Review of evidence to inform the New Zealand National Immunisation Programme, 2026: Mumps

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October 2026 (edited November 2026)

Immunisation Advisory Centre

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Abbreviations

ACIP	Advisory Committee on Immunization Practices
AE	adverse events
AEFI	adverse events following immunisation
aHR	adjusted hazard ratio
aOR	adjusted odds ratio
AR	attack rate
ATSI	Aboriginal and Torres Strait Islanders – indigenous peoples of Australia
95% CI	confidence interval
ED	emergency department
EPI	Expanded Programme on Immunisation
ESR	Institute for Environmental and Scientific Research
GMT / GMC	Geometric mean titre / concentration
GMR	Geometric mean titre ratio
GP	general practitioner
HN	haemagglutinin-neuraminidase
HR	hazard ratio
IBD	inflammatory bowel disease
IgG	immunoglobulin G
IQR	interquartile range
IR	incidence risk
IRR	Incidence risk ratio
IST	immunosuppressive therapy
MELAA	Middle Eastern, Latin American and African ethnicities
MMR	combined measles mumps and rubella vaccine
MMRn	nth number of measles-mumps-rubella vaccine doses
MR	combined measles and rubella vaccine
MSD	Merck Sharp and Dohm
NIP	National Immunisation Programme
NZ	Aotearoa New Zealand
PHF Science	New Zealand Institute of Public Health and Forensic Science
PLHIV	people living with HIV

RCT	Randomised controlled trial
SAE	severe adverse events
SD	standard deviation
SRMA	systematic review meta-analysis
UK	United Kingdom
US	United States of America
US CDC	Centers for Disease Prevention and Control (US)
VAERS	Vaccine adverse event reporting system (US)
WHO	World Health Organization

Acknowledgements

I would like to express my gratitude to Dr Edwin Reynolds, General Practitioner and Senior Medical Officer, National Public Health Service, for his expertise in peer-reviewing this review of evidence.

Disclaimer

Due to resource constraints, this is not a full systematic review, the quality of the evidence has not been formally graded, and it does not consider cost-benefit analysis. It draws primarily on literature published between January 2018 and June 2026. It was commissioned as part of a contract for services between the Immunisation Advisory Centre at the University of Auckland and the Directorate of Protection - Immunisation at Health New Zealand | Te Whatu Ora. The opinions and interpretations of the literature presented are solely those of the author.

Executive Summary

This review was undertaken to inform decisions relating to mumps prevention within New Zealand's National Immunisation Programme and future updates to the Immunisation Handbook. It aims to evaluate mumps epidemiology, the role of vaccination and assess the potential benefit of additional measles-mumps-rubella vaccine (MMR) doses in adolescents and young adults, following concerns raised during the 2017 to 2019 mumps outbreak in highly vaccinated populations. It draws primarily on literature published between January 2018 and June 2026.

Evidence indicates that the current two-dose MMR programme remains highly effective in reducing mumps disease burden and complications, but immunity against mumps appears less durable than immunity against measles or rubella. Outbreaks continue to occur primarily among adolescents and young adults, particularly where immunity gaps, waning immunity and high-intensity exposure settings coincide.

Key questions being considered by this review include:

- Which populations remain at risk of mumps in New Zealand despite routine vaccination?
- How effective and durable is protection against mumps following the current two-dose MMR schedule?
- What role should additional MMR doses play in preventing and controlling mumps outbreaks?
- What is the optimum timing of additional doses?

Populations at risk

The highest burden of mumps in New Zealand has occurred among adolescents and young adults aged 15 to 29 years, particularly those in secondary schools, tertiary education settings and other environments where close social contact facilitates transmission. International travel provides opportunities for mumps virus importation and exposure (see table below).

Despite high vaccination coverage, outbreaks continue to occur in these age groups because immunity gaps and waning immunity accumulate over time. Internationally, similar outbreak patterns have been observed among university students, military recruits, boarding school students, and other populations experiencing prolonged or intense exposure to the virus. Offering additional MMR vaccination (MMRn) in these high-risk settings may be a useful public health intervention.

Previous examples of settings at high-risk for mumps virus transmission, for adolescents and young adults

Age group	Setting	
15 – <18 years	Education • large high schools • boarding school Sports and school events • national sports competitions • Kapa haka competitions	Community events • Scout jamborees • church gatherings • other large community events
18 – 29 years	Educational accommodation • tertiary halls of residence • flat-sharing Vocational accommodation • military barracks • nursing residences • prison staff and residents Sport events • national and international sports competitions	Community and social events • church gatherings • concerts and festivals • nightclubs Travel • overseas travel to endemic countries • visiting relatives and friends Health care • general practice • urgent care (accident and medical centres) • emergency departments

Vaccine safety

The safety profile of currently used Jeryl Lynn-derived mumps vaccines (including Priorix and M-M-RII) is excellent and well established. No new safety concerns were identified in this review. Adverse events are generally mild and self-limiting and serious adverse events are rare. Evidence relating to additional MMR doses indicates a similar safety profile to routine vaccination, with no significant safety concerns identified among adolescents and young adults receiving a third dose.

Immunogenicity and duration of protection

Key immunogenicity findings

- Approximately 93% – 98% of individuals seroconvert after two doses of MMR.
- Primary vaccine failure following two doses is uncommon (<2%).
- Antibody levels commonly decline within 10 to 15 years after the second dose.
- Meta-analysis estimates suggest mumps antibody wanes approximately twice as fast as measles and rubella antibodies, particularly in non-endemic settings.
- Seropositivity may decline to 50% – 80% by 15 years and 40% – 50% by 20 years after vaccination, without exposure to circulating virus.

Immunity against mumps differs from immunity against measles and rubella. Mumps antibody levels are generally lower following vaccination and decline more rapidly over time. Evidence suggests that antibody levels frequently decline within 10 to 15 years following the second dose. Currently, no correlate of protection has been established for mumps. Consequently, it is difficult to determine when declining antibody levels translate into loss of clinical protection. However, cellular immune memory persists for much longer than serum antibody and likely contributes to ongoing protection and attenuation of breakthrough infections.

Secondary vaccine failure is increasingly recognised during outbreaks in adolescents and young adults. Contributary factors include:

- waning antibody levels over time
- non-sterilising immunity that permits asymptomatic infection and transmission
- antigenic differences and mismatch between vaccine and circulating virus strains
- intense exposure settings that may overwhelm partial immunity.

Overall, the evidence suggests that protection against mumps remains substantial following two doses of MMR, but due in part to lower priming of the immune response, is less robust than measles or rubella immunity.

Vaccine impact and burden of disease

MMR vaccination has substantially reduced the burden of mumps in New Zealand. Compared with the pre-vaccine era, disease incidence, childhood infection, epidemic frequency and severe complications have all declined dramatically. The evidence suggests that current mumps outbreaks are driven more by incomplete immunity and waning protection than by primary vaccine failure, with modern cold chain processes in place. Young children remain relatively well protected through high coverage with the routine childhood immunisation schedule.

Before vaccination, mumps epidemics occurred every 3-5 years and most people were infected by adolescence. Although often mild, mumps can cause serious complications, particularly in adolescents and adults, including orchitis, meningitis, encephalitis, pancreatitis and permanent hearing loss. Vaccinated individuals who develop mumps are less likely to experience severe disease or complications.

Mumps vaccine has contributed significantly to reducing mumps outbreaks – but high coverage (of over 86%) needs to be maintained to limit transmission. Hospitalisations during outbreaks highlight immunity gaps more than waning immunity.

Although breakthrough infections and outbreaks still occur, vaccination continues to provide important public health benefits.

- Attack rates during outbreaks are substantially lower among vaccinated individuals.
- Vaccination reduces the risk of hospitalisation.
- Vaccination reduces the occurrence of complications such as orchitis and meningitis.
- High childhood coverage has largely prevented outbreaks in early childhood settings and continues to provide important population-level protection.

The principal public health challenge for mumps has shifted from protecting young children to sustaining immunity in adolescents and young adults. In the absence of circulating virus, long periods since vaccination may increase susceptibility, especially in settings that facilitate transmission when cases occur.

Additional doses of MMR

Additional doses of MMR can boost mumps immunity and reduce outbreak risk in adolescents and young adults. Studies consistently demonstrate reduced attack rates and improved outbreak control when additional doses are used in populations at increased risk of exposure, particularly in tertiary institutions, boarding schools, correctional facilities, and other close-contact settings.

Evidence suggests susceptibility to breakthrough mumps increases approximately 13 to 17 years after the second MMR dose, coinciding with the age at which many young people enter higher-risk environments, such as larger educational settings and national or international school, sports or community events. Outbreak epidemiology indicates that both waning immunity and historical under-vaccination contribute to susceptibility in these age groups.

Although no studies directly compared a universal adolescent dose regardless of vaccination history (MMRn) with a third dose given only to individuals with documented receipt of two previous doses (MMR3), an age-based MMRn approach has potential advantages:

- to boost waning immunity against measles, mumps and rubella in fully vaccinated individuals
- provides a first or second dose to under-vaccinated individuals or those who have received only one dose
- avoids the practical challenges associated with verifying prior vaccination history
- to increase population immunity before entry into higher-risk settings associated with mumps transmission.

Targeted vaccination before exposure may also offer advantages over relying primarily on outbreak-response vaccination. Given the long incubation period of mumps, viral shedding before symptom onset, and the potential for asymptomatic transmission, substantial spread may occur before an outbreak is recognised. Consequently, improving immunity before exposure is likely to provide greater public health benefit than reactive vaccination once transmission has become established.

International travel provides opportunities for mumps virus importation and exposure. Ensuring travellers are up to date with recommended MMR vaccination may help reduce transmission and close existing immunity gaps, particularly among adolescents and young adults. While the evidence does not support an additional universal travel dose of MMR, travel health consultations represent a useful opportunity for catch-up vaccination and strengthening population immunity.

However, important uncertainties remain regarding the duration of protection following an additional dose, the optimal age for administration, and the long-term population benefits of a routine booster programme. The current evidence is therefore insufficient to support introduction of a universal adolescent MMRn programme. Historically, New Zealand offered the second dose at age 11 years which may have improved duration of protection into early adulthood, but left younger children who did not respond adequately to their first dose at risk of measles and mumps. In some cases, the second dose was missed, leaving an immunity gap.

Summary of key findings

Review question	Key findings	Implications for New Zealand
Which populations remain at risk of mumps in New Zealand despite routine vaccination?	• Mumps outbreaks primarily affect young people aged 15-29 years, within schools, tertiary education settings, and other close-contact environments. • Both historical immunity gaps and waning immunity contribute to susceptibility.	• Maintain high childhood MMR coverage • Prevention, surveillance, catch-up vaccination and outbreak preparedness should focus on adolescents and young adults
How effective and durable is protection against mumps following the current two-dose MMR schedule?	• Two doses of MMR provide high initial protection and have substantially reduced mumps incidence, hospitalisation, and complications • Mumps antibody levels decline more rapidly than measles and rubella antibodies, with waning becoming evident within 10-15 years after vaccination • Susceptibility appears to increase approximately 13-17 years after the second MMR dose. • Cellular immunity appears to persist longer, although its contribution to protection is not fully understood.	• The current two-dose schedule remains the foundation of mumps control. • Waning immunity is likely to contribute to outbreaks in older adolescents and young adults, particularly in high-exposure settings.
What role could additional MMR doses play in preventing and controlling mumps outbreaks?	• Additional doses boost immunity and reduce attack rates during outbreaks. • The greatest benefit has been observed in adolescents and young adults exposed in tertiary institutions, boarding schools, correctional facilities, and other close-contact settings	• Additional doses may be beneficial before entry into higher-risk settings and when used early in outbreaks. • Evidence currently supports targeted use in populations at increased risk of exposure and transmission.
Should New Zealand consider an age-based adolescent dose (MMRn) or a third dose only for those with documented prior vaccination (MMR3)?	• No studies directly compared MMRn and MMR3. • However, outbreak epidemiology suggests that both waning immunity and historical under-vaccination contribute to susceptibility. • An age-based MMRn approach could boost waning immunity, provide missed doses to under-vaccinated individuals, avoid difficulties verifying vaccination history, and increase immunity before exposure in high-risk settings. • Evidence is currently insufficient to definitively support routine implementation of either strategy.	• An MMRn strategy may offer greater population benefit than MMR3 because it addresses both immunity gaps and waning protection. • Further evidence is needed on duration of protection, optimal timing, effectiveness, and overall population impact. • Evidence does suggest that MMRn in high-risk settings could be a useful public health intervention.
Should additional doses be given before exposure or only during outbreaks?	• Mumps has a long incubation period, viral shedding occurs before symptom onset, and asymptomatic transmission is common. Consequently, transmission may be well established before an outbreak is recognised.	• Targeted pre-exposure vaccination of populations at increased risk may provide greater public health benefit than relying solely on reactive vaccination once outbreaks are established. However, outbreak-response vaccination remains an important control measure.

