results was found in participants with unknown vaccination status, indicating possible gaps in vaccination coverage. These findings underscore the importance of maintaining complete vaccination records and ensuring adequate protection across all age groups to sustain herd immunity.

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IMUNITETO TYMŲ VIRUSUI ĮVERTINIMAS PAGAL NUSTATYTUS IgG ANTIKŪNUS

Santrauka

Tymai yra labai užkrečiama virusinė infekcija, galinti sukelti rimtų komplikacijų. Šio tyrimo tikslas buvo įvertinti tikslinės populiacijos imunitetą tymų virusui nustatant IgG antikūnus. 176 asmenys buvo ištirti ELISA metodu. Rezultatai rodė, kad 14 tiriamųjų (7,95 %), daugiausia iš 1976–1981 ir 1982–1987 metų amžiaus grupių, neturėjo imuniteto. Daugiausia neigiamų rezultatų nustatyta „vakcinacijos būklė nežinoma" kategorijoje (17,4 %). Statistiškai reikšmingo skirtumo tarp lyčių nenustatyta. Didesnė dalis tiriamųjų buvo iš Kauno, jame taip pat nustatytas didžiausias neigiamų rezultatų skaičius.

Reikšminiai žodžiai: tymai, IgG antikūnai, serologinis nustatymas