https://www.banglajol.info/index.php/BJMM/index

Bangladesh Journal of Medical Microbiology

January 2026, Volume 20, Number 1, Page 39-45

ISSN (Print) 2070-1810

ISSN (Online) 2072-3105

Original Article ***Open Access***

Seroprevalence of Mumps IgG Antibody among Health Care Workers in Relation with Sociodemographic Change at A Tertiary Care Hospital in Bangladesh

Tarana Jahan[1], Tarun Kanti Paul[2], Premananda Das[3], Syed Anwarul Hoque[4], Md. Moynul Haque[5]

[1]Associate Professor, Department of Microbiology, Monno Medical College, Manikganj, Bangladesh; [2]Lecturer, Department of Microbiology, Sylhet MAG Osmani Medical College, Sylhet, Bangladesh; [3]Professor and Head, Department of Microbiology, Sylhet MAG Osmani Medical College, Sylhet, Bangladesh; [4]Professor and head, Department of Microbiology, Park View Medical College, Sylhet, Bangladesh; [5]Professor and Former Head, Department of Microbiology, Sylhet MAG Osmani Medical College, Sylhet, Bangladesh

Abstract

Background: Mumps is a major problem worldwide as it highly contagious in region where population density is more. However, mumps was an early childhood illness, now a day it affects adolescents and young adults. **Objective:** The purpose of the present study was to evaluate the immune status of mumps among health care worker by determining the anti-mumps antibody (IgG) level in a tertiary care hospital of Bangladesh. **Methodology:** This cross-sectional observational study was conducted in the Department of Microbiology, Sylhet MAG Osmani Medical College, Sylhet, Bangladesh during the period from 1st January 2018 to 31st December 2018. By convenient sampling apparently healthy adult individuals (n=120) were selected according to enrollment criteria. Healthy adult health care worker (age between 18-45 years and any gender) were included. Serum IgG antibody against Mumps were measured by ELISA method following the instructions provided by manufacturer's package insert. All data were processed and analyzed with the help of SPSS (Statistical Package for Social Sciences) Version 21.0. **Results:** Total 180 participants were recruited in this study. The age of the participants ranged from 18 to 45 years with the mean ± SD age of 28.54± 7.74 years. Protective immunity against mumps was found more in male which was 55 (70.51%). The highest mean serum IgG level was 1.48± 0.64 in urban participants, the lower socioeconomic group (1.59 ± 0.59) and the student's group (1.63 ± 0.71). The mean serum IgG level was significantly higher among participants with a history of mumps infection (2.10 ± 0.12) and participants with a history of close contact with mumps infection had a higher mean serum IgG level (1.69 ± 0.57) than those without a history of close contact (1.44 ± 0.62), and this difference was statistically significant (F = 6.160; p = 0.014). **Conclusion:** In conclusion, significant number of participants remains unprotected against mumps. Countries that have low immunization rates, people are more vulnerable to mumps infection especially young adult age group.

Keywords: Mumps Virus; Anti-mumps antibody; health care worker; sociodemographic change

Bangladesh Journal of Medical Microbiology, January 2026;20 (1):39-45

Introduction

Mumps is an acute viral communicable disease caused by the mumps virus, a member of the *Paramyxoviridae* family, primarily transmitted via respiratory droplets and close contact. In pre vaccine eras, mumps was a ubiquitous childhood infection, with incidence peaking every 2–5 years and most adults eventually acquiring immunity through natural infection[1]. Although often self limiting, mumps can lead to significant complications such as orchitis, meningitis, deafness, and reproductive system involvement, especially among adolescents and adults. The disease burden among clinical populations is further accentuated in settings where immunization coverage for mumps is limited or absent. Healthcare workers (HCWs) are a special group regarding their occupational status, who have an increased risk during exposure to infectious agents in medical settings. Healthcare workers can become infected and transmit