Recommendations for New Zealand

Priority actions

- Maintain high two-dose MMR coverage in early childhood.
- Improve catch-up vaccination among under-vaccinated children, adolescents and young adults.
- Identify populations at increased risk of exposure and transmission. (see examples in Table below).
- Consider targeted pre-exposure MMR vaccination for adolescents and young adults entering higher-risk settings, such as tertiary education.
- Use additional MMR doses as early as cases are identified during outbreaks and in high-risk settings – this provides a response to an outbreak, but due to the long incubation period will not prevent the initial cases.
- Maintain surveillance of mumps epidemiology, vaccine effectiveness and waning immunity.
- Support research into correlates of protection and the long-term benefits of additional MMR doses.

Overall, the evidence indicates that the current MMR programme continues to provide substantial protection against mumps and its complications. While waning immunity contributes to outbreaks among adolescents and young adults, maintaining high coverage and considering targeted pre-exposure vaccination strategies for populations at increased risk appears better supported by the current evidence than major changes to the routine childhood schedule. Any changes to MMR recommendations also require consideration of the impact on protection against all three antigens – measles, mumps and rubella.

Outstanding questions

Decisions around mumps vaccination is closely tied to measles, which is more contagious, has a higher threshold for herd immunity, and has more severe complication risks.

Would a universal adolescent dose reduce immunity gaps against measles? And in turn, could it improve the duration of mumps immunity and ensure rubella immunity during pregnancy?

Important uncertainties remain regarding the duration of protection following an additional dose, the optimal age for administration, and the long-term population benefits of a routine booster programme. The frequency of additional doses would depend on the risk of exposure to wild-type virus – more frequent exposure is both likely to boost immunity exogenously but also increases the risk of infection and greater transmission.

Did the change in National Immunisation Schedule in 2020 in response to the measles epidemic – giving both MMR doses before age 2 years (ie from ages 15 months and 4 years to ages 12 and 15 months) – affect the duration of protection for the mumps component more than for measles and rubella immunity? Evidence is yet to emerge as to whether changing the immunisation schedule in 2020 will impact on the duration of protection against mumps and increase the risk for mumps cases to shift from young adults to younger adolescents.

Would a more immunogenic vaccine improve the duration of protection? Noting that increasing immunogenicity needs to be balanced with the increased risk for adverse events. For example, aseptic meningitis has been associated with the more immunogenic live attenuated mumps virus strains (eg Urabe AM9 strain).

Without a defined correlate of protection and a defined role for cell-mediated immunity, it is unclear what measurable benefit there would be in increasing vaccine immunogenicity or an antigenically better-matched vaccine to circulating strains. Would boosting immunity with additional doses, given before immunity wanes below protective thresholds, overcome the need for greater initial immunogenicity?

Updates for the Immunisation Handbook

The following are suggestions where more current evidence can be included in the mumps chapter of the Immunisation Handbook. Generally, the use of MMR is determined by measles protection.

- Current evidence around the duration of protection against mumps after two-doses.
- Evidence of effectiveness of additional doses used for containing outbreaks and challenges of long incubation periods and asymptomatic presentation.

Review of evidence: Mumps

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October 2026 (edited November 2026)

Introduction

This review of evidence aims to assess the duration of protection of mumps vaccine (as part of combined measles-mumps-rubella vaccine, MMR) and the use of additional doses to extend protection. It draws on literature published primarily between January 2018 and June 2026. This information will support the Aotearoa New Zealand National Immunisation Programme and updates to the Immunisation Handbook. See **Disclaimer**.

Key questions considered for this review are:

- Which age groups are at highest risk from mumps in New Zealand?
- Which vaccinated groups are at risk of breakthrough mumps?
- What is the duration of protection of MMR against mumps?
- Does the timing of the second dose affect the duration of protection?
- Is there a value in routinely giving an additional MMR dose in adolescence (MMRn), regardless of MMR vaccine history?
- How does that compare with giving a dose of MMR during an outbreak situation?

During a mumps outbreak in New Zealand in 2017 – 2019 and the subsequent measles outbreak in 2019, there were large school and community-based campaigns to vaccinate under-vaccinated adolescents and young adults in affected high schools and colleges. However, the planned immunisation efforts following these outbreaks were impacted by the public health measures focussing on the COVID-19 pandemic response. These outbreaks highlighted gaps in immunity but also highlighted the likelihood of needing additional doses of MMR in those who had been fully vaccinated in early childhood.

Any changes to MMR recommendations also require consideration of impact protection against all three antigens – measles, mumps and rubella.

Mumps

Symptoms and transmission

Mumps is a highly contagious viral infection that causes a generally acute, relative benign disease. Prior to the introduction of mumps vaccines, nearly everyone had evidence of mumps infection by the age of 15 years. Common presentations include parotitis (swelling of salivary glands) and orchitis (testicular inflammation). More serious complications can occur, particularly in adults. Pre-vaccines, mumps was a leading cause of viral encephalitis and sudden-onset deafness.[1]

Following initial non-specific viral infection symptoms, such as fever, headache, malaise, myalgia, around 16 –18 days after exposure parotitis can develop that lasts for 10 or more days. Fever usually lasts one to six days. Orchitis occurs in up to one third of post-pubertal males and is typically unilateral; sterility is very rare. In females, oophoritis (in ovaries) and mastitis (breast tissue) can occur at rates ranging from 5% – 30% of cases. Pancreatitis occurs in around 4% of cases. Neurological symptoms often precede parotitis with clinical evidence of meningitis in around 5% of cases and encephalitis in 0.5% of cases. Encephalitis is responsible for many of the mumps-associated fatalities.[1] Although hearing loss in approximately 2% of cases is usually transient and unilateral, sudden-onset permanent deafness occurs in around one in 20,000 cases.

Virus is shed in saliva from 11 days after exposure, from a week before and up to 9 days after parotitis onset.[1, 2] The period of virus shedding is not influenced by asymptomatic infection or vaccination in symptomatic cases.[1, 3] Due to its long incubation period (range 12–25 days) and viral shedding prior to symptom onset, limiting the transmission of mumps by isolating cases is less effective than for viruses with shorter incubation times. However, for contact tracing purposes, infected people are considered most infectious from two to five days after the onset of parotitis.[2]

Mumps virus

The mumps virus is an enveloped RNA virus of the Paramyxoviridea family, *Rubulavirus* genus. Its genome encodes seven proteins. Antibodies directed against the haemagglutinin-neuraminidase (HN) protein and the fusion protein confer protection. These proteins are involved in the fusion of the virion to the host cell membrane, to induce cell-to-cell fusion, and the release of new virions from the infected cell surface.[1]

Although mumps virus is serologically monotypic, there is some evidence that breakthrough infections can occur due to antigenic differences between heterologous strains (genotypes) in people with low neutralising antibody levels.[1] For example, the current Jeryl-Lynn strain-derived vaccine is genotype A but the wild-type virus associated with recent outbreaks has been genotype G. For more detail, see the **Immunogenicity** section below.

Mumps vaccines

In Aotearoa New Zealand (NZ), the mumps vaccine has always been part of a combined measles, mumps and rubella vaccine (MMR). Some countries had mumps-only vaccines prior to the use of MMR.

As of December 2023, 123 of the 194 WHO member states use at least one dose of mumps-containing vaccine in their immunisation programmes and most use a two-dose regimen.[1, 4] In most cases, MMR1 is administered at around age 12 – 18 months but scheduling of MMR2 varies from one month to 10 – 12 years after dose one. For examples, see **International immunisation schedules and recommendations.**

Immunisation schedule changes

The New Zealand National Immunisation Schedule (the Schedule) has been adjusted over the years primarily in response to measles outbreaks.

- MMR was first introduced in New Zealand in 1990 for all infants at age 12–15 months. A second dose was introduced in 1992 at age 11 years.
- During a measles epidemic in 1997, all children aged under 10 years were offered MMR and the first dose was brought forward to age 12 months. In Auckland, infants aged 6–11 months were given MMR0 and a repeat dose given at age 15 months.
- In 2001, the second dose was changed from age 11 to a preschool dose at age 4 years, with a school-based catchup programme for all children aged 5–10 years.
- Subsequently, the schedule was established at ages 15 months and 4 years.
- Since 2020, MMR1 is given at age 12 and MMR2 at 15 months. This change was in response to another measles outbreak in 2019 in which infants younger than 15 months were hospitalised.

However, there are holes in coverage. During the 2017–19 mumps outbreak, an estimated 40% of those born between 1990 and 2005 (aged 15 – 29 years at the time) may not have been fully vaccinated,[5] and specifically, did not receive the second dose. This lack of immunity was related both to changes in schedules and generally poor vaccine uptake.

Anyone born prior to 1981 is considered to have mumps immunity in New Zealand (ie those aged over 11 years when a second dose of MMR was introduced in 1992).

History of mumps vaccines

Many other countries introduced mumps vaccines and MMR sooner than NZ. A mumps vaccine was first introduced in the United States (US) in 1967 and in some European countries in the late 1970s to mid-1980s. MMR was first used in the US in 1971 and across Western Europe in the 1980s.

Mumps virus was first cultivated in embryonated hens' eggs in 1945. After initially trialling inactivated vaccines, more effective live-attenuated mumps vaccines were developed. The virus strain in the current MMR vaccines used in NZ was first isolated at Merck & Co in 1965 from the throat of a girl, Jeryl Lynn Hillman. Subsequently, the vaccine virus was found to contain of two distinct but genetically related mumps viruses (in 5:1 ratio, designated JL-major, JL-1 or JL-5 and JL-minor or JL-2). GSK further isolated JL-major in chicken embryo fibroblasts, from the Merck M-M-R II vaccine, and uses it to seed the RIT4385 vaccine (Priorix®).[1] The clinical significance of these vaccine viruses is unknown.

Other attenuated mumps strains have been used in mumps and MMR vaccines, but some have been withdrawn due either to rare adverse events or lack of efficacy.[1]

- Urabe Am9 - in use worldwide (Trimovax, Imovax mumps, Sanofi)
- Rubini – withdrawn (Triviraten, Berna Biotech)
- Leningrad-Zagreb (L-Zagreb) – available in India, South America and Eastern Europe (Trisivac, Serum Institute India and Institute of Immunology of Zagreb).

New Zealand primarily used M-M-R II on the Schedule until 2017 when it was replaced by Priorix. Priorix was also available for private purchase.

Epidemiology

Historically, mumps occurred mostly in children aged 5 – 9 years but the average age of cases gradually increased to 15 years and older with widespread use of mumps vaccine.[1]

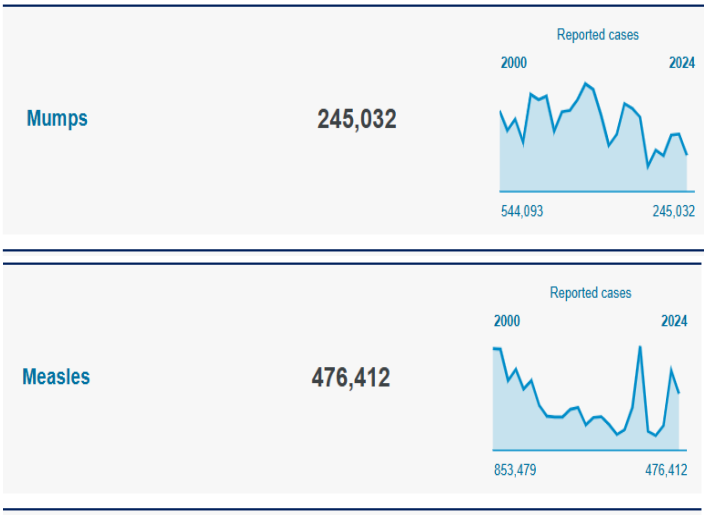
Before the introduction of MMR in 1990, mumps epidemics occurred in New Zealand every three to five years.[2] MMR had been doing a good job at preventing mumps, from an epidemic in 1994 until the most recent epidemic in 2017 – 2019. Outbreaks have been associated with international travel but identifying chains of transmission is challenging with a high proportion of asymptomatic infections.

Global risk

Global incidence rate for notified mumps cases in 2024 was 67.2 per million total population. Of the 245,032 reported cases, 105,587 occurred in the Western Pacific Region with a similar incidence rate to the global rate (64.5 per million). Unlike measles, with a sharp decline in cases but more recent epidemics, the cases of mumps continue in 3 – 5-yearly epidemic patterns (see Figure 1). However, since mumps can be a benign disease or asymptomatic, this is likely to be a significant under-

estimate particularly for countries where mumps is a common childhood disease and not notifiable. Data from low and middle-income countries is sparse.[4]

Figure 1: Reported cases of mumps and measles worldwide, in 2024 and pattern between 2000 - 2024 (WHO)



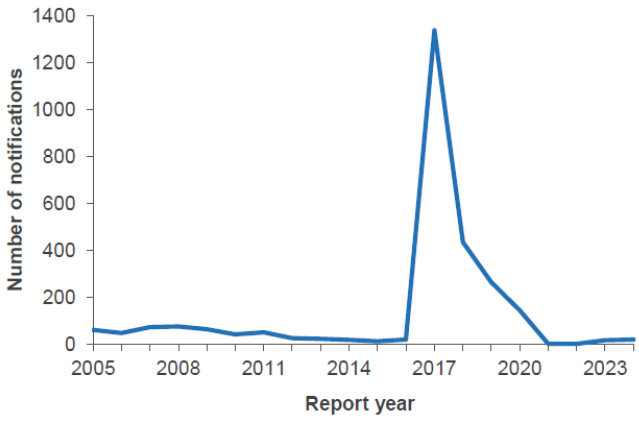
Source: https://immunizationdata.who.int/

Many high-income countries have reported emergence of large outbreaks of mumps, including in fully vaccinated adolescents and young adults, which have been associated with low historical MMR coverage, mismatched immunity with circulating virus or waning immunity.[6-10] Reduced but not interrupted circulation of mumps virus can result in adults with low immunity and greater risk from infection.[4] WHO recommends that mumps vaccine be introduced only where a high MMR vaccination coverage can be achieved (>80%).[4]

New Zealand mumps epidemic 2017 – 2019

Between January 2017 to December 2019, there was a large epidemic of mumps with 1,772 cases. The highest notification rates were in adolescents and young adults aged 14 – 29 years, predominantly in the Auckland region.

