Vaccinations in pregnancy

Optimising maternal and infant protection

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In an era marked by rising vaccine hesitancy and resurgent infectious threats, maternal vaccination stands as a powerful safeguard for the mother and for the infant in their first six months of life. This article unpacks the latest recommendations, demystifies safety concerns and explores bold strategies to improve vaccine uptake across the preconception, pregnancy and breastfeeding continuum, providing clinicians with practical tools to champion vaccination and protect Australia's next generation.

KEY POINTS

- Maternal vaccination protects both the pregnant woman and her infant in their first six months of life, with antibody transfer in utero and through breast milk offering vital early life protection against severe infections.
- Preconception vaccination offers a critical opportunity to address immunity gaps, particularly for rubella, varicella and hepatitis B, reducing the risk of serious congenital infections.
- Vaccines recommended during pregnancy in Australia include influenza, pertussis (diphtheria-tetanus-acellular pertussis) and, most recently, respiratory syncytial virus, with the timing optimised to maximise passive immunity for the newborn.
- Vaccination during breastfeeding is safe and beneficial, with most vaccines posing no risk to the infant and potentially enhancing passive immune protection.
- Barriers to vaccine uptake, such as misinformation, access issues and variable healthcare provider engagement, must be addressed through co-ordinated public health capacity building and communication, integrated antenatal vaccine delivery and digital health solutions.
- Future maternal vaccines, including those for group B streptococcus and cytomegalovirus, are on the horizon and sustained investment in research, surveillance and trust-building will be key to success.

Vaccination plays a crucial role in safeguarding both expectant mothers and their newborns from various vaccine preventable diseases (VPDs).[1,2] By administering specific vaccines preconception, during pregnancy and while breastfeeding, immunisation confers direct protection to the pregnant woman and subsequent passive immunity to their child, thereby reducing morbidity and mortality rates among these vulnerable populations.[3]

For healthcare professionals, a key indispensable resource is the *Australian Immunisation Handbook*, the national clinical guideline for vaccination recommendations. A list of resources is provided in Box 1. Using the best scientific evidence available, the Australian Technical Advisory Group on Immunisation (ATAGI), in collaboration with other key stakeholders, develop the handbook's recommendations for the safest and most effective use of vaccines.[4] Augmenting the ongoing development of the handbook is the National Centre for Immunisation Research and Surveillance (NCIRS), with many of its collaborative works including the Sharing Knowledge About Immunisation (SKAI) and AusVaxSafety programs, providing reliable information to support healthcare professionals in discussing vaccination and VPDs with their patients.

Most, but not all, recommended vaccines are funded and delivered through the National Immunisation Program (NIP), a joint Commonwealth, State and Territory government initiative, acknowledged as one of the world's most comprehensive immunisation programs.[5-7]

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1. RESOURCES FOR GPS

- ***Australian Immunisation Handbook*** **from the Australian Technical Advisory Group on Immunisation:** https://immunisationhandbook.health.gov.au
- **National Centre for Immunisation Research and Surveillance (NCIRS):** https://ncirs.org.au
- **Sharing Knowledge About Immunisation from the NCIRS:** https://skai.org.au
- **AusVaxSafety from the NCIRS:** https://www.ausvaxsafety.org.au
- **National Immunisation Program Schedule:** https://www.health.gov.au/resources/publications/national-immunisation-program-schedule?language=en
- **COVID-19 vaccination shared decision making guide for women who are pregnant, breastfeeding or planning pregnancy:** https://www.health.gov.au/resources/publications/covid-19-vaccination-shared-decision-making-guide-for-women-who-are-pregnant-breastfeeding-or-planning-pregnancy?language=en

Resources from the *Australian Immunisation Handbook* on vaccine considerations in special risk groups planning pregnancy

- **Specified medical conditions associated with increased risk of influenza disease and severe outcomes:** https://immunisationhandbook.health.gov.au/resources/tables/table-specified-medical-conditions-associated-with-increased-risk-of-influenza-disease-and-severe-outcomes
- **Risk conditions for pneumococcal vaccination and eligibility for National Immunisation Program funding:** https://immunisationhandbook.health.gov.au/resources/tables/table-risk-conditions-for-pneumococcal-vaccination-and-eligibility-for-nip-funding
- **Specified immunocompromised conditions:** https://immunisationhandbook.health.gov.au/contents/vaccination-for-special-risk-groups/vaccination-for-people-who-are-immunocompromised
- **Aboriginal and Torres Strait Islander people:** https://immunisationhandbook.health.gov.au/contents/vaccination-for-special-risk-groups/vaccination-for-aboriginal-and-torres-strait-islander-people
- **Occupational risks:** https://immunisationhandbook.health.gov.au/contents/vaccination-for-special-risk-groups/vaccination-for-people-at-occupational-risk
- **International travellers:** https://immunisationhandbook.health.gov.au/contents/vaccination-for-special-risk-groups/vaccination-for-international-travellers
- **Individuals who have had an adverse event following immunisation:** https://immunisationhandbook.health.gov.au/contents/vaccination-for-special-risk-groups/vaccination-for-people-who-have-had-an-adverse-event-following-immunisation
- **Individuals who have recently received normal human immunoglobulin and other blood products:** https://immunisationhandbook.health.gov.au/contents/vaccination-for-special-risk-groups/vaccination-for-people-who-have-recently-received-normal-human-immunoglobulin-and-other-blood-products
- **High-risk groups:** https://immunisationhandbook.health.gov.au/contents/vaccination-for-special-risk-groups/vaccination-for-other-groups-inmates-men-who-have-sex-with-men-people-who-inject-drugs-and-sex-workers
- **Migrants, refugees and people seeking asylum:** https://immunisationhandbook.health.gov.au/contents/vaccination-for-special-risk-groups/vaccination-for-migrants-refugees-and-people-seeking-asylum-in-australia
- **Bleeding disorders:** https://immunisationhandbook.health.gov.au/contents/vaccination-for-special-risk-groups/vaccination-for-people-with-bleeding-disorders

Recent developments, including the introduction of a new respiratory syncytial virus (RSV) vaccine into the NIP, heightened vaccine hesitancy following the coronavirus disease 2019 (COVID-19) pandemic and the resurgence of pertussis, underscore the critical need to optimise maternal vaccination uptake.[8-15] Pregnant women may also be recommended to receive additional vaccines if they are at increased risk of other specific VPDs because of factors including occupation, personal behaviour or medical conditions.[1] This article offers healthcare professionals an in-depth review of vaccination during preconception, pregnancy and breastfeeding, focusing on current recommendations, safety profiles, barriers to uptake and strategies to improve immunisation rates among pregnant women.