Correspondence: Dr. Tarana Jahan, Associate Professor, Department of Microbiology, Monno Medical College, Monno City, Gilando, Manikganj, Bangladesh; Email: tarana.nipa01@gmail.com; Cell no: +8801684605056

ORCID: https://orcid.org/0000-0002-9405-6990

DOI: https://doi.org/10.3329/bjmm.v20i1.90301

vaccine preventable diseases (VPD) to at-risk patients leading to harm on the workforce and patient care efforts[2]. Seroprevalence studies, based on the detection of pathogen-specific IgG, are critical for characterizing the immune status against VPD and in defining infection control measures within healthcare facilities[3]. Especially the determination of mumps IgG in HCWs, allows to detect lacking immunity and then to plan direct interventions as for example vaccination or revaccination campaign. The fact that a percentage of HCWs can still be susceptible to mumps despite occupational exposure has been shown in other geographic areas, and emphasizes the importance of determining immune status by serology rather than presuming immunity[4,5]. Because of implementation of successful worldwide immunization programs, the frequency of many VPDs has been greatly reduced. After two doses, the combination measles mumps rubella (MMR) vaccine offers strong protection against all three diseases: 97% against measles, 88% against mumps and >97% against rubella[6,7,8]. The use of the MMR vaccine is different in different countries. In high-income countries, it is usually given to children as part of routine vaccination. In many low- and middle-income countries, including Bangladesh, the mumps vaccine is not given routinely.

In Bangladesh, EPI has provided various vaccines, including measles and rubella; however, mumps vaccination is not currently offered for routine immunization through the national immunization program. Local studies by epidemiologists have suggested that lack of mumps immunization continues to drive population vulnerability[9]. In the absence of routine vaccination against mumps, natural infection is still the main contributor to population immunity and different age groups are unprotected or less protected for mumps. Seroprevalence of mumps is still scarcely reported in Bangladesh, especially among adults including HCWs. It has been reported in the literature that there are gaps of immunity against these infectious diseases at least for certain infections, because of lack of complete vaccine coverage and routine immunization particularly for some pathogens[10]. These are not the only such gaps in evidence reported worldwide: for example, HCWs in a tertiary hospital in South Korea showed an overall mumps seropositivity rate of 87.0% which might be suboptimal to prevent nosocomial transmission since herd immunity threshold estimates for mumps range between 85.0% and 92.0% cases[11]. This emphasizes the need for serological assessment followed by targeted vaccination, rather than assuming all HCWs are immune.

Sociodemographic factors play a significant role in immunity. Variables such as age, gender, occupation, years of work, and department of assignment can affect IgG seropositivity[12]. Younger healthcare workers may have lower antibody levels if they were born during periods of reduced disease circulation or changes in vaccine policy. Older HCWs may have immunity from past natural infection, but antibody levels can wane over time, leaving them partially susceptible[13]. Occupational roles also influence risk. Clinicians and nurses, who have frequent direct contact with patients, may have higher exposure to mumps than administrative staff or laboratory personnel who have limited patient interaction. Urbanization and changes in the healthcare workforce further complicate the epidemiological situation in Bangladesh. Large urban tertiary hospitals serve as referral centers and see a high number of patients. This increases the likelihood of occupational exposure to infectious agents, including mumps. Despite the high risk, few systematic studies have investigated mumps seroprevalence among HCWs in Bangladesh. Without such information, it is difficult to plan evidence-based infection control policies or vaccination programs tailored to the local context. Filling this knowledge gap is essential. Understanding which healthcare workers are protected and which remain susceptible allows hospitals to plan targeted vaccination campaigns and booster programs. Blood testing for IgG antibodies provides reliable evidence of immunity status. Those who lack protective antibodies can then be vaccinated to increase their immunity. These protect healthcare workers and reduce the risk of transmitting infections to patients, many of whom may be vulnerable due to age, chronic illness, or immunocompromised status.

