National Institute for Public Health
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The National Immunisation Programme in the Netherlands

Surveillance and developments in 2024-2025

RIVM report 2025-0092

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Colophon

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Editors: A.M. van Roon, S.J. Lanooij, H.E. de Melker

Authors: D.L.L. Adriaansens, K. Ainslie, M. Bakker, S. Beelen, E. Benincà, K.S.M. Benschop, B.H.B. van Benthem, D.S.F. Berry, M. Bertran, R.S. van Binnendijk, R. Bodewes, P.T. de Boer, M. Bootsma, R. van den Broek, J.G.M. Brouwer, S. de Bruijn, A.M. Buisman, J. van Bussel, V. Coppens, E. op de Coul, J. Cremer, A.P. van Dam, H. Davelaar, J.W. Duijster, E. Duizer, F. Dusseldorp, D. Eggink, C.A.C.M. van Els, K. van Ewijk, I.H.M. Friesema, C.M. Gaasbeek, R. van Gageldonk-Lafeber, I. Gerstenbluth, B. de Gier, T. Gordon, C. Gumbs, F. de Haan, C.C.E. van Hagen, K. Hajji, Y. Halabi, S.J.M. Hahné, S.J. van Hameren, G. den Hartog, Y. ten Have, M. Haverkate, M. Henry, B.J.A. Hoeve-Bakker, S. van den Hof, M. Holwerda, M. Hooiveld, J. Hubert, A. J. Huiberts, I. Jansen, R. Joosten, P. Kaaijk, J. van de Kassteele, P.B. van Kasteren, J.M. Kemmeren, G. Klous, M.J. Knol, F. Kroese, M.S. Lambooij, S.J. Lanooij, M. Lanzl, D. van Leerdam, E.A. van Lier, E. Lista-de Weever, E. Maduro, R. Mariman, A. Meiberg, A. Meijer, D.L. van Meijeren, H.E. de Melker, M. Middeldorp, L.L. Montesano Montessori, I.M. Nauta, L. de Nes-Reijnen, D.W. Notermans, T. Osmënaj, T. Otten, S. Picavet, R. Pijnacker, J. Pijpers, M. de Rooij, A.M. van Roon, F. Rooyer, T. Roozenbeek, N.Y. Rots, W.L.M. Ruijs, J.F. van Slobbe, B. Smagge, N.M. van Sorge, A. Steens, M. Stein, M. Stok, A.C. Teirlinck, J.W. Vanhommerig, H. Vennema, L.J. Visser, B. Voordouw, E.R.A. Vos, H. van Werkhoven, A. Westerhof, M. te Wierik, M. Wijsman, D. Wong, T. Woudenberg

Contact:
H.E. de Melker
Centre for Epidemiology and Surveillance of Infectious Diseases
hester.de.melker@rivm.nl

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PO Box 1 | 3720 BA Bilthoven
The Netherlands
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Synopsis

The National Immunisation Programme in the Netherlands

Surveillance and developments in 2024-2025

Every year, the Dutch National Institute for Public Health and the Environment (RIVM) tracks how many people fall ill due to a disease against which vaccination is included in the National Immunisation Programme (NIP). In 2024, the number of people who contracted such a disease mostly returned to pre-pandemic levels. For some diseases, this was not the case.

For example, the number of children with pertussis (whooping cough) in 2024 was notably high. The increase started in 2023, it increased until April 2024, and then decreased again. In total, there were 18,208 notifications in 2024. Also, the number of people with measles increased sharply in 2024 (205), and this trend continued into the first four months of 2025. The increase in mumps cases that began in 2023 also continued in 2024.

The numbers of invasive pneumococcal disease (2,321), *Haemophilus influenzae* type b (Hib) (55), meningococcal disease (138), and chronic hepatitis B (854) were similar in 2024 as in 2023. As in 2023, there were no cases of rubella or polio in 2024. The number of cases of diphtheria (3) and tetanus (3) remained low.

In 2024, about 950,000 children up to 18 years of age were vaccinated as part of the NIP. They received a total of over 2.4 million vaccinations. Also, more than 110,000 pregnant people were vaccinated against flu and/or pertussis. These vaccinations protect their baby in the first few months after birth against flu and pertussis. They received a total of over 145,000 vaccinations.

Finally, in 2025, two changes were made to the NIP. First, an injection against respiratory syncytial virus (RSV) was added for babies born from April 2025 onwards. In addition, the vaccination schedule in general was adjusted, the moments when children receive the vaccinations. This was done to offer children even better protection.

A few examples: babies born from January 1, 2024 onwards, receive vaccinations against, among others, pertussis and pneumococcal disease one month later: at 12 months instead of 11 months. Also, children now receive their second vaccination against mumps, measles, and rubella at 3 years instead of at 9 years. Furthermore, the vaccination against diphtheria, pertussis, and tetanus is now given when children are 5 years old instead of 4 years.

Keywords: mumps, COVID-19, diphtheria, *Haemophilus influenzae* type b, hepatitis B, whooping cough, measles, meningococcal disease, pneumococcal disease, rotavirus, respiratory syncytial virus, tetanus

Publiekssamenvatting

Het Rijksvaccinatieprogramma in Nederland

Surveillance en ontwikkelingen in 2024-2025

Het RIVM houdt elk jaar bij hoeveel mensen een ziekte krijgen waartegen het Rijksvaccinatieprogramma (RVP) vaccineert. Het aantal mensen dat in 2024 een RVP-ziekte kreeg was vaak weer terug op het niveau van voor de coronapandemie. Bij sommige ziekten was dat niet zo.

Het aantal kinderen met kinkhoest bijvoorbeeld was in 2024 opvallend hoog. De stijging begon in 2023, nam toe tot april 2024 en daalde daarna weer. In totaal waren er 18.208 meldingen in 2024. Verder nam in 2024 het aantal mensen met mazelen sterk toe (205), wat doorzette in de eerste vier maanden van 2025. De stijging van bof die sinds 2023 te zien is zette ook door in 2024.

Invasieve pneumokokkenziekte (2.321), *Haemophilus influenzae* type b (Hib) (55), meningokokkenziekte (138) en chronische hepatitis B (854) kwamen in 2024 ongeveer even vaak voor als in 2023. Net als in 2023 waren er in 2024 geen mensen met rodehond en polio. Het aantal meldingen met difterie (3) en tetanus (3) was laag.

In 2024 zijn ongeveer 950.000 kinderen tot 18 jaar gevaccineerd via het RVP. Zij kregen in totaal ruim 2,4 miljoen vaccinaties. Ook hebben meer dan 110.000 zwangeren zich tegen de griep en/of kinkhoest laten vaccineren; deze vaccinaties beschermen de baby de eerste maanden na de geboorte tegen de griep en kinkhoest. In totaal zijn ruim 145.000 vaccinaties aan zwangeren gegeven, de meeste tegen kinkhoest.

Ten slotte zijn in 2025 twee zaken veranderd in het RVP. Ten eerste is de prik tegen het RS-virus erbij gekomen voor baby's die vanaf 2025 zijn geboren. Verder is het vaccinatieschema aangepast, de momenten waarop kinderen de vaccinaties krijgen. Dit is gedaan om kinderen nog beter te beschermen.

Enkele voorbeelden: baby's die op of na 1 januari 2024 zijn geboren, krijgen de vaccinaties tegen onder andere kinkhoest en pneumokokken een maand later: met 12 in plaats van 11 maanden. Ook krijgen kinderen hun tweede vaccinatie tegen bof, mazelen en rodehond met 3 jaar zijn in plaats van met 9 jaar. Verder wordt de vaccinatie tegen difterie, kinkhoest en tetanus gegeven als kinderen 5 jaar zijn in plaats van 4.

Kernwoorden: bof, COVID-19, difterie, *Haemophilus influenzae* type b, hepatitis B, kinkhoest, mazelen, meningokokkenziekte, pneumokokkenziekte, rotavirus, respiratory syncytial virus, tetanus

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Preface

This report presents an overview of surveillance data on and developments in 2024 and the first four to six months of 2025 that are relevant for the Netherlands with respect to diseases against which vaccination/immunisation is included in the current National Immunisation Programme (NIP): diphtheria, *Haemophilus influenzae* serotype b (Hib) disease, hepatitis B, human papillomavirus (HPV) infection, measles, meningococcal disease, mumps, pertussis, pneumococcal disease, poliomyelitis, respiratory syncytial virus (RSV), rubella, tetanus, rotavirus, and COVID-19. It also describes surveillance data for potential NIP target diseases: hepatitis A, varicella zoster virus (VZV) infection. In addition, the report presents an update of information on vaccines in development for infectious diseases that have reached the clinical testing phase and are relevant for the Netherlands, including COVID-19 vaccines

For disease surveillance and developments with regard to influenza and tuberculosis, the other diseases for which national vaccination programmes exist, please refer to the reports issued by the RIVM (National Institute for Public Health and the Environment) Centre for Infectious Disease Control (CIb), the Health Council, and KNCV Tuberculosis Foundation (See Chapter 1 for these references.)

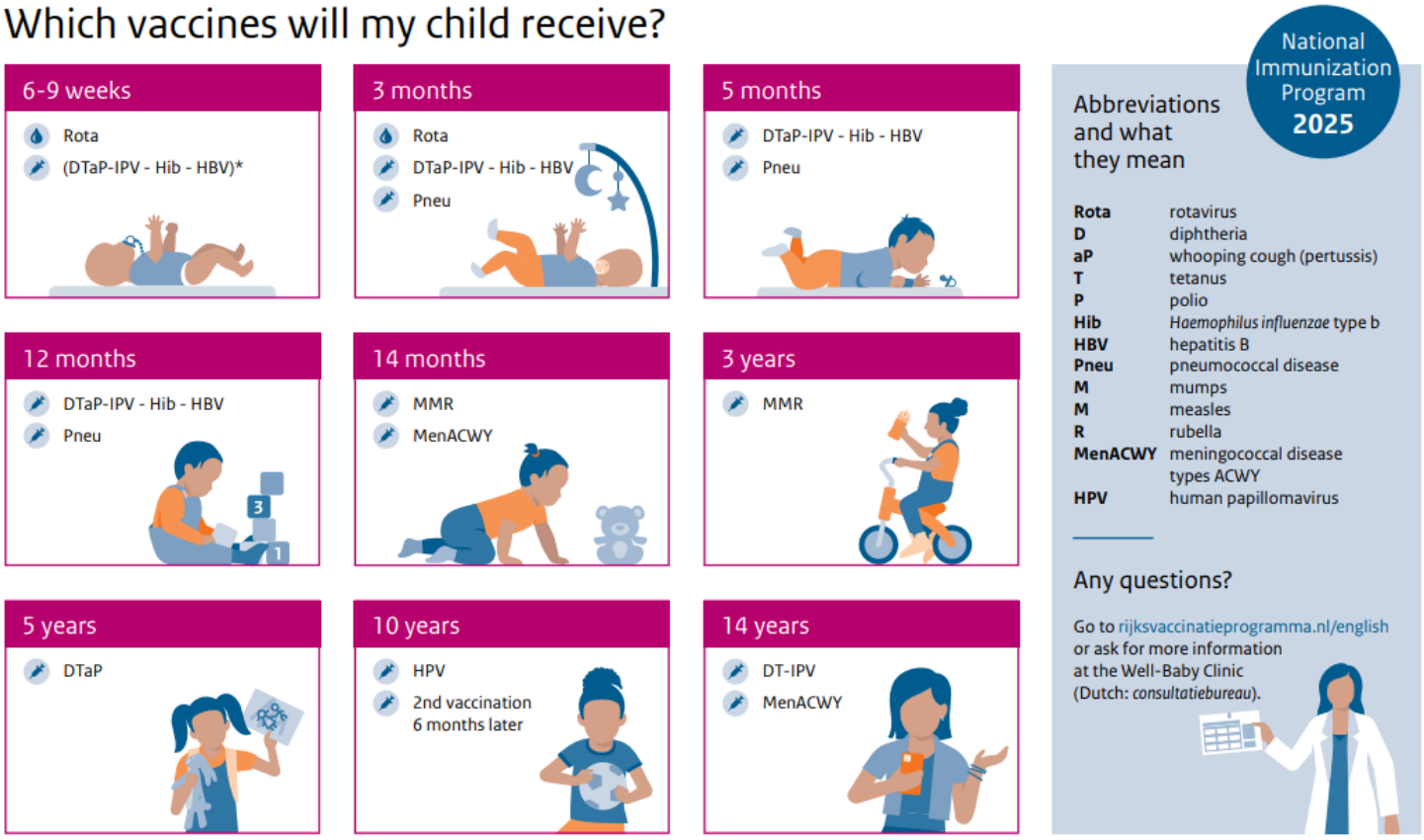
The report is structured as follows:
Chapter 1 contains a summary introduction of the NIP organisation, new recommendations from the Health Council, and new decisions issued by the Ministry of Health, Welfare and Sports. Recent data regarding vaccination coverages are discussed in Chapter 2. Chapter 3 focusses on the public acceptance of vaccination and NIP communication. The burden of diseases covered by the NIP are described in Chapter 4, whilst information on adverse events following immunisation (AEFIs) is presented in Chapter 5. Chapter 6 focuses on current NIP target diseases, including COVID-19. For each disease, the section starts with key points outlining the most prominent findings followed by figures and tables. An update of information on epidemiology, the pathogen, the outcome of recent and ongoing studies, and international developments is provided. Vaccination coverages and developments in relation to current NIP target diseases in the Dutch overseas territories, including the Dutch Caribbean islands, are presented in Chapter 7. Chapter 8 describes potential NIP target diseases that are under consideration for (future) vaccination. Lastly, Chapter 9 presents an update of information on vaccines in development for infectious diseases that have reached the clinical testing phase and are relevant for the Netherlands.

Appendix 1 describes the surveillance methods used to monitor the NIP. Appendix 2 reports on mortality and morbidity figures from 2015 onwards, based on various data sources. Appendix 3 provides an overview of changes in the NIP since 2010, whilst Appendix 4 presents the composition of the vaccines used in the 2024–2025 period. Appendix 5 provides an overview of recent publications by the RIVM, and Appendix 6 lists relevant websites.

Comprehensive summary

Current NIP vaccination schedule

Figure 1 The NIP vaccination schedule in 2025.[1]



* Only if the mother was not vaccinated against whooping cough during pregnancy (maternal whooping cough vaccination). This extra vaccine dose is also given in special circumstances. The pediatrician will discuss this with you.

[1] From September 2025 onwards, immunisation against Respiratory Syncytial Virus (RSV) will be offered to all babies born on or after 1 April 2025.
Source: Vaccination schedule English: Which vaccines will my child receive? | Rijksvaccinatieprogramma.nl

As of 2025, changes have been made to the ages at which children receive their vaccinations. For children born from 1 January 2024, the DTaP-IPV-Hib-HBV and pneumococcal vaccines move from 11 to 12 months. For those born from 1 January 2016, the MMR vaccine moves from 9 years to 3 years, and the DT-IPV vaccine from 9 years to 14 years. For children born from 1 January 2021, the DTaP vaccine moves from 4 to 5 years. Additionally, from autumn 2025, all infants in their first year of life will be offered immunisation against RSV (nirsevimab).

Vaccination coverage

From 2022 onwards, RIVM can no longer precisely determine the national vaccination coverage, due to the implementation of the informed consent procedure for data exchange with RIVM. As a result,

some vaccinations are reported anonymously and cannot be included. Therefore, registered coverage is lower than the actual vaccination coverage.
Based on estimations taking anonymous vaccinations and an administrative correction for missing DTaP-IPV schedule indications into account, it appears that the actual vaccination coverage for newborns and toddlers has slightly decreased compared to the previous year. The HPV vaccination coverage increased though, especially for boys. Additionally, participation in maternal Tdap and influenza vaccination seems to have slightly increased. For other vaccinations, the actual coverage appears to have remained roughly the same.

The ongoing 'Detervax'-study investigates sociodemographic factors in childhood vaccination uptake over time. This is a first step described as a 'situational analysis' of the WHO Tailoring Health Programmes (THP) approach. School-level analyses show a strong decline in MMR and DTaP-IPV uptake from birth cohort 2013 to 2020 among children in Islamic primary schools (MMR: 87% to 59%; DTaP-IPV: 88% to 60%). Uptake also moderately declined among children in Orthodox Protestant primary schools (MMR: 60% to 54%; DTaP-IPV: 60% to 55%), whereas it fluctuated among children in anthroposophical primary schools (MMR: 81% to 78%; DTaP-IPV: 79% to 79%).

The COVID-19 vaccination coverage in the autumn round of 2024 for people aged 60 years and over was 46.6%.

Acceptance of vaccination

The SocioVax (social science research on vaccination) programme has implemented a survey monitor among parents. The results from the first wave in 2024 show that most parents consider vaccination to be important, are satisfied with recent vaccination experiences, trust health care professionals, and see childhood vaccination as the social norm, even in groups with lower uptake. Also, health care professionals remain an important information source for parents deciding about vaccination.

Results of a survey in 2024 links higher trust in institutions, especially those involved with vaccination policies, to greater vaccine willingness. Some people trust vaccination policies even if they generally distrust government. Higher susceptibility to misinformation is also associated with greater concern about childhood vaccination.

A mixed-methods study using surveys and interviews among people aged 60+ years found that willingness to get the flu vaccine is more stable than for COVID-19; people reconsider the COVID-19 vaccine yearly, while flu vaccine decisions are more fixed after one has made a decision.

Long-term survey data from the Doetinchem cohort study among those born between 1928 and 1967 show that willingness to vaccinate against influenza, pneumococcal disease, pertussis, and shingles increased after the COVID-19 pandemic, especially for influenza, particularly among older adults and those with poorer health.

Burden of disease

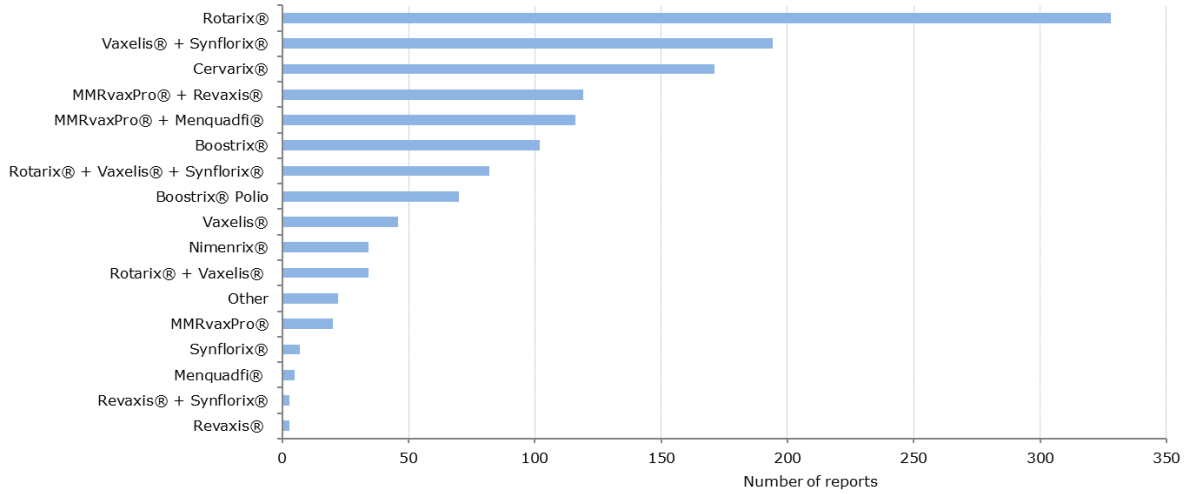
For the year 2024, the estimated total burden of disease caused by (partially) vaccine-preventable diseases was highest for HPV (17,800 disability adjusted life years (DALYs); 73% among women), invasive pneumococcal disease (9000 DALYs), pertussis (7600 DALYs), invasive *Haemophilus influenzae* disease (1300 DALYs), rotavirus infection (950 DALYs), and invasive meningococcal disease (940 DALYs). Particularly for pertussis, measles, mumps, and hepatitis A infection, the estimated burden in 2024 was considerably higher than in 2023.

For COVID-19, the estimated burden in 2024 (at least 18,000 DALYs, excluding long-term consequences of the disease) was considerably lower than in 2023 (37,800 DALYs).

Adverse events

In 2024, Lareb received 1391 reports representing a total of 4731 adverse events following immunisation (AEFI), for all vaccines included in the NIP, excluding reports regarding COVID-19 vaccination. As a result of the introduction of rotavirus vaccination more or less coinciding with the end of the HPV catch-up campaign, the number of AEFI reports received by Lareb remained approximately the same as in earlier years. The number of reported AEFIs per report was between 3 to 4, which is similar to earlier years.
The most frequent local and systemic reactions following COVID-19 vaccination reported to Lareb with a vaccination date between 1 May 2024 and 30 April 2025 were malaise, headache and fatigue.
Overall, in 2024 no new signals of potentially serious adverse events were found for any vaccine included in the NIP.

Figure 2 Number of adverse event reports per suspected vaccine(s) in 2024.[1]



[1] The number of reports following COVID-19 vaccination is not shown in this figure. Lareb received a total of 1001 reports concerning COVID-19 vaccines administered between 1 May 2024 and 30 April 2025.
Source: Lareb.

Disease surveillance and developments - Current NIP

Diphtheria
In 2024, three diphtheria patients (0.02/100,000) were reported in the Netherlands, all had been infected by *C. diphtheriae* with cutaneous disease. The numbers of patients were lower than in 2022–2023 and similar to 2012–2021. Since 2022, a nationwide outbreak of diphtheria caused by *C. diphtheriae* with sequence type (ST) 574 has continued in Germany, and patients due to *C. diphtheriae* ST574 were also notified in five other European countries. ECDC considers the risk highest for unvaccinated vulnerable groups, such as recently arrived migrants, homeless people, and drug and/or alcohol users.

Haemophilus influenzae disease
In 2024, the incidence of invasive disease caused by *Haemophilus influenzae* serotype b (Hib) was 0.31 per 100,000 (n=55) and seems to have stabilised in 2022–2024 after two years of high incidence in 2020–2021 (0.39 and 0.40 per 100,000). The incidence among <5-year-olds decreased significantly in 2024 to 3.2 per 100,000 after previous increases. Hib vaccine effectiveness in 2024 among those eligible for vaccination and aged >3 months was 89% (95% CI: 69–96%), and was unaffected by recent vaccine changes. The incidence of invasive non-typeable *Haemophilus influenzae* (NTHi) disease in 2024 was 1.41 per 100,000 (n=226), which is the highest since at least 1992. The NTHi incidence was highest among persons aged 65 and over (4.1 per 100,000; n=152).

Hepatitis B
In 2024, acute hepatitis B (HBV) incidence was 0.53 per 100,000 (n=95), similar to 2023 (0.53/100,000, n=94), and higher among men (0.85/100,000) than women (0.21/100,000). None of the reported acute HBV cases in 2024 were vaccinated against hepatitis B as part of the national immunisation programme since 2003. The number of newly diagnosed chronic HBV infections was 831 in 2024, and amounted to 4.6 per 100,000, which is comparable to 2022 (4.8/ 100,000) and 2023 (4.8/ 100,000).

Human Papillomavirus infection
HPV vaccination greatly reduces the risk of invasive cervical cancer (CRR 0.085; VE 92%) and cervical intraepithelial neoplasia grade 3 or worse (CIN3+) (CRR 0.19; VE 81%) in vaccinated women born in 1993 and offered HPV vaccination at the age of 16 years.

The bivalent HPV vaccine (2vHPV) against genital persistent vaccine-targeted HPV types 16 and 18 remains highly effective (≥97%) up to 14 years after three doses and 100% up to 10 years after two doses. The VE estimates were comparable between female sexual health clinic clients who had been eligible for the catch-up campaign at the age of 13-16 years (92.2%) and those eligible for routine vaccination at the age of 12 years (91.8%). In unvaccinated women an indirect effect of approximately 70% in reducing incident HPV16 infections and 50% for HPV18 infections was seen in the most recent analyses. No statistically significant indirect effects were observed for HPV31, HPV33 and HPV45.

Geometric mean concentrations (GMCs) of antibodies against HPV16 were higher in boys vaccinated at age 9-10 years than girls vaccinated at age 12-13 years at 7 months post-2vHPV vaccination while the GMC for HPV18 was similar. Conversely, GMCs for HPV16 and HPV18 were slightly lower in boys than in girls at two years post-vaccination.

In men born from 1996 to 2003, the penile prevalence of high risk HPV (hrHPV) measured in swabs collected in 2023/2024 was 8.2% and 6.5% in urine samples. Urine is currently not suitable for monitoring HPV-vaccination in young men.

Measles
A large increase in the incidence of measles cases was observed in 2024 (n=205, 1.14/100,000) compared to previous years (n=7 in 2023, n=6 in 2022), and continued into the first four months of 2025 (n=388, extrapolated annual incidence of 6.45/100,000). Reported cases in 2024 were predominantly in children below the age of 13 years (n=157, 77%), and unvaccinated persons (83%). Six per cent of the cases had a breakthrough infection. These either occurred in cases with 2 vaccinations (n=12) or in a case with 3 vaccinations. In June 2025, a fatal case was reported in a once-vaccinated adult with underlying conditions.

Meningococcal disease
In 2024, invasive meningococcal disease (IMD) incidence was 0.77 per 100,000 (n=138), with 88% due to serogroup B (IMD-B; n=21, 0.67/100,000). The IMD-B incidence was higher than the pre-pandemic period (2015–2019) and slightly higher than 2023. The incidence of IMD-ACWY was low in 2024, with an incidence of 0.06 per 100,000 (n=10), like it has been since MenACWY vaccine introduction in 2018. For IMD-B, the incidence was highest in <2-year-olds (6.6 per 100,000) followed by 15–24-year-olds (1.4 per 100,000) and 2–4-year-olds (2.3 per 100,000). Internationally, several IMD cases related to Umrah pilgrimage have been reported in the UK, the US, and France, of which some were ciprofloxacin-resistant.

Mumps
In 2024, mumps notifications increased to 597 cases (3.3/100,000), compared to 93 in 2023 (0.52/100,000) and 7 in 2022. Half of the cases in 2024 were children under the age of 15 (51%), most were unvaccinated (69%), and most resided in the Bible Belt region (59%). Hospitalisation was required in 3.4% of cases. In the first four months of 2025, 103 cases were reported.

Pertussis
The pertussis epidemic that began in late 2023 peaked in March 2024 and then decreased again. In total, there were 18,208 notifications in 2024 (incidence of 102/100,000). This is the highest annual number since 1976. In 2023, there were 2944 cases reported (incidence of 17/100,000). The incidence in 2024 was highest among infants (573 and 446 per 100,000 for 0–5- and 6–11-month-olds, respectively) and teenagers (202/100,000). Pertussis-related deaths increased to 5 infants and 3 elderly in 2024, compared to 0–3 deaths annually since 1964. Maternal Tdap effectiveness against notification of pertussis in 0–2-month-olds was 91% (95% CI: 88–

93%), and complete infant vaccination series effectiveness remained high (90–99%) up to the 4-year booster, declining thereafter. Seroepidemiological data from the PIENTER Corona study, showed a cumulative pertussis infection incidence of 6.3% in 2023–2024, with the highest incidence among 6–18-year-olds (35%). Lower pre-infection FHA antibody levels in infected individuals suggest a protective role of these pertussis-specific antibodies.

Pneumococcal disease
From June 2024 to May 2025, invasive pneumococcal disease (IPD) incidence was 12.6 per 100,000 (n=2279), and 12.4 per 100,000 (n=2232) in patients in which pneumococcus was identified in blood or CSF samples. This was similar to the previous two years and slightly lower than pre-pandemic years (15.0/100,000 in 2015–2019). Incidence among <5-year-olds was lower than in 2023–2024 and similar to pre-pandemic years. In those aged 5–49 years, incidence was similar to the previous two years, but vaccine (PCV10) serotypes increased. In those aged 50-64 years, incidence was lower than in the period from June 2023 to May 2024 and pre-pandemic years. Among those aged 65+ years, the age group with most IPD, incidence remained stable and lower than in pre-pandemic/pre-PPV23 years (PPV23 vaccination was introduced in the autumn of 2020). PCV15 replaced PCV10 in the NIP as booster dose in September 2024 and for all doses from approximately January 2025. No PCV15-IPD has been observed among PCV15-vaccinated children so far. VE for childhood immunisation with PCV10 was 80% (95% CI 48–93). VE estimates for PPV23 in older adults ranged between 41% and 63%.