Rationale for maternal vaccination

Maternal vaccination is a crucial public health strategy designed to prevent or reduce the severity of maternal infection, fetal or congenital infection and infant infection during their first six months of life. This is achieved through a co-ordinated immunisation approach for every pregnancy. The scheduling of vaccine administration varies based on the at-risk individual (mother, fetus and/or infant), the period when the risk of infection is greatest or becomes significant, and the length of protective immunity following vaccination.[16]

Immunological changes in pregnancy

Pregnancy induces complex immunological adaptations that facilitate fetal tolerance while maintaining maternal immune competence.[17] These adaptations include modulation of innate and adaptive immune responses, increased anti-inflammatory cytokine activity and alterations in cellular immunity.[18] Although there is little robust evidence demonstrating that pregnant women are more susceptible to VPDs including influenza and COVID-19, multiple studies confirm they are at increased risk of severe complications, with higher rates of hospitalisation, intensive care unit admission and maternal mortality.[19-27]

Benefits of maternal vaccination

Protection of the mother

Maternal vaccination reduces the risk of severe illness, hospitalisation and adverse pregnancy outcomes.[28] Strong, robust evidence demonstrates that influenza vaccination during pregnancy decreases the likelihood of influenza-related complications, including pneumonia and preterm birth.[29,30]

2. PRECONCEPTION VACCINATION ASSESSMENT[1,49,50]

- Pre-vaccination screening checklist. See: https://immunisationhandbook.health.gov.au/resources/tables/table-pre-vaccination-screening-checklist [50]
- Check prior immunisation history on the AIR to identify potentially missing or incomplete vaccinations
- Consider occupational and lifestyle factors (including travel) that may increase the risk of specific infections
- Evaluate existing medical conditions that may influence vaccine recommendations and necessity
- Seek further expert advice, when necessary, from a specialist immunisation clinic, a medical practitioner experienced in vaccination, the immunisation section in state or territory health authorities, or a local public health unit

Abbreviation: AIR = Australian Immunisation Register.

Passive immunity for the infant

One of the primary advantages of maternal immunisation is the transplacental transfer of antibodies, which provides passive immunity to the infant that is sustained during the vulnerable neonatal period.[31] Immunoglobulin G is actively transported across the placenta via the neonatal Fc receptor, reaching peak concentrations in the third trimester.[32] Studies have demonstrated that maternal pertussis vaccination results in a 70 to 90% reduction in pertussis cases and an up to 90.5% reduction in related hospitalisations among infants younger than three months old.[33-36] Similarly, seasonal influenza vaccination during pregnancy reduces the risk of infection and related complications for mothers and their newborns.[37-41]

Reduction in disease burden

Widespread maternal vaccination programs have led to significant reductions in neonatal morbidity and mortality. For instance, global implementation of maternal tetanus immunisation programs has contributed to the near elimination of neonatal tetanus in many countries.[42,43]

Public heath impact

Maternal vaccination not only benefits individuals but also reduces the overall burden of VPDs within the broader community, as herd immunity extends to unvaccinated individuals, including premature infants and immunocompromised neonates.[44,45] In Australia, sustained maternal pertussis immunisation programs have led to a decline in infant pertussis-related hospitalisations.[46] Moreover, the introduction of maternal RSV vaccination is expected to further decrease RSV-related neonatal morbidity and mortality, and provide additional herd protection beyond this group, while being cost-effective.[47,48]

Preconception vaccination: ensuring immunity before pregnancy

Women planning pregnancy should have their vaccination history thoroughly assessed, including using the Australian Immunisation Register (AIR; available at: https://www.servicesaustralia.gov.au/australian-immunisation-register), as part of comprehensive preconception care (Box 2).[1,49,50] This process is crucial to ensure optimal protection against VPDs that could result in significant pregnancy complications or congenital infections. Furthermore, given that live vaccines are generally contraindicated during pregnancy because of a theoretical risk of transmission,[1,51] the preconception period provides an important opportunity for these vaccines to be administered without undue concern for adverse fetal effects.

Additionally, individuals residing in the same household should also have their vaccination status reviewed and updated to minimise the risk of transmitting VPDs to the prospective mother and the newborn.[1]

Managing uncertain vaccination or infection history

If a woman's vaccination history or infection status is unclear, serological testing should be performed to verify immunity against key pathogens (Box 3).[1] Should serological testing reveal insufficient immunity, the necessary vaccines should be administered, taking into consideration recommended waiting periods before conception.

3. SEROLOGICAL TESTING IN CASES OF UNCERTAIN VACCINATION OR INFECTION HISTORY

Pathology request form details should include the following (where appropriate)

- Hepatitis B serology (HBsAg, HBsAb, HBcAb)
- Measles serology (IgG antibodies)
- Mumps serology (IgG antibodies)
- Rubella serology (IgG antibodies)
- VZV serology (IgG antibodies)

Clinical notes should specify the purpose

- 'To assess preconception immune status'

Abbreviations: HBcAb = hepatitis B core antibody; HBsAb = hepatitis B surface antibody; HBsAg = hepatitis B surface antigen; IgG = immunoglobulin G; VZV = varicella zoster virus.

Recommended preconception vaccines

Women planning pregnancy should be up to date with the following vaccines, as summarised in Table 1.[1,34,52-59]

Hepatitis B

Vaccination is recommended for all hepatitis B-naive women to prevent acquisition and mother-to-infant transmission.[52]

Measles, mumps and rubella

Infection with any of these viruses during pregnancy can have severe consequences such as congenital rubella syndrome. Women lacking confirmed immunity should receive two doses of measles, mumps and rubella (MMR) live vaccine, spaced four weeks apart, and should avoid conception for at least 28 days after the final dose.[53-55]

Varicella (chickenpox)

Vaccination is recommended for seronegative women to prevent congenital varicella syndrome or neonatal varicella. Two live vaccine doses should be administered four to eight weeks apart, with conception avoided for 28 days following the final dose.[56]

TABLE 1. RECOMMENDED PRECONCEPTION VACCINES[1,30,52-59]*

Vaccine-preventable disease	If uncertain history of vaccination or disease, check serology	NIP funded	Vaccine brand (type)	Dosage and timing
Hepatitis B[52]	✓	No	• Engerix-B† (recombinant subunit) • H-B-Vax II† (recombinant subunit)	• Three doses at zero, one and six months OR • Three doses at zero, one and four months OR • Three doses at zero, two and four months
Measles[53]	✓	Only for adolescents and adults aged <20 years who have been incompletely vaccinated or do not have evidence of immunity to either measles, mumps or rubella	• M-M-R II‡ (live attenuated) • Priorix‡ (live attenuated)	• Two doses, four weeks apart • **Avoid pregnancy within 28 days of receiving this live vaccine**
Mumps[54]	✓			
Rubella[55]	✓			
Varicella (chickenpox)[56]	✓	Only for adolescents and adults aged <20 years who have been incompletely vaccinated or do not have evidence of immunity to varicella	• Varilrix‡ (live attenuated) • Varivax, refrigerated‡ (live attenuated)	• Two doses, four to eight weeks apart • **Avoid pregnancy within 28 days of receiving this live vaccine**
COVID-19[57]	×	COVID-19 vaccines are free for everyone in Australia regardless of Medicare or visa status	• Comirnaty JN.1§ (mRNA) • Comirnaty Omicron XBB.1.5§ (mRNA)	• Single dose
Influenza[30]	×	Only for adults aged ≥18 years with specified medical risk conditions#¶	• Vaxigrip Tetra (inactivated) • Flucelvax Quad (inactivated)	• Single dose
Pneumococcal[58‖]	×	Only for people with specified medical risk conditions** Valneuvance (15vPCV) and Prevenar 20 (20cPCV) are not currently NIP-funded	• Prevenar 13 (13vPCV) (conjugate) • Vaxneuvance (15vPVC) (conjugate) • Prevenar 20 (20vPCV) (conjugate) • Pneumovax 23 (23vPPV) (polysaccharide)	• Single dose of a pneumococcal conjugate vaccine (13vPCV, 15vPCV, or 20vPCV) followed by: – two doses of the pneumococcal polysaccharide vaccine (23vPPV), first dose two to 12 months after the PCV, then second dose five years after first 23vPPV dose

Abbreviations: 13vPCV = 13-valent pneumococcal conjugate vaccine; 15vPCV = 15-valent pneumococcal vaccine; 20vPCV = 20-valent pneumococcal vaccine; COVID-19 = coronavirus disease 2019; MMR = measles, mumps and rubella; MMRV = measles, mumps, rubella, varicella; NIP = National Immunisation Program; PCV = pneumococcal conjugate vaccine.