Methodology

Study Settings and Population: This study was a descriptive cross-sectional design. It was conducted in the Department of Microbiology at MAG Osmani Medical College, Sylhet, Bangladesh. The study period lasted one year, from January 2018 to December 2018. The study population comprised apparently healthy adults aged 18 to 45 years residing in the Sylhet region. Individuals within this age group who appeared clinically healthy at the time of recruitment were considered eligible for inclusion. Participants were excluded if they had taken the

mumps vaccine before, were currently on or had recently used immunosuppressive treatment or long-term steroid therapy, or had any condition that reduced their immunity. A convenient sampling technique was used, selecting individuals based on their availability, accessibility, and willingness to participate. Each participant was given a unique ID number to ensure proper record-keeping and data management. Before joining the study, the objectives and procedures were clearly explained in simple language. Participants were encouraged to ask questions, and written informed consent was only collected after they fully understood the study and agreed voluntarily. Throughout the study, ethical standards and participant confidentiality were carefully maintained.

Sample Collection Procedure: Venous blood samples were collected under strict aseptic precautions. Approximately 3 mL of blood was drawn using a sterile disposable 5 mL syringe and transferred into a plain vacutainer tube. The sample was allowed to clot at room temperature for about 30 minutes. Serum was subsequently separated by centrifugation at 2,000 rpm for 10 minutes. A volume of 100 µL of the separated serum was carefully pipetted into a sterile Eppendorf tube, securely capped, labeled, and stored at 2–8 °C until further analysis. All reagents were handled and stored according to the manufacturer's recommendations to preserve assay integrity. Serum IgG levels specific to Mumps virus were measured using an enzyme-linked immunosorbent assay (ELISA) with the commercially available Mumps IgG ELISA kit (CALBIOTECH, A Life Science Company, CA 92020, USA; Catalog No. MP060G, Lot No. MPG5544). The assay was performed strictly following the procedures described in the manufacturer's package insert. All steps were carried out sequentially without interruption to ensure optimal accuracy and reliability of the test results.

Statistical Analysis: Collected data were checked, edited, coded, and recoded by using IBM SPSS version v22(IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Descriptive statistics such as mean, standard deviation and percent were computed for continuous variables of the participants. Categorical variables were expressed as frequencies and percentages, and when data were missing, the corresponding denominator was clearly stated. Chi-square test was used to assess the significance of associations between two nominal variables. ANOVA (Analysis of Variance) is used to compare the mean values of a continuous variable across three or more groups and check whether the differences are statistically significant. One way ANOVA test was performed to see the difference. $p \leq 0.05$ was determined as level of significance.

Ethical Clearance: Ethical approval for the study was obtained from MAG Osmani Medical College, Sylhet (Memo No: SOMC/2018/91). All participants were informed about the purpose and procedures of the study, as well as the confidentiality of their information. Written informed consent was obtained from all participants prior to enrollment. Data were collected anonymously and analyzed using a coded system to ensure participant privacy and confidentiality.

Results

The age of the participants ranged from 18 to 45 years with the mean ± SD age of 28.54± 7.74 years. Maximum number of participants 95 (52.78%) were found in the age group of 18 – 27 years.

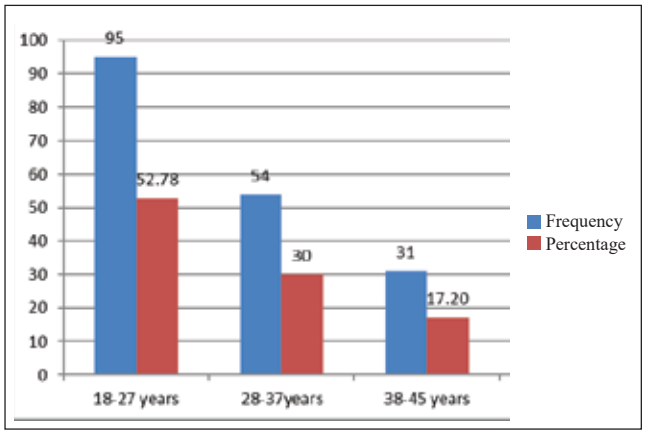

Figure I: Bar diagram showing Distribution of the Participants According To Age

The highest mean serum IgG level was observed among participants aged 18 to 27 years (1.58 ± 0.66). However, there was no statistically significant difference in mean serum IgG levels among the different age groups (p = 0.346) (Table 1).