Poliomyelitis
No poliomyelitis cases have been reported in the Netherlands since 1994, and environmental and enterovirus surveillance in 2024 confirmed absence of poliovirus circulation. Afghanistan and Pakistan remained polio-endemic. Globally, cVDPV2 cases decreased for the second consecutive year in 2024. cVDPV2 was detected in 2024 in sewage in Finland, Poland, Spain, the UK, and Germany, but no human cases were reported in these countries.

Rubella
Since 2015, no new cases of rubella have been reported in the Netherlands. In 2024, one case of congenital rubella syndrome (CRS) was reported in the child of an asylum seeker.

Tetanus
Three tetanus patients were reported in the Netherlands in 2024 (0.02/100,000). One patient died due to the tetanus infection. One patient was unvaccinated and the other patients were born before the introduction of the NIP.

Rotavirus infection
In 2024, 921 rotavirus detections were reported in virological laboratory surveillance, which is slightly lower than in 2016–2019 (mean 977; range: 679–1129) and 2023 (n=959). In 2024, 6610 all-cause gastroenteritis consultations at general practitioners were reported per 100,000 children under the age of 5 years. This was similar to 2023 (7012/100,000 children) but lower than in 2016–2019 (range: 7829–9840/100,000). Similar to

2022 and 2023, rotavirus genotype G3P8 was the most prevalent in 2024 (57%).

COVID-19
The coronavirus does not (yet) have a stable seasonal pattern. In 2024, hospital admissions during SARS-CoV-2 peaks were lower than in previous years (See the respiratory infections surveillance overview for more details).

In autumn 2024, a new COVID-19 vaccination round targeted adults aged 60 years and over, those 18 years and over eligible for the seasonal flu vaccination, people with severe health conditions, and healthcare workers in contact with vulnerable groups. For autumn 2025, the Health Council advised, and the Minister of HWS adopted, vaccination for the same risk groups except for previously-eligible persons aged 18-49 years who are invited for the seasonal flu vaccination.

Seroprevalence data from the PIENTER Corona study showed that about a quarter of all vaccinated individuals in the Dutch population experienced a breakthrough infection during winter 2023–2024 (28%) and summer 2024 (23%). By the end of 2024, practically all inhabitants, including the oldest age groups, had been infected at least once and/or acquired hybrid immunity.

Corona Vaccination Trials monitored immune response after vaccination of healthy participants of all ages. One year after the autumn 2023 vaccination round (Omicron XBB1.5 mRNA vaccine of Comirnaty®), XBB.1.5 antibody levels declined from one month to one year post-vaccination in all age groups (60–69, 70–79, and 80+), but remained significantly higher than pre-vaccination.

Studies from the US and Denmark found moderate (45-46%) to high (70% for Comirnaty ® (BioNTech/Pfizer) and 84.9% for Moderna) effectiveness (VE) of JN.1 vaccination against COVID-19 hospitalisation, respectively. In the Netherlands, the prospective cohort study VASCO showed a VE of 13% for JN.1 vaccination against SARS-CoV-2 infection among people aged 60 years and over who received a vaccination during the autumn of 2024 compared to those who had only received their primary series and at least one booster (but not during the autumn of 2024).

Immunisation programme in the Caribbean part of the Kingdom of the Netherlands

In general, vaccination coverage of the NIP for newborns, toddlers, schoolchildren and adolescents in the Caribbean part of the Kingdom of the Netherlands is high. However, due to differences in target groups and vaccination schedules, data on vaccination coverage is not easy to compare. COVID-19 vaccination coverage among people aged 60 years and over was low (<15%) on all islands (being highest on Saba).

In 2024, vaccination schedules changed on all islands, with differences per island. Among others, Bonaire, St. Eustatius and Saba, added

rotavirus vaccination, moved the DTaP-IPV-Hib-HBV booster to 12 months of age instead of 11 months, and shifted the fifth polio dose to 14 years instead of 9 years. Aruba and St. Maarten (the Dutch part of the island), moved the second MMR dose to 15 months instead of at 4 years.

In 2024, Bonaire reported three hepatitis B cases (two chronic), Saba one parapertussis case, and St. Maarten four hepatitis B cases. For Curaçao, St. Eustatius, and Aruba it was not possible to provide data on cases of NIP diseases in 2024.

Potential NIP target diseases

Hepatitis A
In 2024, 238 hepatitis A cases were reported (13.3/1,000,000). Since 2020 (n=50), the number of patients has increased every year. Compared to 2023 (n=153), the increase was 56%. Infections were mainly seen in the 20–49-year-olds. Hospitalisation was required in 59 cases (25%), which is in the same range as previous years (2015–2023: 22–33%). A total of 80 cases (34%) contracted the infection abroad, which is comparable to pre-pandemic and 2022 percentages (2015–2019 mean: 37%; 2022: 35%). Travel and person-to-person contact are important transmission routes for hepatitis A.

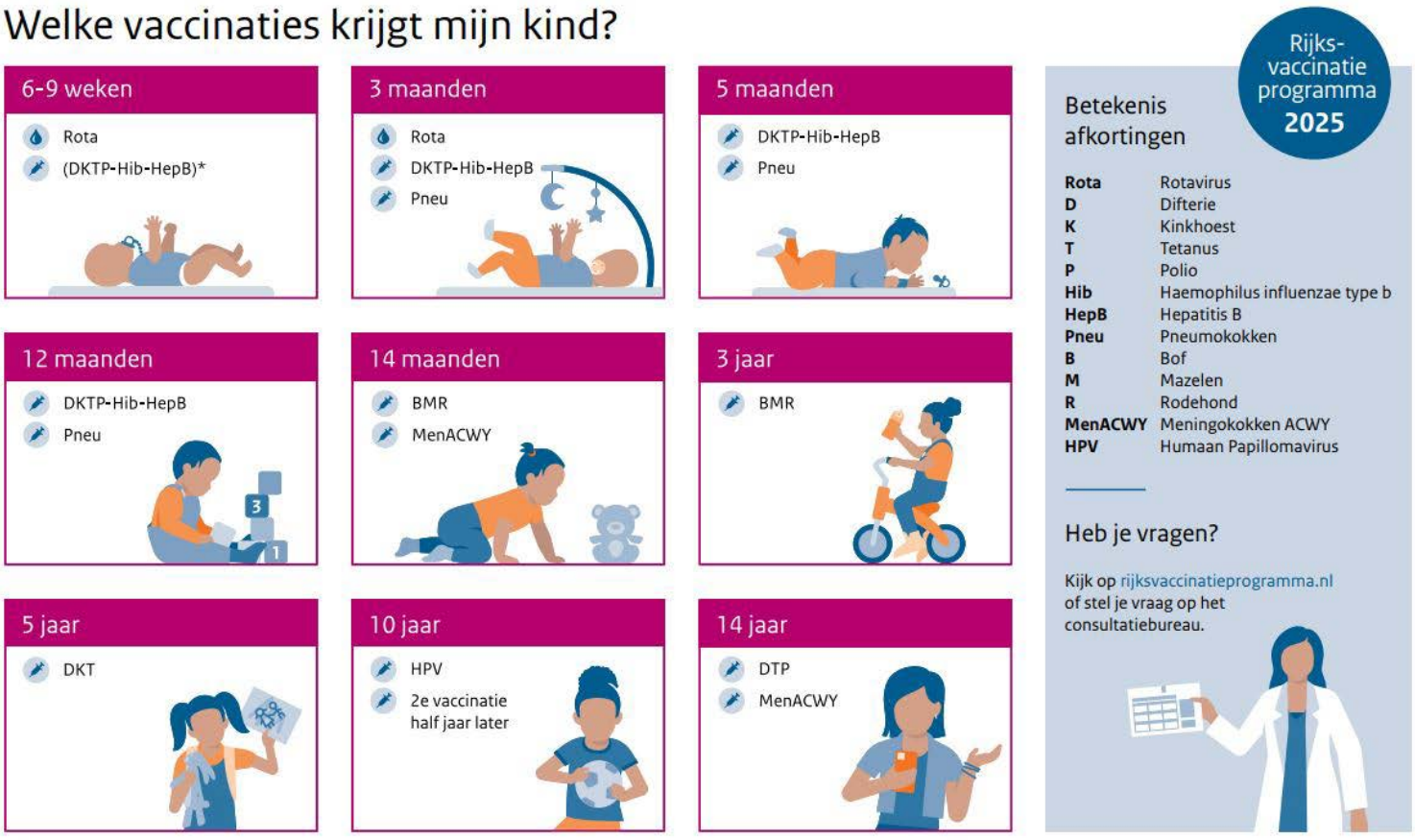
Respiratory syncytial virus infection
In 2024–2025, the RSV season ran from week 46, 2024 to week 16, 2025 with a peak in week 1, 2025, similar to 2022–2023 and the seasons before the COVID-19 pandemic. In September 2025, RSV immunisation of children aged <1 year with the monoclonal antibody nirsevimab was introduced in the NIP in the Netherlands for children born from April 2025. The Health Council of the Netherlands judged that, in view of disease burden in elderly and medical risk groups, RSV vaccination needs to be considered and that available vaccines are effective and safe. However, they find it relevant that more information on the duration of protection becomes available.

Varicella zoster virus infection (varicella and herpes zoster)
In 2024, GPs recorded about 54,000 varicella episodes (300/100,000). Incidence was highest in children aged 0–4 years. The incidence of Herpes Zoster (HZ) increased in 2024 compared to previous years with around 110,000 GP consultations (610/100,000). Incidence was highest in those aged 65 years and over.

Uitgebreide samenvatting

Huidige vaccinatieschema

Figuur 1 Nederlandse vaccinatieschema in 2025.[1-2]



* Alleen als de moeder tijdens de zwangerschap niet is gevaccineerd tegen kinkhoest (kinkhoestprik). En in bijzondere situaties. De jeugdarts bespreekt dit met je.

[1] Vanaf september 2025 wordt immunisatie tegen het Respiratoir Syncytieel Virus (RSV) aangeboden aan alle baby's geboren op of na 1 april 2025.
Bron: Vaccinatieschema 2025 | Rijksvaccinatieprogramma.nl

Vanaf 2025 zijn er wijzigingen aangebracht in de vaccinatieleeftijden voor kinderen. Voor kinderen geboren vanaf 1 januari 2024 worden de DKTP-Hib-HepB- en Pneumokokkenvaccinaties verplaatst van 11 naar 12 maanden. Voor kinderen geboren vanaf 1 januari 2016 wordt de BMR-vaccinatie verplaatst van 9 jaar naar 3 jaar, en de DTP-vaccinatie van 9 jaar naar 14 jaar. Voor kinderen geboren vanaf 1 januari 2021 wordt het DKT-vaccin verplaatst van 4 naar 5 jaar. Daarnaast krijgen vanaf het najaar van 2025 alle zuigelingen in hun eerste levensjaar een immunisatie tegen RSV (nirsevimab) aangeboden.

Vaccinatiegraad

Het RIVM weet niet precies hoe hoog de vaccinatiegraad is door de invoering van het informed consent met betrekking tot de gegevensuitwisseling met het RIVM sinds januari 2022. Hierdoor

ontvangt het RIVM een deel van de vaccinaties anoniem en kan de nationale vaccinatiegraad niet langer exact berekend worden. Het is namelijk niet mogelijk om anonieme vaccinaties mee te tellen. De geregistreerde vaccinatiegraad is daarom lager dan de werkelijke vaccinatiegraad.
Op basis van schattingen, waarbij anonieme vaccinaties en een administratieve correctie voor ontbrekende DKTP-schema-indicaties zijn meegenomen, lijkt het erop dat de werkelijke vaccinatiegraad onder zuigelingen en kleuters iets is afgenomen ten opzichte van het jaar ervoor. De HPV-vaccinatiegraad is duidelijk gestegen, vooral bij jongens. Ook lijken iets meer zwangeren zich te laten vaccineren tegen kinkhoest en griep.
Voor de overige vaccinaties lijkt de vaccinatiegraad ongeveer hetzelfde te zijn gebleven.

In de lopende ‘Detervax’ studie worden sociaal demografische factoren onderzocht die samenhangen met veranderingen in de vaccinatiegraad over de tijd. Dit is een eerste stap beschreven als 'situatie analyse' in de methode van de WHO met betrekking tot op maat gemaakte gezondheidsprogramma's. Analyses op schoolniveau laten een sterke daling zien in de vaccinatiegraad voor BMR en DKTP van geboortejaar 2013 tot 2020 onder kinderen op islamitische basisscholen (BMR: van 87% naar 59%; DKTP: van 88% naar 60%). De vaccinatiegraad is ook matig gedaald onder kinderen op orthodox-protestantse basisscholen (BMR: van 60% naar 54%; DKTP: van 60% naar 55%), terwijl deze bij kinderen op antroposofische basisscholen schommelde (BMR: van 81% naar 78%; DKTP: van 79% naar 79%).

De COVID-19-vaccinatiegraad in de najaarsronde van 2024 voor mensen van 60 jaar en ouder was 46,6%.

Acceptatie van vaccinaties

Het SocioVax-programma (sociaalwetenschappelijk onderzoek naar vaccinatie) heeft een vragenlijst monitor geïmplementeerd onder ouders. De resultaten van de eerste ronde in 2024 laten zien dat de meeste ouders vaccinatie belangrijk vinden, tevreden zijn over hun meest recente vaccinatie-ervaring en vertrouwen hebben in zorgprofessionals. De meerderheid van de ouders ziet kindervaccinatie als de sociale norm, zelfs binnen groepen waar de vaccinatiegraad lager is. Ook blijven zorgprofessionals een belangrijke informatiebron voor ouders die beslissen over vaccinatie.

Resultaten van een enquête in 2024 laten zien dat een groter vertrouwen in instellingen—vooral in de instanties die het vaccinatiebeleid bepalen—samenhangt met een hogere bereidheid om zich te laten vaccineren. Sommige mensen hebben vertrouwen in het vaccinatiebeleid, zelfs als ze over het algemeen weinig vertrouwen hebben in de overheid. Mensen die vatbaarder zijn voor misinformatie, maken zich vaker zorgen over vaccinaties bij kinderen.

Een mixed-methods onderzoek, met enquêtes en interviews onder mensen van 60 jaar en ouder, laat zien dat de bereidheid om de griepprik te halen stabieler is dan de bereidheid om de COVID-19-

vaccinatie te halen. Mensen heroverwegen jaarlijks hun keuze voor de COVID-19-vaccinatie, terwijl de beslissing over de griepprik meer vaststaat nadat men de keuze eenmaal gemaakt heeft.

Enquêtedata uit de Doetinchem-cohortstudie onder mensen geboren tussen 1928 en 1967, waarin mensen door de tijd gevolgd worden, laat zien dat de bereidheid om zich te vaccineren tegen influenza, pneumokokkenziekte, kinkhoest en gordelroos is toegenomen na de COVID-19 pandemie, vooral voor influenza en met name onder ouderen en mensen met een slechtere gezondheid.

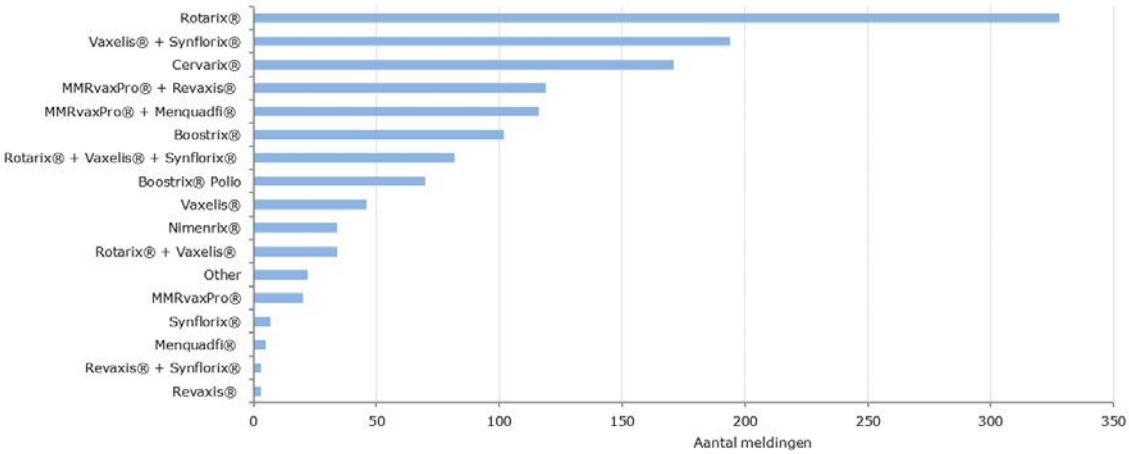
Ziektelast

In 2024, was de geschatte totale ziektelast veroorzaakt door ziekten die (deels) door vaccinatie te voorkomen zijn, het hoogst voor HPV (17.800 disability adjusted life years (DALYs); 73% voor vrouwen), invasieve pneumokokkenziekte (9.000 DALYs), kinkhoest (7.600 DALYs), invasieve ziekte veroorzaakt door *Haemophilus influenzae* (1.300 DALYs), rotavirusinfectie (950 DALYs) en invasieve meningokokkenziekte (940 DALYs). Vooral voor kinkhoest, mazelen, bof en hepatitis A was de geschatte ziektelast in 2024 aanzienlijk hoger dan in 2023.
De ziektelast van COVID-19 wordt geschat op ten minste 18.000 DALYs voor 2024 (exclusief langetermijngevolgen van de ziekte). Dit is aanzienlijk lager dan in 2023 (37.800 DALYs).

Bijwerkingen

In 2024 ontving bijwerkingencentrum Lareb 1391 meldingen van in totaal 4731 mogelijke bijwerkingen van vaccins in het RVP. Meldingen van bijwerkingen van COVID-19-vaccins zijn hierin niet opgenomen. Door de introductie van rotavirusvaccinatie, ongeveer tegelijk met het einde van de HPV-inhaalcampagne, bleef het aantal meldingen ongeveer gelijk aan voorgaande jaren. Het aantal geregistreerde mogelijke bijwerkingen na vaccinatie per melding ligt tussen de 3 en 4, vergelijkbaar met eerdere jaren. De meest gemelde lokale en systemische reacties na COVID-19-vaccinatie tussen 1 mei 2024 en 30 april 2025 waren malaise, hoofdpijn en vermoeidheid. In 2024 werden geen nieuwe signalen van mogelijk ernstige bijwerkingen gevonden voor vaccins in het RVP.

Figuur 2 Aantal meldingen van mogelijke bijwerkingen per vaccin(s) in 2024.[1]



[1] Het aantal meldingen na COVID-19-vaccinatie is niet weergegeven in deze figuur. Lareb ontving in totaal 1001 meldingen over COVID-19-vaccins die zijn toegediend tussen 1 mei 2024 en 30 april 2025.
Bron: Lareb.

Surveillance en ontwikkelingen - Huidige RVP

Difterie

In 2024 werden in Nederland drie difteriegevallen gemeld (0,02/100.000). Alle patiënten hadden een cutane infectie door *C. diphtheriae*. Het aantal patiënten is lager dan in 2022–2023 en vergelijkbaar met 2012–2021. Sinds 2022 is er in Duitsland een landelijke uitbraak van difterie door *C. diphtheriae* met sequence type 574 en werden er ook patiënten door deze stam gemeld in vijf andere Europese landen. ECDC beschouwt het risico als het hoogst voor niet-gevaccineerde kwetsbare groepen, zoals recent aangekomen migranten, daklozen en drugs- of alcoholgebruikers.

Haemophilus influenzae-ziekte

In 2024 was de incidentie van invasieve ziekte door *Haemophilus influenzae* serotype b (Hib) 0,31 per 100.000 (n=55) en deze lijkt gestabiliseerd te zijn in 2022–2024 na een hoge incidentie in 2020–2021 (0,39 en 0,40/100.000). De incidentie bij kinderen jonger dan 5 jaar daalde in 2024 significant naar 3,2 per 100.000 na eerdere stijgingen. De vaccin effectiviteit van Hib in 2024 bij kinderen die in aanmerking kwamen voor Hib vaccinatie en ouder waren dan 3 maanden was 89% (95% BI: 69–96%), en bleek niet beïnvloed door recente wijzigingen in vaccins en doses. De incidentie van invasieve niet-typeerbare *Haemophilus influenzae* (NTHi) in 2024 was 1,4 per 100.000 (n=226), het hoogste sinds tenminste 1992. De NTHi-incidentie was het hoogst bij individuen van 65 jaar of ouder (4,1/100.000 in 2024; n=152).

Hepatitis B

In 2024 was de incidentie van acute hepatitis B-meldingen 0,53 per 100.000 (n=95), vergelijkbaar met 2023 (0,53/100.000, n=94), en hoger bij mannen (0,85/100.000) dan bij vrouwen (0,21/100.000). Geen van de gerapporteerde acute HBV meldingen in 2024 was gerelateerd aan individuen die in aanmerking kwamen voor hepatitis B vaccinatie als onderdeel van het RVP sinds 2003. Het aantal nieuw

gediagnosticeerde chronische HBV-infecties was 831 in 2024 en bedroeg 4,6 per 100.000, wat vergelijkbaar is met 2022 (4,8/100.000) en 2023 (4,8 per 100.000).

Humaan Papillomavirus infectie
HPV-vaccinatie vermindert het risico op invasieve baarmoederhalskanker (CRR 0,085; VE 92%) en op cervicale intra-epitheliale neoplasie graad 3 of hoger (CIN3+) (CRR 0,19; VE 81%) aanzienlijk bij gevaccineerde vrouwen geboren in 1993 die het HPV-vaccin op 16-jarige leeftijd aangeboden kregen.

Het bivalente HPV-vaccin (2vHPV) tegen de persisterende genitale HPV-types 16 en 18 blijft tot ten minste 14 jaar na drie doses en tot 10 jaar na twee doses zeer effectief (≥97% respectievelijk 100%). De VE-schattingen waren vergelijkbaar tussen vrouwelijke soa-polikliniekbezoekers die in aanmerking kwamen voor de inhaalcampagne op 13-16-jarige leeftijd (92,2%) en vrouwen die in aanmerking kwamen voor de routinematige vaccinatie op 12-jarige leeftijd (91,8%). Bij niet-gevaccineerde vrouwen werd in de meest recente analyses een indirect effect gezien van ongeveer 70% voor vermindering van nieuwe HPV16-infecties en 50% voor HPV18-infecties. Voor HPV31, HPV33 en HPV45 werden geen statistisch significante indirecte effecten waargenomen.

De geometrische gemiddelde concentraties (GMC's) van antistoffen tegen HPV16 waren hoger bij jongens die op 9-10-jarige leeftijd waren gevaccineerd dan bij meisjes die op 12-13-jarige leeftijd waren gevaccineerd, gemeten 7 maanden na de 2vHPV-vaccinatie, terwijl de GMC voor HPV18 vergelijkbaar was. Omgekeerd waren de GMC's voor HPV16 en HPV18 iets lager bij jongens dan bij meisjes, gemeten twee jaar na vaccinatie.

Bij mannen geboren tussen 1996 en 2003 was de prevalentie van hoog-risico HPV op de penis, gemeten in selfswabs verzameld in 2023/2024, 8,2% en 6,5% in urinemonsters. Een urinetest is momenteel geen geschikte methode voor het monitoren van HPV-vaccinatie bij jonge mannen.

Mazelen
In 2024 werd een sterke toename in het aantal gevallen van mazelen waargenomen (n=205, 1,14/ 100.000) vergeleken met voorgaande jaren (n=7 in 2023, n=6 in 2022), en deze toename zette door in de eerste vier maanden van 2025 (n=388, geëxtrapoleerde jaarlijkse incidentie van 6,45 per 100.000). De gemelde gevallen in 2024 betroffen voornamelijk kinderen jonger dan 13 jaar (n=157, 77%) en niet-gevaccineerde personen (83%). Zes procent van de gevallen betrof een doorbraakinfectie. Deze kwamen voor bij personen met 2 vaccinaties (n=12) en bij een persoon met 3 vaccinaties. In juni 2025 werd een sterfgeval gemeld bij een eenmaal gevaccineerde volwassene met onderliggende aandoeningen.

Meningokokkenziekte
In 2024 was de incidentie van invasieve meningokokkenziekte (IMD) 0,77 per 100.000 (n=138), waarvan 88% werd veroorzaakt door serogroep B (IMD-B; n=121, 0,67/100.000). De incidentie van IMD-B

was hoger dan in de pre-pandemische periode (2015–2019) en iets hoger dan in 2023. De incidentie van IMD-ACWY was laag in 2024, met een incidentie van 0,06 per 100.000 (n=10), zoals sinds de introductie van het MenACWY-vaccin in 2018 het geval is. Voor IMD-B was de incidentie het hoogst bij kinderen jonger dan 2 jaar (6,6/100.000), gevolgd door jongvolwassenen van 15–24 jaar (1,4/100.000) en kinderen van 2–4 jaar (2,3/100.000). Internationaal zijn er verschillende IMD-gevallen gemeld in verband met de Umrah-bedevaart in het Verenigd Koninkrijk, de Verenigde Staten en Frankrijk, waarvan sommige resistent waren tegen ciprofloxacine.

Bof
In 2024 steeg het aantal meldingen van bof tot 597 gevallen (3,32 per 100.000), vergeleken met 93 in 2023 (0,52 per 100.000) en 7 in 2022. De helft van de gevallen in 2024 betrof kinderen jonger dan 15 jaar (51%), de meeste waren niet gevaccineerd (69%) en de meerderheid woonde in de Biblebelt-regio (59%). In 3,4% van de gevallen was ziekenhuisopname nodig. In de eerste vier maanden van 2025 werden 103 gevallen gemeld.

Kinkhoest
De kinkhoestepidemie die eind 2023 begon, bereikte een piek in maart 2024 en daalde daarna weer. In totaal waren er 18.208 meldingen in 2024. Dit is het hoogste jaarlijkse aantal sinds 1976. In 2023 werden 2944 gevallen gemeld (17/100.000). De incidentie in 2024 was het hoogst bij jonge zuigelingen (573 en 446/100.000 voor respectievelijk 0–5 en 6–11 maanden oude zuigelingen) en tieners (202/100.000). Het aantal kinkhoestgerelateerde sterfgevallen steeg in 2024 naar 5 zuigelingen en 3 ouderen, vergeleken met 0–3 sterfgevallen per jaar sinds 1964. De vaccineffectiviteit van de maternale kinkhoestvaccinatie tegen meldingen van kinkhoest bij 0–2 maanden oude zuigelingen was 91% (95% BI: 88–93%), en de effectiviteit van de volledige primaire vaccinatieserie voor zuigelingen bleef hoog (90–99%) tot aan de 4-jaars booster, waarna deze geleidelijk afnam. Sero-epidemiologische data uit de PIENTER Corona-studie lieten een cumulatieve incidentie van kinkhoestinfecties van 6,3% zien in 2023–2024, met de hoogste incidentie bij 6–18-jarigen (35%). Lagere pre-infectie filamenteus hemagglutinine (FHA)-antistoftiters bij geïnfecteerde personen wijzen op een beschermende rol van deze kinkhoest-specifieke antistoffen.

Pneumokokkenziekte
Van juni 2024 tot mei 2025 was de incidentie van invasieve pneumokokkenziekte (IPD) 12,6 per 100.000 (n=2279), en 12,4 per 100.000 (n=2232) bij patiënten waar pneumokokken in bloed of hersenvloeistof was aangetoond. Dit was vergelijkbaar met de voorgaande twee jaren en iets lager dan in de jaren vóór de pandemie (15,0 per 100.000 in 2015–2019). De incidentie onder kinderen jonger dan 5 jaar was lager dan in 2023–2024 en vergelijkbaar met de jaren vóór de pandemie. Bij personen van 5–49 jaar was de incidentie vergelijkbaar met de voorgaande twee jaren, maar nam het aantal infecties met vaccin (PCV10)-serotypen toe. Bij personen van 50–64 jaar was de incidentie lager dan in de periode van juni 2023 tot mei 2024 en lager dan in de jaren vóór de pandemie. Onder personen van 65 jaar en ouder, de leeftijdsgroep met de meeste IPD, bleef de

incidentie stabiel en lager dan in de jaren vóór de pandemie en vóór de introductie van PPV23 vaccinatie(geïntroduceerd in het najaar van 2020). PCV15 verving PCV10 in het RVP vanaf in september 2024 als boosterdosis en vanaf ongeveer januari 2025 voor alle doses. Tot nu toe is er geen PCV15-IPD waargenomen bij met PCV15 gevaccineerde kinderen. De vaccinatiewerking (VE) voor kinderimmunisatie met PCV10 was 80% (95% BI 48–93). VE-schattingen voor PPV23 bij ouderen varieerden tussen 41% en 63%.