* Also ensure all age-related and relevant specified medical risk group recommended vaccinations are up to date.
† Adult formulation. Switching hepatitis B vaccine brands is not recommended.[52]
‡ Switching of MMR vaccine brands is permitted. MMRV vaccine is not recommended for use in people ≥14 years of age as no data are available on safety, immunogenicity or efficacy in this age group. If a person ≥14 years of age is inadvertently given a dose of MMRV vaccine, this dose does not need to be repeated.
§ Formulation for individuals ≥12 years of age. Adults ≥18 years of age without severe immunocompromise who have not previously received a COVID-19 vaccine are recommended a single primary dose. Adults who are 18 to 64 years of age without severe immunocompromise can consider further doses every 12 months based on a risk–benefit assessment such as the presence of other medical conditions that may increase the risk of severe COVID-19.[59]
# In some states and territories, influenza vaccines for all persons ≥6 months of age may also be provided free of charge to residents, regardless of NIP eligibility.
¶ See Box 1 for a resource on specified medical conditions associated with increased risk of influenza disease and severe outcomes.
‖ As of August 2025, the optimal pneumococcal vaccination program for Australia is currently under review.[58]
** See Box 1 for a resource on risk conditions for pneumococcal vaccination.

COVID-19

COVID-19 vaccination is recommended as a primary course for women who are not previously vaccinated, because of increased risk of severe disease with COVID-19 in pregnant women.[1,59] Single-dose mRNA vaccines (Comirnaty JN.1 or Comirnaty Omicron XBB.1.5) are currently recommended.[57]

Influenza

Women planning pregnancy should receive an influenza vaccine to reduce the risk of influenza-related complications during pregnancy. Annual vaccination is recommended.[30]

Special risk groups considerations

Some women may require additional vaccines or vaccine schedule alterations (Box 1). This includes women who are

immunocompromised because of a congenital or medical condition, or following immunosuppressive treatment, those who have previously experienced an adverse event following vaccination, and those planning overseas travel where relevant exposures are anticipated. Expert consultation may be necessary for individualised risk assessment and vaccine planning.

Vaccination during pregnancy: protecting mother and baby

Vaccination during pregnancy provides dual protection by directly safeguarding the mother against severe illness and indirectly protecting the infant via transplacental transfer of maternal antibodies.

Vaccines recommended during pregnancy

The *Australian Immunisation Handbook* recommended vaccines during pregnancy are detailed in the Figure.[1,9,30,57,60-63]

Influenza

Seasonal influenza significantly increases morbidity in pregnant women, with elevated risks of severe respiratory illness, hospitalisation, preterm labour and adverse fetal outcomes.[37,64,65] Influenza vaccination is therefore strongly recommended for all pregnant women during any trimester, especially those whose pregnancy coincides with the influenza season.[66] Clinical studies have consistently shown influenza vaccination during pregnancy to be safe, with no increased risk of congenital malformations or adverse maternal or fetal outcomes.[1,40]

Pertussis

Pertussis remains a significant public health concern, particularly for infants under six months of age who are at the highest risk for severe disease and death.[67] Vaccination with reduced antigen diphtheria-tetanus-acellular pertussis vaccine (dTpa) is strongly recommended as a single dose between 20 and 32 weeks' gestation, irrespective of previous vaccination status.[1,68-71] This timing maximises the transfer of protective antibodies to the fetus, offering protection during the critical early life period. Multiple studies confirm maternal pertussis immunisation as highly effective, reducing the risk of pertussis infection in infants younger than three months by up to 90%.[33-36,67] Importantly, national and international data confirm no increased risk of adverse pregnancy outcomes associated with pertussis vaccination.[72-74]

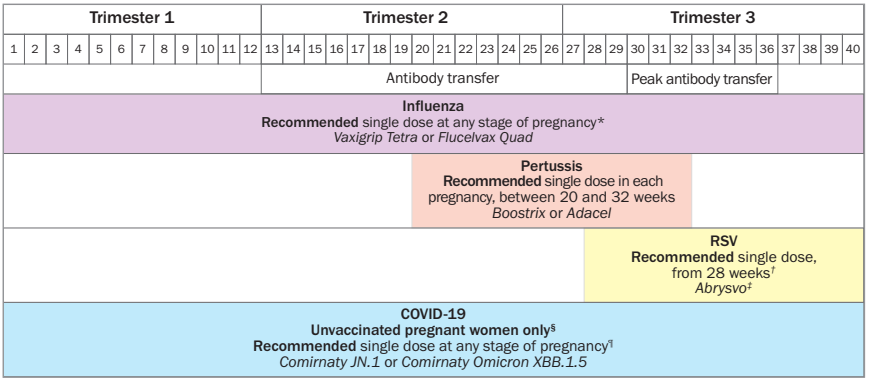

Figure. Recommended vaccines during pregnancy for 2025.[1,9,30,57,60-63]

Abbreviations: COVID-19 = coronavirus disease 2019; RSV = respiratory syncytial virus.

The National Immunisation Program funded vaccine brands are provided above, in additional to the COVID-19 vaccines, which are free for everyone in Australia regardless of Medicare or visa status. Additional brands of influenza vaccines are available but may incur a cost to the patient.

* Women who received the previous year's seasonal influenza vaccine early in their pregnancy are advised to receive the current seasonal influenza vaccine (when it becomes available) later in the same pregnancy. Women who received the vaccine before becoming pregnant should be revaccinated during pregnancy to protect the unborn infant.[30]

† If administered less than 2 weeks before giving birth, the newborn will not be adequately protected.[9]

‡ Abrysvo (RSVpreF) is the only RSV vaccine approved for use in pregnant women.[9]

§ Unvaccinated pregnant women are recommended to receive a primary course of COVID-19 vaccine. Dosing and vaccine choice recommendations are the same as for non-pregnant people of the same age.[57] Unless a woman is otherwise eligible, a dose of COVID-19 vaccine is not routinely recommended in pregnancy.[57] Pregnant women who have previously been vaccinated can discuss with their healthcare provider whether to have a further dose during their pregnancy, based on an individual risk–benefit assessment. Although the latest mRNA COVID-19 vaccines (Comirnaty JN.1 and Omicron XBB.1.5-based vaccines) have not been formally studied in pregnant women, the Australian Technical Advisory Group on Immunisation considers them suitable and safe for use.[57]

¶ People with severe immunocompromise conditions and those who are six months of age or older are recommended two primary doses and are eligible for a third primary dose based on an individual risk–benefit assessment.[57,63]

Adapted from the National Centre for Immunisation Research and Surveillance. Vaccine recommendations for pregnant women – a guide for health professionals.[62]

Respiratory syncytial virus

RSV is a leading cause of severe lower respiratory tract infection among infants, frequently resulting in hospitalisation and intensive care admission.[75] Until recently, preventive options were limited; however, 2023 to 2025 marked a significant shift in RSV prevention in Australia with the approval and rollout of two complementary strategies: maternal vaccination and the monoclonal antibody nirsevimab for newborns and infants.