Table 1: Showing serum IgG level among different age group

Age Group	Mean±SD	P Value
18 to 27 Years	1.58± 0.66	0.346
28 to 37 Years	1.45± 0.57	
38 to 45 Years	1.45± 0.55	

*P≤0.05 was determined as level of significance; SD=Standard Deviation

Protective immunity against mumps was found in 55(70.5%) participants of male and 67(65.7%) participants of female (Table 2).

Table 2: Protective Immunity against Mumps between male and female

Gender	Protective immunity		Total	P Value
	Present	Absent		
Male	55 (70.5%)	23 (29.5%)	78	0.492
Female	67 (65.7%)	35 (34.3%)	102	
Total	**122**	**58**	**180**	

In this study 115 (63.9) participants were in urban and 65 (36%) participants were in rural. Mean serum IgG level was 1.48± 0.64 in urban participants and 1.58±0.57 in rural participants (Figure II).

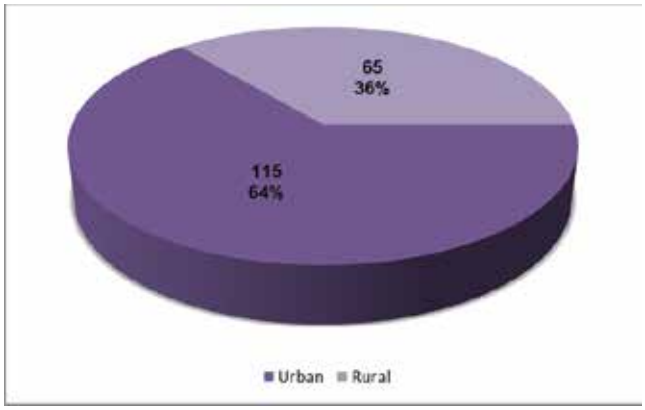

Figure II: Pie chart Showing Distribution of the Participants According to Residence (n=180).

The highest mean serum IgG level was observed among participants from the lower socioeconomic group (1.59 ± 0.59), followed by those from the middle socioeconomic group (1.49 ± 0.61) and the higher socioeconomic group (1.26 ± 0.81). However, there was no statistically significant difference in mean serum IgG levels across the different socioeconomic groups (F = 1.304; p = 0.265) (Table 3).

Table 3: Showing mean serum IgG level among different socioeconomic status

Socioeconomic Status	Mean±SD	F Value	P Value
Lower (n=74)	1.6± 0.59	1.304	0.265
Middle (n=97)	1.5± 0.61		
Higher (n=9)	1.3± 0.81		

Data were presented as mean and standard deviation. One way ANOVA test was performed to see the difference. p≤0.05 was determined as level of significance.SD=Standard Deviation

The highest mean serum IgG level was observed among participants from the students group (1.63 ± 0.71), followed by those from the Attendances in OPD group (1.50 ± 0.58) and the Healthcare personnel group (1.43 ± 0.55). However, there was no statistically significant difference in mean serum IgG levels across the different socioeconomic groups (F = 1.552; p = 0.215) (Table 4).