Polio
Sinds 1994 zijn er in Nederland geen gevallen van poliomyelitis gemeld, en rioolwater- en enterovirussurveillance bevestigden dat er geen polioviruscirculatie was in 2024. Afghanistan en Pakistan bleven in 2024 polio-endemisch. Wereldwijd daalde het aantal cVDPV2-gevallen in 2024 voor het tweede opeenvolgende jaar. In 2024 werd cVDPV2 aangetroffen in rioolwater in Finland, Polen, Spanje, het Verenigd Koninkrijk en Duitsland, maar in deze landen werden geen gevallen van poliomyelitis gemeld.

Rodehond
Sinds 2015 zijn er geen nieuwe gevallen van rubella gemeld in Nederland. In 2024 werd één geval van het congenitaal rubellasyndroom (CRS) gemeld bij een kind van een asielzoekster.

Tetanus
In 2024 werden in Nederland drie gevallen van tetanus gemeld (0,02/100.000). Eén patiënt overleed als gevolg van de tetanusinfectie. Eén van de gemelde patiënten was niet gevaccineerd. De andere patiënten waren geboren vóór de introductie van het Rijksvaccinatieprogramma.

Rotavirusinfectie
In 2024 werden 921 rotavirusdetecties gemeld in de virologische laboratoriumsurveillance, wat iets lager is dan in 2016–2019 (gemiddeld 977; bereik: 679–1129) en 2023 (n=959). In 2024 werden er 6610 consulten bij huisartsen voor gastro-enteritis van alle oorzaken gemeld per 100.000 kinderen jonger dan 5 jaar. Dit was vergelijkbaar met 2023 (7012/100.000 kinderen), maar lager dan in 2016–2019 (bereik: 7829–9840/100.000). Net als in 2022 en 2023 was het rotavirusgenotype G3P8 in 2024 het meest voorkomend (57%).

COVID-19
Het coronavirus vertoont (nog) geen stabiel seizoenspatroon. In 2024 waren het aantal ziekenhuisopnames tijdens SARS-CoV-2-pieken lager dan in voorgaande jaren.

In het najaar van 2024 startte een nieuwe COVID-19-vaccinatieronde voor volwassenen van 60 jaar en ouder, mensen van 18 jaar en ouder die ook in aanmerking kwamen voor de griepprik, andere kinderen en volwassenen met ernstige gezondheidsproblemen die een verhoogd risico op ernstige COVID-19 hebben, en zorgmedewerkers die contact hebben met kwetsbare patiënten en/of cliënten. Voor het najaar van 2025 adviseerde de Gezondheidsraad om dezelfde risicogroepen te vaccineren met uitzondering van mensen van 18-49 jaar die in

aanmerking komen voor de griepprik. Dit advies werd overgenomen door de minister van VWS.

Seroprevalentie-gegevens uit de PIENTER Corona-studie toonden aan dat ongeveer een kwart van alle gevaccineerde personen in de Nederlandse bevolking een doorbraakinfectie doormaakte in de winter van 2023–2024 (28%) en de zomer van 2024 (23%). Eind 2024 waren vrijwel alle inwoners, inclusief de oudste leeftijdsgroepen, minstens één keer besmet geweest en/of hadden hybride immuniteit opgebouwd.

Corona Vaccinatie Trials monitorden de immuunrespons na vaccinatie van gezonde deelnemers van alle leeftijden. Het XBB.1.5-serumantistoffenniveau daalde tussen één maand en één jaar na de vaccinatieronde van het najaar van 2023 (Omicron XBB1.5 mRNA-vaccin van Comirnaty®) in alle leeftijdsgroepen (60–69, 70–79 en 80+), maar bleef significant hoger dan vóór de vaccinatie.

Studies uit de VS en Denemarken vonden een matige (45-46%) tot hoge (70% voor Comirnaty® (BioNTech/Pfizer) en 84,9% voor Moderna) effectiviteit (VE) van JN.1-vaccinatie tegen COVID-19-ziekenhuisopname. In Nederland liet de prospectieve cohortstudie VASCO een VE van 13% zien voor JN.1-vaccinatie tegen SARS-CoV-2-infectie onder mensen van 60 jaar en ouder die een vaccinatie kregen in het najaar van 2024, vergeleken met mensen die alleen hun primaire serie en minimaal één booster hadden ontvangen (maar niet in het najaar van 2024).

Vaccinatieprogramma in het Caribische deel van het Koninkrijk der Nederlanden

Over het algemeen is de vaccinatiegraad van het RVP voor pasgeborenen, peuters, schoolkinderen en adolescenten in het Caribische deel van het Koninkrijk der Nederlanden hoog. Door verschillen in doelgroepen en vaccinatieschema's zijn gegevens over vaccinatiegraad echter niet goed te vergelijken. De COVID-19-vaccinatiegraad onder mensen van 60 jaar en ouder was laag (<15%) op alle eilanden (waarbij de hoogste graad op Saba werd gezien).

In 2024 zijn de vaccinatieschema's op alle eilanden gewijzigd, met verschillen tussen de eilanden. Onder andere Bonaire, St. Eustatius en Saba voegden rotavirusvaccinatie toe, verplaatsten de DTaP-IPV-Hib-HBV-booster naar 12 maanden in plaats van 11 maanden, en verschoven de vijfde poliovaccinatie naar 14 jaar in plaats van 9 jaar. Aruba en St. Maarten (het Nederlandse deel van het eiland) verplaatsten de tweede BMR-dosis naar 15 maanden in plaats van 4 jaar.

In 2024 meldde Bonaire drie gevallen van hepatitis B (waarvan twee chronisch), Saba één geval van parapertussis, en St. Maarten vier gevallen van hepatitis B. Voor Curaçao, St. Eustatius en Aruba was het niet mogelijk om gegevens te verstrekken over het aantal meldingen van RVP-ziekten in 2024.

Potentiële RVP-kandidaten

Hepatitis A
In 2024 werden 238 gevallen van hepatitis A gemeld (13,3/1.000.000). Sinds 2020 (n=50) is het aantal patiënten ieder jaar toegenomen. Vergeleken met 2023 (n=153) was de stijging 56%. Infecties werden vooral gezien bij 20- tot 49-jarigen. Ziekenhuisopname was nodig bij 59 gevallen (25%), wat vergelijkbaar is met voorgaande jaren (2015–2023: 22–33%). In totaal liepen 80 personen (34%) de infectie in het buitenland op, wat overeenkomt met percentages van vóór de pandemie en die van 2022 (gemiddelde 2015–2019: 37%; 2022: 35%). Reizen en mens-op-mens contact zijn belangrijke transmissieroutes voor hepatitis A.

Respiratoir syncytieel virus infectie
In 2024–2025 liep het RSV-seizoen van week 46, 2024 tot week 16, 2025, met een piek in week 1, 2025. Dit was vergelijkbaar met 2022–2023 en de seizoenen vóór de COVID-19-pandemie. In september 2025 werd de RSV-immunisatie van kinderen jonger dan 1 jaar met het monoklonaal antilichaam nirsevimab opgenomen in het RVP voor kinderen geboren vanaf april 2025. De Gezondheidsraad oordeelde dat, gezien de ziektelast bij ouderen en medische risicogroepen, RSV-vaccinatie overwogen moet worden en dat beschikbare vaccins effectief en veilig zijn. Zij vinden het relevant dat er meer informatie beschikbaar komt over de duur van de bescherming.

Varicella zoster virus infectie (waterpokken en gordelroos)
In 2024 registreerden huisartsen ongeveer 54.000 gevallen van waterpokken (300/100.000). De incidentie was het hoogst bij kinderen van 0–4 jaar. De incidentie van gordelroos nam in 2024 toe vergeleken met voorgaande jaren, met ongeveer 110.000 huisartsconsulten (610/100.000). De incidentie was het hoogst bij mensen van 65 jaar en ouder.

1 Introduction

1.1 NIP vaccination schedule

In the Netherlands, vaccination of children against diphtheria, tetanus, and pertussis (DTP) was introduced in 1952. The National Immunisation Programme (NIP) started in 1957, offering DTP and inactivated polio vaccination (IPV) to all children born from 1945 onwards in a programmatic approach. Nowadays, in addition to DTP-IPV, the programme for all children includes vaccinations against 14 infectious diseases, among others, measles, mumps, rubella (MMR), *Haemophilus influenzae* serotype b (Hib), meningococcal disease, invasive pneumococcal disease, hepatitis B virus (HBV), human papillomavirus (HPV), and rotavirus (Figure 1.1).
As of December 2019, maternal vaccination against diphtheria, tetanus, and pertussis (Tdap) also forms part of the NIP programme. Since 2023, maternal vaccination against influenza has been offered to pregnant people.
In the Netherlands, NIP vaccines are offered to all children up to the age of 18 years, residing in the Netherlands including the BES islands free of charge and on a voluntary basis.

The vaccination schedule presented in Figure 1.1 is the routine schedule offered to all children in 2025. In this schedule, DTaP-IPV-HBV-Hib vaccinations are offered at the ages of 3, 5, and 12 months. Children whose mother did not receive a maternal Tdap vaccination at a sufficiently early moment during her pregnancy, and children who had a low birth weight or were born prematurely (before 37 weeks' gestation), receive an additional DTaP-IPV-HBV-Hib vaccination at the age of 6-9 weeks. Also, newborns to HBsAg-positive mothers are given a HBV vaccination and HBV immunoglobulin, preferably within 2 hours after birth, but no later than 48 hours after birth. These infants receive an additional DTaP-IPV-HBV-Hib dose at the age of 2 months.

If necessary, all children who have recently taken up residence in the Netherlands receive additional NIP vaccinations to provide them with long-term immunity against NIP target diseases. The Youth Health Care physician assesses their vaccination status and offers a personalised vaccination schedule, including a HBV vaccination series. Furthermore, all asylum seekers' infant children are offered an additional MMR dose at the age of 9 months. For children who travel to a country where measles are common, MMR vaccination is offered ahead of schedule.

1.1.1 Changes in the NIP vaccination schedule since 1 January 2024

In 2024, rotavirus vaccination was added to the vaccination schedule. The vaccination has been offered at the ages of 6-9 weeks and 3 months for children born from 1 January 2024 onwards.

As of 2025, four adjustments to children's vaccination ages have been implemented. First, for all children born from 1 January 2024 onwards, the dose of DTaP-IPV-Hib-HBV and Pneu vaccine that used to be given at the age of 11 months, is now given at 12 months. Second, for children born from 1 January 2016 onwards, the dose of the MMR vaccination that used to be given at the age of 9 years is now given at the age of 3 years. Third, for children born from 1 January 2021 onwards, the dose of the DTaP vaccine that used to be given at the age

of 4 years is now given at the age of 5 years. Fourth, for children born from 1 January 2016 onwards, the dose of DT-IPV vaccine that used to be given at the age of 9 years is now given at the age of 14 years.

Table 1 Changes in the NIP vaccination schedule since 1 January 2025.

Vaccine	New age	Previous age	Applies to children born on or after
DTaP-IPV-Hib-HBV and Pneu	12 months	11 months	1 January 2024
MMR vaccination	3 years	9 years	1 January 2016
DTaP	5 years	4 years	1 January 2021
DT-IPV	14 years	9 years	1 January 2016

Immunisation against respiratory syncytial virus (RSV) with nirsevimab will be offered to all infants in their first year of life from the autumn of 2025 onwards. Infants born between April 2025 and September 2025 will be offered a dose in September 2025 or October 2025. Immunisation will be offered within 2 weeks after birth to infants born in October, November, and December 2025 and in January, February, and March 2026 (vaccination schedule RSV).

1.1.2 Number of vaccinated children and pregnant people

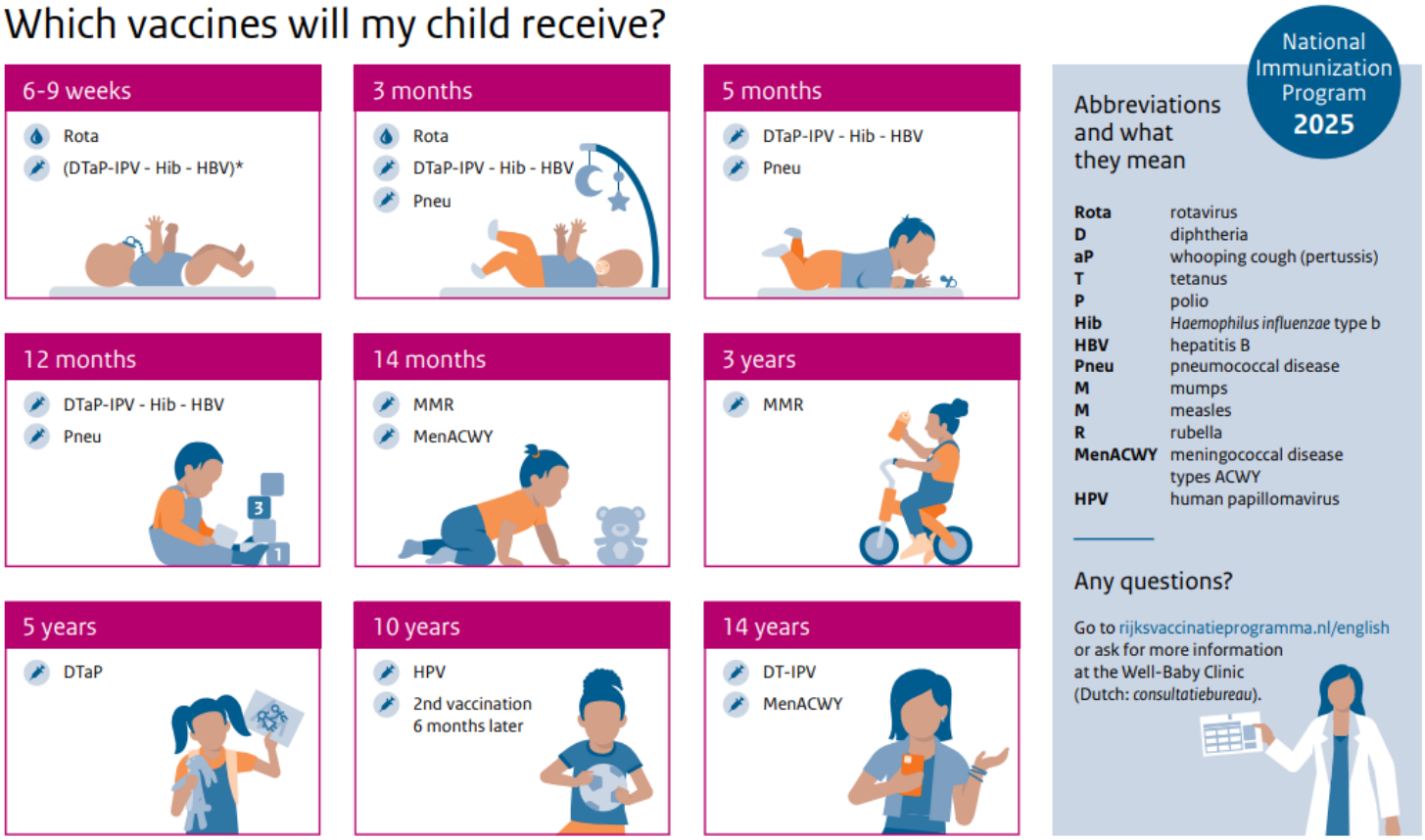
In 2024, the NIP vaccination schedule for children consisted of sixteen vaccine doses per child. Out of these doses, 7 were offered before the age of 12 months. In 2024, at least 950,000 Children (<18 years) were immunised under the Dutch NIP. In total, the children received a total of more than 2.4 million vaccine doses.

Pregnant people are offered a tetanus-diphtheria-and-acellular-pertussis (Tdap) vaccination at 22 weeks of pregnancy to protect their babies against whooping cough. Since 2023, pregnant people have also been offered an influenza vaccine. In 2024, more than 110,000 pregnant people were immunised. In total, pregnant people received more than 145,000 vaccine doses.

The numbers of vaccinated children and pregnant people, as well as the number of vaccine doses may be higher. Due to the implementation of informed consent for national registration, it is unknown whether vaccinations that were registered anonymously were offered within the context of the NIP or not (see Chapter 2.3.1.1.1 and vaccination coverage report, reporting year 2025).

In 2025, the vaccination schedule for children consists of sixteen vaccine doses per child. Out of these doses, 7 are offered before the age of 12 months.

Figure 1.1 The NIP vaccination schedule in 2025.[1]



* Only if the mother was not vaccinated against whooping cough during pregnancy (maternal whooping cough vaccination). This extra vaccine dose is also given in special circumstances. The pediatrician will discuss this with you.

[1] From September 2025 onwards, immunisation against Respiratory Syncytial Virus (RSV) will be offered to all babies born on or after 1 April 2025.
Source: Vaccination schedule English: Which vaccines will my child receive? | Rijksvaccinatieprogramma.nl

1.2 New recommendations and decisions

1.2.1 Respiratory syncytial virus (more information in Chapter 8.2)

1.2.1.1 Infants

On 14 February 2024, the Health Council advised offering protection for infants against RSV by passive immunisation of infants in the NIP. For infants born in the RSV season, the Health Council recommends offering nirsevimab as soon as possible (within two weeks after birth) and for the rest before the start of their first RSV season. The State Secretary of Health, Welfare and Sport (HWS) decided to adopt this advice.

1.2.1.2 Elderly

On 27 March 2025, the Health Council advised to wait for more information about the long-term protection of vaccination before implementing an RSV immunisation programme for people aged 75 years and over, medical risk groups and residents of long-term care facilities aged 60-75 years. The State Secretary of HWS decided to adopt this advice.

1.2.2 *Herpes Zoster vaccination*

On 6 March 2025, the State Secretary of HWS published an update about the herpes zoster vaccination for adults aged 60 years and over, indicating his wish to offer this vaccination if it is cost-effective and funding can be secured. In the document 'additional health and welfare agreement', it is stated that the Ministry of HWS will provide funding for a programmatic herpes zoster vaccination programme for all 60-year-olds, including a catch-up campaign. The implementation is expected to be finalised no later than 2027.

1.2.3 *NIP vaccination schedule*

On 7 September 2022, the Health Council advised moving four vaccinations to a different age group and replacing one of them with another combination vaccine. This advice was based on an extensive report.
On 28 April 2023, the Ministry of HWS approved the recommended changes to the NIP. The new NIP vaccination schedule was implemented from January 2025 onwards.

1.2.4 *Pneumococcal vaccination for children*

The Ministry of HWS decided to adopt the advised changes of the pneumococcal vaccine to protect children against the pneumococcal types that currently cause most invasive pneumococcal disease cases. From 1 September 2024 onwards, the PCV-15 vaccine was used. Currently, in September 2025, the Health Council is preparing advice on the new PCV-20 vaccine for children.

1.3 Vaccinations of risk groups

1.3.1 *Influenza and pneumococcal vaccination*

Influenza vaccination is offered through the National Influenza Prevention Programme (NPG) to individuals aged 60 years and over, pregnant people and people with an increased risk of morbidity and of mortality following influenza.
Pneumococcal vaccination for elderly people is offered as part of the National Programme Pneumococcal Vaccination (NPPV). Based on the advice of the Health Council in 2023, the 23-valent vaccine has been replaced by the 20-valent vaccine since the autumn of 2025. Vaccination is offered to people who are turning 60 this year and those born in 1947 or earlier.

1.3.2 *Tuberculosis vaccination*

Vaccination against tuberculosis is offered to children whose parents originate from high-prevalence countries. For developments regarding influenza and tuberculosis, please refer to the reports issued by the Centre for Infectious Disease Control (CIb), the Health Council, and the KNCV Tuberculosis Foundation (see vaccination coverage influenza, influenza vaccination, surveillance acute respiratory infections, influenza information, tuberculosis information).

1.3.3 *COVID-19 vaccination*

In legal terms, COVID-19 vaccination has been placed within the Dutch NIP. Whenever the NIP is mentioned in this report, however, this refers to the childhood vaccination programme only. Information about COVID-

19 vaccination is described in specific subheadings in Chapter 2, Vaccination Coverage; Chapter 3, Acceptance of vaccination; Chapter 4, Burden of disease and Chapter 5, Adverse events. Additional information can be found in Chapter 6.14, COVID-19.

1.3.4 Other

Apart from including HBV vaccination into the NIP, the Netherlands has an additional vaccination programme in place that targets groups at particular risk of HBV due to their sexual behaviour, namely men who have sex with men (MSM), transgender people and sex workers. The Minister of HWS has decided to provide the combination HepA/B vaccine instead of only HepB to MSM from 1 June 2025 onwards. In 2026, the Health Council is expected to advise on the potential structural provision of the combined vaccine to the MSM group.

Following the 2022 and 2023 pre-exposure prophylaxis (PrEP) vaccination campaigns against mpox where specific populations were eligible for mpox vaccination, no mpox vaccination was offered in 2024. A new mpox vaccination programme started in the spring of 2025. Information on notified mpox cases in 2024 can be found in the RIVM report 'Sexually transmitted infections in the Netherlands in 2024'.

Information on vaccinations for travellers and for employees at risk of work-related infections can be found on the website www.rivm.nl/vaccinaties.

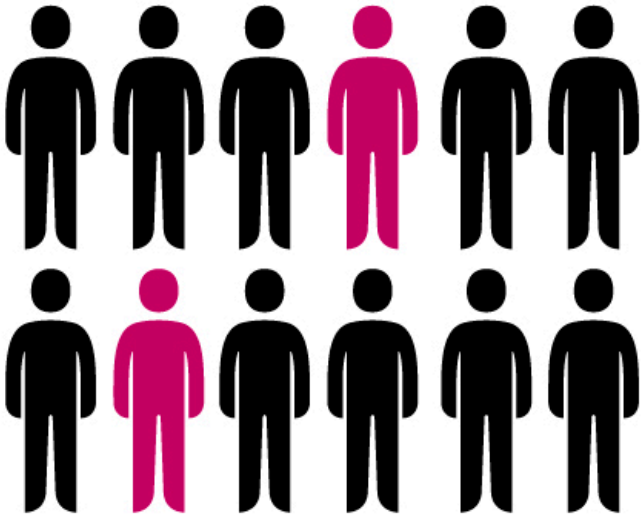
1.4 Vaccination outside of public vaccination programmes

A number of registered vaccines in the Netherlands are available to the public outside of vaccination programmes. Vaccinations registered for use in children and teenagers are meningococcal ACWY (MenACWY), varicella zoster virus (VZV), and meningococcal B disease (MenB).

For both older children and adults, vaccination against influenza, MenACWY, and pertussis is available. In addition, for adults, vaccinations against herpes zoster, pneumococcal disease, hepatitis A and B (HepA and HepB) are available. An overview of these vaccinations can be found at Vaccinaties op eigen verzoek | RIVM. MSM and transgender people can choose to receive a HepA vaccine simultaneously with their HepB vaccine. Since 1 June 2025, the combined Hepatitis A/B vaccine has been included as the standard offer for the MSM group.

Professional guidelines for herpes zoster vaccination, pertussis vaccination for adults, HPV vaccination outside the NIP, MenACWY vaccination, MenB vaccination, VZV vaccination, pneumococcal vaccination for the elderly, HepB vaccination, and HepA vaccination are available at https://lci.rivm.nl/richtlijnen/. This website also provides access to guidelines for vaccination of medical risk groups, such as patients with asplenia.

2 Vaccination coverage



2.1 Key points

- Since 2022, RIVM has been receiving anonymised data for some vaccinations. As anonymous vaccinations cannot be included, vaccination coverage can no longer be calculated exactly. This is because the information necessary to determine the vaccination coverage, such as the year in which the vaccinated child was born, is unknown. Therefore, the registered vaccination coverage is lower than the actual vaccination coverage.
- The changes in actual vaccination coverage have been estimated as accurately as possible, taking into account anonymous vaccinations and an administrative correction for missing -IPV schedule indications.
- It appears that the actual vaccination coverage for newborns and toddlers has slightly decreased compared to the previous year. The HPV vaccination coverage has clearly increased, more so for boys than for girls. Additionally, participation in maternal Tdap and influenza vaccination seems to have slightly increased. For other vaccinations, the coverage appears to have remained roughly the same.
- The ongoing ‘Detervax’ study focusses on sociodemographic factors associated with changes in childhood vaccination uptake over time. This is a first step described as a ‘situational analysis’ of the WHO Tailoring Health Programmes (THP) approach. School-level analyses show a strong decline in MMR and DTaP-IPV uptake from birth cohort 2013 to 2020 among children in Islamic primary schools (MMR: 87% to 59%; DTaP-IPV: 88% to 60%). Uptake also moderately declined among children in Orthodox Protestant primary schools (MMR: 60% to 54%; DTaP-IPV: 60% to 55%), whereas it fluctuated among children in anthroposophical primary schools (MMR: 81% to 78%; DTaP-IPV: 79% to 79%).
- The COVID-19 vaccination coverage of the 2024 autumn round for people aged 60 years and over amounted to 46.6%

2.2 Tables and figures

Table 2.2.1 Vaccination coverage (%) per vaccine for age cohorts of newborns, toddlers, schoolchildren, and adolescents in 2006-2025 [1].