Maternal vaccination

The maternal RSV vaccine (Abrysvo, RSVpreF) was approved by the TGA in early 2024 and is recommended for use in pregnant women from 28 weeks' gestation.[9,76] However, infants are unlikely to receive adequate protection if they are born within 14 days of their mother receiving the vaccine, so administration by 36 weeks' gestation is strongly recommended.[77] Maternal immunisation enables transplacental transfer of RSV-specific antibodies, providing passive protection to infants during their highest risk period. Clinical trial data demonstrated robust safety profiles and high vaccine efficacy, significantly reducing infant RSV-related lower respiratory tract infections and hospitalisations.[78-80]

In May 2025, the TGA issued an updated warning on the known low risk of people developing Guillain–Barré syndrome following vaccination, noting, however, that the benefit–risk balance continues to remain strongly in favour of vaccination

in the target groups.[81] The TGA further stated they had not received any reports of Guillain–Barré syndrome following vaccination with Abrysvo as of 24 March 2025.

Nirsevimab

The TGA also approved nirsevimab (Beyfortus), a long-acting monoclonal antibody administered as a single intramuscular dose to newborns.[82] Nirsevimab provides direct passive immunity and has demonstrated efficacy in reducing medically attended RSV illness and hospitalisations, including among infants with heart or lung disease, premature infants, and those under the age of two years who are immunocompromised.[83-86] In April 2024, Western Australia and Queensland became the first jurisdictions to introduce universal access to nirsevimab for all newborns.[87,88] As of early 2025, all Australian states and territories offer nirsevimab to all infants through either seasonal or year-round programs.[89]

Nirsevimab is recommended by the ATAGI for infants whose mothers did not receive RSV vaccine in pregnancy or were vaccinated less than two weeks before delivery, as well as infants at increased risk of severe RSV disease, regardless of maternal vaccination status.[9]

The availability of both maternal vaccination and nirsevimab raises important considerations for clinical practice. While maternal immunisation is preferred for healthy term pregnancies because of the broader benefits of protecting both mother and infant, nirsevimab offers an effective alternative or adjunct, particularly in cases of late or missed maternal vaccination, early delivery or increased infant risk. Clinicians should counsel women on both options, balancing time, infant risk and vaccine availability.

Ongoing data collection will provide important insights into the uptake and integration of these dual RSV prevention strategies. Ultimately, achieving high coverage with at least one of these options for all newborns will be crucial to reducing the national burden of RSV-related morbidity.

COVID-19

Unvaccinated pregnant women face heightened risks of severe COVID-19 associated with increased rates of hospitalisation, intensive care admission, preterm birth and stillbirth.[21,27,90,91] The ATAGI recommends that only pregnant women who are unvaccinated receive a single primary dose of COVID-19 vaccine.[57] Current recommended vaccines include mRNA vaccines Comirnaty JN.1 or Comirnaty Omicron XBB.1.5. COVID-19 vaccination during pregnancy has been shown to be safe and effectively induces maternal antibody transfer, offering early infant protection against severe COVID-19.[92-94]

Vaccines not routinely recommended during pregnancy

Most other vaccines are not routinely recommended during pregnancy unless there is a specific high-risk scenario.[1] Notably, live virus vaccines such as MMR and varicella vaccines are contraindicated during pregnancy because of theoretical risks of inducing infection and subsequent complications, including adverse fetal outcomes.[95] Many inactivated bacterial vaccines and inactivated viral vaccines are also not recommended during pregnancy.[96,97] The *Australian Immunisation Handbook* makes special mention of human papillomavirus and yellow fever vaccines.[98] Nonetheless, there are scenarios in which the potential benefit of vaccination during pregnancy may outweigh theoretical risks, particularly among women with significant medical or exposure risks. These cases should be individually assessed by a specialist immunisation service or healthcare provider experienced in maternal immunisation, as absolute contraindications for vaccination during pregnancy are rare.[1]

Vaccination during breastfeeding: ensuring ongoing protection

Breastfeeding provides essential immunological protection to infants through the transfer of maternal antibodies, particularly immunoglobulin A. Vaccination during lactation is a vital component of postpartum care, ensuring continued maternal immunity and enhancing passive immunity for the infant.

Safety of vaccination while breastfeeding

Most vaccines, including both inactivated and live-attenuated vaccines, are safe during breastfeeding.[99,100] Extensive research demonstrates that vaccination during lactation does not negatively affect breast milk composition, lactation performance or infant health.[101] Vaccines administered to breastfeeding women do not pose risks of vaccine-associated infections to the infant, making postpartum vaccination a practical and safe preventive health measure.[93,102]

Recommended vaccines for breastfeeding mothers

Breastfeeding mothers who did not receive recommended vaccines during pregnancy, especially for pertussis, should consider postpartum vaccination to ensure ongoing protection.[103]

Addressing barriers to vaccine uptake

Despite clear recommendations and evidence supporting maternal vaccination, coverage in Australia remains suboptimal.[104] Uptake is shaped by a complex interplay of psychological, structural and systemic factors. The COVID-19 pandemic highlighted several challenges, such as the amplification of misinformation and the erosion of trust; however, it also introduced opportunities, including the accelerated innovation in health communication and engagement.[105-107] To improve maternal vaccination rates, it is essential to understand and address these barriers comprehensively.

Addressing and overcoming vaccine hesitancy

Pregnancy is a time of heightened caution. Many women delay or avoid vaccination because of concerns about vaccine safety for their unborn child, unfamiliarity with newer vaccines, or confusing or inconsistent

messaging. The COVID-19 pandemic intensified these hesitations. Rapid vaccine development, the absence of initial trial data for pregnant women, and experiences of coercive public health measures (such as mandates) led some people to feel pressured or mistrustful of authorities.[105] Others described wanting more time to learn about vaccines at their own pace, understanding the importance of early, consistent and evidence-based communication.

Clinicians remain the most trusted source of information and can improve transparency and mitigate hesitancy by clearly recommending vaccines while sharing the robust, real-world, ongoing vaccine safety and surveillance data available for maternal immunisations.[108,109] This may be achieved by engaging empathetically, addressing specific concerns and reinforcing the safety and benefits of vaccination.[110,111] Programs like P3-MumBubVax, now integrated into the NCIRS-led SKAI platform, provide tailored, evidence-based tools to support vaccine discussions in antenatal care.[112]

Clinician knowledge and recommendations

Healthcare providers significantly influence maternal vaccine uptake. Regular training and updates should be provided to GPs, practice and immunisation nurses, and obstetricians and midwives on the latest immunisation recommendations and communication strategies.[113-115] Additionally, healthcare providers should incorporate routine vaccine counselling into all antenatal care visits, supported by clinical decision tools and reminders within electronic medical records.[112,116]

Reducing systemic and logistical barriers

Barriers to vaccine access during pregnancy include limited availability in antenatal settings, logistical issues such as transport and storage needs, and fragmented care models that can lead to vaccination being seen as another healthcare provider's responsibility. This is particularly problematic for Australia's culturally and linguistically diverse (CALD) communities, including First Nation's and Pacific peoples, and those in rural and remote regions. Integrating vaccines into routine antenatal appointments, and providing maternal immunisation through community pharmacies and mobile clinics, offer flexibility and ease of access to help bridge the gap.[117-119] Utilising digital health solutions – such as automated reminders, nudge notifications, and educational tools – can facilitate timely vaccine administration.

Public health initiatives and strategies

Tailored public awareness campaigns addressing vaccine safety, benefits and misconceptions should be specifically designed to include CALD communities. The Vaccine Champions initiative leverages credible healthcare influencers and community healthcare workers to disseminate evidence-based vaccine information and advocate for immunisation within their own networks.[120,121] These champions can address vaccine concerns and shift social norms towards vaccine acceptance.