Table 4: Distribution of Serum IgG Level among Different Group

Group	Mean±SD	F Value	P Value
Student	1.6± 0.71	1.552	0.215
Attendances in OPD	1.5± 0.58		
Healthcare personnel	1.4± 0.55		

Data were presented as mean and standard deviation. One way ANOVA test was performed to see the difference. p≤0.05 was determined as level of significance.SD=Standard Deviation

The mean serum IgG level was significantly higher among participants with a history of mumps infection (2.10 ± 0.12) compared to those without such a history (1.49 ± 0.62) (F = 8.501; p = 0.004). Similarly, participants with a history of close contact with mumps infection had a higher mean serum IgG level (1.69 ± 0.57) than those without a history of close contact (1.44 ± 0.62), and this difference was statistically significant (F = 6.160; p = 0.014) (Table 5).

Table 5: Showing mean serum IgG level of participants according to history of mumps infection and History of close contact with mumps infection.

Participants	Mean±SD	F Value	P Value
History of mumps infection			
Yes (n=9)	2.1± 0.12	8.501	0.004
No (n=171)	1.5± 0.62		
History of close contact with mumps infection			
Yes (n=57)	1.7± 0.57	6.160	0.014
No (n=123)	1.4± 0.62		

Data were presented as mean and standard deviation. One way ANOVA test was performed to see the difference.SD= Standard Deviation

Discussion

The present study aimed to evaluate the association between the seroprevalence of protective anti-mumps IgG antibodies and socio-demographic factors in adults aged between 18 and 45 years. The results showed that even though there was the presence of protective immunity in all the age groups, the maximum proportion of seropositive individuals belonged to the younger age group of 18-27 years. In addition, there was a gradual reduction in the proportion of individuals with protective immunity and the mean serum IgG levels with an increase in age.

However, the difference in the proportion of individuals with protective immunity was not statistically significant across the age groups. This shows a gradual reduction in immunity with an increase in age, which has been evident in previous studies[6,7].

A study on the seroprevalence of mumps infection in Bulgaria[14] revealed that one-third of individuals aged above 30 years lacked protective mumps IgG antibodies, which shows a gradual reduction in immunity with an increase in age. In addition, national surveillance trends in Japan[15] revealed that more than half of the mumps infections between 2000 and 2016 occurred in adults, which shows an increased risk of infection with an increase in age. Similarly, surveillance studies from India[16] have revealed that nearly 80% of mumps infections occurred in adults. This further emphasizes the fact that waning immunity is a major cause of mumps infections in adults[17]. These observations are in line with studies suggesting that immunity to mumps virus tends to wane with time, especially in adults who are not exposed to booster doses of the virus[17].

With respect to differences in immunity between males and females, there was no statistically significant variation in serum levels of IgG antibodies and protective immunity between males and females. This suggests that sex does not play a significant role in modulating humoral immunity to mumps virus. Similar observations have been reported from studies conducted in the United States[18], where there was no significant variation in seropositivity rates between males and females. Regarding to differences in immunity between residents from urban and rural areas, although there was a slightly higher percentage of protective immunity in residents from rural areas compared to those from urban areas, this was not statistically significant. These observations are in contrast to studies from Taiwan[19], where a higher incidence of mumps infections was reported from urban areas. Overcrowded living conditions in urban areas may facilitate viral transmission, potentially increasing subclinical exposure rather than sustained protective immunity. Similar observations have been discussed in global reviews of mumps epidemiology[20].

The occupational analysis did not show a significant difference in the mean serum IgG levels or protective immunity between students, outpatient attendants, and healthcare personnel. However, there was a trend of higher levels of protective immunity among students and healthcare personnel. A study among health science students in India[21] has shown that there is a high rate of seropositive results, especially among nursing students. This is attributed to frequent exposure to mumps virus. This frequent exposure may have boosted immunity among students and healthcare workers. Socioeconomic status did not have a significant effect on mean serum IgG levels or protective immunity. However, there is a trend of declining immunity among people from higher socioeconomic status. Similar findings have been observed in the Netherlands. In the Netherlands[22], there are lower antibody levels among people from higher socioeconomic status. This may have been attributed to a decrease in natural exposure to mumps virus due to improved living standards.