Figure 2: Mumps cases notified from 2005 to 2024 (source PHF Science)



The outbreak peaked in 2017 at 1,338 cases (rate of 27.9 per 100,000) and gradually decreased from 435 to 144 cases between 2018 – 2020 (as shown in Figure 2). It abruptly stopped in 2021 following COVID-19 pandemic control restrictions, with only one case per year in 2021 and 2022.[11]

During 2017, notification rates were the highest for adolescents aged 15 – 19 years (at 111.5 per 100,000), followed by young adults aged 20 – 29 years (66.3) and children aged 10 – 14 years (55.1).[12] By prioritised ethnicity, Pacific peoples

had very high notification rates (235.7 per 100,000), followed by Asian (26.8), Māori (25.2) and Middle-Eastern/Latin American/African (MELAA, rate 24.3).

It should be noted that many Pacific people, particularly those born in Western Pacific countries such as Fiji, may not have mumps immunity because these countries only have or until recently only had measles-rubella (MR) vaccines, not MMR, despite mumps being endemic.

Notification rates were greatest in Auckland (Counties Manukau, Auckland and Waitemata districts), but high rates of cases were also seen in Southland (48 cases) and Waikato (77 cases). The rate in males was slightly higher than for females (29.9 vs 25.9 per 100,000). Vaccination status was known for 802 cases (60%), as shown in Table 1. A high proportion of cases aged over 10 years had received at least one dose of vaccine (77%) or two doses (78%).[12]

Table 1: Mumps cases notified from 2017, by age group and vaccination status (source ESR)

Age group	Total cases	One dose	Two doses	Vaccinated (no dose info)	Not vaccinated	Unknown
<15 months[a]	9	0	0	0	9	0
15 months–3 years	37	16	4	0	11	6
4–9 years	119	10	74	1	19	15
10–19 years	527	46	181	2	126	172
20+ years	645	30	97	12	164	342
Total	**1337**	**102**	**356**	**15**	**329**	**535**

[a] Children aged less than 15 months are ineligible for vaccination.

In summary, with high MMR vaccine coverage in young children, early childhood education centres and primary schools were largely spared from outbreaks. Most cases occurred in high school students and young adults socialising in crowded spaces.

Recent New Zealand epidemiology

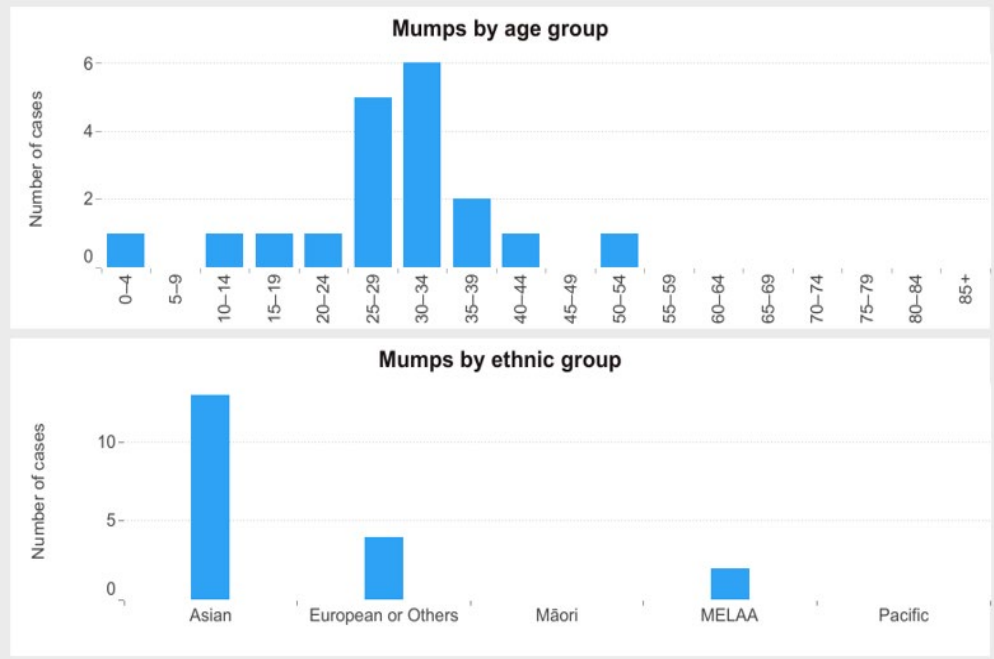
In the absence of declared outbreak, diagnosis and notification of mumps is likely under reported. Milder cases are difficult to diagnose, with a large differential diagnosis. Cases that present outside of the 9-day window for PCR testing require serology testing that adds further to the uncertainty and delay in diagnosis. With a long incubation period, small outbreaks can continue to spread undetected.

Nineteen cases of mumps were notified in 2024 (rate of 0.4 per 100,000 respectively).[11] As shown in Figure 2, six cases were aged 20 – 29 years (rate 0.9 per 100,000) and eight cases aged 30 – 39 years (1.0 per 100,000). By ethnicity, 13 were Asian, four European or Other and two MELAA. One of the notified cases was hospitalised but another 12 cases were recorded by ICD-10 coding as having mumps as the principal diagnosis in hospital.[11]

It should be noted that many people, particularly children, born in from Western Pacific countries such as Fiji may not have mumps immunity because they only have or until recently only had measles-rubella vaccines, not MMR, despite mumps being endemic.

Vaccination status was known for 10 of the 19 cases: four were unvaccinated (including an infant too young to be vaccinated), two had received one dose of mumps vaccine, three had received two doses, and one vaccinated case had received an unknown number of doses. No cases were aged 1 – 4 years. The nine cases with unknown vaccination status were all aged over 20 years.[11]

Figure 3: Number of mumps cases reported in 2024, by age and ethnicity. (Source PHF Science, Notifiable diseases dashboard)



In 2025, 20 cases of mumps were notified but no further details have been published yet. For the latest notifiable disease reports see the PHF Science digital library.

Evidence is yet to emerge as to whether changing the immunisation schedule in 2020, from age 15 months and 4 years to age 12 and 15 months, will impact on the duration of protection against mumps and increase the risk for mumps cases to shift from young adults to younger adolescents.

International immunisation schedules and recommendations.

The following reviews recommendations for mumps immunisation in selected countries. Most recommendations focus on the use of MMR for measles immunity rather than for mumps and rubella. There is no evidence that any countries explicitly recommend additional or third doses of MMR in adolescents, except where MMR is given as a targeted dose during mumps outbreaks, alongside active catch-up programmes for those who have not received two MMR doses previously. See Table 2 for some of the international recommendations.

Table 2: International schedules and recommendations for mumps (MMR) immunisation

Country	Presumed natural immunity to mumps if born before:	Routine schedule	Additional doses / outbreak response	Vaccine
NZ	1981	12 + 15 months	Catch up only	MMR
Australia	1966	12 + 18 months	• Aged <20 years catch up • Adolescents and adults at risk of infection during outbreak can be given a 3rd dose to maintain protection.	MMR then MMRV
UK	1980	12 + 18 months	Catch up only	MMR or MMRV
Canada	1970	12-15 months + from 18 months (no later than school entry, age 4-6 years)	Catch up, no evidence of mumps immunity: • adults born from 1970 – 1 dose MMR • students in tertiary settings born from 1970 – 2 doses MMR • students born before 1970 – 1 dose MMR • military personnel – 2 doses regardless of birth year • travellers - 1 dose if born prior to 1970; 2 doses, if born since 1970 Outbreak setting – additional dose (up to 3rd dose) may be considered for close contacts following exposure.	MMR or MMRV
Ireland	1988	12 months (at GP) + 4-5 years (at school)	Catch up recommended – particularly for students and health care workers	MMR
US	1957	12-15 months + 4-6 years (prior to school entry)	• Adults - no recommendation for two-dose catch up if born prior to 1989 • Two doses recommended for special populations at increased risk: college students, international travellers, all healthcare personnel (regardless of age, if lack laboratory evidence of immunity) • 3rd doses for groups at risk during mumps outbreaks.[13]	MMR or MMRV

Sources:

- https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/mumps#recommendations
- https://www.gov.uk/government/publications/mumps-the-green-book-chapter
- https://www2.hse.ie/conditions/mmr-vaccine/
- https://www.cdc.gov/mumps/hcp/vaccine-considerations/index.html
- https://www.cdc.gov/mumps/hcp/vaccine-considerations/specific-groups.html

European schedules

https://vaccine-schedule.ecdc.europa.eu/

Most European countries administer mumps vaccination from age 12 months with a second dose either between ages 15–18 months or as a preschool or primary school dose (various ages from 3 to 7 years). A few countries offer the second dose at age 11 or 12 years.

Germany offers one dose of MMR to those aged over 18 years born since 1970 who were previously unvaccinated, with uncertain vaccination status or only received one dose of MMR in childhood.

Most European countries offer MMR catch-up for adolescents or adults, including Latvia where two doses are mandatory for those not previously vaccinated.

Review of recent literature

The following is a review of selected literature on MMR vaccine and mumps vaccination published predominantly between January 2018 and July 2026. Some earlier papers are also included where the evidence supports the questions being asked for this review. See **Summary of evidence** tables for further details of the studies presented.

Vaccine safety

The Jeryl-Lynn (JL) strain-based mumps vaccines (M-M-R II and Priorix) have excellent, well-established safety profiles – infrequent adverse effects are like those of the wild-type virus such as parotitis and more rarely, orchitis and pancreatitis. Although some other vaccine strains are more immunogenic and induce better immunity, they are also associated with stronger reactogenicity and adverse events, such as aseptic meningitis, that are not associated with JL-based vaccines.[14] Allergic reactions to gelatine (an excipient of M-M-R II) have been reported and a history of severe gelatine hypersensitivity is a contraindication to this vaccine. Egg allergy is not a contraindication.[1]

Vaccine safety in immunocompromised individuals

Generally, live viral vaccines are contraindicated for individuals who are immunocompromised due to immunodeficiency or receiving immunosuppressive treatments. In some cases, particularly in outbreak situations, the risk from the disease outweighs the risk from the attenuated vaccine virus.

A small multicentre study in Germany investigated the safety of MMR in 22 children and adolescents aged 1 – 18 years with stable inflammatory bowel disease receiving immunosuppressive treatments or liver transplant recipients without rejection.[15] Decision to vaccinate was determined using an immunological-based prevaccination checklist that classified pharmacological immunosuppressants into three intensity categories (low, medium and high intensity immunosuppression) and included evaluations of laboratory tests to determine the individual's immune function and reactivity. When MMR was administered according to this risk assessment, the incidence of adverse events (AE) was low and within expected rates: three AE were reported after dose 1 was given to 15 recipients: with one case each parotiditis, injection-site inflammation and generally feeling unwell. One case out of seven who received dose 2 reported fatigue and muscles aches. No severe adverse events were reported – noting that the number included in this study was small.[15] It was concluded that MMR can be administered to measles-naïve immunosuppressed children on a risk-benefit basis using immunological parameters, rather than by type of immunosuppressive medication, regardless of underlying disease. Whether these same parameters apply to mumps was not indicated. Theoretically, they could be applied but noting that the risk from mumps infection may not be as severe as for measles.

Summary

The safety of MMR is well established. Limited current literature and no new safety concerns were found in relation to the Jeryl-Lynn mumps component.

Immunogenicity

Summarised from Plotkin's Vaccines,[1] mumps vaccination induces early IgM followed by mumps-specific IgG and neutralising antibodies. Overall, immunogenicity remains lower than after wild-type infection and varies with age and immune maturity. Although mumps antibody seroconversion rates with current MMR vaccines are high, at around 98% after two doses, the magnitude and durability of the responses vary with age and are lower than for measles, particularly in infants aged under 6 months (who are not routinely recommended MMR). Primary vaccine failure occurs in a small proportion of recipients at approximately 5% after dose one, but this is unlikely to be a major driver of outbreaks when two-dose coverage is high.[1]

Secondary vaccine failure is more difficult to decipher. While vaccine effectiveness clearly declines with time since vaccination, viral shedding in breakthrough cases does not appear to correlate with time since immunisation. This complicates attempts to link waning immunity to susceptibility, infectiousness or transmission risk.[1]

See **Table 4** for details of the studies included below.