Effective public health communication must recognise these contextual influences. Strategies that combine respectful dialogue, consistent messaging and local engagement are essential to rebuilding trust and improving maternal vaccine confidence post-COVID-19 pandemic.

Future directions and research priorities

To sustain and enhance maternal and infant health protection through vaccination, continued research and development is essential.

Emerging vaccines for pregnant women

Group B streptococcus vaccine

Group B streptococcus (GBS) remains a leading cause of neonatal sepsis and meningitis, resulting in significant morbidity and mortality.[122] Several candidate GBS vaccines are undergoing clinical trials to assess safety, immunogenicity and efficacy.[123,124] Successful development and integration of a maternal GBS vaccine could substantially reduce neonatal infections.

Cytomegalovirus vaccine

Congenital cytomegalovirus (CMV) infection is a significant cause of birth defects and neurological impairment.[125] Research into effective maternal CMV vaccines is ongoing, focusing on safety, efficacy and the potential for widespread implementation.[126]

Conclusion

Vaccination preconception, during pregnancy and while breastfeeding remains a cornerstone of maternal and neonatal healthcare, significantly reducing the risks posed by VPDs. Despite compelling evidence supporting the safety, efficacy and necessity of maternal vaccination, barriers such as vaccine hesitancy, limited healthcare provider engagement and systemic accessibility challenges persist. Addressing these challenges requires co-ordinated efforts involving healthcare professionals, public health authorities, policymakers and communities.

Continued research into emerging vaccines, such as those targeting GBS and CMV, alongside initiatives aimed at improving vaccine confidence, will be crucial to advancing maternal and neonatal health outcomes. Through enhanced awareness, strengthened clinical recommendations, improved accessibility and supportive public health policies, Australia can ensure comprehensive protection and optimal health outcomes for mothers and their infants. MT

References

A list of references is included in the online version of this article (www.medicinetoday.com.au).

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References

1. Australian Technical Advisory Group on Immunisation. Vaccination for women who are planning pregnancy, pregnant or breastfeeding. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccination-for-special-risk-groups/vaccination-for-women-who-are-planning-pregnancy-pregnant-or-breastfeeding (accessed August 2025).
2. Immunisation Coalition. Vaccination during pregnancy guide: a guide on how to be best protected during pregnancy with vaccinations. Melbourne: Immunisation Coalition; 2024. Available online at: https://www.immunisationcoalition.org.au/resources/vaccination-during-pregnancy/ (accessed August 2025).
3. Abu-Raya B, Edwards KM. Prevention of fetal and early life infections through maternal-neonatal immunization. In: Abu-Raya B, ed. Remington and Klein's Infectious Diseases of the Fetus and Newborn Infant. 9th ed. Elsevier; 2025. p. 1105-1120.
4. Australian Technical Advisory Group on Immunisation. About the handbook. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2022. Available online at: https://immunisationhandbook.health.gov.au/contents/about-the-handbook (accessed August 2025).
5. Royle J, Lambert SB. Fifty years of immunisation in Australia (1964-2014): the increasing opportunity to prevent diseases. J Paediatr Child Health 2015; 51: 16-20.
6. Australian Government Department of Health, Disability and Ageing. National Immunisation Strategy for Australia 2025-2030. 50p. Canberra: Australian Government Department of Health, Disability and Ageing; 2025. Available online at: https://www.health.gov.au/sites/default/files/2025-06/national-immunisation-strategy-for-australia-2025-2030_0.pdf (accessed August 2025).
7. Australian Government Department of Health, Disability and Ageing. National Immunisation Program. Canberra: Australian Government Department of Health, Disability and Ageing: 2025. Available online at: https://www.health.gov.au/our-work/national-immunisation-program (accessed August 2025).
8. Butler M, Australian Goverment Department of Health and Aged Care. Protection against RSV for mums and bubs with free vaccine available from 3 February. Media release. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://www.health.gov.au/ministers/the-hon-mark-butler-mp/media/protection-against-rsv-for-mums-and-bubs-with-free-vaccine-available-from-3-february-0 (accessed August 2025).
9. Australian Technical Advisory Group on Immunisation. Respiratory syncytial virus (RSV). Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/respiratory-syncytial-virus-rsv (accessed August 2025).
10. Spence L, Armstrong MR, Griffin PM. Respiratory syncytial virus infection: what's available to prevent it and what's coming? Respiratory Medicine Today 2024; 9: 6-19.
11. Smith SE, Sivertsen N, Lines L, De Bellis A. Weighing up the risks - vaccine decision-making in pregnancy and parenting. Women Birth 2022; 35: 547-552.
12. Dahlen HG, Homer C, Boyle J, Lequertier B, Kildea S, Agho KE. Vaccine intention and hesitancy among Australian women who are currently pregnant or have recently given birth: the Birth in the Time of COVID-19 (BITTOC) national online survey. BMJ Open 2023; 13: e063632.
13. Smith SE, Sivertsen N, Lines L, De Bellis A. Decision making in vaccine hesitant parents and pregnant women - an integrative review. Int J Nurs Stud Adv 2022; 4: 100062.
14. Spence L, Armstrong MR, Griffin PM. Pertussis: the post-COVID-19 resurgence in Australia. Respiratory Medicine Today 2025; 10: 4-18.
15. National Notifiable Diseases Surveillance System. National Communicable Disease Surveillance Dashboard. Canberra: Australian Government Department of Health, Disability and Ageing; 2025. Available online at: https://nindss.health.gov.au/pbi-dashboard/ (accessed August 2025).
16. Vermillion MS, Klein SL. Pregnancy and infection: using disease pathogenesis to inform vaccine strategy. NPJ Vaccines 2018; 3: 6.
17. Abu-Raya B, Michalski C, Sadarangani M, Lavoie PM. Maternal immunological adaptation during normal pregnancy. Front Immunol 2020; 11: 575197.
18. Weng J, Couture C, Girard S. Innate and adaptive immune systems in physiological and pathological pregnancy. Biology (Basel) 2023; 12: 402.
19. Kourtis AP, Read JS, Jamieson DJ. Pregnancy and infection. N Engl J Med 2014; 370: 2211-2218.
20. Munoz FM, Jamieson DJ. Maternal immunization. Obstet Gynecol 2019; 133: 739-753.
21. Stock SJ, Carruthers J, Calvert C, et al. SARS-CoV-2 infection and COVID-19 vaccination rates in pregnant women in Scotland. Nat Med 2022; 28: 504-512.
22. Murison KR, Grima AA, Simmons AE, Tuite AR, Fisman DN. Severity of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in pregnancy in Ontario: a matched cohort analysis. Clin Infect Dis 2023; 76: e200-e206.
23. Rasmussen SA, Jamieson DJ, Uyeki TM. Effects of influenza on pregnant women and infants. Am J Obstet Gynecol 2012; 207: S3-8.
24. Duque J, Howe AS, Azziz-Baumgartner E, Petousis-Harris H. Multi-decade national cohort identifies adverse pregnancy and birth outcomes associated with acute respiratory illness hospitalisations during the influenza season. Influenza Other Respir Viruses 2023; 17: e13063.
25. Australian Institute of Health and Welfare (AIHW). Maternal and perinatal outcomes during the 2020 and 2021 COVID-19 pandemic. Canberra: AIHW; 2024. Available online at: https://www.aihw.gov.au/reports/mothers-babies/maternal-and-perinatal-outcomes-during-covid-19/contents/introduction/impacts-of-covid-19-infection-during-pregnancy (accessed August 2025).
26. Lindsay L, Calvert C, Shi T, et al. Neonatal and maternal outcomes following SARS-CoV-2 infection and COVID-19 vaccination: a population-based matched cohort study. Nat Commun 2023; 14: 5275.
27. Villar J, Soto Conti CP, Gunier RB, et al. Pregnancy outcomes and vaccine effectiveness during the period of omicron as the variant of concern, INTERCOVID-2022: a multinational, observational study. Lancet 2023; 401: 447-457.
28. Cho HK, Frivold C, Chu HY. Maternal immunization. J Infect Dis 2024; 231: 830-836.