Reporting year	Newborns* Cohort	DTaP-IPV	Hib	HBV[a]	PCV **	MMR	MenC/ ACWY	Full ***
2006	2003	94.3	95.4	15.2	-	95.4	94.8	
2007	2004	94.0	95.0	17.1	-	95.9	95.6	
2008	2005	94.5	95.1	17.9	-	96.0	95.9	
2009	2006	95.2	95.9	18.6	94.4	96.2	96.0	
2010	2007	95.0	95.6	19.3	94.4	96.2	96.1	
2011	2008	95.4	96.0	19.4	94.8	95.9	95.9	
2012	2009	95.4	96.0	19.5	94.8	95.9	95.9	
2013	2010	95.5	96.1	19.7	95.1	96.1	96.0	
2014	2011	95.4	95.9	51.4	95.0	96.0	95.8	
2015	2012	94.8	95.4	94.5	94.4	95.5	95.3	
2016	2013	94.2	94.9	93.8	93.8	94.8	94.6	
2017	2014	93.5	94.2	93.1	93.6	93.8	93.5	91.2
2018	2015	92.6	93.4	92.2	92.8	92.9	92.6	90.2
2019	2016	92.4	93.1	92.0	92.6	92.9	92.6	90.2
2020	2017	92.6	93.5	92.3	93.0	93.6	93.2	90.8

Reporting year	Cohort	Newborns*						
		DTaP-IPV	Hib	HBV[a]	PCV **	MMR	MenC/ ACWY	Full ***
2021	2018	93.1	93.8	93.0	93.3	93.6	93.3	91.3
2021	2018							(91.9)
2022	2019	92.2	92.9	92.2	92.5	92.3	92.0	90.1
2022	2019	(92.7)#	(93.3)#	(92.7)#	(92.6)#	(92.7)#	(92.8)#	(90.6)#
2023	2020	87.3#	89.0#	87.6#	90.0#	88.8#	88.3#	83.6#
2023	2020	(88.0)#	(89.6)#	(88.2)#	(90.0)#	(89.4)#	(89.4)#	(84.2)#
2024	2021	85.4#	87.2#	85.7#	87.8#	88.3#	88.0#	83.1#
2024	2021	(86.1) #	(87.8) #	(86.3) #	(87.9) #	(88.8) #	(88.9) #	(83.7) #
2025	**2022**	**87.9#**	**88.6#**	**87.9#**	**87.8#**	**88.1#**	**87.7#**	**85.4#**
2025	**2022**	**(88.5) #**	**(89.2) #**	**(88.5) #**	**(87.8) #**	**(88.8) #**	**(88.7) #**	**(86.0) #**

Reporting year	Toddlers*				Schoolchildren*			Adolescents*				
	Cohort	DTaP-IPV[b]	DTaP-IPV[c]	DTaP-IPV[d]	Cohort	DT-IPV	MMR****	Cohort	HPV♀[e]	HPV♂	Cohort	MenACWY
2006	2000	92.5	1.4	93.9	1995	93.0	92.9					
2007	2001	92.1	1.6	93.7	1996	92.5	92.5					
2008	2002	91.5	1.6	93.1	1997	92.6	92.5					
2009	2003	91.9	2.0	93.9	1998	93.5	93.0					
2010	2004	91.7	2.6	94.3	1999	93.4	93.1					
2011	2005	92.0	2.6	94.7	2000	92.2	92.1					
2012	2006	92.3	2.1	94.4	2001	93.0	92.6	1997	56.0			
2013	2007	92.3	2.4	94.7	2002	93.1	92.9	1998	58.1			
2014	2008	92.0	2.4	94.4	2003	92.7	92.4	1999	58.9			
2015	2009	91.9	2.2	94.1	2004	92.7	92.7	2000	61.0			
2016	2010	91.5	2.1	93.7	2005	92.0	92.0	2001	61.0			
2017	2011	91.1	2.1	93.2	2006	90.8	90.9	2002	53.4			
2018	2012	90.4	2.3	92.7	2007	90.0	90.1	2003	45.5			
2019	2013	90.3	2.2	92.5	2008	89.5	89.5	2004	45.5			
2020	2014	89.9	2.4	92.2	2009	89.7	89.7	2005	53.0			
2021	2015	89.4	2.6	92.0	2010	88.9	89.0	2006	63.1			
2021					2010	(91.9)	(91.9)	2006	(68.0)			
2022	2016	88.5	2.3	90.8	2011	86.3	86.4	2007	47.6		2006	84.3
2022	2016	(89.0)[#]		(91.2)[#]	2011	(89.7)[#]	(89.7)[#]	2007	(66.4)[#]		2006	(85.3)[#]
2023	2017	86.6[#]	2.1[#]	88.7[#]	2012	82.5[#]	82.7[#]	2008	58.5[#]		2007	80.3[#]
2023	2017	(87.1)[#]		(89.1)[#]	2012	(85.0)[#]	(85.1)[#]	2008	(63.6)[#]		2007	(81.3)[#]
2024	2018	80.1[#]	1.8[#]	82.0[#]	2013	78.2[#]	78.5[#]	2012	51.8[#]	45.5[#]	2008	66.1[#]

Reporting Year	Toddlers*				Schoolchildren*			Adolescents*				
	Cohort	DTaP-IPV[b]	DTaP-IPV[c]	DTaP-IPV[d]	Cohort	DT-IPV	MMR****	Cohort	HPV♀[e]	HPV♂	Cohort	MenACWY
2024	2018	(80.6)[#]		(82.4) [#]	2013	(81.1) [#]	(81.2) [#]	2012	(60.1) [#]	(54.1) [#]	2008	(68.6) [#]
2025	**2019**	**78.4[#]**	**1.8[#]**	**80.2[#]**	**2014**	**78.2[#]**	**79.0[#]**	**2013**	**57.5[#]**	**53.7[#]**	**2009**	**69.0[#]**
2025	**2019**	**(78.9) [#]**		**(80.6) [#]**	**2014**	**(80.6) [#]**	**(81.2) [#]**	**2013**	**(62.9) [#]**	**(59.3) [#]**	**2009**	**(70.7) [#]**

* Vaccination coverage is assessed at the ages of 2 (newborns), 5 (toddlers), 10 (schoolchildren), 14/11 (adolescents, HPV), and 15 years (adolescents, MenACWY). In grey and between brackets: vaccination coverage including vaccinations given later (reporting year 2021: situation on 2 March 2021, reporting year 2022: situation on 3 March 2022, reporting year 2023: situation on 7 March 2023, reporting year 2024: situation on 5 March 2024, reporting year 2025: situation on 4 March 2025).
** Only for newborns born on or after 1 April 2006.
*** Key figure for full participation of newborns: those who received all offered NIP vaccinations according to schedule at the age of 2 years.
**** Two MMR vaccinations (in the past, 'at least one MMR vaccination' was reported).
[#] The informed consent affects these figures (excluding anonymous vaccinations; underreporting of the actual vaccination coverage). The effect was limited for cohort 2019-2020 (newborns), cohort 2016-2017 (toddlers), cohort 2011-2012 (schoolchildren), cohort 2007-2008 (HPV), and cohort 2006-2007 (MenACWY) because it concerned children who largely reached the recommended vaccination age before 1 January 2022 (Paragraph 2.3.1.1.1.). In addition, the DTaP-IPV-HBV-Hib figures for newborns born from August 2020 until December 2021 were negatively affected if the youth health care indication for the DTaP-IPV vaccine schedule was missing, and assessment of the vaccination status was too strict as a result (Paragraph 2.3.1.1.1).
[a] Percentage for the total cohort. Universal hepatitis B vaccination was introduced in 2011; only risk groups were vaccinated previously.
[b] Revaccinated toddlers.
[c] Toddlers who reached basic immunity at the age of 2–5 years were not eligible for revaccination at toddler age.
[d] Sufficiently protected toddlers (sum of [b] and [c]).
[e] From cohort 2012 onwards, the vaccination coverage is reported at the age of 11 instead of 14 years because of a lowering of the vaccination age.
Source: Præventis

Table 2.2.2 Estimation of registered vaccination coverage for maternal vaccinations (by cohort or influenza season) (excluding anonymous vaccinations for Tdap, for maternal influenza vaccination both with and without anonymous vaccinations) [1].

	Maternal vaccinations			
	Tdap		Influenza	
Cohort[a]	%	Influenza season[b]	%	% incl. anonymous vaccinations
2020	70			
2021	66[c]			
2022	64[#]			
2023	64[#]	2023/2024	15[#]	16
2024	**67[#]**	**2024/2025**	**18[#]**	**20**

[a] 2024: women whose child was born between January and December 2024, 2023: women whose child was born between January and December 2023, 2022: women whose child was born between January and December 2022, 2021: women whose child was born between January and December 2021.
[b] For maternal influenza vaccination, the number of pregnant people eligible for vaccination was estimated at 40/52 of the denominator for maternal Tdap vaccination.
[c] Due to administrative issues, not all maternal Tdap vaccinations had been registered in Præventis. In the reporting year 2023, participation was reestimated at 71%.
[#] Informed consent affects these figures (excluding anonymous vaccinations; underreporting of the actual vaccination rate).

Table 2.2.3 Overview and status of a selection of the WHO's European Immunisation Agenda 2030 (EIA2030) targets related to the vaccination coverage.

WHO target	Definition	Status (reporting year)[a]
Sustained polio-free status	Country certified as having sustained polio-free status by the European Regional Certification Commission for Poliomyelitis Eradication (RCC).	Reached (2024)[b]
Achieved and sustained measles and rubella elimination	Confirmation from the Regional Verification Commission for Measles and Rubella Elimination (RVC) that measles and rubella have been eliminated* or elimination has been sustained.	Reached (2024)[b]
Achieved established hepatitis B control target	The validation process by the ETAGE Hepatitis B Working Group is based on a composite assessment and focusses on: • ≤ 0.5% hepatitis B surface antigen (HBsAg) prevalence in vaccinated cohorts or in countries with low hepatitis B endemicity, among pregnant people; • ≥ 90% coverage with three doses of hepatitis B vaccine in infants; • ≥ 90% coverage with interventions to prevent perinatal transmission of hepatitis B.	Reached (2020)[c]
Achieved global HPV immunisation target	A coverage of at least 90% for girls aged 15 years who have received the last recommended dose of HPV vaccine.	Not reached (2025)[d]
Evidence of under-immunised populations at subnational levels	There is evidence of under-immunised** populations at the subnational level: • if < 90% of districts*** reach at least 95% coverage for DTP3[e]; or • if ≥ 90% of districts*** reach at least 95% DTP3 coverage, and have had evidence of outbreaks or endemic transmission**** of measles or polio at subnational level among < 5-year-old population in the past three years*****.	Yes, it is likely there are under-immunised populations (e.g. Bible Belt, areas in large cities) (2025)[f]

WHO target	Definition	Status (reporting year)[a]
Sufficient coverage with vaccines included in national immunisation schedules (DTP3, PCV3, MCV2, HPVc)	For the reporting year, a coverage of at least 90% achieved for all four vaccines – DTP3, PCV3, MCV2, and HPVc.	Not reached (2025)[d]

DTP3 = diphtheria/tetanus/pertussis vaccine, third dose; PCV3 = pneumococcal conjugate vaccine, third dose; MCV2 = measles-containing vaccine, second dose ; HPVc = HPV vaccine, completed series.
* Elimination is defined as endemic transmission being interrupted for at least 36 months. Countries that have interrupted endemic transmission for 12 months or 24 months are defined as being on the path to elimination.
** Under-immunised population is defined as those that had no access or some access to immunisation services but did not complete their vaccination schedule in the first year of life. For this indicator, they are operationally measured as those who did not receive DTP3.
*** District is a term used to indicate the third administrative level (municipality level in the Netherlands); the first administrative level is the nation.
**** Refer to the WHO Vaccine preventable diseases surveillance standards for the definition of an outbreak or endemic transmission.
***** Surveillance data of the past two years including the assessed year. For example, the status of 2022 is evaluated on the basis of 2021—2022 surveillance data.
[a] Based on the most recent available data. When we refer to, for instance, 'reporting year 2024', WHO refers to '2023 data'.
[b] The RCC and RVC typically gather in September to review the annual status updates of the WHO European Region Member States for polio, measles, and rubella. On the basis of what we know now, we expect to reach these targets in reporting year 2025 as well.
[c] The assessment by ETAGE is based on these indicators in combination with the chosen strategy in a country. The Netherlands achieved the goal in 2020. To date, there are no concrete plans for reassessment in the future.
[d] Despite the informed consent (Paragraph 2.3.1.1.1), it is clear that the vaccination coverage for HPVc is below 90%, while this is less certain for the other vaccines for which the coverage is closer to 90%. Hence, this target is not reached.
[e] This is the coverage for the 'primary series' determined at the age of 12 months [1]. In the Netherlands, we provide 3 doses by the age of 12 months, specifically at 3, 5, and 12 months (except for some extenuating circumstances in which the child also receives a dose at 2 months). Within this schedule, however, we regard the first 2 (or 3) doses as the 'primary series' (coverage determined at the age of 12 months), and the first 3 (or 4) doses as 'basic immunity' (coverage determined at the age of 24 months). Thus, part of the children for whom DTP3 coverage is presented to WHO fall into this category where the primary series consists of 2 doses instead of 3. The DTP3 coverage presented from cohort 2020 onwards mostly includes primary series of 2 doses, but also a small number of children who received a primary series of 3 doses.
[f] Despite the informed consent (Paragraph 2.3.1.1.1), it is unlikely that ≥ 90% of districts would reach at least 95% DTP3 coverage.
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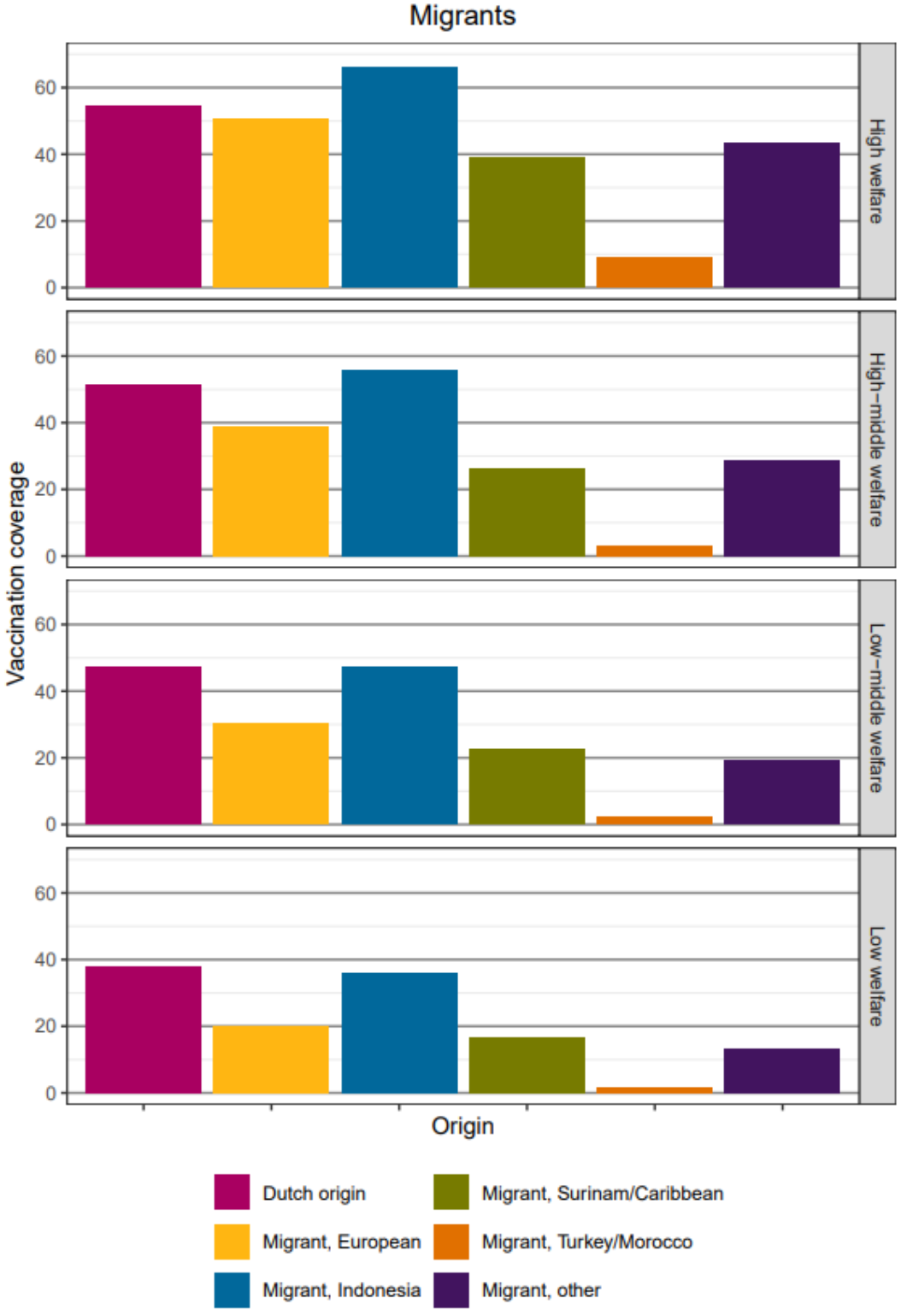
Table 2.2.4 Registered COVID-19 vaccination coverage for the autumn round 2024, for week 38 up to and including week 49, 2024.[1-2]

Age group (years)	Birth cohort	Vaccine coverage autumn round 2024
60+	1964 or before	46.6%

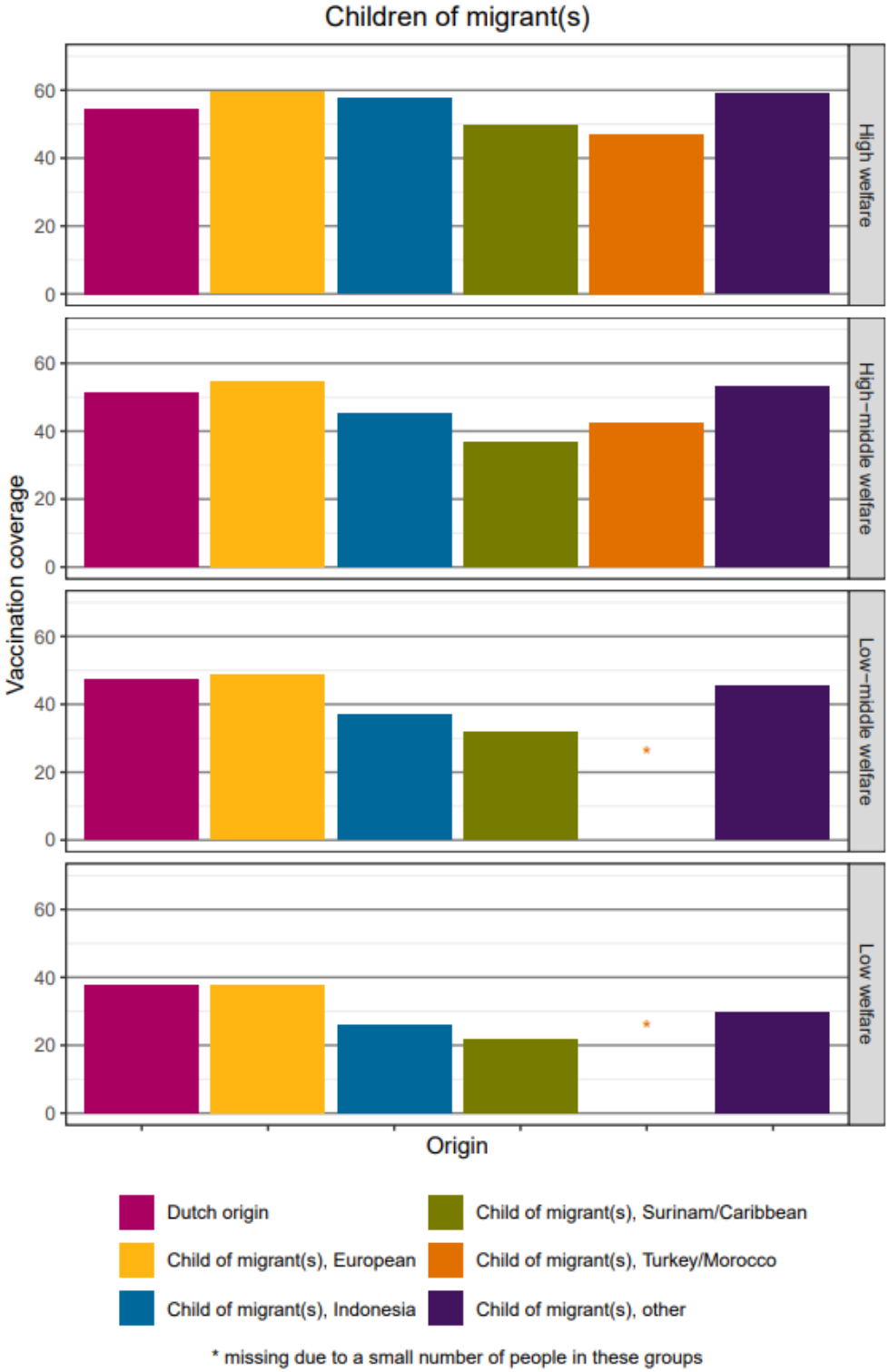
[1] Data source: CIMS.
[2] COVID-19 vaccination was available for people aged 60 years and older, people between the ages of 18 and 59 who receive an annual invitation to have the flu vaccine, children and adults with a high medical risk for severe COVID-19 (such as severely immunocompromised persons) and healthcare workers who are in direct contact with vulnerable patients.

Figure 2.1A COVID-19 vaccination coverage autumn round 2024 for persons aged 60 years and over, by financial welfare and country of origin[1].



[1] Migrant: Dutch citizen born abroad. Dutch origin: persons born in the Netherlands with both parents born in the Netherlands.

Figure 2.1B COVID-19 vaccination coverage autumn round 2024 for persons aged 60 years and over, by financial welfare and country of origin[1].



[1] Child of migrant: Dutch citizen with one or both parents born abroad. Dutch origin: persons born in the Netherlands with both parents born in the Netherlands.

2.3 National developments

2.3.1 Vaccination coverage

2.3.1.1 Vaccinations for newborns, toddlers, schoolchildren, and adolescents

The vaccination coverage of the NIP is reported in the annual vaccination coverage report, accompanied by a comprehensive interpretation [1]. Please, find a brief summary of this report below.

Considering anonymous vaccinations and the effect of the administrative correction for missing DTaP-IPV schedule indications (see Paragraph 2.3.1.1.1), it appears that the actual vaccination coverage for newborns (DTaP-IPV-HBV and PCV) and toddlers (DTaP-IPV) has slightly decreased compared to last year. The vaccination coverage for HPV has clearly increased, more so for boys than for girls. Additionally, participation in maternal Tdap and influenza vaccination seems to have slightly increased (Table 2.2.2). For the other vaccinations, the coverage appears to have remained roughly the same.

The vaccination coverage tends to increase slightly over time, as it is possible to catch up on vaccination at a later moment [2]. Therefore, the registered vaccination coverage without age limit (which also includes vaccinations administered between the respective age limit up to the beginning of March of the reporting year) is higher than the registered vaccination coverage with age limit (Table 2.2.1).

2.3.1.1.1 *Limitations*

Informed consent

Since 1 January 2022, informed consent has been required to exchange vaccination data with personal data with RIVM. This informed consent also applies to COVID-19-vaccination (Paragraph 2.3.1.2). As a result, RIVM can no longer determine vaccination coverage exactly. Anonymous vaccinations cannot be included in vaccination coverage calculations, as year of birth, sex, place of residence, and vaccination dose are unknown. Therefore, the registered vaccination coverage is lower than the actual vaccination coverage.

Furthermore, the proportion of anonymous vaccination differs by year. Consequently, when comparing vaccination coverage across years, there is a varying extent of the influence of the informed consent. It is possible for the registered vaccination coverage to increase due to a lower proportion of anonymous vaccination, whereas in actuality the vaccination coverage may be equal to or lower than that of the year before. Therefore, the interpretation of the changes in vaccination coverage is complex.

In 2024, 3% of vaccinations administered within the NIP were reported anonymously, compared to 4% in 2023 [1]. For COVID-19 vaccination, 98% of the people who were vaccinated at the municipal health services during the 2024 autumn round gave informed consent for registration in CIMS.

Correction for missing DTap-IPV vaccine schedule information
In the reporting years 2023-2024, the DTaP-IPV-HBV-Hib vaccination coverage for newborns was negatively affected when it was not indicated in Præventis what DTaP-IPV vaccine schedule was followed. If Youth Health Care organisations did not specify whether a child was vaccinated according to the 2-3-5-11(12)-month schedule or according to the 3-5-11(12)-month schedule, Præventis assumed the 2-3-5-11(12)-month schedule was in order. This is too strict an assessment if the vaccination at 2 months is not necessary (i.e. in case the mother participated in the maternal Tdap vaccination during pregnancy) or, retrospectively, if the child is aged 11 months or over and has completed their vaccination series. As a result, the vaccination coverage for DTaP-IPV (and to a lesser extent, for Hib and HBV) was underestimated for newborns born from August 2020 until December 2021 [1].

To prevent this underestimation, an administrative correction was made in Præventis in 2024. Since then, on the basis of at least three registered DTaP-Hib-HBV-IPV-vaccinations, Præventis has determined which DTaP vaccination schedule a child has followed in practice. On the basis of the schedule identified by Præventis, the vaccination status is then determined. Therefore, starting from the reporting year 2025, there is no longer an underestimation of the vaccination coverage when the DTaP schedule indication is missing. Thus, the increase in the registered vaccination coverage in the reporting year 2025 compared to the previous year for the DTaP-IPV-HBV-Hib vaccination is not due to an actual increase in vaccination coverage, but rather to this administrative correction [1].

Although this correction prevents underestimation of vaccination coverage, it remains important for Youth Health Care organisations to indicate the correct DTaP-IPV vaccine schedule. While children following a 3-5-11(12)-month schedule are sufficiently protected at the age of 1 and 2 years, absence of the correct schedule means that it cannot be accurately assessed whether a child was vaccinated in time, and whether they were sufficiently protected at the age of 2-3 months. Additionally, information on the vaccine schedule to be followed is crucial for the planning and administration of follow-up vaccinations, Furthermore, missing or wrong DTaP-IPV vaccine schedule information results in unnecessary issuing of reminders. Last, the impact of vaccination and vaccine effectiveness cannot be accurately assessed if it is unclear whether a DTaP-IPV-Hib-HBV-vaccination should have been administered at 2 months.

2.3.1.2 COVID-19 vaccination for adults aged 60 years and over

The 2024 autumn round started on 16 September and ended on 6 December 2024. At the end of the 2024 autumn round, the vaccination coverage for persons aged over 60 years amounted to 46.6% (Table 2.2.4). The vaccination coverage differed by age and region. Vaccination coverage among over-60s was lowest for people aged 60-64 (29.1%) and highest for people aged 80-84 (60.7%). Vaccination coverage was slightly lower in the three largest cities (Amsterdam, Rotterdam, The Hague). In some municipalities in the provinces of Friesland and Overijssel, in the ‘Bible belt’, and along the

eastern border of the Netherlands, vaccination coverage was also below the national average. More information is available in Chapter 4 of the report 'COVID-19 vaccination evidence update for the Health Council' and in the report 'Deelname COVID-19-vaccinatie in Nederland' (in Dutch)'.

Vaccination coverage among the over-60s was 3.9% lower in the 2024 autumn round, than in the 2023 autumn round (46.6% versus 50.5%).

2.3.2 Vaccination coverage by sociodemographic determinants

2.3.2.1 Immunisation programme for newborns, toddlers, schoolchildren, and adolescents

The ongoing RIVM 'Detervax' study aims to identify sociodemographic factors associated with changes in childhood vaccination uptake over time. These findings can inform public health interventions and policies to improve MMR and DTaP-IPV vaccination coverage and reduce health inequities. This situational analysis is the first step in the WHO Tailoring Health Programmes (THP) approach. On the basis of these findings, further research in the SocioVax research programme (see Chapter 3) will explore the decision-making process, barriers, and drivers in groups with lower coverage to inform targeted public health interventions. Implementation and evaluation of these interventions in collaboration with Youth Health Care organisations would be the last phase of the WHO THP.

This retrospective study uses CBS Remote Access to link individual vaccination data from Praeventis with nationwide sociodemographic data, such as maternal education, income, urbanisation, and family size, for children born in the Netherlands in the 2008–2020 period. Determinants of MMR and DTaP-IPV uptake were analysed by primary school denomination between birth cohorts 2013 to 2020. The vaccination coverage for MMR and DTP, averaged across all birth years, was relatively high for Catholic, Protestant, and public schools (96% and 95% (MMR and DTaP-IPV), 95% and 95%, and 94% and 94%, respectively). In contrast, vaccination coverage for MMR and DTP was relatively low at Orthodox Protestant, Islamic, and anthroposophical schools (57% and 58%, 74% and 75%, and 78% and 77%, respectively). Vaccination coverage remained stable over time by primary school denomination, except for Islamic, Orthodox-Protestant, and anthroposophical schools. A strong decline in vaccination uptake was observed among Islamic schools (MMR: 87% to 59% ; DTaP-IPV: 88% to 60%). MMR and DTaP-IPV uptake also declined at orthodox Protestant schools (MMR: 60% to 54%; DTaP-IPV: 60% to 55%), whereas it fluctuated at anthroposophical schools (MMR: 81% to 78%; DTaP-IPV: 79% to 79%) [1, 3].

2.3.2.2 COVID-19 vaccination

The RIVM 'Co-Detervax' study aims to identify sociodemographic factors associated with COVID-19 vaccination uptake. These findings can support public health interventions and policies to optimise COVID-19 vaccination coverage and reduce health inequities. In this study, individual vaccination data from CIMS is linked to sociodemographic data in the CBS microdata environment. First, this is done to assess vaccine coverage among key socio-demographic subgroups. Figure 2.1A

presents the COVID-19 vaccination coverage for migrants by country of origin, where a migrant is defined as a person born outside of the Netherlands. For all subgroups, vaccination coverage is some percentage points lower than the year before (2023), but the trends are similar. The coverage among migrants born in Turkey or Morocco is much lower than that of all other groups. This difference occurs irrespective of financial welfare. Figure 2.1B shows the same information for children of migrants: persons born in the Netherlands, with one or both parents born abroad. Here, the differences are much less pronounced.

A recently published Co-Detervax study focussed on determinants of being unvaccinated against COVID-19 in the primary vaccination round and the 2022 vaccination round, among individuals aged ≥60 years in five different population subgroups: migrant populations with below average vaccination coverage (persons born in Morocco, Turkey, Surinam, and the Dutch-Caribbean) and persons born in the Netherlands with both parents born in the Netherlands [4]. Being a migrant with two foreign-born parents, younger age, living in highly/extremely urban areas, and having a lower income, lower education level, and low medical risk for severe COVID-19 were risk factors for being unvaccinated. Socioeconomic status only partially mediated the effect of being a migrant with two foreign-born parents on lower vaccine coverage.

Another recent study within the Co-Detervax framework studied medical risk groups (MRG) aged 18 years and over to identify determinants of COVID-19 vaccine uptake and dropout. Dropout was defined as being vaccinated in the 2022 round, but not in 2023, despite eligibility. Dropout was analysed separately for the age groups 18–59 years and ≥60 years within the MRG population.

A strong decline in vaccination coverage was observed among MRG: in the 18–59 age group, coverage decreased from 19% in 2022 to 6% in 2023; in the ≥60 age group, coverage declined from 61% to 53%. Among all MRG vaccinated in 2022 (n = 1,593,265), the overall dropout in 2023 amounted to 33%. Dropout was strongly associated with younger age in both age groups. Other factors associated with dropout included living in a household with children, being in a lower income quartile, having a lower medical risk, being born abroad, living in a non-urban area, and lack of car ownership. Importantly, an interaction was observed between lack of car ownership and greater distance to the vaccination location, indicating that individuals without access to a car who lived further away from vaccination locations had an even higher likelihood of dropout [5].