A significant association was observed between histories of mumps infections and higher mean serum levels of IgG. All participants who had a history of previous mumps infection had protective immunity. This is consistent with the World Health Organization's assertion that natural infection with mumps virus usually results in lifelong immunity[23]. Protective immunity in those without a history of mumps infection might have been due to subclinical infection, herd immunity, and recall bias. Moreover, participants who had histories of close contacts with mumps-infected persons had higher mean serum levels of IgG and protective immunity. This lends credence to the hypothesis that subclinical infections play a crucial role in immune system boosting. An outbreak investigation in Korea[11] revealed high secondary attack rates in students sharing dormitories. This demonstrated the effect of close contacts in the transmission and development of immunity to mumps virus infection. The findings of this study have demonstrated that there is indeed protective immunity to mumps infection in various sociodemographic groups. However, immunity appears to wane with age and exposure.

Conclusion

The findings of this study show that many healthcare workers in the tertiary care hospital already carry mumps IgG antibodies, which likely reflects past exposure to the virus. However, differences in antibody levels across age, gender, living area, and socioeconomic background suggest that not everyone has the same level of protection, and some individuals may still be at risk of infection. These results point to

the importance of regular antibody screening and well-planned vaccination programs for healthcare workers to help reduce the possibility of mumps outbreaks and ensure a safer hospital environment for both staff and patients.

Acknowledgements
None

Conflict of Interest
The authors declare that they have no competing interests.

Financial Disclosure
The author(s) didn't receive any fund to carry out this study.

Authors' contributions
Conceptualization, methods and literature reviews: Jahan T, Paul TK, Das P; Data collection: Jahan T; Hoque SA; Statistical analysis: Jahan T, Hoque MM; Draft manuscript: Jahan T. All the authors work and approved the final manuscript. All authors read and approved the final manuscript.

Data Availability
Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate
Ethical approval for the study was obtained from the Institutional Review Board (IRB) of MAG Osmani Medical College, Sylhet (Memo No: SOMC/2018/91) on 24.07.2018. As this was a cross-sectional observational study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

How to cite this article: Jahan T, Paul TK, Das P, Hoque SA, Haque MM. Seroprevalence of Mumps IgG Antibody among Health Care Workers in Relation with Sociodemographic Change at A Tertiary Care Hospital in Bangladesh. Bangladesh J Med Microbiol, 2026;20(1):39-45

ORCID
Tarana Jahan: https://orcid.org/0000-0002-9405-6990
Tarun Kanti Paul: https://orcid.org/0009-0003-9167-8289
Premananda Das: https://orcid.org/0009-0004-8136-294X
Syed Anwarul Hoque: https://orcid.org/0009-0007-5589-4338
Md. Moynul Haque: https://orcid.org/0009-0005-7747-6140

Article Info
Received: 7 September 2025
Accepted: 24 October 2025
Published: 1 January 2026