29. Mohammed H, Roberts CT, Grzeskowiak LE, Giles LC, Dekker GA, Marshall HS. Safety and protective effects of maternal influenza vaccination on pregnancy and birth outcomes: a prospective cohort study. eClinicalMedicine 2020; 26: 100522.
30. Australian Technical Advisory Group on Immunisation. Influenza (flu). Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/influenza-flu (accessed August 2025).
31. Cinicola B, Conti MG, Terrin G, et al. The protective role of maternal immunization in early life. Front Pediatr 2021; 9: 638871.
32. Dolatshahi S, Butler AL, Pou C, et al. Selective transfer of maternal antibodies in preterm and fullterm children. Sci Rep 2022; 12: 14937.
33. Amirthalingam G, Andrews N, Campbell H, et al. Effectiveness of maternal pertussis vaccination in England: an observational study. Lancet 2014; 384: 1521-1528.
34. Kandeil W, van den Ende C, Bunge EM, Jenkins VA, Ceregido MA, Guignard A. A systematic review of the burden of pertussis disease in infants and the effectiveness of maternal immunization against pertussis. Expert Rev Vaccines 2020; 19: 621-638.
35. Principi N, Bianchini S, Esposito S. Pertussis epidemiology in children: the role of maternal immunization. Vaccines (Basel) 2024; 12: 1030.
36. Saul N, Wang K, Bag S, et al. Effectiveness of maternal pertussis vaccination in preventing infection and disease in infants: the NSW Public Health Network case-control study. Vaccine 2018; 36: 1887-1892.
37. McRae J, Blyth CC, Cheng AC, et al. Preventing severe influenza in Australian infants: maternal influenza vaccine effectiveness in the PAEDS-FluCAN networks using the test-negative design. Vaccine 2022; 40: 2761-2771.
38. Madhi SA, Cutland CL, Kuwanda L, et al. Influenza vaccination of pregnant women and protection of their infants. N Engl J Med 2014; 371: 918-931.
39. Regan AK, Klerk N, Moore HC, Omer SB, Shellam G, Effler PV. Effectiveness of seasonal trivalent influenza vaccination against hospital-attended acute respiratory infections in pregnant women: a retrospective cohort study. Vaccine 2016; 34: 3649-3656.
40. Wolfe DM, Fell D, Garritty C, et al. Safety of influenza vaccination during pregnancy: a systematic review. BMJ Open 2023; 13: e066182.
41. Regan AK, Moore HC, Sullivan SG, N DEK, Effler PV. Epidemiology of seasonal influenza infection in pregnant women and its impact on birth outcomes. Epidemiol Infect 2017; 145: 2930-2939.
42. Shattock AJ, Johnson HC, Sim SY, et al. Contribution of vaccination to improved survival and health: modelling 50 years of the Expanded Programme on Immunization. Lancet 2024; 403: 2307-2316.
43. Yusuf N, Raza AA, Chang-Blanc D, et al. Progress and barriers towards maternal and neonatal tetanus elimination in the remaining 12 countries: a systematic review. Lancet Glob Health 2021; 9: e1610-e1617.
44. Marshall H, McMillan M, Andrews RM, Macartney K, Edwards K. Vaccines in pregnancy: the dual benefit for pregnant women and infants. Hum Vaccin Immunother 2016; 12: 848-856.
45. Beigi RH, Fortner KB, Munoz FM, et al. Maternal immunization: opportunities for scientific advancement. Clin Infect Dis 2014; 59: S408-S414.
46. Regan AK, Moore HC, Binks MJ, et al. Maternal pertussis vaccination, infant immunization, and risk of pertussis. Pediatrics 2023; 152: e2023062664.
47. Nazareno AL, Newall AT, Muscatello DJ, Hogan AB, Wood JG. Modelling the epidemiological impact of maternal respiratory syncytial virus (RSV) vaccination in Australia. Vaccine 2024; 42: 126418.
48. Nazareno AL, Wood JG, Muscatello DJ, Homaira N, Hogan AB, Newall AT. Estimating the cost-effectiveness of maternal respiratory syncytial virus (RSV) vaccination in Australia: a dynamic and economic modelling analysis. Vaccine 2025; 46: 126651.
49. Dorney E, Black K. Preconception care. Aust J Gen Pract 2024; 53: 805-812.
50. Australian Technical Advisory Group on Immunisation. Table. Pre-vaccination screening checklist. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/resources/tables/table-pre-vaccination-screening-checklist (accessed August 2025).
51. Wiley K, Regan A, McIntyre P. Immunisation and pregnancy - who, what, when and why? Aust Prescr 2017; 40: 122-124.
52. Australian Technical Advisory Group on Immunisation. Hepatitis B. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2023. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/hepatitis-b (accessed August 2025).
53. Australian Technical Advisory Group on Immunisation. Measles. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/measles (accessed August 2025).
54. Australian Technical Advisory Group on Immunisation. Mumps. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/mumps (accessed August 2025).
55. Australian Technical Advisory Group on Immunisation. Rubella. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/rubella (accessed August 2025).
56. Australian Technical Advisory Group on Immunisation. Varicella (chickenpox). Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/varicella-chickenpox (accessed August 2025).
57. Australian Technical Advisory Group on Immunisation. COVID-19. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/covid-19 (accessed August 2025).
58. Australian Technical Advisory Group on Immunisation. Pneumococcal disease. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2024. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/pneumococcal-disease (accessed August 2025).
59. Suseeladevi AK, Denholm R, Retford M, et al. COVID-19 vaccination and birth outcomes of 186,990 women vaccinated before pregnancy: an England-wide cohort study. Lancet Reg Health Eur 2024; 45: 101025.
60. Australian Technical Advisory Group on Immunisation. Statement on the administration of seasonal influenza vaccines in 2025. Canberra: Australian Government Department of Health and Aged Care; 2025. 3p. Available online at: https://www.health.gov.au/resources/publications/atagi-statement-on-the-administration-of-seasonal-influenza-vaccines-in-2025-0?language=en (accessed August 2025).
61. Australian Government Department of Health, Disability and Ageing. Therapeutic Goods Administration Product and Consumer Medicine Information Repository. eBusiness Services. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://www.ebs.tga.gov.au (accessed August 2025).
62. National Centre for Immunisation Research and Surveillance (NCIRS). Vaccine recommendations for pregnant women – a guide for health professionals. NCIRS. Available online at: https://ncirs.org.au/vaccine-recommendations-pregnant-women-guide-health-professionals (accessed August 2025).
63. Australian Goverment Department of Health and Aged Care. COVID-19 vaccines