2.4 International developments

2.4.1 Vaccination coverage trends

According to the World Health Organization (WHO) and UNICEF, global childhood immunisation data shows a modest progress in vaccination coverage compared to 2023. Slightly more children received at least one vaccine against diphtheria, tetanus, and pertussis (DTP1) (89%) or completed the full three-dose series (DTP3) (85%). Similarly, coverage

for measles also increased to a modest extent, although it is still below the 95% target to prevent outbreaks: 84% of children received the first dose (MCV1), and 76% received the second dose (MCV2).
In 57 low-income countries, supported by Gavi, the Vaccine Alliance, the number of unvaccinated and under-vaccinated children was reduced by roughly 650,000. Despite this progress, over 14 million children remain unvaccinated, and vaccine access continues to be deeply unequal and highly impacted by fragility, conflict, and humanitarian crises. [6-8]
Furthermore, upper-middle and high-income countries with historically high vaccination coverage, show signs of stagnation and decline. Several countries have reported a considerable negative impact of the COVID-19 pandemic on routine childhood vaccination coverage [9-15].
Additionally, inequalities in childhood vaccination uptake persist or have increased within countries since the COVID-19 pandemic [16-19]. Under-immunised population groups are disproportionally vulnerable to outbreaks of vaccine preventable diseases (VPD) [19].

In the WHO European Region, childhood vaccination coverage remained the same or declined by 1% in 2024 compared to 2023, thus not yet regaining pre-pandemic levels of annual uptake [20]. Stagnating or even declining vaccine coverage, coupled with persisting inequality, have led to a resurgence of vaccine-preventable diseases in the WHO European Region. In 2024, the European region saw the highest number of measles cases in nearly three decades, as well as a threefold increase of whooping cough cases [20, 21].

Amidst these challenges, the Strategic Advisory Group of Experts on Immunisation has expressed concerns regarding the harmful impact of current political and societal developments on global health, such as the diversion of resources away from vaccination programmes worldwide. Vaccination is a key contributor to improved child survival and health across the world [7, 11, 12]. WHO estimated that, since the establishment of the Expanded Programme on Immunisation, approximately 154 million deaths were averted by vaccination, out of which 146 million were prevented among children [8].

To achieve the full benefits of vaccination, the WHO Immunisation Agenda 2030 (IA2030) and the aligned WHO European Immunisation Agenda 2030 (EIA2030) have set global and regional strategies for the 2020-2030 period. One of the aims of IA2030 and EIA2030, is to achieve at least 90% coverage of four key vaccinations given in childhood and adolescence: DTP3, PCV3 (pneumococcal conjugate vaccine, third dose), MCV2, and HPVc (HPV vaccine, completed series) (Table 2.2.3). In the WHO European region, PCV3 and HPVc coverage for both girls and boys are below this target (86%, 32%, and 20%, respectively). However, coverage has increased since 2019 for these vaccines due to their introduction into more countries and improved coverage within countries [20]. DTP3 and MCV2 coverage decreased compared to 2019 pre-pandemic levels, but has remained above 90% (93% and 91%) [22]. In the Netherlands, it is no longer possible to determine whether this target is met. Based on individually registered vaccinations (excluding anonymous vaccinations), coverage of DTP3, PCV3 and MCV2 is just below the 90% target at 89%, 88%, and 81%, respectively. Targeted coverage for HPVc is clearly not achieved at 63%

for girls and 59% for boys. Other selected EIA2030 targets and the extent to which they were reached are presented in Table 2.2.3.

In the Netherlands, the Joint External Evaluation (JEE) and Public Health Emergency Preparedness Assessment (PHEPA) identified priority actions to strengthen the public health system against threats (see the full report). With regard to immunisation, one of the priority actions to address suboptimal coverage of key vaccinations is to increase the understanding of subpopulations with low vaccination coverage and to invest in implementing tailored approaches through Youth Health Care organisations [23].

Sustained efforts and targeted approaches are needed to reverse stagnating and declining trends and to ensure equitable vaccination. Several countries have introduced measures to increase vaccination coverage, such as the use of vaccination reminder systems, implementation of school-based vaccination, or mandatory vaccination [18, 24, 25].

2.5 Literature

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3 Acceptance of vaccination

3.1 Key points

- The SocioVax (social science on willingness to vaccinate) survey monitor shows that most parents consider vaccination important, are satisfied with their most recent vaccination experience, perceive vaccinating children as a social norm, and trust health care professionals. There is no specific belief that predominantly determines vaccination participation.
- Survey research in 2024 on trust in institutions and misinformation susceptibility indicates that higher trust in the government (both in general, and in the government's vaccination policy specifically) is linked to greater willingness to vaccinate, while susceptibility to misinformation independently contributes to vaccine concerns and lower willingness.
- A mixed-methods study using surveys and interviews among people aged 60 years and over found that willingness to receive the flu vaccine is more stable and normalised than for the COVID-19 vaccine. For the flu vaccination, people often make their decision once and stick to their choice afterwards. In contrast, COVID-19 vaccination involves more uncertainty and information-seeking behaviour, and more people still make a new assessment every year.
- Long-term survey data from the Doetinchem cohort study (people born between 1928 and 1967) shows that willingness to vaccinate against influenza, pneumococcal disease, pertussis, and shingles increased after the COVID-19 pandemic, especially for influenza. Willingness to vaccinate was generally higher among older adults and those with poorer health. These findings suggest that both aging and heightened awareness due to the COVID-19 pandemic contributed to increased vaccine willingness.

3.2 Childhood vaccinations

3.2.1 SocioVax monitor 2024: insight into vaccination willingness for the National Immunisation Programme (NIP)

SocioVax has implemented a survey monitor to study vaccination willingness in the context of the National Immunisation Programme (NIP). This survey is conducted biannually among a sample of parents in the Netherlands. These parents are representative of Dutch society. The questions address vaccination willingness and participation, experiences with vaccination services, as well as various beliefs and opinions parents may hold about vaccinations. The answers to these questions provide insight into what motivates parents in their vaccination choices and any practical considerations that influence their decision to vaccinate or not. It also offers a view of potential differences between groups of people and of how these differences can be explained. As the survey is repeated, it is possible to investigate whether changes occur over time in how parents perceive childhood vaccinations. Results from the first wave of the survey monitor in 2024 indicate that the vast majority of parents consider vaccination to be important for protecting their child. However, self-reported vaccination participation is lower among Dutch parents from a non-Dutch origin and among parents whose highest level of education is secondary school (practical education, VMBO, HAVO, VWO) or vocational education (MBO). On average, these parents perceive vaccination to be less important, have more doubts about vaccine safety, and show less trust in the government and the health

care system. There is no specific belief that predominantly determines vaccination participation. Nonetheless, the majority of parents perceive vaccinating children as a social norm, even within groups where uptake is lower. Furthermore, most parents are satisfied with their most recent vaccination experience and report high levels of trust in health care professionals who administer vaccines. Health care professionals also remain an important source of information when parents make decisions regarding vaccination. The full results are available on the SocioVax webpage.

3.2.2 *Trust in institutions and misinformation susceptibility both independently explain vaccine scepticism*

Through survey research in 2024 involving a representative sample of 1356 Dutch respondents, the relationship between institutional trust, susceptibility to misinformation, and willingness to vaccinate was examined in the context of childhood vaccinations. Validated measurements tools were utilised to assess trust (both in general, and in the government's vaccination policy specifically), vaccination attitudes, and susceptibility to misinformation, with a focus on three forms of vaccine scepticism: concerns, hesitancy, and refusal.
The study results show that trust in institutions – such as RIVM, GGD, and one's GP – is strongly linked to higher vaccine willingness: greater trust is associated with higher vaccine uptake [1]. Specifically, trust in the government regarding their vaccination policies emerged as by far the most significant predictor. This subdimension of trust reflects individuals' perceptions of governments' capability, honesty, and intentions with respect to vaccines. An important insight from our research is that people appear to distinguish their general trust in the government and their trust in vaccination policies. This means that people might be sceptical of the 'government' in a broad sense but may still have confidence in the implementation of the National Immunisation Programme. This is encouraging: increasing vaccination coverage may not necessarily require the restoration of broad trust in the government as a whole, but rather the strengthening of trust in the specific area of vaccination policy.

In addition, it appears that susceptibility to misinformation also plays an important role. People who are more susceptible to misinformation were found to be more frequently concerned about vaccinating their child. This correlation remained significant after adjusting for socio-demographic characteristics. Notably, we found no evidence for the so-called 'buffer hypothesis': people with high trust in the government are no better protected against the influence of misinformation than those with low trust. In other words, both trust and susceptibility to misinformation play a role in vaccine scepticism.

The findings point to the following conclusions and policy implications:

- Trust matters. Specifically, trust in the government's vaccination policy is strongly related to vaccination uptake. Citizens differentiate between general trust in the government and trust in the government's vaccination policy. For policymakers, this means that they can focus on targeted measures aimed at increasing specific trust in the government's vaccination policy.

- Misinformation is an independent risk factor. Susceptibility to misinformation is associated with lower vaccine willingness, regardless of demographic variables and trust levels. This underscores the importance of interventions aimed at curbing misinformation, promoting media literacy, and equipping healthcare professionals with tools to address misinformation.
- Trust and misinformation are independent explanatory factors of vaccination uptake. A comprehensive approach that both strengthens trust in vaccinations and vaccination policy and enhances resilience to misinformation could benefit vaccination uptake.

3.3 COVID-19 and flu

3.3.1 Older adults' vaccination decisions regarding COVID-19 and flu vaccinations

People aged 60 and over are eligible for both flu and COVID-19 vaccinations. The monitored vaccination participation in 2023 showed that more people aged 60+ opted for flu vaccination than for COVID-19 vaccination. Moreover, vaccination participation for COVID-19 vaccination was declining compared to previous years (see Chapter 2 Vaccination Coverage). We studied whether, and if so how, people aged 60+ make their decision regarding COVID-19 vaccination differently than regarding flu vaccination.

On the basis of a mixed-method approach combining two rounds of survey data (in June and November 2024: n = 2185 and 2066) and interviews (October 2024: n = 20), we found that:
1) Among people aged 60 and over, the willingness to be vaccinated against flu is more stable than against COVID-19. Before the summer of 2024, 55% of the participants in the questionnaire survey were already sure that they wanted to get the flu vaccination; for COVID-19 vaccination, this proportion only amounted to 35% at that time.
2) The choice for the flu vaccination seems to be more normalised than the choice for COVID-19 vaccination. For flu vaccination, people often make their decision once, and stick to their choice afterwards. For COVID-19 vaccination, more people still make a new assessment every year. At that time, they are also looking for information about the advantages and disadvantages.
3) When choosing COVID-19 or flu vaccination, participants weigh up the risk of infection and their own vulnerability (risk perception), the perceived usefulness of vaccination (response effectiveness), and the possible disadvantages of vaccination. Specifically with COVID-19 vaccination, some wonder whether it is still necessary, and whether it is safe. Participants indicate that they hear little about it. We hardly heard this with regard to flu vaccination.

On the basis of these findings and behavioural science literature on habit formation, we formulated some implications for policy and practice:
1) Normalisation of COVID-19 vaccination can be promoted if it is clear that it will be offered structurally (annually) and if this is communicated. Providing the latest insights about the effectiveness and safety of the COVID-19 vaccine is in line with the current information need and can increase confidence.

2) Further aligning the flu and COVID-19 vaccination procedure (same provider, same location, if possible same time) may increase normalisation and habit formation. If this is not possible, it may be advisable to keep the procedures for getting the COVID-19 vaccination (invitation letter, method of making an appointment, locations) the same over the years.

3.3.2 Willingness to get vaccinated in Doetinchem cohort study: before and after the COVID-19 pandemic

Since 1987, a group of randomly selected Dutch adults from Doetinchem, originally aged between 20 and 59 years, has been surveyed every five years to monitor their lifestyle habits and health. During the 6th survey round (2013-2017) of the Doetinchem cohort study and the 7th survey round (2018-2023), which took place partly before and partly after the COVID-19 lockdown, willingness to vaccinate was assessed for four illnesses: influenza, pneumococcal disease, pertussis, and shingles. At the start of the 6th survey round, vaccines for the latter three diseases were not introduced to the older adults.

Before the COVID-19 pandemic (survey round 6: 2013-2017)

Among the 3063 participants (aged 46-86 years) in survey round 6, 36% were willing to be vaccinated against influenza, 35% were neutral, and 28% were unwilling [2]. Willingness to vaccinate for the newer vaccines was lower (23-26%), with the majority falling into the neutral middle group (50-54%). Participants aged 65 and over were more willing to be vaccinated than those under 65. Relatively higher willingness to be vaccinated was observed among men, individuals with a lower level of education, those not working, and those with poorer health. These were figures prior to the COVID-19 pandemic.

3.3.2.1 Change in willingness to be vaccinated following the COVID-19 outbreak (2018-2023)

In survey round 7, willingness to be vaccinated was reassessed among 2093 participants (aged 51-91 years): part of the group was surveyed prior to the lockdown (n=727) and the rest afterwards (n=1366). Among these participants, the willingness to be vaccinated against influenza increased from 32% in round 6 to 45% before the lockdown, and increased even further to 59% after the lockdown. For pneumococcal disease, pertussis, and shingles, a similar, albeit less pronounced, pattern was observed. The corresponding figures for pneumococcal disease were 24%, 32%, and 41%, for pertussis 26%, 34%, and 36%, and for shingles 22%, 30%, and 34%. Those who changed from being unwilling or neutral to being willing to be vaccinated were more often slightly older, had a relatively higher BMI, and/or had cardiovascular disease [3].

Within the Doetinchem study population, we have found that as individuals age, willingness to vaccinate appears to increase. This increase may be due to a growing awareness of higher susceptibility to severe infectious diseases and their impact on health while growing older. The COVID-19 pandemic seems to have further amplified this effect.

3.4 Literature

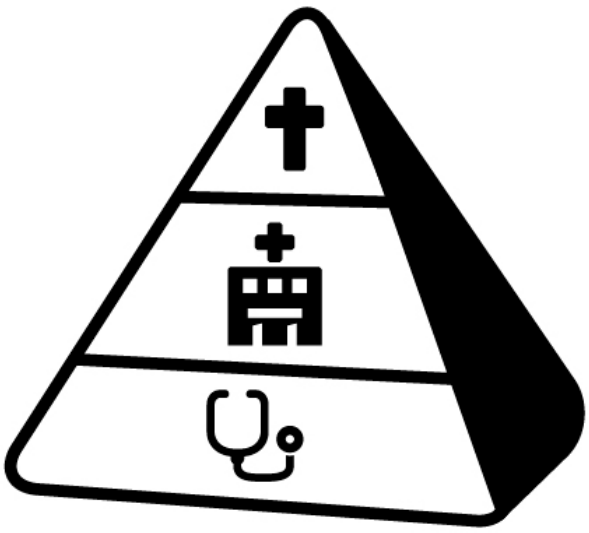
1.* Roozenbeek T, van den Berg, C., Lambooij., M., van der Linden., S., Maertens, R., Ferreira., J.A., van Dijk., M., Roozenbeek., J. . Trust in institutions and misinformation susceptibility both independently explain vaccine skepticism. Scientific Reports. 2025; 15(1), 1-10.

2.* Maertzdorf KM, Rietman ML, Lambooij MS, Verschuren WMM, Picavet HSJ. Willingness to get vaccinated against influenza, pneumococcal disease, pertussis, and herpes zoster - A pre-COVID-19 exploration among the older adult population. Vaccine. 2023;41(6):1254–64.

3.* Kuijpers Y, HSJ Picavet, MS Lambooij, A-M Buisman, WMM Verschuren. Increase in vaccination willingness of older persons for influenza, pneumococcal disease, pertussis and herpes zoster during the COVID-19 pandemic. (submitted)

*Publication with RIVM authors.

4 Burden of disease



4.1 Key points

- The estimated total burden of disease caused by (partially) vaccine-preventable diseases for the year 2024 was highest for HPV (17,800 disability-adjusted life years (DALYs); 73% among women), invasive pneumococcal disease (9000 DALYs), pertussis (7600 DALYs), invasive *Haemophilus influenzae* disease (1300 DALYs), rotavirus infection (950 DALYs), and invasive meningococcal disease (940 DALYs).
- Particularly for pertussis, measles, mumps, and hepatitis A, the estimated burden in 2024 was considerably higher than in 2023.
- The burden of COVID-19 is estimated to be 18,000 DALYs for 2024, where 72% of the burden is due to premature death because of COVID-19. This is an underestimation of the actual burden, since long-term consequences of the disease have not been taken into account and COVID-19 may have been recognised and recorded as the cause of death less comprehensively than in previous years. For COVID-19, the burden was considerably lower in 2024 than it had been in 2023 (37,800 DALYs).

4.2 Tables and figures

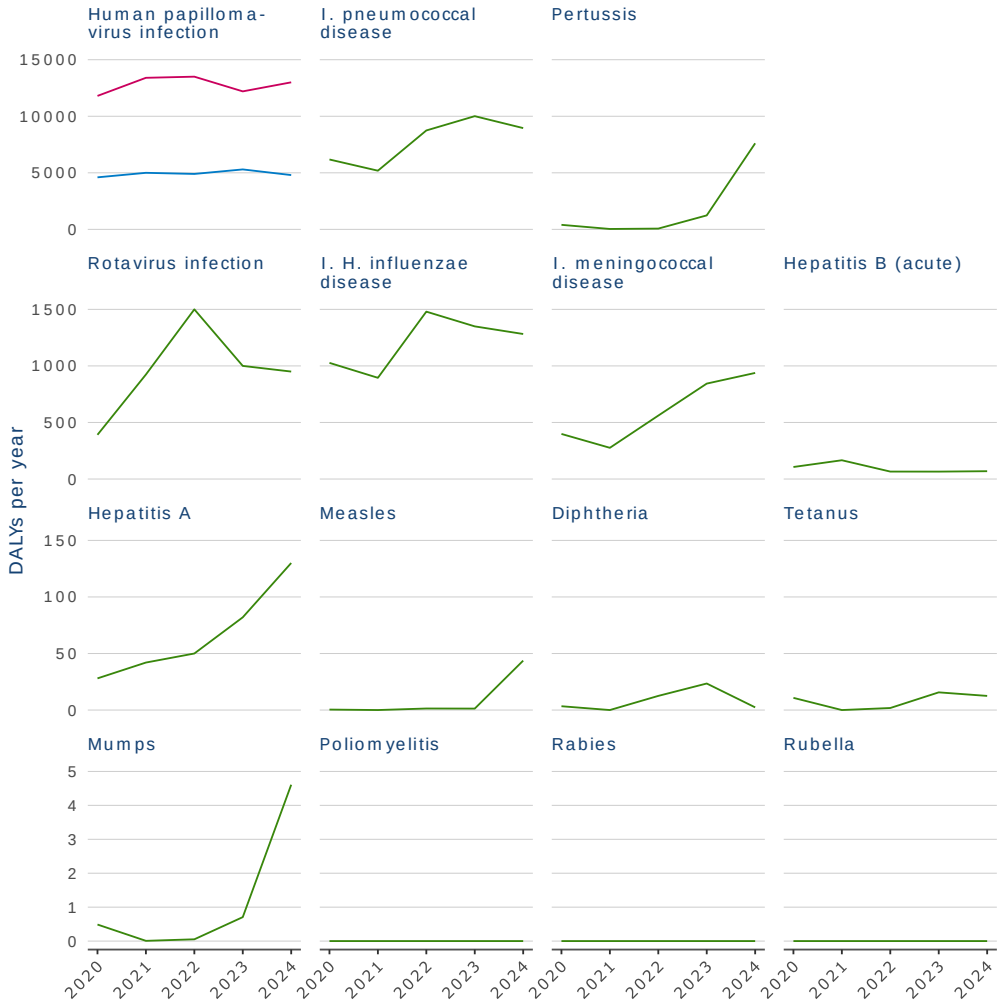
Table 4.1 Estimated annual burden of disease in DALYs in 2020–2024, and DALYs per 100 infections in 2024 in the Netherlands (with 95% uncertainty intervals) [1-3].

Disease	DALYs (95% uncertainty interval)					DALYs/100 infections in 2024
	2020	2021	2022	2023	2024	
Diphtheria	3 (3–4)	0 (0–0)	13 (10–15)	23 (19–28)	2 (2–3)	79 (66–92)
Hepatitis A	28 (17–45)	42 (26–69)	50 (30–83)	82 (50–130)	130 (78–210)	11 (8–15)
Hepatitis B (acute)	110 (99–110)	170 (150–180)	66 (61–71)	65 (62–69)	69 (65–73)	15 (14–16)
Human papillomavirus infection[a]						
- Females	11,800 (11,000–12,500)	13,400 (12,700–14,200)	13,500 (12,700–14,300)	12,200 (11,500–13,000)	13,000 (12,200–13,800)	n/a
- Males	4600 (3800–5500)	5000 (4200–6000)	4900 (4100–5900)	5300 (4400–6300)	4800 (4000–5700)	n/a
Invasive *H. influenzae* disease	1000 (970–1100)	890 (840–950)	1500 (1400–1600)	1300 (1300–1400)	1300[b] (1200–1300)	340 (330–360)
Invasive meningococcal disease	400 (300–510)	280 (190–380)	560 (440–700)	840 (690–1000)	940[c] (780–1100)	650 (600–700)
Invasive pneumococcal disease	6,200 (5800–6600)	5200 (4900–5500)	8700 (8200–9300)	10,000 (9400–10,600)	9000[d] (8400–9500)	370 (350–390)
Measles	0.4 (0.3–0.5)	0 (0–0)	1 (1–2)	1 (1–1)	44 (39–49)	2 (2–2)
Mumps	0.5 (0.5–0.5)	0.007 (0.006–0.008)	0.1 (0.1–0.1)	0.7 (0.7–0.7)	5 (4–5)	0.4 (0.4–0.4)
Pertussis	400 (370–430)	35 (32–37)	68 (62–75)	1200 (1100–1400)	7600 (7200–8100)	1 (1–1)

Disease	DALYs (95% uncertainty interval)					DALYs/100 infections in 2024
	2020	2021	2022	2023	2024	
Poliomyelitis	0 (0–0)	0 (0–0)	0[e] (0–0)	0 (0–0)	0 (0–0)	n/a
Rabies	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	n/a
Rotavirus infection	390 (160–790)	920 (360–1900)	1500 (580–3000)	1000 (400–2100)	950 (380–1900)	0.5 (0.3–0.9)
Rubella	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	n/a
Tetanus	11 (9–12)	0 (0–0)	2 (2–2)	16 (14–17)	12 (11–14)	350 (310–390)

DALY= disability-adjusted life year.
n/a = not applicable; no cases occurring in 2023 or unknown number of infections (HPV).
[a] To estimate the burden, the numbers of cases with cancer, anogenital warts and high-grade cervical lesions attributable to HPV were used. The most recent year of available data on the incidence of anogenital warts was 2023. Therefore, the incidence rate for 2024 was estimated from previous years; in addition, the incidence for 2020–2024 has been updated. The most recent year of available data on the incidence of high-grade cervical lesions was 2023; the incidence rate for 2023 was carried forward to 2024.
[b] Proportion of disease burden due to disease caused by vaccine type b in 2024: 24%.
[c] Proportion of disease burden due to disease caused by the NIP vaccine serotypes ACWY together in 2024 is 5% (vaccine type C in 2024: 1% and type W in 2024: 4%); proportion caused by type B in 2024: 91%.
[d] Proportion of disease burden due to disease caused by PCV10 vaccine types 1, 4, 5, 6B, 7F, 9V, 14, 18C, 19F, 23F in 2024: 8%; proportion caused by PCV15 vaccine types 1, 3, 4, 5, 6A, 6B, 7F, 9V, 14, 18C, 19A, 19F, 22F, 23F, 33F in 2024: 45%; proportion caused by PPV23 vaccine types 1, 2, 3, 4, 5, 6B, 7F, 8, 9N, 9V, 10A, 11A, 12F, 14, 15B, 17F, 18C, 19A, 19F, 20, 22F, 23F, 33F in 2024: 79%.
[e] There was one asymptomatic case for whom no burden was calculated.
Sources: Osiris, NRLBM, sentinel laboratory surveillance, national cancer registry, PALGA, NIVEL-LINH.

Figure 4.1 Estimated annual disease burden in DALYs in the Netherlands in 2020–2024 [1-3].



Notes:
1. DALY= disability-adjusted life year.
2. Vaccination against rabies and hepatitis A is not part of the NIP, vaccination against rotavirus infection was added to the NIP in 2024.
3. For the three invasive bacterial diseases and HPV, only certain serotypes are covered by the vaccines used: *Haemophilus influenzae* serotype b (Hib), meningococcal serotypes A, C, W, and Y, PCV10 pneumococcal serotypes for children (PCV15 since fall 2024), PPV23 serotypes for older adults, and HPV16/18.
4. For HPV, the burden is based on the number of cases with cancer, anogenital warts and high-grade cervical lesions attributable to HPV. The pink line shows the burden for females, the blue line shows the burden for males.
5. Note that the y-axes are not the same for all diseases.
Sources: Osiris, NRLBM, sentinel laboratory surveillance, national cancer registry, PALGA, NIVEL-LINH.

4.3 Burden of NIP diseases

In this section, we present an update of the disease burden of (partially) vaccine-preventable diseases in the 2020–2024 period in the Netherlands, expressed in disability-adjusted life years (DALYs). We present the same estimates that were published in the 'State of infectious diseases in the Netherlands, 2024', in which more detailed information on the parameters used can be found [1]. Estimates for hepatitis A and rotavirus infection were derived from the report 'Voedselgerelateerde en overige enterale infecties in Nederland. Jaarrapportage 2024.' [3]. Estimates for human papillomavirus (HPV) infection were derived from a separate analysis [2] and updated for more recent years using the Global Burden of Disease (GBD) 2010 life expectancy. Note that the calculation method used for HPV is not fully comparable to the one used for other diseases: instead of using the number of incident infections (which is unknown), the number of cases with cancer, anogenital warts and high-grade cervical lesions attributable to HPV was used. All DALY estimates were rounded up or down: to three significant digits for numbers ≥10,000, to two significant digits for numbers between 10 and 10,000, and to one significant digit for numbers <10. We refer to section 8.3.4.1.4 in the VZV chapter for preliminary disease burden estimates for VZV both including and excluding the impact of invasive group a streptococcal disease (iGAS).

Table 4.1 shows the estimated DALYs per year in the 2020–2024 period (a measure of the disease burden at population level) and the DALYs per 100 infections in 2024 (a measure of the disease burden at individual patient level) in the Netherlands, with 95% uncertainty intervals. For poliomyelitis, rabies, and rubella, the estimated disease burden in 2024 was zero because no cases were reported. For diphtheria and mumps, the disease burden in 2024 was estimated to be relatively low, while the highest burden was estimated for HPV infection, followed by invasive pneumococcal disease, pertussis, invasive *Haemophilus influenzae* disease, rotavirus infection, and invasive meningococcal disease.

The incidence of pertussis is known to surge every few years. In the pre-vaccination era, the incidence of rotavirus peaked every year, in early spring (Figure 4.1). Particularly for pertussis, measles, mumps, and hepatitis A, the estimated burden in 2024 was considerably higher than in 2023.
After two years with no reported invasive meningococcal serogroup C cases in 2020–2021, and therefore zero burden, the proportion of the burden of invasive meningococcal disease due to serogroup C in 2022, 2023, and 2024 amounted to 3%, <1%, and 1%, respectively. The proportion of the burden of invasive meningococcal disease due to serogroup W decreased from 42% in 2018, the year when MenACWY vaccination was introduced into the NIP, to 29% in 2019, 14% in 2020, 6% in 2021, 2% in 2022, and to 1% in 2023, but increased somewhat to 4% in 2024. Nowadays, most of the burden due to meningococcal disease is caused by serogroup B (91% in 2024). In 2024, the burden of invasive pneumococcal disease caused by the currently used PCV10 pneumococcal serotypes was only 8% of the total burden due to invasive pneumococcal disease, whereas the burden of disease caused by the PPV23 pneumococcal serotypes was 79%. The burden of invasive

pneumococcal disease caused by the PCV15 pneumococcal serotypes was still 45% of the total burden due to invasive pneumococcal disease, but this is expected to decrease in the future due to the switch from the PCV10 to PCV15 vaccine for children in the autumn of 2024. The proportion of invasive *H. influenzae* disease burden in 2023 due to the vaccine-preventable *H. influenzae* disease serotype b (Hib), was 24%; similar to the years 2018/2019 and 2022/2023. This proportion increased in 2020 (47%) and 2021 (50%), due to an increase of Hib and a decrease of disease caused by other *H. influenzae* serotypes including the dominant non-typeable strains. The absolute number of DALYs due to Hib had increased in 2020 and 2021, and was still relatively high in 2022/2023 (2018: 290 DALYs, 2019: 270 DALYs, 2020: 480 DALYs, 2021: 450 DALYs, 2022: 420 DALYs, 2023: 360 DALYs) but decreased to 300 DALYs in 2024.