Duration of immunity

Evidence for waning immunity is consistent, although interpretation is constrained by the absence of a definitive correlate of protection for mumps. Without a clearly defined correlate of protection, immunogenicity data cannot be directly translated into vaccine effectiveness or duration of protection. Mumps-specific IgG declines at similar rates to measles antibody but starts at lower levels, such that, marginal seropositivity is reached after around 12 years, whereas measles antibodies remain protective over a longer period.[1] Declining mumps antibody levels have been reported within 10–15 years of a second dose of MMR despite high initial seroconversion rates.[16-18]

Cellular immunity persists for decades, yet its contribution to protection is poorly defined, and natural infection generates more robust polyfunctional T-cell responses than vaccination.[1] The duration of cellular immunity, as determined by assays to measure mumps-specific lymphoproliferation and cytokine responses from peripheral blood cells, lasts longer than mumps-specific IgG.[19]

Large mumps outbreaks continue to occur in communities with high vaccination coverage (>90%), suggesting a degree of asymptomatic transmission between vaccinated individuals. Available evidence indicates that MMR vaccination does not induce sterilising immunity against mumps; one study found that the viral load in saliva was no different between vaccinated and unvaccinated infected children.[1]

Seroconversion and annual exponential waning rates of humoral (antibody) immunity against measles, mumps and rubella were assessed in a systematic review and meta-analysis by Schenk et al (2021), which included 62 studies published up to December 2019.[20] Both primary and secondary vaccine failures were observed for each of the MMR components and with the different MMR vaccines. Seroconversion rates did not differ significantly between the first and second doses and were independent of age at vaccination (8 months to 44 years). Seroconversion rates were slightly lower for the mumps component (93%; 95% CI 91-92%) than for the measles (96%; 95-97%) and rubella (98%; 97-99%) components. Estimated annual exponential waning rate suggested that mumps antibody waned twice as fast as measles and rubella antibodies.[20] Additional doses induce a booster response to restore mumps antibody levels.[18]

Two Finnish studies examined mumps immunity in two groups of 183 young adults over 20 years after completing a two-dose MMR schedule, with doses administered at ages 18 months and 6 years, or at 6 years and 11–12 years of age.[19, 21] Mumps antibody showed greater waning than measles and rubella antibodies. From a subgroup of 58 people, 74% remaining seropositive to mumps 13 – 15 years after dose 2, compared with 95% and 100% for measles and rubella, respectively.[21] From 50 samples, no correlation was seen between mumps-specific antibody titres and cellular responsiveness (as indicated by lymphoproliferation or cytokine production assays).[19] Despite greater antibody waning in vaccinated individuals, cellular immune responses were similar in 50 vaccinated and 11 naturally immune participants, with 96%-100% showing a significant lymphocyte response to mumps antigen. All participants with negative antibody levels demonstrated a measurable cellular response.[19]

This is an important finding. As mumps is an intracellular infection, by inducing a cell-mediated immune memory, vaccine-induced cellular immunity is likely to last longer than detectable serum antibody levels suggest.

Age-dependent waning aligned with disease patterns of frequent mumps outbreaks in adolescents in South Korea.[22] Based on a serosurvey conducted in 2019 in South Korea, the duration of two-dose MMR vaccine-induced antibody immunity was estimated to be 19 years for measles, 9.7 years for mumps and 31.6 years for rubella, when equivocal results were considered to be negative. Longer durations of protection were estimated when equivocal results were positive – up to 15 years for mumps and 27.3 years for measles and almost 40 years for rubella. Due to the increased risk of mumps in young male adults, an additional dose MMR is mandated for military service in South Korea.[22]

A phase 3 clinical conducted by GSK following children for 10 years after one or two doses of MMR (Priorix) or MMRV (Priorix-Tetra, containing varicella vaccine) found that unlike measles and rubella IgG antibody geometric mean concentrations (GMCs), which declined moderately, anti-mumps IgG remain fairly stable over 10 years with seropositivity rates ranging from 86% - 100% throughout the study and rates of at least 90% at 10 years. Although these seropositivity rates were generally lower than for measles and mumps at ≥94% and ≥96.6%, respectively, seroprotection against mumps was maintained at year 10 across all groups. A second dose, regardless of whether it was given 42 days or 4 – 10 years after dose one, boosted mumps antibody titres and seropositivity rates. A second dose had less of an impact on measles or rubella seropositivity rates, which were already high. After the second dose, given at any time point, seropositivity peaked at 97.8% and 100% for the MMRV and MMR groups, after which the mumps antibody GMCs appeared to return to the post-dose 1 levels.[23] The ability to boost the mumps response suggests robust immune memory and supports a role for two or more doses.

Summary

Serological measures alone may underestimate long-term protection after mumps vaccination. Mumps antibody immunity wanes over 10 – 15 years following MMR vaccination, but durable cellular immune memory persists for more than 20 years and likely contributes to ongoing protection. One study found that MMR antibody levels remained relatively stable for 10 years after vaccination in most individuals but drop below theoretical seroprotective threshold faster for mumps than measles and rubella antibodies. Robust immune memory has been shown with the use of second and additional doses.

Immunity against different genotypes

Antigenic differences between vaccine strains (typically genotype A, Jeryl Lynn–derived) and circulating wild-type strains (e.g., genotype G) further complicate secondary vaccine failure.[24] These differences do not represent complete antigenic mismatch but do reduce antibody potency and may contribute to breakthrough infections in individuals with declined immunity, especially in settings with high and prolonged exposure such as university campuses where inoculum loads can overwhelm partial protection.[1] Despite this, vaccination remains effective at controlling outbreaks. The predominance of vaccinated cases during outbreaks largely reflects high population coverage rather than vaccine failure.

A New Zealand-based investigation, using viral isolates collected during the 2017 mumps outbreak, showed that genetic drift in the circulating genotype G mumps virus led to changes in epitopes. In conjunction with waning immunity against conserved epitopes, these genetic changes could be responsible for genotype A vaccine-induced immunity dropping below the threshold required for protection in vaccinated individuals.[5]

Overall, the interplay between waning antibodies, incomplete correlates of protection, antigenic variation, and unmeasured immune mechanisms (e.g., antibody-dependent cellular cytotoxicity, complement-mediated lysis, Fc-mediated phagocytosis) underscores the limitations of current immunogenicity data and the need for more precise markers of durable protection.[1] Questions persist about the quality of vaccine-induced B-cell memory; the limited opportunities for exogenous boosting in highly vaccinated populations; the impact of parenteral vaccination compared with mucosal immunity induced by infection; and the immunogenicity of different vaccine virus strains.[1]

New mRNA-based vaccines could help improve the match between the vaccine virus and wild-type genotypes, as well as provide safe vaccination for immunocompromised groups, but currently, the research interest is around measles not mumps vaccinations.[25] However, it is unclear whether the mismatch is actually contributing to vaccine failure.[1] Without a correlate of protection, it is difficult to predict the efficacy of new vaccines.

Role of an additional dose of mumps vaccine

As described above, a New Zealand-based investigation showed that genetic drift in the circulating genotype G mumps virus led to changes in epitopes.[5] Boosting antibody levels against conserved epitopes, to increase the immunological pressure with an additional dose of MMR, could overcome heterogenous genotype differences.[5]

Students aged 18 – 25 years who had received an additional dose of MMR, on average 13 years after dose 2, had a lower risk of mumps during an outbreak in the Netherlands than those who had only received two doses given routinely at ages 14 months and 9 years.[26] Vaccine-strain IgG and virus neutralising antibodies against vaccine strain (genotype A) and outbreak strain (genotype G) were assessed at 4 weeks, 1 year and 3 years after dose 3. Participants with the lowest baseline showed the greatest increases in mumps antibody. Mumps IgG antibody rose in the first 4 weeks after dose 3, declined steeply by 1 year and then more gradually in years 1 – 3. Neutralising antibody declined less and stabilised from year 1 to 3 years.[26] At 3 years post MMR3, the level of seroprotection was marginally higher than at baseline (87% vs 81%) and was estimated to be close to the herd immunity threshold of ≥86%, to limit widespread transmission and reduce a mumps outbreak. The findings suggested a benefit of giving MMR doses early in an outbreak in high-exposure settings.[26]

Summary of immunogenicity

Mumps vaccine-induced immunity differs from measles and rubella vaccines in that antibody responses are generally lower initially and wane more rapidly over time. Although seroconversion rates after two doses of MMR are high (approximately 93%–98%), mumps-specific antibody levels commonly decline within 10–15 years, and estimated waning rates are faster than those for measles and rubella.

Without a defined correlate of protection, it is difficult to determine when declining antibody levels translate into loss of clinical protection. Primary vaccine failure is uncommon after two doses (less than 2%), but secondary vaccine failure is increasingly recognised as immunity declines in adolescence and young adulthood. Secondary vaccine failure is less well understood and may be related to declining antibodies against the Jeryl-Lynn vaccine strain.

Immunological factors suggested to contribute to outbreaks include:

- Antibody levels wane below a protective threshold faster for mumps than measles and rubella antibodies.
- High vaccination coverage does not prevent all outbreaks, suggesting that vaccine-induced immunity is non-sterilising and that asymptomatic transmission between vaccinated individuals can occur in settings with high risk of exposure, such as close communities.
- Antigenic mismatch between vaccine and circulating strain is accentuated by depleted antibody against conserved epitopes.

These findings support the use of targeted booster doses in high-risk settings, while highlighting the need for better correlates of protection and improved understanding of the relative contributions of humoral and cellular immunity to long-term protection against mumps.

The role of cellular immune memory is unclear, but additional doses of vaccine induce an anamnestic response, suggesting a role for memory T and B cells. To combat waning immunity, either a stronger initial immune response is required with improved antibody avidity and memory B cell response, which needs to be balanced against the risk for adverse events such as aseptic meningitis. Alternatively, an additional vaccine dose is needed to boost existing immunity, ideally, before seroprotection is lost or an outbreak occurs.

Impact of vaccination and duration of protection

There is no question that mumps vaccines have reduced the burden of the disease, especially in the youngest age groups and in the frequency of outbreaks, but sporadic outbreaks still occur. Many outbreaks affect adolescents and young adults more than young children, despite previous vaccination. But gaps in immunity, rather than waning immunity, are associated with hospitalisations during outbreaks.[27]

New evidence detailing vaccine effectiveness is very limited since short-term effectiveness is well established. The following reviews current evidence examining the impact of MMR vaccination on outbreak control and duration of protection. See **Table 5** and **Table 6** for details of the studies presented.

Impact of MMR during outbreaks

Cases of mumps in fully immunised individuals have challenged the assumption that live attenuated mumps vaccines induce life-long protection. Connell et al (2020) investigated the impact of mumps

vaccination and identified several factors that interplay in association with mumps outbreaks in highly vaccinated populations (see Figure 4).[28]

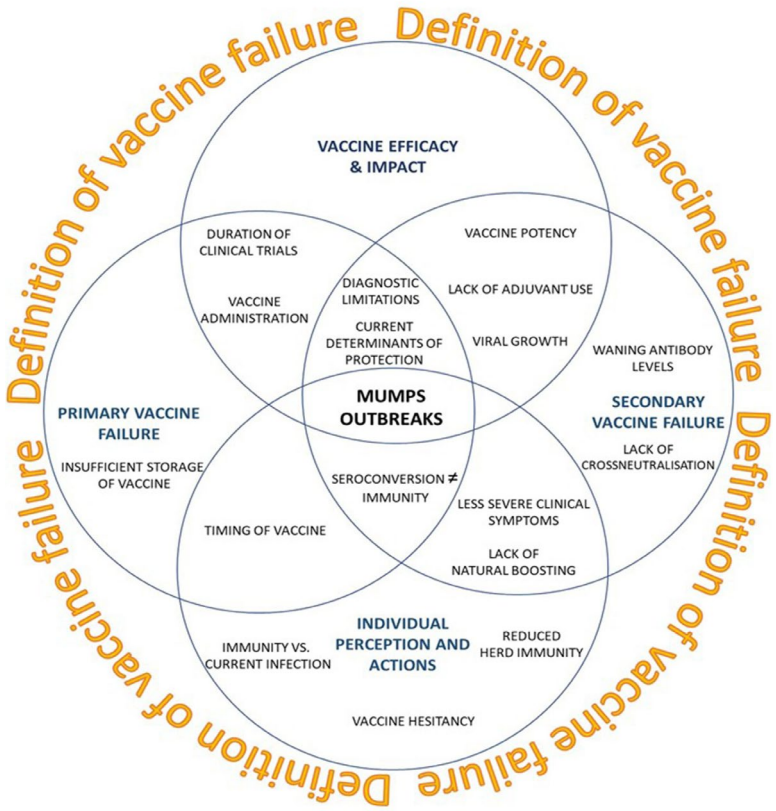


Figure 4: Current perspectives on recent mumps outbreaks seen in vaccinated populations (blue circles) (Connell et al 2020, open access)

As discussed in Plotkin's Vaccines, the two-dose MMR programme was primarily established for measles protection, but two doses of MMR are also more effective than one dose against mumps.[1] Key points presented are given below.[1]

- The attack rates in fully immunised populations during mumps outbreaks were around five to 10-times less than in unvaccinated people (2% – 8% vs 25% – 49%).[1]
- Data from outbreaks show that mumps immunity is likely to have limited the outbreak spread.
- Mumps vaccination reduces severity of symptoms.