References

1 Levinson W. Virology. In: Review of Medical Microbiology and Immunology. 13th ed. New York: McGraw-Hill; 2014. 701–3.
2. Su SB, Chang HL, Chen KT. Current status of mumps virus infection: epidemiology, pathogenesis, and vaccine. Int J Environ Res Public Health. 2020;17(5):1686.
3. Rubin S, Eckhaus M, Rennick LJ, Bamford CG, Duprex WP. Molecular biology, pathogenesis and pathology of mumps virus. J Pathol. 2015;235:242–52.
4. Abu Bashar MD, Khan IA, Sridevi G. Recent surge in mumps cases in India: need for urgent remedial measures. Indian Pediatr. 2024;61(4):370–4.
5. Gong X, Fang Q, Zheng W, Lai S, Xu W, Yin Z. Epidemiological characteristics and serological survey of mumps 15 years after MMR vaccine inclusion in the immunization program. J Med Virol. 2024;96(8):e29856.
6. Jefferson T, Price D, Demicheli V, Bianco E, European Research Program for Improved Vaccine Safety Surveillance (EUSAFEVAC) Project. Unintended events following immunization with MMR: a systematic review. Vaccine. 2003;21(25-26):3954-60.
7. Hanson KE, Marin M, Daley MF, Groom HC, Jackson LA, Sy LS, Klein NP, DeSilva MB, Panagiotakopoulos L, Weintraub E, Belongia EA. Safety of measles, mumps, and rubella vaccine in adolescents and adults in the vaccine safety datalink. Vaccine: X. 2023;13:100268.
8. Miller S. Virology. In: Carol KC, Morse SA, Metzger T, Miller S, editors. Jawetz, Melnick & Adelberg's Medical Microbiology. 27th ed. New York: McGraw-Hill; 2016. p. 589–90.
9. Aruna R, Zahid. Mumps in India. National Health Portal, Ministry of Health and Family Welfare, Government of India; 2017. Available from: www.nhp.gov.in/disease/communicable-disease/mumps [Accessed 7 October 2018].
10. National Institute of Infectious Diseases. Infectious Disease Surveillance Annual Report. Tokyo: National Institute of Infectious Disease; 2017. Available from: http://www.nih.go.jp/ niid/ja/ surveillance/data2015.htm [Accessed 22 November 2018].
11. Paul S, Mahajan PB, Sahoo J, Bhatia V, Sonu H. Investigating mumps outbreak in Odisha, India: an opportunity to assess the health system using the essential public health services framework. Am J Trop Med Hyg. 2017;96:1215–21.
12. Hviid A, Rubin S, Muhlemann K. Mumps. Lancet. 2008;371:932–44.
13. Dayan GH, Quinlisk MP, Parker AA, Albert E, Harris ML, Jennifer M, Dennis P, Seward F. Recent resurgence of mumps in the United States. N Engl J Med. 2008;358:1580–9.
14. Hoes J, Anna GC, Mirjam J, Hester E, Melker D, Liesbeth M. Socioeconomic status is associated with antibody levels against vaccine preventable diseases in the Netherlands. Front Public Health. 2016;6:209.
15. Wohl S, Metsky HC, Schaffner SF, Piantadosi A, Burns M, Lewnard JA, et al. Combining genomics and epidemiology to track mumps virus transmission in the United States. PLoS Biol. 2020;18(2):e3000611.
16. Zamir CS, Schroeder H, Shoob H, Abramson N, Zentner G. Characteristics of a large mumps outbreak: clinical severity, complications and association with vaccination status. Hum Vaccin Immunother. 2015;11(6):1413–7.
17. Galazka AM, Robertson SE, Kraigher A. Mumps and mumps vaccine: a global review. Bull World Health Organ. 1999;77:3–14.
18. Ryu J, Kim E, Youn S, Rhim J, Lee K. Outbreaks of mumps: an observational study over two decades in a single hospital in Korea. Korean J Pediatr. 2014;57:396–402.
19. Hiebert J, Saboui M, Frost JR, Zubach V, Laverty M, Severini A.

Mumps resurgence in a highly vaccinated population: insights from surveillance in Canada, 2002–2020. Vaccine. 2023;41(25):3728–39.
20. Park SH. Resurgence of mumps in Korea. Infect Chemother. 2015;47(1):1–9.
21. Watson-Creed G, Saunders A, Scott J, Lowe L, Pettipas J, Hatchette TF. Two successive outbreaks of mumps in Nova Scotia among vaccinated adolescents and young adults. CMAJ. 2006;175(5):483–8.
22. Mair L, Relan P, Hamilton DO, Al-Noman A, O'Dempsey T. Lessons learned from an under-reported mumps epidemic among Rohingya refugees in Cox's Bazar District, Bangladesh. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2020;114(9):635-8
23. Haviari S, Bénet T, Saadatian-Elahi M, André P, Loulergue P, Vanhems P. Vaccination of healthcare workers: A review. Human vaccines & immunotherapeutics. 2015 2;11(11):2522-37