It must be noted that the total disease burden for pneumococcal disease, meningococcal disease, and *H. influenzae* disease is higher than presented here, as the analyses were limited to laboratory-confirmed invasive disease only. The disease burden related to hepatitis B has also been underestimated. The analyses only reflect the (future) burden of new cases of hepatitis B virus infection in the 2020–2024 period; the disease burden of (chronic) hepatitis B cases who were infected prior to this period is not included.

When considering these burden estimates, it is important to note several points. First, the burden of pneumococcal, meningococcal, and Hib disease, as well as of HPV infection, is not fully vaccine-preventable because not all serotypes are covered by the used vaccines and because the vaccination coverage and vaccine-effectiveness is not 100%. Second, for HPV, the burden is still high because time between infection and disease (cancer) is much longer than for most other diseases, therefore the HPV burden reflects cases who were mainly infected in the pre-vaccination era. Furthermore, for pertussis it is known that vaccine protection is not long-lasting, resulting in epidemic years. For rotavirus, the vaccination programme only started in January 2024, so the effects on the rotavirus burden of disease are expected in subsequent years. The increasing burden of measles and mumps is likely to be related to suboptimal and declining vaccine coverage.

4.4 Burden of COVID-19

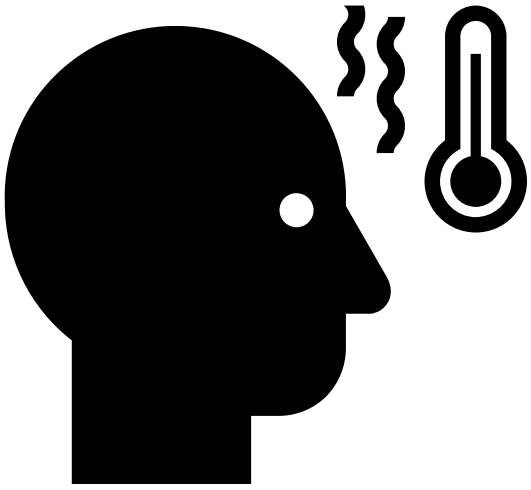
The disease burden of COVID-19 in 2024 is estimated to be 18,000 DALYs (95% uncertainty interval 16,800–19,300), where 72% of the burden is due to premature death because of COVID-19 [1]. In 2023, the burden was estimated to be 37,800 DALYs (95% uncertainty interval 36,400–39,200).
The burden for COVID-19 is underestimated since long-term consequences of the disease have not been taken into account. Furthermore, there is insufficient data about the epidemiology and long-term impact of COVID-19 at this time to properly estimate the disease burden in DALY/100 cases. Moreover, it is possible that the role of COVID-19 in a causal pathway to death was recognised and recorded less comprehensively than during the COVID-19 pandemic years.

4.5 Literature

1.* Staat van Infectieziekten in Nederland, 2024 [State of Infectious Diseases in the Netherlands, 2024]. Bos J, editor. Bilthoven: National Institute for Public Health and the Environment (RIVM); 2025. RIVM report 2025–0123.
2.* McDonald SA, Qendri V, Berkhof J, de Melker HE, Bogaards JA. Disease burden of human papillomavirus infection in the Netherlands, 1989-2014: the gap between females and males is diminishing. Cancer Causes Control. 2017;28(3):203–14.
3.* Friesema I, Benincà E, Pijnacker R, Tulen L, van den Berg O, Adriaansens D, et al. Annual report (2024) on enteric, vectorborne and zoonotic infections [Voedselgerelateerde en overige enterale infecties in Nederland. Jaarrapportage 2024]. Bilthoven: National Institute for Public Health and the Environment (RIVM); 2025 (RIVM report 2025–0098).

*Publication with RIVM authors.

5 Adverse events



5.1 Key points

- In 2024, Lareb received 1391 reports representing a total of 4731 adverse events following immunisation (AEFI). Apart from reports involving COVID-19 vaccination, these reports related to all vaccines included in the NIP. As a result of the introduction of rotavirus vaccination more or less coinciding with the end of the HPV catch-up campaign, the number of reports remained approximately the same as in earlier years [1]. The number of reported AEFIs per report was between 3 to 4, which is similar to earlier years. The most frequent local and systemic reactions following COVID-19 vaccination reported to Lareb relating to a vaccination date between 1 May 2024 and 30 April 2025 were malaise, headache, and fatigue, which is similar to earlier years. In 2024, no new signals of potentially serious adverse events were found for any vaccines included in the NIP.

5.2 Tables and figures

Table 5.1 Reports of adverse events following immunisation, the Netherlands 2024 [1].

Vaccines	Total 2023	Total 2024	0-2m	3-4m	5-6m	7-8m	9-10m	11-12m	13-14m	15-16m	17-23m	2-5yrs	6-9yrs	10-14yrs	15-18yrs	18yrs +	Other/ Unknown
Rotarix®		**328**	278	48	2												
Rotarix®, Vaxelis®		**34**	29	5	0												
Rotarix®, Vaxelis®, Synflorix®		**82**	2	79	1												
Rotarix®, Synflorix®		**3**	0	3	0												
Rotarix®, Vaxelis®, Vaxneuvance®		**3**	0	3	0												
Vaxelis®	237	**46**	11	7	4	0	1	7	4	0	12						
Vaxelis® + Synflorix®	59	**194**	3	44	70	6	2	50	10	4	5						
Vaxelis® + Vaxneuvance®		**18**	0	3	2	0	0	13	0	0	0						
Synflorix®	2	**7**	1	1	2	1	0	1	0	1	0						
Vaxneuvance®		**1**			0	0	0	1	0	0	0						
MMRVaxPro® + Menquadfi®	118	**116**						0	69	41	6						
MMRVaxPro® + Nimenrix®	2																
MMRVaxPro®	29	**14**						1	5	2	6						
Menquadfi®	11	**5**						0	2	2	1						
Boostrix Polio®	91	**70**										70					
MMRVaxPro® + Revaxis®	127	**119**											118	1			
MMRVaxPro®	1	**6**											5	1			

Vaccines	Total 2023	Total 2024	0-2m	3-4m	5-6m	7-8m	9-10m	11-12m	13-14m	15-16m	17-23m	2-5yrs	6-9yrs	10-14yrs	15-18yrs	18yrs +	Other/ Unknown
Revaxis®	8	**3**											2	1			
Cervarix®	590	**171**											65	72	8	26	
Nimenrix®	30	**34**												33	1		
Boostrix® (pregnant women) with or without Influvac Tetra®	106	**102**														102	
Vaccination not according to current schedule	25	**35**	2			1			1	2		3	8	14	3	1	
Vaccination errors	3	**0**															
Total 2024		**1391**	**326**	**193**	**81**	**8**	**3**	**73**	**91**	**52**	**30**	**73**	**198**	**122**	**12**	**129**	**0**
Total 2023	1439		30	100	63	3	2	75	92	72	7	105	182	223	52	430	3
Total 2022	1217		23	107	67	6	2	69	111	55	11	190	197	207	50	119	3
Total 2021	1462		35	167	90	6	5	98	155	94	14	240	153	163	44	197	1
Total 2020	1475		58	165	94	7	5	143	145	86	22	292	144	87	26	198	3
Total 2019	2009		181	192	46			128	236			316	128	75	497	9	201
Total 2018	1519		187	169				170	263			326	110	65	62		167
Total 2017	1383		216	167				154	200			387	106	77			76
Total 2016	1483		174	155				126	171			572	84	146			55
Total 2015	1494		173	156				142	208			422	88	257			48
Total 2014	982		148	138				101	139			274	108	59			15
Total 2013	1212		217	193				118	133			335	92	82			42
Total 2012	1387		250	264				103	138			423	52	104			53
Total 2011	1103		212	240				105	129			280	51	51			35

Table 5.2 Reported severe or remarkable adverse events following immunisation, the Netherlands 2024 per vaccination moment [1].

Adverse events	0-2m	3-4m	5-6m	7-8m	9-10m	11-12m	13-14m	15-16m	17-23m	2-5yrs	6-9yrs	10-14 yrs	15-18 yrs	18 yrs+	Unknown	Total
General disorders and administration site conditions																
Extensive swelling of vaccinated limb*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Body temperature > 42°C*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Screaming	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	5
Immune mediated disorders																
Autoimmune thyroiditis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Immune thrombocytopenia	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	3
Systemic lupus erythematosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vaccine failure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Infections and infestations																
Abscess soft tissue	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Encephalitis/meningitis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Adverse events	0-2m	3-4m	5-6m	7-8m	9-10m	11-12m	13-14m	15-16m	17-23m	2-5yrs	6-9yrs	10-14 yrs	15-18 yrs	18 yrs+	Unknown	Total
Metabolism and nutrition disorders																
Dehydration	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	6
Type 1 diabetes mellitus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intussusception	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Musculoskeletal and connective tissue disorders																
Fibromyalgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juvenile idiopathic arthritis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neurologic symptoms																
Ataxia, spasms, tics	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Autism spectrum disorder	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Delirium febrile	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2
Febrile convulsion, seizures, tonic convulsion, epilepsy	2	2	3	0	0	4	5	2	1	1	3	0	0	0	0	23
Facial paralysis/Bell’s palsy	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2
Hypotonic-hyporesponsive episode/paralysis	2	17	4	0	0	0	1	0	0	1	1	0	0	0	0	26

Adverse events	0-2m	3-4m	5-6m	7-8m	9-10m	11-12m	13-14m	15-16m	17-23m	2-5yrs	6-9yrs	10-14 yrs	15-18 yrs	18 yrs+	Unknown	Total
Migraine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Status epilepticus	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	2
(Pre)syncope	0	1	1	1	0	0	0	0	0	2	17	8	2	1	0	33
Complex regional pain syndrome (CRPS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Respiratory symptoms																
Apnoea, Dyspnoea, Irregular breathing	3	3	4	1	0	2	1	1	0	0	3	2	0	3	0	23
Breath holding spells	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	3
Skin conditions																
Rash, eczema	13	10	10	2	0	10	31	14	2	15	36	18	1	2	0	164
Skin discolouration	1	4	3	0	0	0	0	0	0	0	0	0	0	0	0	8
Urticaria	0	3	3	0	0	4	0	1	0	3	5	4	0	1	0	24
Henoch-Schönlein purpura	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Acute haemorrhagic oedema of infancy	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Vascular Disorders																
Kawasaki’s disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Postural orthostatic tachycardia (POTS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Adverse events	0-2m	3-4m	5-6m	7-8m	9-10m	11-12m	13-14m	15-16m	17-23m	2-5yrs	6-9yrs	10-14 yrs	15-18 yrs	18 yrs+	Unknown	Total
Death**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Sudden Infant Death Syndrome (SIDS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Death	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Adverse events concerning pregnancy																
Foetal death*														1		1
Stillbirth*														1		1
Premature baby														3	2	5
Small for dates baby	1															1
Chorioamnionitis														1		1
Guillain-Barré syndrome														1		1

* This year, Lareb did not code this category separately
** For a full description of the cases of death: see the Lareb annual report [1].

Table 5.3 Number of reports to Lareb following COVID-19 vaccination with a vaccination date between 1 May 2024 and 30 April 2025.

Vaccine	Number of reports
Pfizer/BioNTech JN.1	996
Pfizer/BioNTech XBB.1.5 12+	3
Vaccine unknown	2
Total	1,001

Source: Lareb, reporting date 16 May 2025.

*Table 5.4 Most frequent local reactions and systemic events reported to Lareb following COVID-19 vaccination, with a vaccination date between 1 May 2024 and 30 April 2025.**

Adverse event	Number of reports
Malaise	406
Headache	357
Fatigue	338
Myalgia	315
Chills	259
Arthralgia	243
Injection site pain	220
Nausea	208
Pyrexia	156
Injection site inflammation	113

Source: Lareb, reporting date 16 May 2025.
* For the most recent information, see the Lareb page on side effects following COVID-19 vaccination.

Figure 5.1 Reported local adverse events (AE) by 15,454 VASCO participants at one month after receiving the BioNTech/ Pfizer (Comirnaty) - JN.1 vaccine during the Autumn campaign 2024 (September to December 2024).

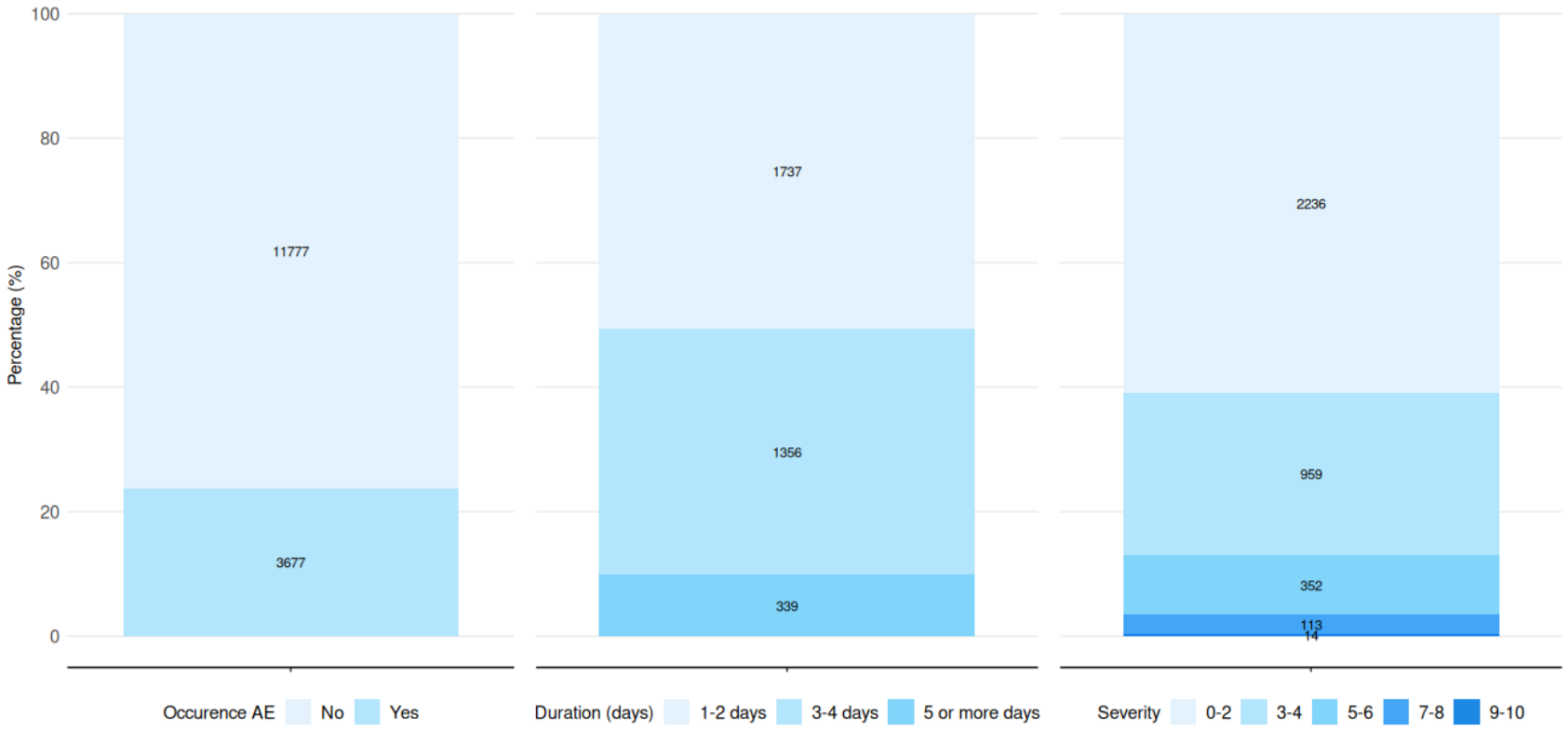


Figure 5.2 Reported systemic adverse events (AE) by 15,454 VASCO participants at one month after receiving the BioNTech/ Pfizer (Comirnaty) - JN.1 vaccine during the Autumn campaign 2024 (September to December 2024).

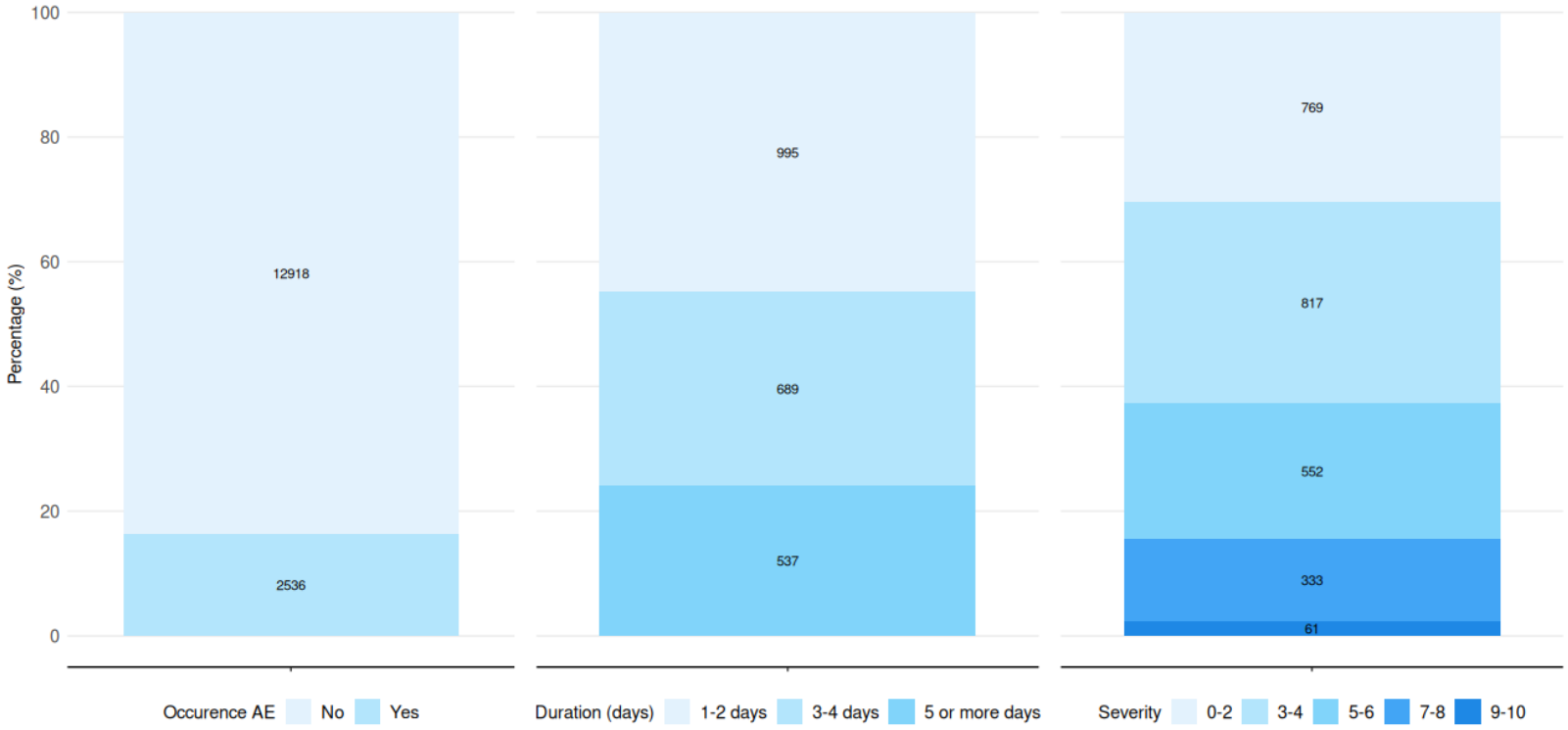


Figure 5.3 Top 20 of reported adverse events for which contact was sought with a healthcare professional among 15,454 VASCO participants who received the BioNTech/Pfizer (Comirnaty) – JN.1 vaccine during the Autumn campaign 2024 (September to December 2024). Out of these, 126 participants (0.82%) sought medical are following vaccination.

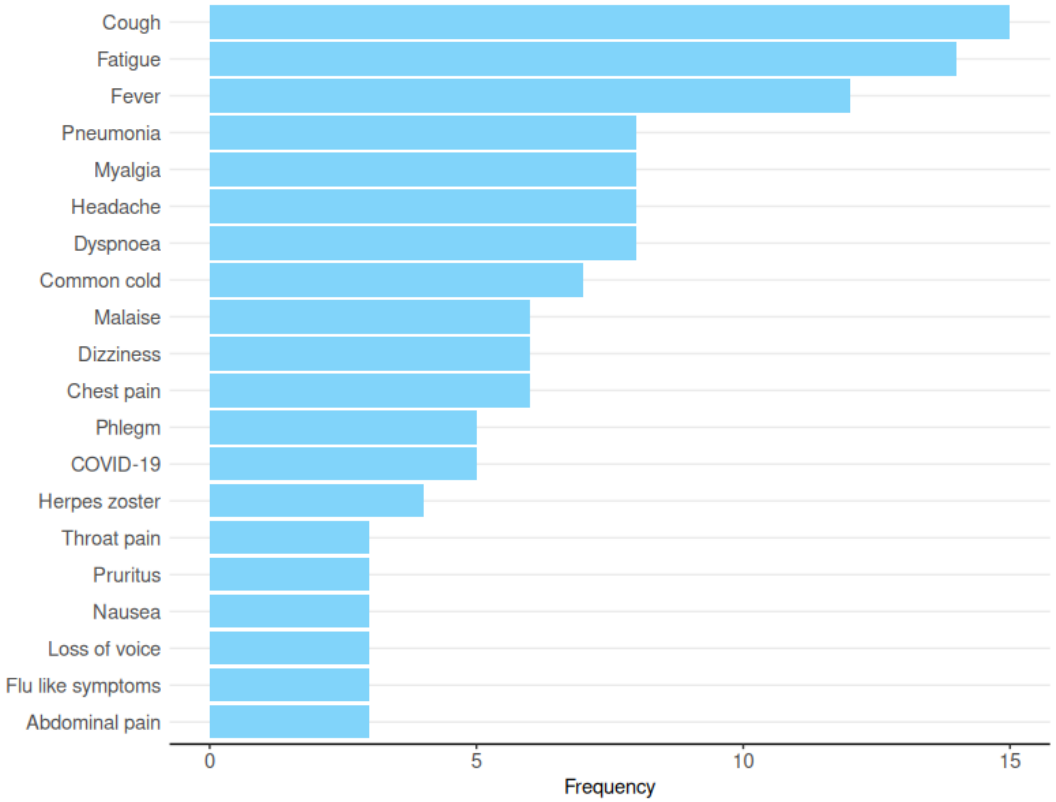
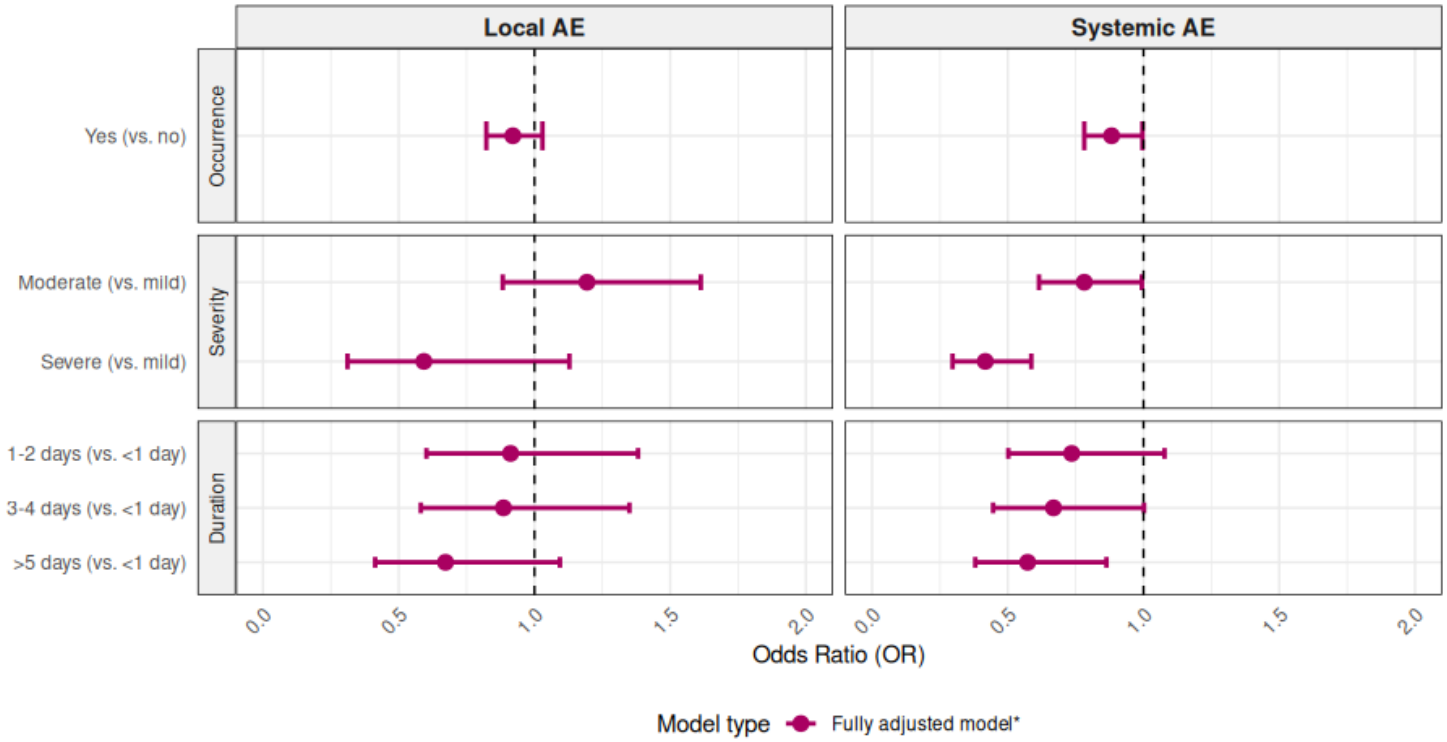


Figure 5.4 Association between vaccination during the autumn 2024 booster campaign and experiencing adverse events (AE) following COVID-19 vaccination received during the autumn 2023 booster campaign (n=15,138).



*The models included variables for age, sex, medical risk, healthcare worker (HCW), educational level, household composition, migration background and SARS-CoV-2 infection 6 months prior to the campaign.

5.3 Spontaneous Reporting System

5.3.1 Reports

The enhanced passive surveillance system managed by the National Pharmacovigilance Centre Lareb receives AEFI reports. In Chapter 5.3.1.1, background information on these reports is given for the childhood vaccinations included in the NIP. The reports related to COVID-19 vaccination are described in Chapter 5.3.1.2.

5.3.1.1 Reports related to childhood vaccinations

In 2024, Lareb received 1391 reports (Table 5.1) with a total of 4731 AEFIs [1]. This number of reports is similar to the number of reports received in earlier years (2020: n=1,475, 2021: n=1,462, 2023: n=1,439), but somewhat higher than in 2022 (n=1,217). The introduction of rotavirus vaccination in the NIP resulted in an increase in the number of reports, while the number of reports following HPV vaccination showed a sharp decrease due to the end of the HPV catch-up campaign in 2024. Most reported AEFIs were malaise (n=584), fever (n=433), injection site reactions (n=347), fatigue (n=334), nausea (n=295), and diarrhoea (n=287).

For most vaccines, the number of reports falls within the range of the last years (see Table 5.1), although changes in the NIP, especially in the first year of life, make it difficult to compare the number of reports to those from previous years. However, the still declining trend of reports following the DTP-IPV booster vaccination at the age of 4 years is remarkable. The number of reported AEFIs per report was 3 to 4, which is similar to earlier years. Due to the implementation of an informed consent for data exchange with RIVM in January 2022, it is not possible to determine precisely how many vaccine doses are given. Therefore, a reliable estimation of the number of AEFIs per vaccine dose is not possible.