Examples include a summer camp outbreak in New York, in which the frequency of orchitis in males reduced from 11% in unvaccinated to 4% in vaccinated adolescents.[1] Similar observations have been reported in the Netherlands and Taiwan, with reduced risk for complications and hospitalisations. Other studies have not found vaccination status to be associated with complication prevalence or severity.[1]

During an outbreak in England and Wales in 2004 – 2005, people who had received at least one dose of MMR were significantly less likely to be hospitalised. After adjusting for age and sex, the risk of hospitalisation was reduced by 44%, hospitalisation with orchitis by 28%, and hospitalisation with meningitis by 72%. The risk was reduced even further among those who had received two doses of

MMR. During this outbreak, it was estimated that 6% of cases were hospitalised and over 4% had orchitis (though these were predominantly in the older cohort not eligible for MMR).[29]

Conversely, by attenuating symptoms, vaccination may increase the number of asymptomatic infections (from 15% – 40% in unvaccinated individuals compared with 66% of vaccinated cases) from which transmission can occur.[28]

Summary

Immunity from two doses of MMR can attenuate disease symptoms, particularly complications such as orchitis and meningitis. It also limits the spread of mumps during outbreaks but asymptomatic infections in immunised people can still occur.

Duration of protection

Analysis of an outbreak in Ireland during August 2018 to January 2020 found that the time since the last dose of MMR, as well as low vaccine uptake, may have influenced the spread of the outbreak by highly mobile young adults. With 3,736 confirmed and probable cases, the highest rates of cases were in 15 –19- and 20–24-year-olds and more than half of cases were within tertiary and secondary educational settings (see Figure 5).[6] Vaccination status was recorded for 32% of cases (1,199/3,736). Of these, 72% had received two doses of MMR, 16% one dose and 12% were unvaccinated. Twelve cases had received a third dose. Figure 6 shows the time between the last dose of MMR vaccination and the onset of disease for 618 cases with recorded vaccination dates (excluding unvaccinated cases).[6] The analysis showed that although just over half of these cases (52%) had received two doses of MMR, the majority were 13 – 17 years since their last dose.[6] Unfortunately, it was not possible to estimate vaccine effectiveness due to incomplete vaccination information for a majority (68%) of the cases.

Figure 5: Age-specific incidence rates of mumps notifications in Ireland, 2018 - 2020 (total 3,736 cases) (Ferenczi et al 2020, open access)

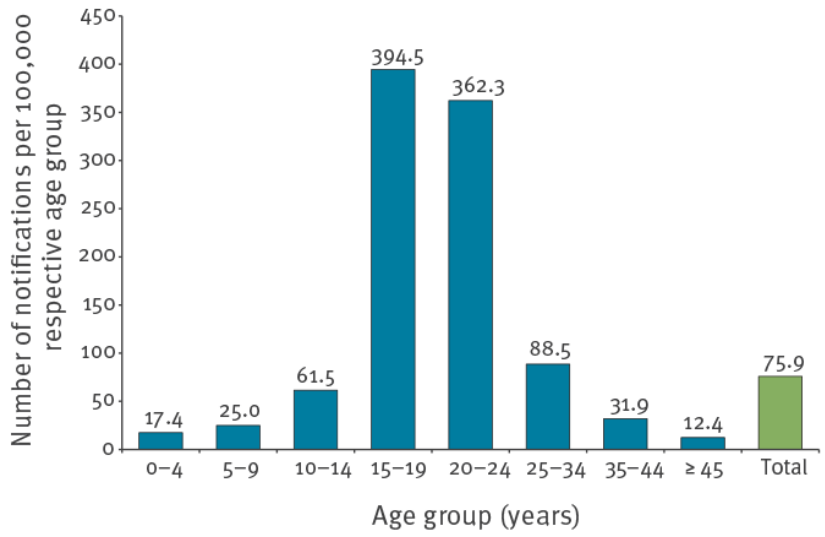
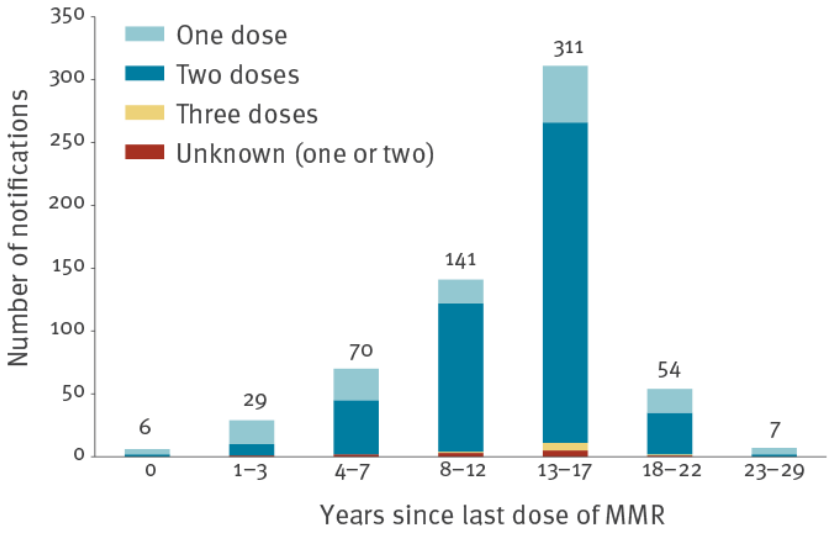


Figure 6: Years between the receipt of the last dose of MMR and onset of disease, by doses of MMR, during a mumps outbreak in Ireland, 2018-2020 (n = 618) (Ferenczi et al 2020, open access)



Three distinct outbreaks occurred during 2017–2018 in Queensland, Australia within large, high-density living situations: a correction facility, a boarding school and within a discrete Indigenous community.[9] Of 93 cases, 74 (79.6%) were fully vaccinated with MMR and 14 cases (15.1%) were partially vaccinated. Most of the cases (92.5%) were Aboriginal and Torres Strait Islander peoples. The overall attack rate was 41.6 (95% CI 33.3 – 49.8) per 1,000 population. The highest attack rates were seen in those aged 20–24 years (156 per 1,000; 84 – 229) and those aged 15–19 years in the correctional facility (200 cases per 1,000; 25-556).[9] The time since the last dose of MMR was significantly shorter for the cases than controls (3.0 vs 4.1 years, p = 0.01). However, this study also raised a concern about the spacing between dose one and two. For those born prior to March 2000, the spacing between doses for the cases was significantly shorter than for the controls (3.6 vs 5.9 years, p = 0.0003). For those born after March 2000, when the schedule changed to 6 months between dose one and dose two (at age 12 and 18 months), the average spacing for cases was 2.6 years and 2.9 years for the controls – highlighting issues with timeliness of dose two.[9] Further investigation would be needed to determine whether there was an optimum gap between doses for long term protection.

During an earlier Australian outbreak of 893 cases in Western Australia, 798 (89%) were Aboriginal people aged under 35 years from sparsely populated regions (age cohorts born since MMR vaccination had begun in 1981 in Australia).[10] The high mobility over very large distances within and between communities was likely to have contributed substantially to the transmission of mumps during this outbreak despite very low overall population density. The peak age of cases was 15–19 years, in a highly vaccinated population (with 89% of those aged 1–19 years were fully immunised and 7% were partially vaccinated). The proportion of mumps cases increased with time since dose two, peaking at 16 – 18 years post vaccination but from 7 – 9 years post vaccination the proportion of cases had remained steady. There was a sharp decline in the proportion of mumps cases at 19 – 21 years post dose two.[10] All of the cases were caused by genotype G mumps virus and none of those who had been infected previously with genotype J in a 2007–2008 outbreak was renotified.

Waning immunity and the time since the last dose of MMR was also identified as a risk factor for an outbreak of 259 cases of mumps at the University of Iowa in 2015–2016 in which 98.1% of students

had received two MMR doses (as mandated).[30] Across all 20,496 enrolled students, the attack rates of mumps were lower in students who had received MMR less than 12 years prior compared with previously vaccinated at least 13 years ago. Compared with those with less than 2 years since MMR dose two, the risk was much higher for those with a gap of 13 – 15 years and 16 – 23 years: attack rate per 1,000 population was 1.6, 11.3 and 17.6, respectively.[30]

Summary

The limited evidence suggests that MMR vaccination protects against mumps hospitalisations of adolescents and young adults. But outbreaks occur in well vaccinated populations, particularly when more distal to their last vaccine dose. Despite this, a history of two doses of MMR does appear to reduce attack rates for symptomatic disease, curtails outbreaks, and is likely to reduce the odds of being hospitalised with mumps-related complications. However, with a longer gap between MMR2 and an outbreak, the risk of secondary vaccine failure increases. This suggests that offering additional MMR vaccination (MMRn) in high-risk settings could be a useful public health intervention.

Additional doses of MMR in adolescents and young adults

As demonstrated in the immunogenicity section, an additional dose of MMR boosts mumps immunity in fully immunised adolescents and young adults. The impact of this on mumps outbreaks and individual risk is presented below. See **Table 6** for further details of these studies.

A meta-analysis of 30 studies, reporting over 50,000 mumps cases in more than 21 countries, found that the attack rate during mumps outbreaks was around 13% – 16% and highest in adults at 32%.[27] Among those who were vaccinated, attack rates were highest for those given a single dose of mumps vaccine (36%) and lowest for those who had received three doses (10%).[27] Despite substantial heterogeneity between studies, the review concluded that a third/additional dose should be considered in countries with an established two-dose mumps vaccination programme to mitigate outbreak severity and complications such as orchitis, particularly in higher risk groups.[27]

An additional dose of MMR was given to the target populations as part of a public health response in Queensland during the three outbreaks mentioned above (i.e. to those aged 8–52 years in a close-knit Indigenous community, an entire correctional facility population and boarding school students). This reduced the attack rate of mumps by one third, from 31 cases (95% CI 24.2 - 39.0) to 10.6 cases (95% CI 6.7 - 15.9) per 1,000 population, and significantly assisted in containment of these outbreaks.[9]

A third dose of MMR was used in a university outbreak in Iowa during 2015–2019.[30] The risk of mumps was 78% lower in those who received a third dose at university than for those who had only had two doses (adjusted hazard ratio 0.22; 95% CI 0.12 - 0.39). The estimated vaccine effectiveness was 60% (28% – 74%) after 7 days and 78% (61% – 88%) at 28 days post-vaccination. The study concluded that improved outbreak control was achieved with a third dose of MMR and that waning immunity was likely to have propagated the outbreak in this well vaccinated population of young adults.[30]

On further investigation of the University of Iowa outbreak, one study found that while vaccination played a role in improving protection against mumps, the overall impact was modest. A mathematical modelling study examined the population impact of the third MMR dose during the

Iowa outbreak by timing of vaccine administration and coverage.[30, 31] It compared a daily time series of reported mumps cases and the number of MMR doses. The model found that vaccine effectiveness was overestimated because the earlier study[30] did not consider the forces of infection, between those who received three doses and those who did not, and the role that major holidays (Thanksgiving, Christmas and Spring Break) played in slowing the outbreak. The estimated vaccine effectiveness of the third dose was 47% (95% CI 14% – 87%) and reduced the outbreak size by an estimated 4.5% (0.2% – 20.8%). However, vaccination may have been introduced after the peak in the number of infections (80 days after the first cases with 23% coverage). According to the modelling, if the vaccine had been introduced sooner in the outbreak, with 20% coverage, the outbreak size could have been reduced by an estimated 6% (4% – 14%) and with 80% coverage by 32% (25% – 46%).[31] It was concluded that by offering additional doses of MMR early in an outbreak, mumps transmission can be limited even at low coverage levels.

Summary

Evidence suggests that administering an additional MMR dose before or early in an outbreak, including to adolescents and adults who have already received two or more doses, can reduce mumps transmission, limit outbreak size and lower the risk of complications, particularly in close-contact communities.

Summary of evidence

Table 3: Vaccine safety

Outcomes	Ref	Participants / study design	Results	Findings
Children				
Immunocompromised children	15	Prospective multicentre observational study, 22 children and adolescents (age 1 – 18y), incomplete vaccinations – inflammatory bowel disease and post liver transplant. Questionnaire used to assess AEFI after dose 1 and 2.	Immunological-based prevaccination checklist: • classified pharmacological immunosuppressive therapy (IST) – low, medium and high intensity, based on drug class, dosage and blood levels for certain drugs. MIIST - azathioprine, everolimus and tacrolimus up to specific dose limits. HIIST - use of biologics (e.g. adalimumab, infliximab) All other if not listed as contraindicated - LIIST • Immunological pretesting – activity of underlying disease and intensity of IST. (leukocyte and lymphocyte counts, serum IgG, T-cell function (using TB IGRA test). Rate of vaccine-related AE: 20 per 100 doses. • Dose 1 – 3/15 (20%) – parotiditis, injection site inflammation, generally feeling of illness – no medical treatment required • Dose 2 – 1/5 (20%) - fatigue/aching limbs – no medical treatment required	MMR vaccination was safe and effective (against measles) during immunosuppressive treatment of children with IBD in remission or post liver transplant without rejection. Administering MMR on a risk-benefit basis in measles naïve children can be based on immunological parameters, rather than type of immunosuppressive medication, regardless of underlying disease.