in Australia. Canberra: Australian Government Department of Health and Aged Care; 2024. Available online at: https://www.health.gov.au/sites/default/files/2024-11/covid-19-vaccines-in-australia-a3-poster.pdf (accessed August 2025).
64. Frawley JE, He WQ, McCallum L, et al. Birth outcomes after pertussis and influenza diagnosed in pregnancy: a retrospective, population-based study. BJOG 2025; 132: 355-364.
65. Sahni LC, Olson SM, Halasa NB, et al. Maternal vaccine effectiveness against influenza-associated hospitalizations and emergency department visits in infants. JAMA Pediatr 2024; 178: 176-184.
66. Australian Government Department of Health, Disability and Ageing. Immunisation for pregnancy. Canberra: Australian Government Department of Health, Disability and Ageing; 2025. Available online at: https://www.health.gov.au/topics/immunisation/when-to-get-vaccinated/immunisation-for-pregnancy (accessed August 2025).
67. Australian Technical Advisory Group on Immunisation. Pertussis (whooping cough). Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2024. Available online at: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/pertussis-whooping-cough (accessed August 2025).
68. Eberhardt CS, Blanchard-Rohner G, Lemaitre B, et al. Maternal immunization earlier in pregnancy maximizes antibody transfer and expected infant seropositivity against pertussis. Clin Infect Dis 2016; 62: 829-836.
69. Abu Raya B, Bamberger E, Almog M, Peri R, Srugo I, Kessel A. Immunization of pregnant women against pertussis: the effect of timing on antibody avidity. Vaccine 2015; 33: 1948-1952.
70. Kent A, Ladhani SN, Andrews NJ, et al. Pertussis antibody concentrations in infants born prematurely to mothers vaccinated in pregnancy. Pediatrics 2016; 138: e20153854.
71. Naidu MA, Muljadi R, Davies-Tuck ML, Wallace EM, Giles ML. The optimal gestation for pertussis vaccination during pregnancy: a prospective cohort study. Am J Obstet Gynecol 2016; 215: 237.e1-6.
72. Mohammed H, Roberts CT, Grzeskowiak LE, et al. Safety of maternal pertussis vaccination on pregnancy and birth outcomes: a prospective cohort study. Vaccine 2021; 39: 324-331.
73. Kildegaard H, Jensen A, Andersen PHS, et al. Safety of pertussis vaccination in pregnancy and effectiveness in infants: a Danish national cohort study 2019-2023. Clin Microbiol Infect 2025; 31: 995-1002.
74. Munoz FM, Bond NH, Maccato M, et al. Safety and immunogenicity of tetanus diphtheria and acellular pertussis (Tdap) immunization during pregnancy in mothers and infants: a randomized clinical trial. JAMA 2014; 311: 1760-1769.
75. Zar HJ, Cacho F, Kootbodien T, et al. Early-life respiratory syncytial virus disease and long-term respiratory health. Lancet Respir Med 2024; 12: 810-821.
76. Therapeutic Goods Administration. Australian public assessment report for Abrysvo. Canberra: Australian Government Department of Health and Aged Care; 2024. 59p. Available online at: https://www.tga.gov.au/sites/default/files/2024-05/auspar-abrysvo-240502.pdf (accessed August 2025).
77. Australian Technical Advisory Group on Immunisation. Pregnant women are recommended to receive an RSV vaccine during pregnancy to protect their infant. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/recommendations/pregnant-women-are-recommended-to-receive-an-rsv-vaccine-during-pregnancy-to-protect-their-infant (accessed August 2025).
78. Kampmann B, Madhi SA, Munjal I, et al. Bivalent prefusion F vaccine in pregnancy to prevent RSV illness in infants. N Engl J Med 2023; 388: 1451-1464.
79. Otsuki T, Akada S, Anami A, et al. Efficacy and safety of bivalent RSVpreF maternal vaccination to prevent RSV illness in Japanese infants: subset analysis from the pivotal randomized phase 3 MATISSE trial. Vaccine 2024; 42: 126041.
80. Simoes EAF, Pahud BA, Madhi SA, et al. Efficacy, safety, and immunogenicity of the MATISSE (Maternal Immunization Study for Safety and Efficacy) maternal respiratory syncytial virus prefusion F protein vaccine trial. Obstet Gynecol 2025; 145: 157-167.
81. Therapeutic Goods Administration. Updated warnings for respiratory syncytial virus vaccines Arexvy and Abrysvo. Canberra: Australian Government Department of Health, Disability and Ageing; 2025. Available online at: https://www.tga.gov.au/news/safety-updates/updated-warnings-respiratory-syncytial-virus-vaccines-arexvy-and-abrysvo (accessed August 2025).
82. Therapeutic Goods Administration. Australian public assessment report for Beyfortus. Canberra: Australian Government Department of Health and Aged Care; 2024. 38p. Available online at: https://www.tga.gov.au/sites/default/files/2024-04/auspar-beyfortus-240412.pdf (accessed August 2025).
83. Griffin MP, Yuan Y, Takas T, et al. Single-dose nirsevimab for prevention of RSV in preterm infants. N Engl J Med 2020; 383: 415-425.
84. Hammitt LL, Dagan R, Yuan Y, et al. Nirsevimab for prevention of RSV in healthy late-preterm and term infants. N Engl J Med 2022; 386: 837-846.
85. Domachowske J, Madhi SA, Simoes EAF, et al. Safety of nirsevimab for RSV in infants with heart or lung disease or prematurity. N Engl J Med 2022; 386: 892-894.
86. Domachowske J, Hamren UW, Banu I, et al. Safety and pharmacokinetics of nirsevimab in immunocompromised children. Pediatrics 2024; 154: e2024066508.
87. Cook R, Sanderson JA. Western Australian children first to access protection from RSV. Media release. Perth: Government of Western Australia; 2024. Available online at: https://www.wa.gov.au/government/media-statements/Cook-Labor-Government/Western-Australian-children-first-to-access-protection-from-RSV-20240305 (accessed August 2025).
88. Miles S, Fentiman S. Free RSV immunisation program for Queensland infants and young children. Media release. Brisbane: The State of Queensland Department of the Premier and Cabinet; 2024. Available online at: https://statements.qld.gov.au/statements/99963 (accessed August 2025).
89. National Centre for Immunisation Research and Surveillance (NCIRS). State and territory Nirsevimab (Beyfortus) infant program summary 2025. Sydney: NCIRS; 2025. 7p. Available online at: https://ncirs.org.au/sites/default/files/2025-05/State%20and%20territory%20nirsevimab%20%28Beyfortus%29%20infant%20program%20summary%202025_May%202025.pdf (accessed August 2025).
90. Simeone RM, Zambrano LD, Halasa NB, et al. Effectiveness of maternal mRNA COVID-19 vaccination during pregnancy against COVID-19-associated hospitalizations in infants aged <6 months during SARS-CoV-2 Omicron predominance - 20 states, March 9, 2022-May 31, 2023. MMWR Morb Mortal Wkly Rep 2023; 72: 1057-1064.
91. Stock SJ, Moore E, Calvert C, et al. Pregnancy outcomes after SARS-CoV-2 infection in periods dominated by delta and omicron variants in Scotland: a population-based cohort study. Lancet Respir Med 2022; 10: 1129-1136.
92. Marchand G, Masoud AT, Grover S, et al. Maternal and neonatal outcomes of COVID-19 vaccination during pregnancy, a systematic review and meta-analysis. NPJ Vaccines 2023; 8: 103.
93. Fernandez-Garcia S, Del Campo-Albendea L, Sambamoorthi D, et al. Effectiveness and safety of COVID-19 vaccines on maternal and perinatal outcomes: a systematic review and meta-analysis. BMJ Glob Health 2024; 9: e014247.
94. Fleming-Dutra KE, Zauche LH, Roper LE, et al. Safety and effectiveness of maternal COVID-19 vaccines among pregnant people and infants. Obstet Gynecol Clin North Am 2023; 50: 279-297.
95. Australian Technical Advisory Group on Immunisation. Table. Vaccines that are contraindicated in pregnancy: live attenuated vaccines. Australian

Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/resources/tables/table-vaccines-that-are-contraindicated-in-pregnancy-live-attenuated-vaccines (accessed August 2025).
96. Australian Technical Advisory Group on Immunisation. Table. Vaccines that are not routinely recommended in pregnancy: inactivated bacterial vaccines. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2025. Available online at: https://immunisationhandbook.health.gov.au/resources/tables/table-vaccines-that-are-not-routinely-recommended-in-pregnancy-inactivated-bacterial-vaccines (accessed August 2025).
97. Australian Technical Advisory Group on Immunisation. Table. Vaccines that are not routinely recommended in pregnancy: inactivated viral vaccines. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2024. Available online at: https://immunisationhandbook.health.gov.au/resources/tables/table-vaccines-that-are-not-routinely-recommended-in-pregnancy-inactivated-viral-vaccines (accessed August 2025).
98. Australian Technical Advisory Group on Immunisation. Table. Vaccines that are not recommended in pregnancy. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2024. Available online at: https://immunisationhandbook.health.gov.au/resources/tables/table-vaccines-that-are-not-recommended-in-pregnancy (accessed August 2025).
99. US Centers for Disease Control and Prevention. Vaccination safety for breastfeeding mothers. Atlanta: US Department of Health and Human Services; 2023. Available online at: https://www.cdc.gov/breastfeeding/breastfeeding-special-circumstances/vaccinations-medications-drugs/vaccinations.html (accessed August 2025).
100. US Centers for Disease Control and Prevention. Special situations. Vaccines and immunizations. Atlanta: US Department of Health and Human Services; 2024. Available online at: https://www.cdc.gov/vaccines/hcp/imz-best-practices/special-situations.html (accessed August 2025).
101. Mulleners SJ, Juncker HG, Zuiderveld J, Ziesemer KA, van Goudoever JB, van Keulen BJ. Safety and efficacy of vaccination during lactation: a comprehensive review of vaccines for maternal and infant health utilizing a large language model citation screening system. Vaccines (Basel) 2025; 13: 350.
102. National Institute of Child Health and Human Development. COVID-19 vaccines. Drugs and Lactation Database (LactMed®). Bethesda: National Library of Medicine; 2025. Available online at: https://www.ncbi.nlm.nih.gov/books/NBK565969/ (accessed August 2025).
103. Australian Technical Advisory Group on Immunisation. Women who recently gave birth and did not receive pertussis-containing vaccine during pregnancy are recommended to receive the vaccine as soon as possible. Australian Immunisation Handbook. Canberra: Australian Government Department of Health and Aged Care; 2023. Available online at: https://immunisationhandbook.health.gov.au/recommendations/women-who-recently-gave-birth-and-did-not-receive-pertussis-containing-vaccine-during-pregnancy-are-recommended-to-receive-the-vaccine-as-soon-as-possible (accessed August 2025).
104. McRae JE, McHugh L, King C, et al. Influenza and pertussis vaccine coverage in pregnancy in Australia, 2016-2021. Med J Aust 2023; 218: 528-541.
105. Javid N, Phipps H, Homer C, et al. Factors influencing uptake of the COVID-19 vaccination among pregnant women in Australia: a cross-sectional survey. Birth 2023; 50: 877-889.
106. Nuwarda RF, Ramzan I, Weekes L, Kayser V. Vaccine hesitancy: contemporary issues and historical background. Vaccines (Basel) 2022; 10: 1595.
107. Ruggeri K, Vanderslott S, Yamada Y, et al. Behavioural interventions to reduce vaccine hesitancy driven by misinformation on social media. BMJ 2024; 384: e076542.
108. Tuckerman J, Kaufman J, Danchin M. Effective approaches to combat vaccine hesitancy. Pediatr Infect Dis J 2022; 41: e243-e245.
109. Goje O, Kapoor A. Meeting the challenge of vaccine hesitancy. Cleve Clin J Med 2024; 91: S50-S56.
110. Whitehead HS, French CE, Caldwell DM, Letley L, Mounier-Jack S. A systematic review of communication interventions for countering vaccine misinformation. Vaccine 2023; 41: 1018-1034.
111. O'Leary ST, Opel DJ, Cataldi JR, et al. Strategies for improving vaccine communication and uptake. Pediatrics 2024; 153: e2023065483.
112. Jos C, Kaufman J, Tuckerman J, Danchin M. P3-MumBubVax intervention adaptation for general practitioners: a qualitative interview study. Aust J Gen Pract 2022; 51: 373-379.
113. Lip A, Pateman M, Fullerton MM, et al. Vaccine hesitancy educational tools for healthcare providers and trainees: a scoping review. Vaccine 2023; 41: 23-35.
114. Queensland Department of Health. Immunisation Services. Queensland Health Guidelines. Brisbane: The State of Queensland; 2022. Available online at: https://www.health.gov.au/sites/default/files/national-immunisation-education-framework-for-health-professionals.pdf (accessed August 2025).
115. Australian Government Department of Health. National immunisation education framework for health professionals. Canberra: Australian Government Department of Health; 2017. 25p. Available online at: https://www.health.gov.au/sites/default/files/national-immunisation-education-framework-for-health-professionals.pdf (accessed August 2025).
116. Homer CSE, Javid N, Wilton K, Bradfield Z. Vaccination in pregnancy: the role of the midwife. Front Glob Womens Health 2022; 3: 929173.
117. Hart B. The evolving role of Australian community pharmacists in vaccination: challenges and opportunities. Microbiology Australia 2024; 45: 201-204.
118. Patel C, Vette K, Dalton L, et al. Assessment of the first 5 years of pharmacist-administered vaccinations in Australia: learnings to inform expansion of services. Public Health Res Pract 2024; 34: 3432420.
119. Wilcox CR, Woodward C, Rowe R, Jones CE. Embedding the delivery of antenatal vaccination within routine antenatal care: a key opportunity to improve uptake. Hum Vaccin Immunother 2020; 16: 1221-1224.
120. Kaufman J, Overmars I, Leask J, et al. Vaccine Champions training program: empowering community leaders to advocate for COVID-19 vaccines. Vaccines (Basel) 2022; 10: 1893.
121. Kaufman J, Overmars I, Fong J, et al. Training health workers and community influencers to be Vaccine Champions: a mixed-methods RE-AIM evaluation. BMJ Glob Health 2024; 9: e015433.
122. Goncalves BP, Procter SR, Paul P, et al. Group B streptococcus infection during pregnancy and infancy: estimates of regional and global burden. Lancet Glob Health 2022; 10: e807-e819.
123. Pena JMS, Lannes-Costa PS, Nagao PE. Vaccines for Streptococcus agalactiae: current status and future perspectives. Front Immunol 2024; 15: 1430901.
124. Madhi SA, Anderson AS, Absalon J, et al. Potential for maternally administered vaccine for infant Group B Streptococcus. N Engl J Med 2023; 389: 215-227.
125. Schleiss MR. Taking a step beyond serology: progress in the search for a biomarker predicting the risk of maternal-fetal transmission of cytomegalovirus (CMV). eBioMedicine 2024; 101: 105039.
126. Chiavarini M, Genga A, Ricciotti GM, D'Errico MM, Barbadoro P. Safety, immunogenicity, and efficacy of cytomegalovirus vaccines: a systematic review of randomized controlled trials. Vaccines (Basel) 2025; 13: 85.