Table 5.2 summarises severe or remarkable adverse events per vaccination moment as reported to Lareb. These events are included because of their severity and their known or perceived relation with vaccination. In general, the spectrum of reported AEFIs is mostly in line with previous years. A new feature concerns the side effects following rotavirus vaccination. Lareb received two serious reports of intussusception after vaccination with the rotavirus vaccine Rotarix. The first child was 3 months old when vaccinated with Rotarix. The intussusception occurred two months after vaccination. It is unclear whether the vaccine caused the intussusception, as the extremely rare side effect intussusception usually occurs within a week after vaccination with Rotarix [2]. The second child was 8 weeks old when vaccinated with Rotarix and the DTP-Hib-HepB vaccine. After three days, an intussusception occurred. During surgery, a congenital intestinal abnormality was seen, which is a risk factor for developing intussusception.
Lareb received one report of the death of a 14-month-old child one day after vaccination with the MMR vaccine and the meningococcal ACWY vaccine. The cause of the death is unknown. Moreover, Lareb received two reports of deaths following DTP vaccination during pregnancy. In one child, born after 22 weeks of pregnancy, chorioamnionitis was

diagnosed. This child died shortly after birth. The other report involved a stillbirth after vaccination during pregnancy with the DKT vaccine Boostrix® and the influenza vaccine Influvac tetra®. After two days, intrauterine fetal death was diagnosed, along with a very significant decrease in amniotic fluid. Prenatal screening and ultrasound scans during pregnancy were normal.

In addition to the spontaneous reporting system, three cohort studies collecting information on potential adverse events following vaccination were running in 2024. The HPV monitor data collection has been completed. Data analysis is ongoing. The two other RVP monitor studies are still ongoing (see https://www.lareb.nl/news/informatie-over-bijwerkingen-na-eerste-jaar-rotavirusvaccinatie/ for interim evaluations). To date, the cohort study 'Mothers of Tomorrow' has revealed no evidence of adverse pregnancy outcomes following DTP vaccination during pregnancy [3, 4].

Overall, no new signals of disturbing adverse events were found.

5.3.1.2 Reports related to COVID-19 vaccinations

Lareb received a total of 1001 reports concerning COVID-19 vaccines administered between 1 May 2024 and 30 April 2025, representing a total of 4089 AEFIs. Detailed results of reports per administered vaccine and the (top 10) most reported adverse events are presented in Tables 5.3 and 5.4, respectively. The top 10 most reported adverse events is the same as last year's (Ch. 9.8).

5.3.2 Signals/Overviews

On the basis of the reports, the following analyses were conducted by Lareb in 2024:

Rotavirus vaccination and gastroenteritis

Lareb received 61 reports of vomiting in combination with diarrhoea, with or without dehydration following vaccination with the rotavirus vaccine Rotarix, with a mean latency period of 3 days and an average duration of the complaints of 11 days. The mean age of the cases was 7 weeks. The cohort study RVP monitor 2024 also shows that approximately 2% of the children are affected. The reports have been communicated to the Medicines Evaluation Board and RIVM, and subsequent reports will be monitored closely, but no regulatory action is required at the moment.

Rotavirus vaccination and fever

Lareb received 25 reports of fever following vaccination with the rotavirus vaccine, with a mean latency period of 3 days. For most cases, the average duration time of the complaints was unknown. The mean age of these infants was 8 weeks. The cohort study RVP monitor 2024 shows that approximately 3.5% of children are affected. These reports have been further analysed and discussed with the Medical Evaluation Board. The reports did not warrant further action at this time.

Impact of abdominal pain complaints following rotavirus vaccination

Abdominal pain following rotavirus vaccination is frequently reported in the cohort study (14%) with a mean latency period of 2 days and an

average duration of 4.5-5.5 days. One third of the parents perceive the complaint to be (very) burdensome.

5.4 Research

5.4.1 Adverse events reported in VASCO

The Vaccine Study Corona (VASCO) is a population-based cohort study, aimed at assessing the long-term effectiveness of COVID-19 vaccines among ~45,000 community-dwelling persons aged 18-85 years [5]. Participants in VASCO are requested to complete a questionnaire one month after vaccination, in which questions are asked about potential adverse events (AE) following vaccination. A distinction was made between local (at injection site) and systemic reactions. Participants were asked how severe the reactions were and how long they lasted. The included questionnaires were completed by participants who received the BioNTech/Pfizer (Comirnaty) - JN.1 vaccine during the autumn campaign of 2024. 18,110 participants received the vaccine, of whom 85.3% completed an AE questionnaire regarding this vaccine. In total, 15,454 unique participants were included in the analysis.

5.4.1.1 Local reactions

24% of the participants reported injection-site reactions following COVID-19 vaccination (Figure 5.1). Participants under the age of 60 years reported injection-site reactions more frequently (35%) than participants over 60 years (21%). And women reported injection-site reactions more frequently than men (31% vs 15%).
According to half the questionnaires, injection-site reactions lasted between one and two days. An additional 40% of participants reported injection-site reactions lasting three to four days. Regarding severity, more than half the participants (61%) rated the reactions as 1 or 2 on a 10-point scale, where 1 indicates extremely mild and 10 extremely severe reactions. Another 26% rated the reactions as 3 or 4 in severity.
Results were comparable to those reported following the XBB.1.5 vaccine, which was administered in the autumn campaign of 2023, when 25% of all participants reported injection-site reactions and 62% of the participants rated the reactions as 1 or 2 on a 10-point scale (see last year's report, Chapter 9.8).

5.4.1.2 Systemic reactions

16% of participants reported systemic reactions following COVID-19 vaccination (Figure 5.2). Participants under the age of 60 years reported more systemic reactions (24%) than participants over 60 years (15%). Women also reported more systemic reactions than men (19% vs 13%). In 45% of the questionnaires, systemic reactions lasted between one and two days, while 31% reported a duration of three to four days. Most participants rated the severity of these reactions as 1 or 2 (30%) or as 3 or 4 (32%) on a 10-point scale, where 1 indicates extremely mild and 10 extremely severe reactions. Notably, 16% of participants rated the severity as 7 or higher.
Results were comparable to those reported following the XBB.1.5 vaccine, which was administered in the autumn campaign of 2023, when 18% of participants reported systemic reactions (see last year's report, Chapter 9.8).

5.4.1.3 General practitioner contact

0.8% of the participants who completed the questionnaire contacted their GP for a (possible) AE. Women contacted their GP slightly more often (0.84%) than men (0.79%) did, and those over 60 years (0.84%) did so more often than those younger than 60 years (0.70%). Participants contacted the GP most frequently for coughs, fatigue, or fever (Figure 5.3).

5.4.2 Adverse events and its relation to revaccination

Within VASCO, we performed logistic regression to investigate the association between the occurrence, severity, or duration of local and systemic AE following COVID-19 vaccination and revaccination during the autumn booster campaigns of the subsequent year. Analyses were restricted to participants who were eligible for booster vaccination in 2024. Furthermore, analysis was adjusted for variables that are known to influence the outcome (revaccination): age, sex, medical risk, healthcare worker (HCW), educational level, household composition, migration background, and SARS-CoV-2 infection 6 months prior to the start of the campaign.

Participants who reported a systemic AE in 2023 were significantly less likely to revaccinate in the following year (OR: 0.88 [95% CI: 0.78-0.996]), compared to those without a reported systemic AE (Figure 5.4). Reporting a moderate systemic AE (OR: 0.78; 95% CI: 0.61–0.99) or a systemic AE lasting more than five days (OR: 0.57; 95% CI: 0.38–0.86) was also significantly associated with reduced odds of revaccination, compared to mild reactions or those lasting less than one day, respectively. Experiencing a severe systemic AE had the most pronounced negative effect on subsequent vaccine uptake (OR: 0.42 [95% CI: 0.30-0.59]). In contrast, no statistically significant associations were observed between local AE and revaccination.

5.5 International Developments

5.5.1 Vaccines targeting diseases included in the current NIP

5.5.1.1 Meningococcal ACWY vaccines

No new safety issues were reported for conjugate meningococcal ACWY in infants, adolescents, and adults [6-12] or for MenACWYX vaccines in toddlers and adults [13-15].

5.5.1.2 MMR/MMRV vaccines

The MMR, MMRV, and measles-containing vaccines are generally well tolerated, even in patients with underlying disorders [16-20] or in breastfeeding mothers and their infants [21]. The safety of MMR vaccination was also demonstrated in infants under the age of 12 months [22, 23]. However, a rise in vaccine-induced thrombosis and thrombocytopenia syndrome reports following several vaccinations including MMR was found, particularly in young women [24]. These results are difficult to interpret since the two syndromes (thrombosis and thrombocytopenia) are combined in the study.

Two studies documented the safety profile of novel MMR vaccines [25, 26].

5.5.1.3 Pneumococcal vaccines

Several studies showed the safety of PCV13 [27-29], PCV13i [30], PCV14 [31], PCV15 [32-34], PCV20 [35-38], PCV21 [39-41], PPV23 [34, 42-44], and PCV24 [45, 46]. A phase 1a trial demonstrated the safety of a novel protein-based pneumococcal vaccine in healthy adults aged 18-49 years [47].

5.5.1.4 DTaP-IPV-HBV-Hib vaccines

Several studies demonstrated the safety of infant quadri-, penta-, and hexavalent vaccines [20, 48-52]. One study demonstrated that, compared to an aP-only schedule, a mixed wP/aP primary schedule was associated with more severe reactions, but was well accepted by parents [53]. A reduced-dose recombinant pertussis vaccine booster in adolescents aged 9-17 years presented a good safety profile [54]. A new inactivated poliomyelitis vaccine (Sabin strains) demonstrated good safety for primary and booster vaccinations, when administrated separately or simultaneously with other vaccines [55].
As demonstrated in earlier studies, Tdap vaccination is safe in adults, in pregnant woman, in pregnant women infected with HIV, or when co-administrated with other vaccines [56-61].

5.5.1.5 Hepatitis B vaccines

Several studies demonstrated the safety of the hepatitis B vaccines [62], even in preterm children [63] or in patients with underlying diseases [64-66]. One study found no evidence of adverse pregnancy outcomes for recipients of hepatitis B vaccines [67]. Other studies suggest potential associations between hepatitis B vaccines and (autoimmune) disorders [68-72]. Since most of these studies are based on the Vaccine Adverse Event Reporting System, further investigation is necessary to prove a conclusive link between these vaccines and its side effects. One study found a rise in vaccine-induced thrombocytopenia syndrome reports following several vaccinations including hepatitis B vaccination, particularly in young women (see above) [24].

5.5.1.6 HPV vaccines

2valent (v) HPV, 4vHPV and 9vHPV vaccines
Several studies demonstrated the safety of 2vHPV vaccines [73], 4vHPV vaccines [74, 75], and 9vHPV vaccines [75, 76] or of unspecified HPV vaccines [77, 78], while 4vHPV, and 9vHPV were also well-tolerated in immunocompromised women [79-82]. Other studies suggest that HPV vaccination may reduce the risk of diseases such as fibromyalgia [83] and new-onset cardiovascular and cerebrovascular diseases [84]. One study found that HPV vaccination will reduce preterm births and low birth weight in infants [85], although another study concluded that an elevated risk of spontaneous abortion caused by HPV vaccination could not be completely ruled out, and further research is needed [86]. In situations of concurrent administration, the optimal sequence related to AE risks would be to receive the HPV vaccine after the COVID-19 vaccine [87].
Extending the interval to 12-53 months between first and second 9vHPV vaccine doses showed a favourable safety profile compared to an administered 2nd dose of 6-12 months after the first dose [88].

New vaccines
In clinical trials, a novel Escherichia coli-produced HPV-16/18 bivalent vaccine demonstrated an acceptable safety profile [89].

5.5.1.7 Rotavirus vaccines

Although one study confirmed known adverse drug reactions to rotavirus vaccination [90], no safety issues were demonstrated for monovalent [91] or pentavalent rotavirus vaccines [91, 92]. This even holds true for preterm infants [93] or for infants who were exposed to biologics in utero as a result of maternal drug use during pregnancy [94, 95] and in breastfeeding mothers and their infants [96]). This confirms the conclusion of a literature review, which found that the evidence base of the safety of rotavirus vaccination does not contain any major gaps [97], although a rise in vaccine-induced thrombocytopenia syndrome reports following rotavirus vaccination was found, particularly in young women (see above) [24]. Two studies demonstrated the safety of new inactivated rotavirus vaccines [98, 99].

5.5.1.8 COVID-19

Here, we summarise some literature that was published after the previous NIP report. Rustagi and colleagues performed a systematic review on SARS-CoV-2 pathophysiology and post-vaccination severity [142]. They did not find any new side effects. Most AEFIs were mild and disappeared quickly following immunisation. Most reported mild reactions were pain at the injection site, redness and swelling, fatigue, headache, muscle pain, fever and chills, nausea, and swollen lymph nodes. Severe adverse events were also reported, such as acute ischemic stroke, cerebral venous sinus thrombosis, Guillain-Barré syndrome, vaccine-induced thrombotic thrombocytopenia, and other thrombotic events. However, they conclude that the significant benefits of COVID-19 vaccination outweigh the extremely low risk of these severe conditions by far. Woestenberg and colleagues studied the association between COVID-19 vaccination during pregnancy and neonatal health outcomes [143]. They used data from the Dutch Pregnancy Drug Register, which included 3655 women with a due date between 14 January 12021 and 15 May 2022 and a singleton live birth after at least 24 weeks' gestation. In total, 3655 participants were included of whom 92.1% were vaccinated during pregnancy. They did not find a significant association between the self-reported health outcomes small for gestational age at birth, large for gestational age at birth, or neonatal health problems.
Ferreira-da-Silva and colleagues performed a network analysis of adverse event patterns following immunisation with mRNA COVID-19 vaccines [144]. They analysed EudraVigilance data from 1 January 2020 to 31 December 2023, focussing on Moderna and Pfizer/BioNTech. The most common systemic reactions (sometimes classified as serious) were headache, fatigue, pyrexia, muscle pain, joint pain, malaise, nausea, and chills. The most reported local reactions were pain, redness, and swelling at the injection site. 8.9% of the reported AEFI were associated with hospitalisation. 1.9% were associated with a life-threatening condition and 1.3% were associated with death. However, causation cannot be established. Reported serious AEFI differed per age group. Myocarditis and pericarditis were primarily observed in young males. Testosterone is suggested as a contributing factor. Cerebrovascular and

cardiovascular disorders were more frequently reported among older adults. This is probably linked to vascular changes and elevated inflammatory responses in this age group.
Van Dijk and colleagues conducted a case-control study to investigate the association of venous thrombosis with administration of different SARS-CoV-2 vaccine types. They found an association between the administration of AstraZeneca and Janssen and the risk of venous thromboembolism [145]. For AstraZeneca, the OR was 1.5 (95%CI 1.0-2.5) and for Janssen, the OR was 2.9 (95%CI 0.9-9.2). Relative risk varied between age groups and sexes. For AstraZeneca, the risk of venous thromboembolism was higher among young (<60 years) and among women. For Janssen, the risk of venous thromboembolism was higher among men than among women. Janssen was only administered to individuals aged <60 years of age. No association between the administration of mRNA vaccines and venous thromboembolism was found. On a population level, in the Netherlands in 2021 SARS-CoV-2 vaccines had a net beneficial effect on the number of venous thromboembolism events [145]. Results of this study are in line with previous studies and were also described in previous NIP reports.

5.5.2 Vaccines targeting diseases that may be included in the NIP in the future

5.5.2.1 Varicella vaccines

Several studies demonstrated the safety of live attenuated varicella vaccines [100-105], including for breastfeeding mothers and their infants [96, 106], and for patients with multiple sclerosis [107]. One study analysed ten serious adverse events, including six deaths that occurred following vaccination with a live zoster vaccine. Most of these cases related to patients with underlying diseases, and the authors proposed that some deaths were not only caused by impaired immune responses but also by a viremia in which one of the genotypes was a vaccine variant [108].

5.5.2.2 Herpes Zoster vaccines

Several studies demonstrated the safety of a recombinant zoster vaccine in adults [109-117], even in patients with underlying diseases [117-124] or when co-administrated with other vaccines [125, 126]. However, one study reports two cases of post-vaccinal seronegative autoimmune encephalitis following recombinant zoster vaccination [127]. Another report describes a case with reactivation of herpes zoster ophthalmicus following the administration of this vaccine [128]. A systematic review concluded that anaphylaxis in adults following herpes zoster vaccination may occur but is rare [129].

5.5.2.3 Hepatitis A vaccines

No new safety issues were reported for the hepatitis A vaccine [130, 131]. When administered to a nursing mother, hepatitis A vaccine does not affect the safety of breastfeeding for mothers or infants [132].

5.5.2.4 Meningococcal B vaccines

Several studies demonstrated the safety of meningococcal B vaccines [133-135], although one study demonstrated more episodes of fever in preterm infants on a 3+1 schedule than in preterm infants on a 2+1 schedule [136]. The pentavalent MenABCWY vaccine had also an acceptable safety and tolerability profile in adolescents and adults [137-

139], although in infants, local and systemic reactions tended to be more frequent with MenABCWY than with 4CmenB+MenACWY-TT [140]. A novel adenoviral-vectored capsular group B meningococcal vaccine was well tolerated with no safety concerns in healthy adults aged 18 to 50 [141].

5.6 Literature

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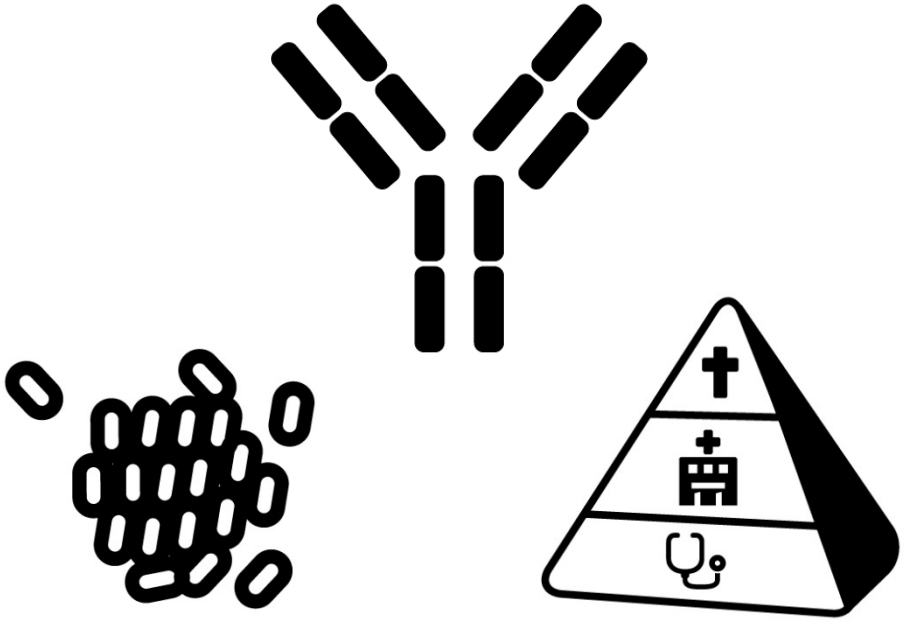
*Publication with RIVM authors.

6 Current National Immunisation programme



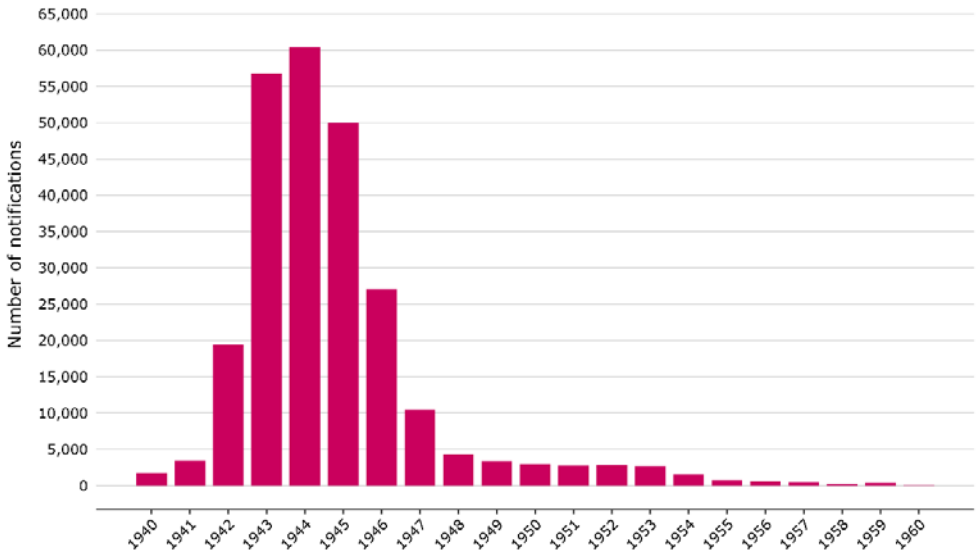
6.1 Diphtheria

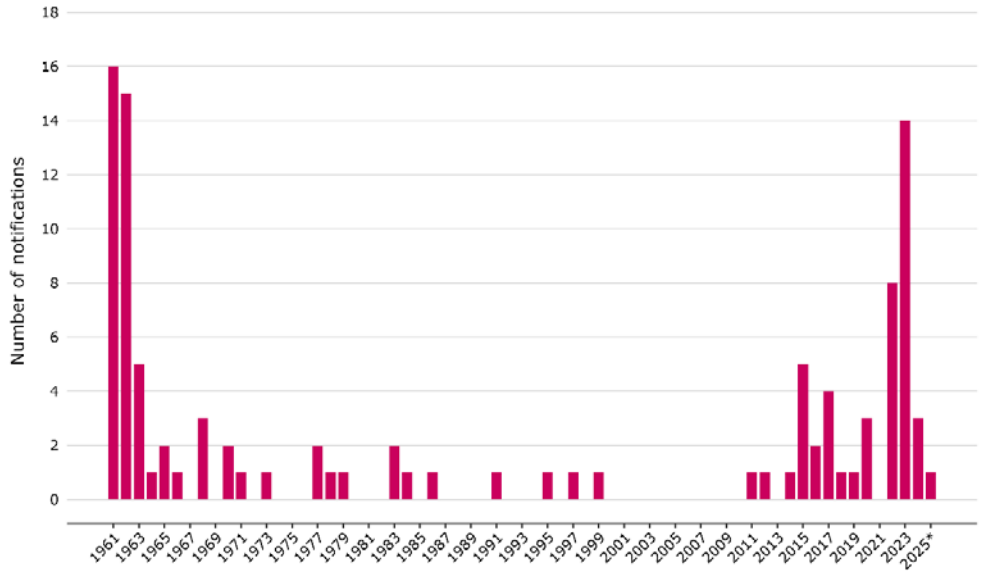
6.1.1 *Key points*

- In the Netherlands, three diphtheria patients were reported in 2024 (0.02 per 100,000 inhabitants).
- The number of patients in 2024 is lower than in the years 2022–2023 and similar to the years 2012–2021.
- In Germany, a nationwide outbreak of diphtheria caused by C. diphtheriae sequence type (ST) 574 has been ongoing since 2022 and at least 14 patients due to C. diphtheriae ST574 were notified in five other European countries too.
- ECDC published a rapid risk assessment (RRA) in response to this outbreak. The risk of infection is considered highest in unvaccinated vulnerable individuals, such as recently arrived migrants, homeless people, and drug and/or alcohol users.
- From 2025 onwards, vaccination doses for diphtheria are given at the ages of (2)–3–5–12 months, 5 years, and 14 years instead of at the ages of (2)–3–5–11 months, 4 years and 9 years.

6.1.2 *Tables and figures*

Figure 6.1.1 Annual numbers of diphtheria notifications for 1940–1960 (above) and for 1961–2025 (below).





Until 2009, only infections with *Corynebacterium diphtheriae* were notifiable. From 2009 onwards, infections with *C. ulcerans* have been notifiable too. From 2024 onwards, all Corynebacterium species that are potentially toxic gene-positive (*C. diphtheriae, C. belfantii, C. rouxii, C. ulcerans, C. pseudotuberculosis, C. silvaticum*, and *C. ramonii*) have been notifiable. Patients are classified by year in order of data availability: date of symptom onset, date of diagnosis, date of notification. Source: Osiris
* Up to and including 22 May.

Table 6.1.1 Laboratory results of confirmation testing for C. diphtheriae/C. belfantii and C. ulcerans at RIVM for 2016–2025**.*

	*Corynebacterium diphtheriae/ C. belfantii**					*Corynebacterium ulcerans*				
	PCR		Elek			PCR		Elek		
	Neg	Pos**	Pos	NC	Neg	Neg	Pos**	Pos	NC	Neg
2016	12	1	1	0	0	2	1	0	1	0
2017	9	1	0	0	1	0	2	0	2	0
2018	7	0	n/a	n/a	n/a	1	2	1	1	0
2019	7	0	n/a	n/a	n/a	8	0	n/a	n/a	n/a
2020	3	1	0	1	0	5	1	0	1	0
2021	7	0	n/a	n/a	n/a	2	0	n/a	n/a	n/a
2022	9	5	3	0	2	2	1	0	0	1
2023	17	13	11	0	2	5	1	1	0	0
2024	17	2	0	1	1	7	1	0	0	1
2025***	5	2	2	0	0	2	0	n/a	n/a	n/a

Date of arrival at the laboratory is used for year of classification.
Repeated isolates from the same person were counted once. ELEK test only performed on PCR-positive isolates.
Pos = positive, Neg = negative, NC = non-conclusive, n/a = not applicable
*For the purpose of comparability, from 2022 onwards, strains have included *C. belfantii*, since this was a biovar of *C. diphtheriae* in previous years. There were no detections of the additional species that became notifiable in 2024.
** PCR-confirmed strains reported to RIVM.
*** Strains that were sent to RIVM up to May 2025.

6.1.3 *Epidemiology*

Three diphtheria patients were reported in 2024 and one was reported in 2025 up to and including 22 May 2025 (Figure 6.1.1). All four had cutaneous disease caused by *C. diphtheriae*. They were aged between 55 and 70 years. For two patients, the vaccination status was unknown, one patient was unvaccinated, and one had been vaccinated with 3 doses. The three patients reported in 2024 had no epidemiological link and had probably been infected abroad, in countries where *C. diphtheriae* is known to be endemic. This is supported by the whole genome sequencing (WGS) results. The sequence types (STs) of the isolates, namely ST 302, 100, and 462, do not circulate in Europe. The patient reported in 2025 was an asylum seeker who arrived in the Netherlands more than half a year before the diagnosis date. Although the date of symptom onset and the epidemiological link were unknown, it was reported that the most probable country of infection was the Netherlands. However, the results of WGS suggest that the patient was infected outside Europe.

6.1.4 *Pathogen*

In case of suspected diphtheria, strains can be sent to RIVM for confirmation. In 2024, RIVM received a total of 27 strains, subdivided into 18 *C. diphtheriae*, 1 *C. belfantii,* and 8 *C. ulcerans* strains isolated from wounds, pustules, ulcers or tissue, blood cultures, and throat cultures. In 2025, for the period up to and including April, RIVM received seven *C. diphtheriae* strains and two *C. ulcerans* strains. Out of the three PCR-confirmed toxin gene-positive strains in 2024, two strains had negative test results regarding exotoxin production. For one strain, exotoxin production could not be reliably determined. The three toxin gene-positive strains in 2024 refer to three patients reported in 2024, of whom the patient who was infected with *C. ulcerans* had symptom onset in 2023. Both toxin gene-positive strains in 2025 had positive test results regarding exotoxin production. These strains refer to one confirmed diphtheria case that had symptom onset in 2024 and one case with symptom onset in 2025. See Table 6.1.1 for details on the laboratory results for the respective strains.

6.1.5 *International developments*

On 30 April 2025, the German Robert Koch Institute (RKI) reported on a nationwide diphtheria outbreak that affects mainly vulnerable population groups, such as recently arrived migrants, homeless people, and/or drug and alcohol users. This outbreak has been ongoing since the European outbreak among migrants in 2022–2023, that affected Germany too. The outbreak is caused by *C. diphtheriae* with ST 574, a ST that was first observed during the outbreak among migrants. In 2022, 55 patients were reported, 49 in 2023, 18 in 2024, and 4 in 2025 up to May. Three patients died, among whom an unvaccinated child. Between 2023 and 2025, a total of 14 patients due to *C. diphtheriae* ST574 were notified in at least five other European countries (Austria n=1, Norway n=1, Czechia n=8, Poland n=1, Switzerland n=3). In response, ECDC published a Rapid Risk Assessment (RRA) in July 2025. In this assessment, the probability of infection in general populations with high vaccination coverage is considered very low, although infection is possible in pockets of unvaccinated individuals within that population. The probability of infection in general populations with low vaccination

coverage and in vulnerable individuals who are fully vaccinated is considered low. For unvaccinated vulnerable individuals, the risk of infection is considered moderate.
Several African countries, namely Chad, Niger, South-Africa, Algeria, Gabon, Guinea, and Nigeria experienced outbreaks of diphtheria in 2024 and/or 2025 up to and including 22 May.