Abbreviations: AE – adverse events; AEFI – adverse events following immunisation; HIIST – high intensity immunosuppressive therapy; IBD – inflammatory bowel disease; IST - immunosuppressive therapy; TB IGRA – tuberculosis interferon-gamma release assay; MMR – measles, mumps and rubella vaccine

Table 4: Immunogenicity and seroprevalence

Outcomes	Ref	Participants / study design	Results	Findings
Genotype G genome sequencing, NZ	5	Two samples taken in NZ during 2017 were compared with vaccine virus using a modified RT-PCR for whole genome sequencing	• Genetic drift had occurred in Genotype G mumps virus • Epitope differences in haemagglutinin-neuraminidase were shown between vaccine virus (genotype A) and the circulating virus	Insufficient levels of antibodies targeting conserved epitopes may result in immune escape of genotype G circulating virus. An additional dose of MMR could allow sufficient antibody to prevent infection of heterologous serotypes.
Immunogenicity and persistence	20	Systematic review / meta-analysis, 62 studies for analysis. Published in English up to Dec 2019.	Overall estimated seroconversion rates after vaccine dose • Measles: 96.0% (95% CI 94.5-97; I2 = 91%) • Mumps (exl Rubini strain): 93.3% (91.1-95.2; I2= 95%) • Rubella 98.3% (97.3-99.2, I2 = 97%). • No significant difference in seroconversion rates between first and second doses and were independent of age at vaccination (8m – 44y) • No regional differences • No difference between mumps vaccine strains when Rubini was excluded (p=0.66) Overall estimated annual exponential waning rates: • Measles: 0.009 (0.005-0.016) • Mumps: 0.024 (0.016-0.039) • Rubella: 0.012 (0.010-0.014) Extrapolated from Figure S12 in appendix (too expensive for copyright licence) • After 15 years, ~50-80% would remain seroconverted against mumps from 100% after single dose • After 20 years, ~40-50% would remain seroconverted from 100% • Mumps antibody wanes faster than measles ~80% seroconverted after 15 years	Based on humoral immunity alone, primary and secondary vaccine failures exist for the individual components and between MMR vaccines. Seroconversion rates for mumps are marginally less than for measles and rubella and immunity seems to wane twice as fast.
Antibody persistence	17	(Included in SR above). Children (n=308) enrolled in 1994-1995 in rural Wisconsin, US, vaccinated MMR2 age 4-6y, compared with older cohort of children (n=308) vaccinated at age 9-11 years. MMR1 given to both groups at age 1 year.	Prior to MMR2 – none of younger group were seronegative but 16% had lowest detectable titre. Following MMR, 3% had low titres. After 12 years, titres halved and proportion with low titres were not different to pre-MMR2; 5% seronegative. Older groups showed similar pattern at age 17y with comparable antibody titres to younger group. Both groups likely to have been exposed to circulating mumps.	Over 12 years, mumps antibody declines to levels similar to pre-MMR2. No advantage in vaccinated at age 9-11 over ages 4-6 years.

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Outcomes	Ref	Participants / study design	Results	Findings
Seropositivity in young adults	16	Cohort study, Australia, 331 health science students aged 17-35 years (mean age 21), enrolled to study July 2023-May 2024 (160 (48%) domestic and 171 (52%) international)	International students had highest seropositivity rates for all 3 viruses Of those who were seropositive for 3 viruses (n=89, 27%) 36 (40%) domestic students and 53 (60%) international students Mumps immunity: • Domestic: 40 (25%) seronegative; 120 (75%) seropositive • International: 28 (16%) seronegative; 143 (84%) seropositive • Total: 68 (21%) seropositive; 263 (79%) seropositive More domestic students were seropositive to mumps than to measles (53%) or rubella (43%) – slightly fewer were immune to mumps born 2000-2009 vs 1990-1999 but antibody levels were not significantly different Decline in antibody responses peaked approximately 10-11 years following vaccination against all three MMR antigens.	Two-dose MMR may not confer lifelong immunity. Observed decline in immunity 10-15 years post vaccination
Long term persistence of mumps antibodies	18	Retrospective cohort study, medical school students and residents, Italy enrolled April 2014 – June 2018. Included only those with documented history of 2 doses MMR. Excluded those without a history of vaccination, single dose MMR or ≥3 doses MMR. Seroprotection mumps IgG >11 AU/ml. Seronegative = another dose, tested 20-25 days later; equivocal after booster – retested, still < cut-off, given another booster and retested.	2000 / 4225 (47.3%) of students received complete MMR schedule Average age 21.1 ± 2.4 years (18-38), similar between males and females. • 1880/2000 (94%, 95% CI 92.9-95.0%) had protection mumps IgG titres. • 102/120 (85%) seronegative received booster dose, out of 81 who were reevaluated, 73 (90.1%; 81.5-95.6%) seroconverted; 8 (9.9%; 4.4-18.5%) remained negative. • From time of 2nd MMR, average Protective Antibody Survival (PAS) was 10.2 ± 3.0 years (range 0.0 – 23.0) • Anti-mumps IgG loss in 25% of fully vaccinated was estimated to be 19 years (95% CI 17-22) • Incidence rate persons-year of seronegativity 0.006 (0.005-0.007) • Age of first MMR was not associated with PAS, but older age at study enrolment (HR 0.36; 95% CI 0.25-0.47, but not for IgG seropositivity) and being of male sex (HR 1.46; 95% CI 1.0-2.15) were statistical risk factors. (stratified by age of 2nd dose).	More than 6% of participants did not show circulating anti-mumps IgG after two doses of MMR. One or more doses of MMR elicited a booster response (99% seroconversion).

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Outcomes	Ref	Participants / study design	Results	Findings
Long term seropositivity after MMR2, Finland	21	Antibody persistence, 183 vaccine recipients in 20-year follow-up after dose 1 (given in 1982 at age 14-18 months) and 13-15 years after dose 2 (given in 1987 at age 6 years) Older cohort, given MMR2 at age 11-13y in 1987-89 but 90% were seropositive for measles prior to first dose, 27% positive for mumps and 17% rubella positive) Subgroup 58 subsequent samples from 1, 8 and 15 years after MMR2.	After 20 years, proportion seropositive for measles = 95% mumps = 74% rubella = 100% • Of 90 initially mumps seronegative group – 40 % seropositive, 34% equivocal, 26% seronegative – 15 years after MMR2 • No significant difference in GMTs between younger and older cohorts who were seronegative at time of first dose. Decay of antibody – tested 58/178 younger cohort samples (seronegative at time of MMR1) 5, 12 ad 20 years after dose 1 and 1, 8 and 15 years after dose 2. Significant decline for all viruses ($p<0.001$) at 1-8 years and >8-15 years after MMR2: • measles 50%; 23% • mumps 69%; 22% • rubella 58%; 21% Mean antibody decay rate 1-8 years and >8-15years post MMR2: • measles 7.1%; 2.5% • mumps 9.2%; 3.2% • rubella 8.2%; 3.1%	Waning of vaccine induced antibody levels may indicate difficulties in maintaining elimination status in Finland if exposures from other countries without elimination continue.

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Outcomes	Ref	Participants / study design	Results	Findings
cellular vs humoral immunity, Finland	19	Group A: 50 young adults (ages 22-23 or 27-28y) who have been followed for 21 years since first doses MMR vaccination in Finland (group A, as in cohort above [21]) Group B positive controls: 11 adults aged 40-63y unvaccinated, mumps seropositive who had clinical mumps in childhood. Group C negative controls: 10 samples of cord blood for lymphoproliferative and cytokine tests. Compared cellular response (lymphoproliferation, IFN-γ and IL-10) to mumps IgG titre ≥230 or <230.	27 received first MMR at age 18months (groupA-1), 23 received MMR1 at age 6 years (group A-6); MMR2 at ages 6y or 11-12y, respectively. • seroconverted after dose 1: 93% group A-1; 83% group A-6 • seroconverted after dose 2: 100% and 91%, respectively Persistence of mumps antibody (serum IgG, ELISA): no difference in GMT between group A-1 or A-6). Group B significantly higher (p=0.0032). Anti-mumps IgG detected in: • group A-1: 21/27 (78%) • A-6 = 16/23 (65%) • B = all 11 (100%) Lymphoproliferation to mumps antigen (stimulation index, SI ≥3) (2 samples excluded due to lack of response to antigen or control) • Group A-1: 25/26 (96%) • A-6 = all 22 (100%) • B = all 11 (100%) • All antibody seronegative (IgG <230) had significant mumps-specific lymphoproliferative responses. • No correlation between Ab and lymphoproliferation in group A (R = 0.11) • Intensity of response did not differ significantly between group A and B or between A-1 and A-6. • Mean mumps-specific IFN-γ or IL-10 did not differ significantly between groups A and B. Strong positive correlation between mumps-specific IFN-γ and IL-10 for groups A and B.	All but one participant who had received MMR2 during early childhood had detectable mumps-specific cellular immune responses 21 years after first MMR dose. Mumps-specific lymphoproliferation and cytokine produced was as high as those who had naturally acquired immunity. Although waning humoral immunity occurs after two doses of MMR, mumps specific cellular immunity lasts longer and is likely to provide some protection even with low serum antibody titres.
Duration of immunity, South Korea	22	2019 national serosurvey data (3050 samples) in South Korea estimated decay rate of antibody. Using age as proxy of time since vaccination with 95% MMR2 coverage in 1995-2019 age cohorts. (age 12-15m and 4-6y)	Despite exposure to mumps – seropositivity was lowest (~60% vs 73% for measles) Average decay rates for MMR were 8.71%, 12.02% and 5.84% per year measles, mumps rubella. Duration of vaccine-induced immunity (no natural exposure to measles and rubella, mumps continued increasing from 2013) • measles – 19 (16.5-27.5) years (equivocal Ab results regarded as negative); 27.3 years (equivocal positive) • mumps – 9.7 (8.2-11.3) years; 15.25 y • rubella – 31.6 (28.3-34.8) years; 39.8	Vigilance required in settings with disease elimination due to waning immunity. Noting that MMR3 is given routinely during military service due to risk of mumps.

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Outcomes	Ref	Participants / study design	Results	Findings
Long-term antibody with different schedules	23	Phase III RCT antibody persistence, over 10 years from age 12-22 months., of 1887 healthy children vaccinated with 1 or 2 doses MMR (42 days apart) (Priorix or Priorix-Tetra, GSK) conducted in Europe and Russia. Post-hoc analysis: 364 children of 1-dose group received 2nd dose from 4-10 years post dose 1. GSK study NCT00226499.	Measles and rubella antibodies declined but remained above seropositivity for 10 years. Second MMR had minor, transient effect on waning. MMRV induced higher antibody titres than MMR +V or MMR alone. Mumps: remained relatively stable over 10 years • second dose given at any time boosted mumps antibody titres and seropositivity rates. • seropositivity rates ranged from 86% - 100% over study. After 10 years, ≥90% were seropositive. Later dose of MMR2 increased rates to ≥98.6% • Recent reports demonstrate waning, but none followed the same individuals over time. Initial boost seen at day 84 after dose 2 but returns to post dose 1 levels	1 or 2 doses MMR given in 2nd year of life induced antibody that lasted for at least 10 years. A second dose of MMR boosted mumps antibody regardless of when given.
Antibody persistence, EPI	32	Clinical trial cohort Priorix or M-M-R II 169 children in Thailand, blood samples collected annually from 4 - 7 years (4.5 years after 2nd dose) EPI, Thailand changed MMR doses at age 9m and 2.5 years (previously 4-6y).	Decline in seropositivity over 4.5 years against measles and mumps, not rubella. Seropositivity for mumps was lower than for measles: • Age 4 – 62.2%; age 5 – 48.5%; age 6 – 43.3% and age 7 – 54.4% • By year 7, there was a slight risk in GMC likely to be due to natural exposure to circulating virus. • Seroprotection rates are below the estimated level for herd protection (~85%).	A decline in seroprotection was shown within a few years after primary vaccination for measles and mumps antibodies but not rubella.

Abbreviations: EPI – Expanded Programme on Immunisation; GMC – geometric mean concentration; HR – hazard ratio; IgG – immunoglobulin G; MMR – measles, mumps and rubella vaccine; NZ – New Zealand; PAS – protective antibody survival; RT-PCR – reverse transcription-polymerase chain reaction; SR/MA – systematic review and meta-analysis; WPR

Table 5: Duration of protection and attack rates during outbreaks

Outcomes	Ref	Participants / study design	Results		Findings

Systematic review of epidemiology	27	SR/MA, published 2004-2024, epidemiology and outbreak duration. 47 articles selected for SR across 21 countries, 30 studies included in meta-analysis.	Included cases
			• 47 studies across 21 countries documenting 71,174 cumulative mumps cases, 61 outbreaks between 2004-2024
			• Affected population aged 0 -90 years.
			• 31 studies used laboratory criteria for mumps confirmation.
			Vaccine schedules
			• Most countries had no routine booster dose. Some gave a catchup campaign during outbreaks, or a 3rd dose was given for those at increased risk during outbreaks. Mumps vaccine was not included in the programme in India (5 studies, 10.6% of outbreaks)
			Outbreaks
			• Mean duration 10.95 months (SD 12.42) – published not surveillance-based.
			• Published reports of outbreaks cover all WHO regions except Africa. EUR had the most outbreaks (44.7%), AMR (North America 25.5%), Southeast Asia (12.8%) and WPR (8.5%, 2/4 Australian) and EMR (Israel, 8.5%)
			  ○ Children: 66.7% of cases aged 0-10 years (across 32 studies).
			  ○ Adolescents: 25% were aged 11-18 years (12 studies) – link to university or workplace.
			  ○ 8.3% adults aged ≥19y (3 studies)
				• Vaccination status – large proportion had ≥2 doses MMR (57.4% two doses, 21.3% 3 doses), only 8.5% unvaccinated, 6.4% one dose.
				Complications
				• Parotitis most frequently reported symptom, also orchitis and meningitis.
				• pooled complication rate 10.3% (5.7-14.9), high heterogeneity I^2 = 99.7%
				• Orchitis most common (63.1%; 49.8-76.6) across 22 studies.
				• Other complications – encephalitis (0.2; 0.1-0.4), meningitis (1.4; 0.8-2.0) oophoritis, hearing loss infrequent.
				Attack rates (AR, proportion who develop disease vs exposed in outbreak)
				• Pooled AR (30 studies, 50,643 cases) 14.5% (12.9-16.1) I^2 = 99.7%]
				• Subgroup analysis – adults ≥19y had highest AR= 31.8 (4.6-68.1) vs children 0-10years 13.6 (11.0-16.0) and adolescents 11.7 (9.4-14.0)
				• Later outbreaks (2016-2020) had higher AR than earlier (28% vs 8.5-12.6%)
				• One dose AR 35.7 (8.7-62.5) three doses 10.1 (7.3-12.9)
					In global mumps outbreaks over two decades, adults exhibited highest AR (32%) vs pooled AR of 14.5%. Complication rate is around 10%. Additional doses of vaccine lower the attack rate, and could be beneficial in countries with evidence of waning immunity and a well-established two-dose programme.

Complications	29	Enhance mumps surveillance and hospital admission 2004-2005 England/Wales during mumps outbreak. Those born between 1981 and 1986 in 2001 = 43,344 cases (54% male) and 2,647 hospitalised from Apr 2002-Mar 2006	During outbreak – clear increase in hospitalisations, estimated 6.1% mumps cases hospitalised, 4.4% orchitis, 0.35% meningitis, 0.33% pancreatitis. Orchitis reported in the older cohort (born 1980-1989 vs 1990-2006). Of the 15,524 confirmed cases 47% had documented MMR; 53.4% unvaccinated, many were born prior to 1988 and not eligible for MMR.	Reduced risk of hospitalisation if vaccinated ≥1 dose MMR; (2 doses, very small case numbers) odds ratio adjusted for age/sex • Hospitalisation: 1 dose aOR 0.54 (0.43-0.68); 2 doses aOR 0.45 0.25-0.80 • Orchitis: 0.72 (0.56-0.93); 0.64 (0.28-1.44, 7 cases) • Meningitis: 0.28(0.14-0.56); 0.17 (0.02-1.26, 1 case) • Pancreatitis: 0.95 (0.42-2.19); no cases	Odds of hospitalisation with orchitis and meningitis were significantly lower in vaccinated than unvaccinated mumps patients.

Outcomes	Ref	Participants / study design	Results	Findings
Outbreak, Ireland	6	Ireland, 18 Aug 2018 – 24 Jan 2020. Rapid communication Vaccination schedule 1992-1998 – 2nd dose at age 10-14 years. From 1999 – ages 12m and 4-5 years. Resulting in gaps in immunity.	3736 cases of mumps notified (2583 confirmed, remainder probable or possible) Declined during summer of 2019, increased with start of academic year Sep 2019. • Rate highest in 15-19- and 20-24-year age groups = 394.5 and 362.3 per 100,000, vs 75.9 total. • median age 20, IQR 18-36 • Settings – 44% college/university, 20% social, 16% secondary school • Vaccination status known for 1199/3736 (32%) of cases. Of those 72% receive 2 doses MMR (23% of total), 16% received one dose and 12% unvaccinated. 12 cases had received a 3rd dose MMR. • Time since last dose – for 618 cases (17%) 52% had received last dose 13 – 17 years before disease onset. • 291/3,159 (9%) of cases had some form of hospital contact (incl non-emergency) – of those with known vaccination status 12% had 2 doses MMR vs 13% unvaccinated.	Factors likely to be involved in outbreak – crowded social environment, historically low MMR uptake, insufficient effectiveness of mumps component, waning immunity. Outbreak mainly affected adolescents and young adults who are highly mobile. Need to raise awareness of risk of exportation of mumps. With limited data on vaccination status study was unable to estimate vaccine effectiveness in this outbreak.
Outbreak, Australia	9	QLD, Australia 2017-2018. Retrospective case control study. Controls: selected based on influenza vaccination in Indigenous community (potential for health user bias); unaffected school population and prisoners. for further details see Table 6	93 cases mumps in three distinct outbreaks: discrete indigenous community, correctional facility, boarding school. 74 cases (79.6%) fully MMR vaccinated, 14 (15.1%) partially vaccinated. 86 (92.5%) ATSI peoples. • Overall attack rate – 41.6 cases (95% CI 33.3-49.8) per 1,000 population; discrete indigenous community AR 65.7 (50.4-81.0); boarding school 26.1 (15.0-42.0), correctional facility 17.2 (7.1-17.2). • Age 20-24y: AR 156.3 (83.6-228.9); 10-14y: 140.0 (72.0-208.0); 15-19y highest in correctional facility and school (200 [25.2-556.1] and 44 [24.9-71.7] cases per 1,000)	During an outbreak in large, high-density living situations, such as a correctional facility or boarding school, the attack rate can be significantly reduced by vaccinating a minimum of 1/3 of the target population, to assist in containment.
Outbreak, Australia	10	Population-based surveillance study. Outbreak March 2015-Dec 2016 WA, Australia. Analysis of notifications and public health case follow-ups, vaccination information from Australian immunisation register.	893 outbreak cases (genotype G), 798 (89%) ATSI and almost all were from sparsely populated regions. 4% hospitalised; 7% men with orchitis. Peak age 15-19 years; 89% aged 1-19y were fully vaccinated and 7% partly vaccinated. None of cases were renotifications after previous Genotype J outbreak in 2007-2008. Proportion of mumps cases increase with time since second dose peaking at 16-18 years, but after 7-9 years proportion of cases remained steady. At 19-21 years from 2nd dose, sharp decline in proportion of mumps cases.	Most of the cases were seen in highly vaccinated Aboriginal people aged <35 years (age cohorts born since mumps vaccination began in 1981). Mobility of Indigenous people within and between communities is likely to have contributed substantially to mumps transmission during the 2015–16 outbreak, which spread rapidly over large distances to discrete communities and towns, despite very low overall population density.

Abbreviations: AMR – Americas region; AR – attack rate; ATSI – Aboriginal and Torres Strait Islander peoples; EMR – Eastern Mediterranean region; EUR – European region; IQR – interquartile range; MMR – measles, mumps and rubella vaccine; QLD – Queensland; SR/MA – systematic review and meta-analysis; WA – Western Australia; WPR – Western Pacific region

Table 6: Additional doses in young people

Outcomes	Ref	Participants	Results		Findings
Additional doses					
Additional dose	27	Systematic review / meta-analysis, Mumps outbreaks reported between 2004 – 2024 included 47 studies, 21 countries, 71,174 mumps cases. meta-analysis on attack rates – 30 studies, 50,643 cases	Pooled attack rate (AR): 14.5% (95% CI 12.9-16.1; I^2 99.7%) Complication rate: 10.3% (5.7-14.9, I^2 99.7%; p<0.001); primarily orchitis, with pooled prevalence of 63% (49.8-76.6, 22 studies). Subgroup analysis AR: • adults ≥19 years: 31.8% (4.6-68.1, I^2 0.0%) • children 0-10years: 13.6 (11.0-16.0, I^2 99.8%) Varied by WHO region – Western Pacific and Europe lowest with variability in programmes.	Attack rates were higher in later outbreaks (2016-2000 vs 2004-2009). • One vaccine dose: 35.7 (8.7-62.5, 3 studies) • Two doses: 16.4 (13.0-20.0, 14 studies) • Three doses: 10.1 (7.3-12.9, 5 studies) • (Unvaccinated – may be in countries without mumps programme, AR 10% 5.5-14.5, 4 4 studies)	Adults demonstrate the highest attack rates of mumps during outbreaks. Those who have received 3 doses / booster doses had significantly reduced attack rates. Incorporation of an additional dose should be considered particularly in countries with long-standing two-dose programmes, in high-risk groups to mitigate outbreak severity and reduce complications, such as orchitis.
Impact additional dose	9	QLD, Australia 2017-2018. Retrospective matched case control study. (as also described in Table 5)	93 cases mumps in three distinct outbreaks: discrete indigenous community, correctional facility, boarding school. • 74 cases (79.6%) fully MMR vaccinated, 14 (15.1%) partially vaccinated. Out of 141/168 controls (83.9%) received 2 doses and 16 (9.6%) 1 dose; 5 cases and 11 controls had no evidence of mumps vaccination. • 86 (92.5%) Indigenous peoples. • 74 cases (79.6%) vs 83.9% in control population had received 2 documented MMR Time interval between dose 1 and 2: • mean 3 years for cases vs 4.1 years for controls. • For those born prior to 1 March 2000 (when 2nd dose changed to 6m after dose 1) – significantly less for cases (p=0.0003): 3.6 years cases vs 5.9 years controls. • No significant difference in spacing for those born after 1 March 2000 (but concern about timeliness of vaccination since spacing was 2.6 years and 2.9 years respectively, not 6 months as scheduled) Time from last dose: • significantly greater in correctional facility and boarding school • not for discrete Indig community between cases and controls. • All 12.7 years for cases and 10.9 for controls (p=0.01) Additional doses MMR were given to 35.4% of Indigenous community, 73.6% of correctional facility and 35.8% of boarding school. • Reduced overall attack rate from 31.0% (95% CI 24.2-39.0) to 10.6 (95% CI 6.7-15.9) per 1000 population post additional dose. • Significant only in discrete Indigenous community (from 54.9 [41.0-71.8) to 16.8 (8.6-24.9)		This study demonstrated the impact of an additional dose of MMR as part of a public health response to mumps in various high-risk community settings. Additional dose of MMR can effectively control outbreaks in highly vaccinated populations. Also need to identify under-vaccinated populations to ensure vaccine timeliness. The timing between dose 1 and 2 appears to be of concern. In the older cohort the interval between was significantly less for the cases than controls. Currently the schedule spacing is only 6 months but many of those born to this schedule had delayed immunisations. An optimum gap needs to be further explored.

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Outcomes	Ref	Participants	Results	Findings
Third dose for outbreak control	30	University students in Iowa. Out of 20,496 enrolled students, 259 cases of mumps in 2015-2016. Ages for each dose: dose 1 12-23m dose 2 4-6 years dose 3 18-24 years.	98.1% of students had received ≥2 doses MMR (mandated). During outbreak 4,783 students received a 3rd dose. AR lower after 3 vs 2 doses: 6.7 vs 14.5 case per 1,000 (p<0.001) 3rd dose 78.1% lower risk of mumps than if received 2nd dose (aHR 0.22, 0.12-0.39) Analysis of all students, AR was lower in those who had received 2 doses <12 years ago vs those ≥13 years before outbreak. Risk of mumps – 9 times higher if been >13 years since 2nd dose. AR /1,000 after MMR2: • <2 years = 1.6 (3 cases /1889) • 3-12 years = 3.9 (5 cases /1293) • 13-15 years = 11.3 (99/8794) • 16-23 years = 17.6 (148 cases/8417) VE of 2 doses vs 0: • <13 years since 2nd dose VE 89.4% (-2.5-98.9) • >13 yrs VE 31.8% (-388.9 to 90.5); p=0.002 A third dose reduced the risk of mumps more than 2 doses after adjustment for number of years since 2nd dose. • Dose 3 vs dose 2 VE 60% (38.4-74.0) at 7 days and 78.1% (60.9-87.8) at 28 days.	A campaign to administer an additional dose (3rd dose) MMR improved outbreak control and indicated that waning immunity was likely to have propagated the outbreak.
Modelling third dose	31	Deterministic maths model of population impact of third dose by timing of vaccine admin and coverage, based on outbreak above (Iowa) [30] Daily time series of mumps cases and number of MMR doses. Time included 4 major holidays of >4 days.	Study above did not consider forces of infection between those who received 3 doses and those who did not, the effect of school holidays and effectiveness of 3rd dose in preventing infection. Susceptibility based on waning rather than leaking model. Estimated that 3rd dose provided 47.3% (14.1-87.4) protection against mumps • Vaccination may have been introduced after number of infections had peaked – vaccine campaigns introduced 80 days after first cases (23% coverage) – estimated 4.5% (0.2-20.8%) reduction in outbreak size. • If introduced sooner with 20% to 80% coverage, reduction in outbreak size from 5.9% (3.8-13.9) to 32.0% (25.5-46.2)	While vaccination played a role in improving protection against mumps, the overall impact was modest. Particularly due to timing of introduction of 3rd dose, which could have reduced the number of susceptible students. Physical distancing during winter break also likely to have helped to reduce transmission. Introducing the vaccination early during an outbreak can help limit mumps transmission and lower levels of vaccination coverage are needed to reduce the outbreak size.

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Outcomes	Ref	Participants	Results	Findings
Antibody levels after 3rd dose	26	147 participants aged 18-25 years (mean 22) who had MMR2 and no mumps history. Blood samples taken 4 weeks ± 7 days before, 1 years ± 1 months and 3 years ± 3 months (by self-collected finger prick) after 3rd MMR dose. Measured IgG against vaccine strains and virus neutralising (VN) Ab against vaccine strain genotype A and wild-type outbreak strain genotype G. Surrogate seroprotection mumps at ≥102 RU/ml Netherlands, MMR schedule age 14 months and 9 years.	119/147 (81%) responded 3 years post vaccination On average 2nd MMR dose given 13 years prior to study entry. Seroprotection (serum IgG > cutoff) • baseline – 81% participants. • 4 weeks – 94% • 1 years – 90% • 3 years – 87% (marginally but statistically higher than baseline) similar dynamics for VN antibody. year 1 to 3 • Total IgG 0.87-fold change (0.82-0.93) • vaccine-strain VN stabilised 0.99-fold (0.91-1.1) • outbreak-strain VN 0.99 (0.90-1.1) Measles and rubella – 100% seroprotection maintained for 3 years after MMR3. Also significantly higher at baseline. Mumps had greatest increase from baseline – low baseline correlated significantly with stronger Ab increases– suggesting a clear benefit of MMR3 for those with low Ab levels. Based on a herd immunity to block mumps transmission of ≥86%, at 3 years post MMR3 seroprotection was close that needed to limit widespread spread and to reduce a mumps outbreak.	Students who received MMR3 had lower risk of mumps during outbreak than those who had MMR2. MMRn doses should be given early in an outbreak to those who had received MMR a few years ago during an outbreak in settings with a high virus exposure risk.

Abbreviations: Ab – antibody AR – attack rate; ATSI – Aboriginal and Torres Strait Islander peoples; QLD – Queensland; MMR – measles, mumps and rubella vaccine (1, 2, 3 or n doses); VE – vaccine effectiveness; VN – virus neutralising

Method for literature search

Key questions:

1. Risk groups for infection
2. Duration of protection of MMR
3. Evidence for a 3rd dose – is that all?
4. Best age groups to target

Concepts

mumps	vaccine	age groups	immuni?ation
virus	MMR	adolescents	immun*
complications	mumps	young adults	immunogenicity
burden	effectiveness	toddlers	immunity
epidemiology	duration of protection		antibody
transmission	additional doses		
breakthrough			

The final library contained 111 references, including peer-reviewed original articles, 3 reports, 2 electronic book sections, 3 systematic reviews and 6 review articles. Many of the papers were found through the systematic reviews and review articles rather than database searches.

Medline search strategy

2018 – current (11 June 2026)

# ▲	Searches	Results
1	exp Mumps Vaccine/	4485
2	limit 1 to (english language and humans and yr="2018 -Current")	935
3	breakthrough disease.mp.	164
4	2 and 3	0
5	*Vaccine Efficacy/	907
6	limit 5 to (english language and humans and yr="2018 -Current")	855
7	2 and 6	5

Vaccine efficacy, 2 selected

9	Humans/ and Mumps/ and Adolescent/ and Measles-Mumps-Rubella Vaccine/ and Vaccination/	114
10	limit 9 to (english language and yr="2018 -Current")	60

Vaccination - selected 27

11	find similar to Persistence of measles, mumps, and rubella immunity following childhood vaccination in Australian health science students: a cohort study.	2
12	find similar to Differential durability of immune responses to measles and mumps following MMR vaccination.	49

#11 selected none; #12 selected 9

13	*Seroepidemiologic Studies/ or seroprevalence.mp.	29954
14	limit 13 to (english language and yr="2018 -Current")	12472
15	2 and 14	65

#15 Selected 27

Total search - imported 26 in total and removed 9 duplicates = 17

References

1. Rubin S. Mumps Vaccines. In: Orenstein WA, Offit PA, Edwards KM, et al., editors. Plotkin's Vaccines Eighth Edition [Internet] New York: Elsevier; 2023 [cited 1 Ocober 2026].
2. Health New Zealand. Mumps: Health New Zealand | Te Whatu Ora; Communicable Disease Control Manual; 2026 [updated 20 July 2026]. Available from: https://www.healthnz.govt.nz/health-professionals/guidance-standards/topic/conditions/communicable-disease-control-manual/mumps
3. Polgreen PM, Bohnett LC, Cavanaugh JE, et al. The duration of mumps virus shedding after the onset of symptoms. Clin Infect Dis. 2008;46(9):1447–9. doi: 10.1086/587104
4. World Health Organization. Mumps virus vaccines: WHO Position Paper, March 2024. Weekly Epidemiological Record. 2024;99(11):115–33. doi: https://www.who.int/publications/i/item/who-wer-9911-115-133
5. Dilcher M, Barratt K, Douglas J, et al. Monitoring viral genetic variation as a tool to improve molecular diagnostics for mumps virus. J Clin Microbiol. 2018;56(10):10.1128/jcm.00405–18. doi: 10.1128/JCM.00405-18
6. Ferenczi A, Gee S, Cotter S, et al. Ongoing mumps outbreak among adolescents and young adults, Ireland, August 2018 to January 2020. Euro Surveill. 2020;25(4):01. doi: 10.2807/1560-7917.ES.2020.25.4.2000047
7. Gokhale DV, Brett TS, He B, et al. Disentangling the causes of mumps reemergence in the United States. Proc Natl Acad Sci U S A. 2023;120(3):e2207595120. doi: 10.1073/pnas.2207595120
8. Perez Duque M, San-Bento A, Leon L, et al. Mumps outbreak among fully vaccinated school-age children and young adults, Portugal 2019/2020. Epidemiology & Infection. 2021;149:e205. doi: 10.1017/S0950268821002028
9. Walker J, Adegbija O, Smoll N, et al. Epidemiology of mumps outbreaks and the impact of an additional dose of MMR vaccine for outbreak control in regional Queensland, Australia, 2017-2018. Commun Dis Intell (2018). 2021;45. doi: 10.33321/cdi.2021.45.67
10. Westphal DW, Eastwood A, Levy A, et al. A protracted mumps outbreak in Western Australia despite high vaccine coverage: a population-based surveillance study. Lancet Infect Dis. 2019;19(2):177–84. doi: 10.1016/S1473-3099(18)30498-5
11. PHF Science. Notifiable diseases in New Zealand annual report 2024. Porirua: New Zealand Insitute for Public Health and Forensic Science; 2025 17 November 2025 https://www.phfscience.nz/digital-library cited 11 June 2026
12. Institute of Environmental and Scientific Research Ltd. Notifiable diseases in New Zealand annual report 2017. Porirua: ESR; 2019 March 27 https://www.phfscience.nz/digital-library cited 11 June 2026
13. Marin M, Marlow M, Moore KL, et al. Recommendation of the Advisory Committee on Immunization Practices for Use of a Third Dose of Mumps Virus-Containing Vaccine in Persons at Increased Risk for Mumps During an Outbreak. MMWR Morb Mortal Wkly Rep. 2018;67(1):33–8. doi: 10.15585/mmwr.mm6701a7
14. Miller E, Andrews N, Stowe J, et al. Risks of convulsion and aseptic meningitis following measles-mumps-rubella vaccination in the United Kingdom. Am J Epidemiol. 2007;165(6):704–9. doi: 10.1093/aje/kwk045
15. Keutler A, Lainka E, Hudert C, et al. Safety and immunogenicity of the measles-mumps-rubella vaccine in immunocompromised children with inflammatory bowel disease, or after liver transplantation: An observational study. Vaccine. 2025;59:127288. doi: 10.1016/j.vaccine.2025.127288
16. Schoenfisch C, Kauter K, Walz N, et al. Persistence of measles, mumps, and rubella immunity following childhood vaccination in Australian health science students: a cohort study. Vaccine. 2025;65:127791. doi: 10.1016/j.vaccine.2025.127791
17. LeBaron CW, Forghani B, Beck C, et al. Persistence of mumps antibodies after 2 doses of measles-mumps-rubella vaccine. J Infect Dis. 2009;199(4):552–60. doi: 10.1086/596207
18. Bianchi FP, De Nitto S, Stefanizzi P, et al. Long time persistence of antibodies against mumps in fully MMR immunized young adults: an Italian retrospective cohort study. Hum Vaccin Immunother. 2020;16(11):2649–55. doi: 10.1080/21645515.2020.1735861
19. Jokinen S, Osterlund P, Julkunen I, et al. Cellular immunity to mumps virus in young adults 21 years after measles-mumps-rubella vaccination. J Infect Dis. 2007;196(6):861–7. doi: 10.1086/521029

20. Schenk J, Abrams S, Theeten H, et al. Immunogenicity and persistence of trivalent measles, mumps, and rubella vaccines: a systematic review and meta-analysis. Lancet Infect Dis. 2021;21(2):286–95. doi: 10.1016/S1473-3099(20)30442-4
21. Davidkin I, Jokinen S, Broman M, et al. Persistence of measles, mumps, and rubella antibodies in an MMR-vaccinated cohort: a 20-year follow-up. J Infect Dis. 2008;197(7):950–6. doi: 10.1086/528993
22. Chun JY, Kim A-R, Jeong H, et al. Duration of vaccine-induced immunity following MMR2 vaccination in a measles and rubella-eliminated country. International Journal of Epidemiology. 2026;55(3). doi: 10.1093/ije/dyag076
23. Carryn S, Feyssaguet M, Povey M, et al. Long-term immunogenicity of measles, mumps and rubella-containing vaccines in healthy young children: A 10-year follow-up. Vaccine. 2019;37(36):5323–31. doi: 10.1016/j.vaccine.2019.07.049
24. Šantak M, Lang-Balija M, Ivancic-Jelecki J, et al. Antigenic differences between vaccine and circulating wild-type mumps viruses decreases neutralization capacity of vaccine-induced antibodies. Epidemiology & Infection. 2013;141(6):1298–309. doi: 10.1017/S0950268812001896
25. $5M to develop mRNA measles vaccine [press release]. University of Auckland, 28 August 2025. 'Available from':https://www.auckland.ac.nz/en/news/2025/08/29/Five-million-for-new-measles-vaccine.html
26. Kaaijk P, Wijmenga-Monsuur AJ, Ten Hulscher HI, et al. Antibody levels at 3-years follow-up of a third dose of measles-mumps-rubella vaccine in young adults. Vaccines (Basel). 2022;10(1). doi: 10.3390/vaccines10010132
27. Agrawal R, Rehman T, Sinha D, et al. Epidemiological trends and determinants of mumps outbreaks: a systematic review and meta-analysis. Front Public Health. 2025;13:1711759. doi: 10.3389/fpubh.2025.1711759
28. Connell AR, Connell J, Leahy TR, et al. Mumps outbreaks in vaccinated populations-is it time to re-assess the clinical efficacy of vaccines? Front Immunol. 2020;11:2089. doi: 10.3389/fimmu.2020.02089
29. Yung C-F, Andrews N, Bukasa A, et al. Mumps complications and effects of mumps vaccination, England and Wales, 2002–2006. Emerging infectious diseases. 2011;17(4):661. doi:
30. Cardemil CV, Dahl RM, James L, et al. Effectiveness of a third dose of MMR vaccine for mumps outbreak control. N Engl J Med. 2017;377(10):947–56. doi: 10.1056/NEJMoa1703309
31. Park SW, Lawal T, Marin M, et al. Modeling the population-level impact of a third dose of MMR vaccine on a mumps outbreak at the University of Iowa. Proc Natl Acad Sci U S A. 2024;121(43):e2403808121. doi: 10.1073/pnas.2403808121
32. Sarawanangkoor N, Wanlapakorn N, Srimuan D, et al. Persistence of antibodies against measles, mumps, and rubella after the two-dose MMR vaccination: A 7-year follow-up study. Vaccines (Basel). 2024;12(7):05. doi: 10.3390/vaccines12070744