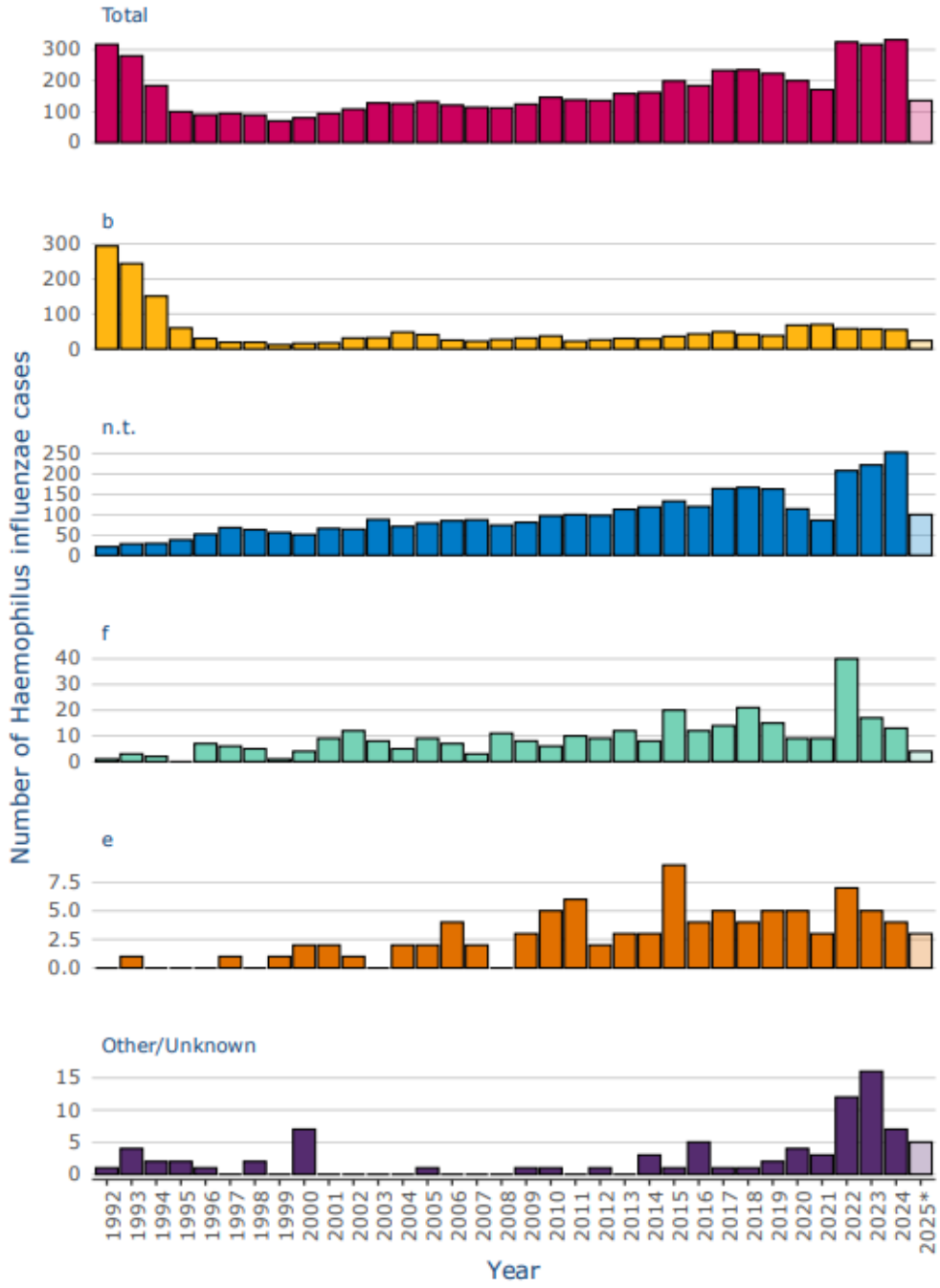
6.2 *Haemophilus influenzae* disease

6.2.1 Key points

- In 2024, 55 cases of invasive *Haemophilus influenzae* serotype b disease (Hib) were diagnosed.
- The incidence of Hib in 2024 was 0.31 per 100,000 population. The higher incidence compared to pre-COVID-19 years (~0.18/100,000), which had been observed since 2020, appears to have plateaued.
- Hib incidence is highest among children under the age of 5 years. However, this incidence was much lower in 2024 than in 2023 (1.7 compared to 3.2 per 100,000).
- Vaccine effectiveness against invasive Hib disease is high at around 90% and was not affected by recent changes to the Hib vaccination schedule.
- The increasing incidence of non-typeable *Haemophilus influenzae* continued in 2024, reaching an incidence of 1.4 per 100,000 population; especially among persons aged 65 years and over (4.1 per 100,000) and among children under the age of 5 years (1.3 per 100,000).
- As per 1 January 2025, the recommended age for the booster dose is moved up from the age of 11 months to 12 months. This applies to children born from 1 January 2024 onwards.

6.2.2 *Tables and figures*

Figure 6.2.1 Number of Haemophilus influenzae invasive disease cases per serotype, January 1992–April 2025.



Please note the different y-axis ranges.
* 2025 is not complete yet

Figure 6.2.2 Age-specific incidence of Haemophilus influenzae type b (Hib) invasive disease per 100,000 population, 2001–2024

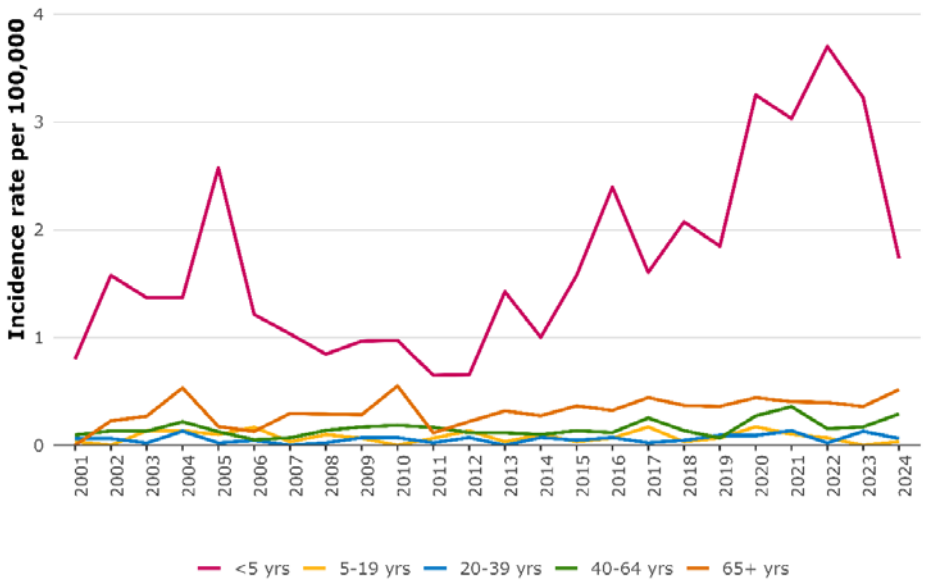
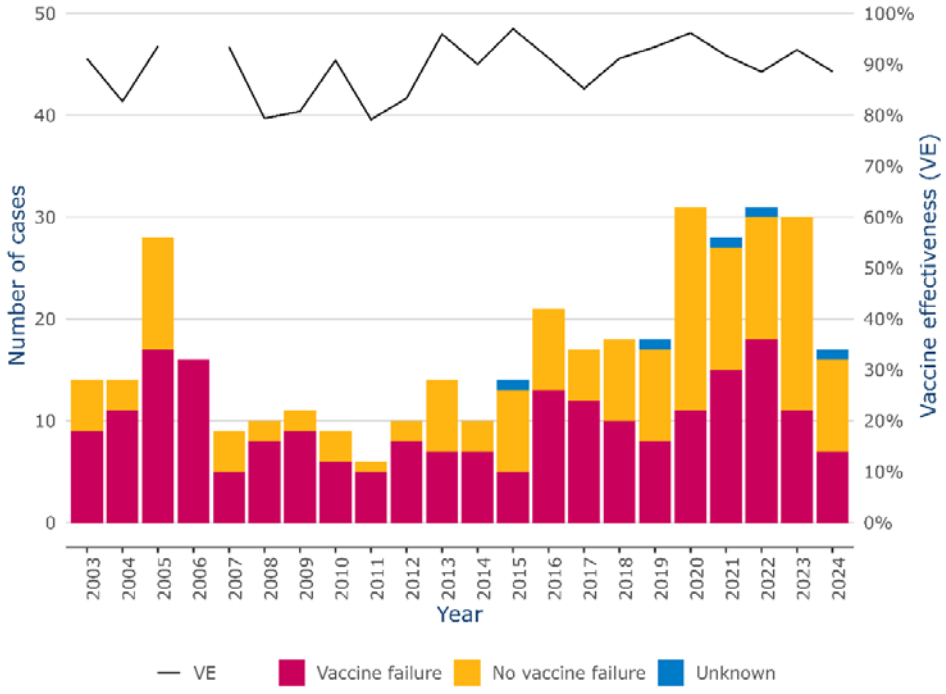
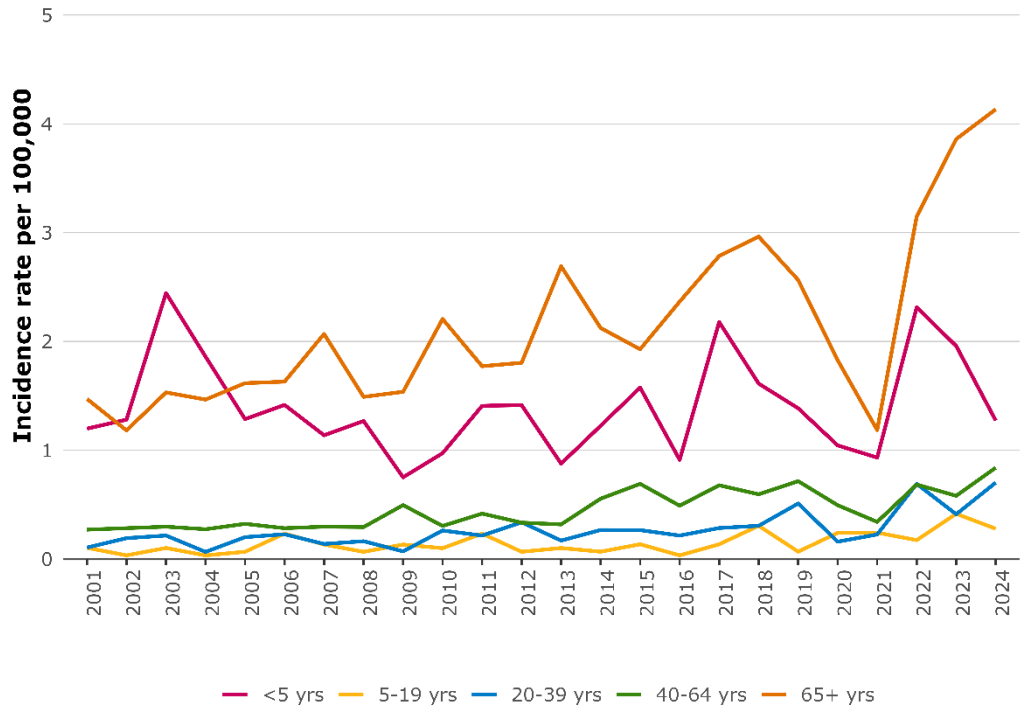


Figure 6.2.3 Number of Haemophilus influenzae type b (Hib) cases in cohorts eligible for vaccination (i.e. born on or after 1 April 1993) and aged at least 3 months, by vaccination status, and the vaccine effectiveness estimated by use of the screening method, 2003–2024.



Note: in 2006, VE could not be estimated because 100% of the cases was vaccinated.

Figure 6.2.4 Age-specific incidence of non-typeable Haemophilus influenzae disease (NTHi), 2001–2024.



6.2.3 *Haemophilus influenzae surveillance*

Invasive disease caused by *Haemophilus influenzae* serotype b (Hib) can present itself as epiglottitis, meningitis, sepsis, pneumonia, and septic arthritis. To confirm an infection with Hib, the isolate is serotyped by the Netherlands Reference Laboratory for Bacterial Meningitis (NRLBM) (see Appendix 1).

In the epidemiological year 2023–2024, a change was implemented in the analysis of surveillance data of Hi, pertaining to the date that is used for statistics. Previously, dates were based on the date of isolate receipt by the NRLBM. Now, the date used for statistics is the first (known) date of: disease onset, culture specimen, and isolate receipt. Therefore, the presented numbers per month or year may be slightly different from what has been presented in previous reports. This has no effect on the previously described trends. As isolates are received later than the disease onset date, the most recent months described here may still be incomplete.

6.2.4 *Hib epidemiology*

6.2.4.1 Incidence

Hib vaccination was introduced in the Netherlands in April 1993. After a large decrease in incidence following vaccination, the number of Hib cases fluctuated around 30 cases per year between 1996 and 2019, corresponding to an incidence of around 0.18/100,000 population (Figure 6.2.1). However, notable age-specific fluctuations occurred, with peaks among persons aged 65 and over in 2004 and 2010, and among <5-year-olds in 2005 and the 2016-2019 period (Figure 6.2.2). During the COVID-19 years 2020 and 2021, the incidence increased further to

0.39 and 0.40/100,000 (n=68 and 70), respectively. In 2022–2024, the number of cases amounted to 58, 57, and 55, respectively, corresponding to incidences of 0.33, 0.32, and 0.31 per 100,000 population. During the first four months of 2025, 24 Hib cases were diagnosed, which is consistent with the incidence observed in 2022–2024. The Hib incidence among <5-year-olds had been steadily increasing in the 2012–2022 period but decreased significantly in 2024 (Figure 6.2.2) and in the first four months of 2025. For the age groups 40–64 years and 65 years and over, Hib incidence increased slightly in 2024 compared to 2023 (Figure 6.2.2), but numbers are small and thus, fluctuations are to be expected.

6.2.4.2 Disease outcome and underlying medical conditions

Disease outcome is known for 53 out of the 55 Hib patients in 2024. Out of these, 2 patients died; both fatal cases were older adults. During the first four months of 2025, 3 cases died from Hib (one older adult and two children under the age of 5 years). Data on the presence of underlying medical conditions was available for 75% of the Hib patients in 2024; of those, 40% had comorbidities. For children aged <5 years, this was 20%.

6.2.4.3 Vaccination status and vaccine effectiveness (VE)

In 2024 and 2025 (up to and including April), 17 and 6 Hib cases, respectively, were reported among vaccine-eligible cohorts (born from 1 April 1993 onwards) and aged at least 4 months (the first dose is provided at 3 months in the standard schedule; Figure 6.2.3).
Vaccine failure was determined according to the following criteria: a Hib case who had received any dose after the age of 12 months, at least 14 days before the date used for statistics (DUFS); a Hib case who had received 4 doses, at least 14 days before the DUFS; a Hib case aged 3–11 months who had received a minimum of 3 doses, at least 14 days before the DUFS; a Hib case aged 2–5 months who received a minimum of 2 doses, at least 14 days before the DUFS; a Hib case aged 1–4 months who received a minimum of 1 dose, at least 14 days before the DUFS. Out of the 17 cases in 2024, 9 were not (fully) vaccinated and 7 were fully vaccinated (1 had an unknown vaccination status). The overall VE of Hib vaccination in 2024 among those eligible for vaccination and aged >3 months was estimated using the 'screening method' (see Appendix 1). The estimated VE was 89% (95% CI: 69–96) (Figure 6.2.3), which is similar to earlier years. Out of the 6 Hib cases among vaccine eligible persons up to April 2025, 3 were vaccine failures, one of whom died of the Hib infection. As per 1 January 2025, the recommended age for the booster dose is moved up from the age of 11 months to 12 months. This applies to children born from 1 January 2024 onwards. No cases of Hib vaccine failure at the age of 11 months, nor following the booster dose at 12 months, have been reported in the first four months of 2025.

6.2.4.4 *Haemophilus influenzae* disease caused by non-b serotypes

In 2024, 253 cases of invasive non-typable Hi (NTHi) disease were reported, resulting in an incidence of 1.41 per 100,000. The incidence is the highest since at least 1992, mainly driven by high incidence among persons aged 65 years and over (4.1 per 100,000; n=152) and among children under the age of 5 years (1.27 per 100,000; n=11)

(Figure 6.2.4). Other non-b serotypes that were observed in 2024 were serotype f (Hif; n=13), e (Hie; n=4), and a (Hia; n=5) (Figure 6.2.1). Following a peak in Hif cases in 2022 (n=39), fewer Hif cases were observed in 2023–2024. No Hi serotype d disease has been found since 2017.

6.2.5 Current/ongoing research at RIVM

The large number of Hib cases in 2020–2021, especially in the context of decreasing incidence of other infectious diseases as a result of COVID-19 pandemic mitigation measures, sparked the question whether recent changes to the Hib vaccination schedule had resulted in a reduced VE. A product change occurred in 2019 and the schedule changed in 2020 from a 3+1 (2, 3, 4, and 11 months) to a 2+1 (3, 5, and 11 months) schedule. In case the mother did not receive a pertussis vaccine during pregnancy, the schedule remains 3+1 with the first dose given between 6 and 9 weeks. A matched case-control study was set up to assess VE against invasive Hib disease by product and by schedule[1]. Cases born since 2005 reported during 2005–2023 were retrieved from the NRLBM data and matched 1:10 to population controls, on birth date and sex. Cases and controls were linked to the vaccination registry Praeventis and vaccination status was categorised as described above. Cases and controls were compared on vaccination status (fully vaccinated versus unvaccinated, i.e. no dose received). Using conditional logistic regression, matched odds ratios were estimated (mOR) and VE=1-mOR among children aged ≥6 months (overall VE), those eligible only for the primary series (aged 6–10 months), and for the booster (≥11 months). No significant differences in VE were observed between products. VE of the hexavalent product used before 2019 was 94.9% (95% CI 91.6–96.9) for all ages over 5 months combined, and VE of the hexavalent product used since 2019 was 97.4% (95%CI 95.0–98.7). Likewise, no difference in VE was found for the 2+1 versus the 3+1 schedule (97.4%, 95%CI 93.7–99.0 versus 96.1%, 95% CI 93.5–97.7). Therefore, the changes to the Hib vaccination schedule probably cannot explain the increased Hib incidence since 2020. Increasing vaccination coverage remains recommendable to reduce incidence.

6.2.6 (Inter)national developments

The increase in invasive Hib disease in 2020–2021 was remarkable as the majority of countries saw a decrease. In the UK, the 2020–2021 season showed decreased incidences of both capsulated and non-typeable Hi disease [2]. A study from the UK showed a transient 5- to 10-fold reduction in carriage of Hi among children under the age of 5 years during non-pharmaceutical interventions in the COVID-19 pandemic [3].

6.2.7 Literature

1.* De Gier B, Bertran M, Garcia Vilaplana T, Van Sorge NM, De Melker HE, Steens A. Product-specific vaccine effectiveness against invasive Haemophilus influenzae type b disease, the Netherlands, 2005-2024. ESPID; Bucharest 2025.

2. Hani E, Abdullahi F, Bertran M, Eletu S, D'Aeth J, Litt DJ, et al. Trends in invasive Haemophilus influenzae serotype b (Hib) disease in England: 2012/13 to 2022/23. J Infect. 2024;89(4):106247.
3. Cleary DW, Campling J, Lahuerta M, Hayford K, Southern J, Gessner BD, et al. Non-pharmaceutical interventions for COVID-19 transiently reduced pneumococcal and Haemophilus influenzae carriage in a cross-sectional pediatric cohort in Southampton, UK. Microbiol Spectr. 2024;12(8):e0022424.

*Publication with RIVM authors.

6.3 Hepatitis B

6.3.1 *Key points*

- In 2024, 950 hepatitis B virus (HBV) infections were reported to RIVM, out of which 855 (90%) were chronic/unknown infections, and 95 (10%) were acute infections. The incidence of 0.53 per 100,000 population of acute HBV notifications in 2024 is unchanged to 2023 with an incidence of 0.53 per 100,000.
- None of the reported acute HBV cases in 2024 were in individuals who had been vaccinated against hepatitis B as part of the national immunisation programme since 2003.
- In 2024, genotype A continued to be the dominant genotype among acute HBV cases with 68% of 65 genotyped cases.
- Among the chronic HBV cases, one perinatal HBV infection was reported even though the infant had received postexposure immunoprophylaxis and vaccination against hepatitis B within three days after birth. The mother was found through the antenatal screening (in 2023: 167,762), among whom 0.19% tested positive. In 2023, 99.6% of babies born to hepatitis B-positive mothers were immunised with hepatitis B immunoglobulin to prevent mother-to-child transmission.
- As per 1 January 2025, the recommended age for the booster dose is moved up from the age of 11 months to 12 months. This applies to children born from 1 January 2024 onwards.

6.3.2 *Tables and figures*

Figure 6.3.1 Incidence of acute HBV infections in men and women by year in the Netherlands 1976–2024, and chronic HBV infections 2000–2024.

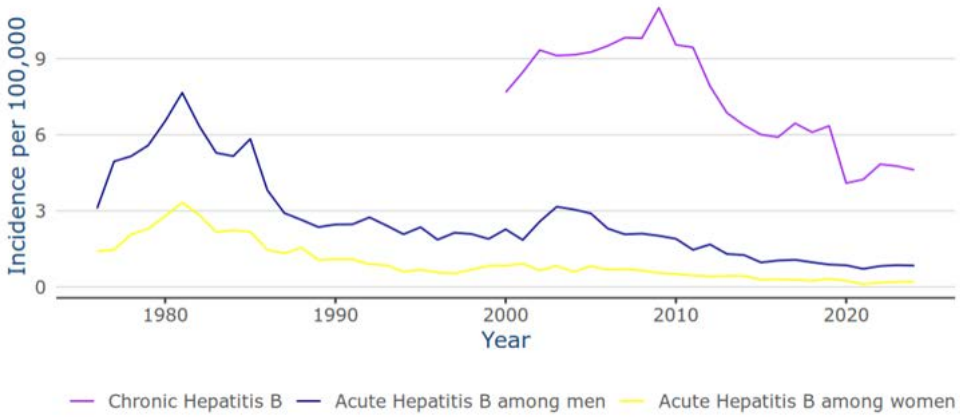


Figure 6.3.2 Number of acute HBV infections in men and women by age and vaccination status in the Netherlands in 2024.

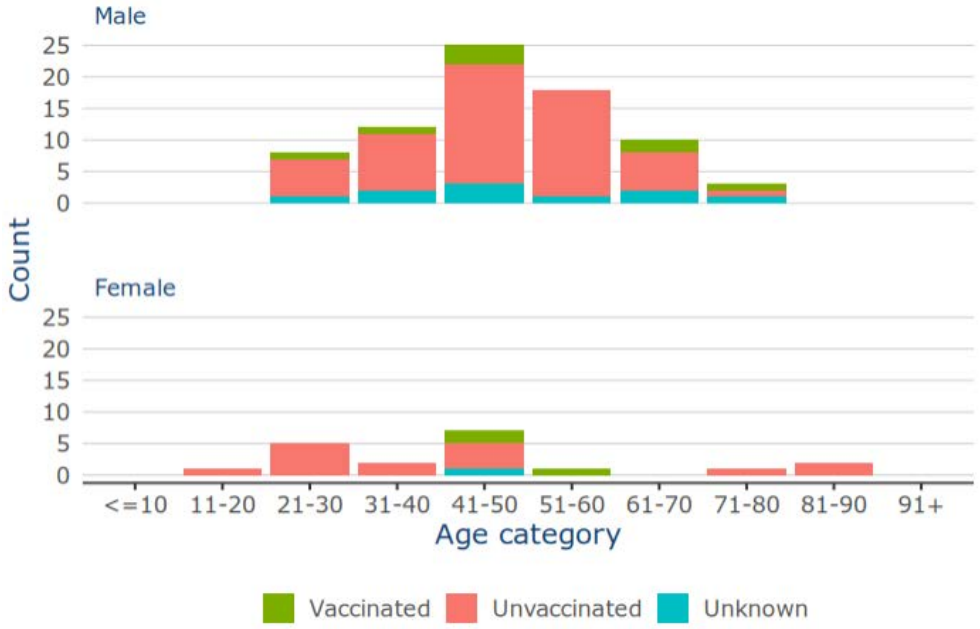


Figure 6.3.3 Optimised maximum parsimony tree based on the full length-sequence of HBV cases in the Netherlands in 2024 by reported transmission route (n=65); Letter=genotype.

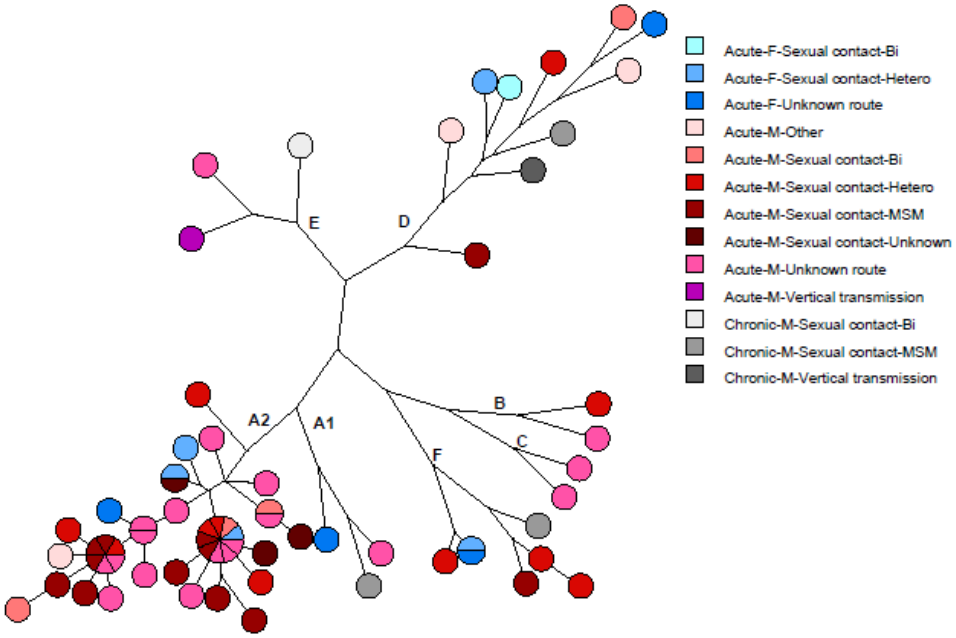


Figure 6.3.4 Genotype distribution of acute HBV cases in the Netherlands from 2004 to 2024.

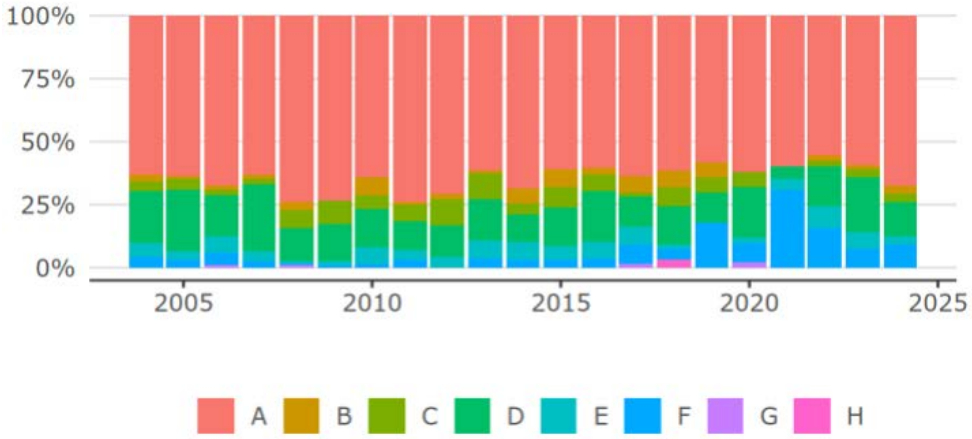
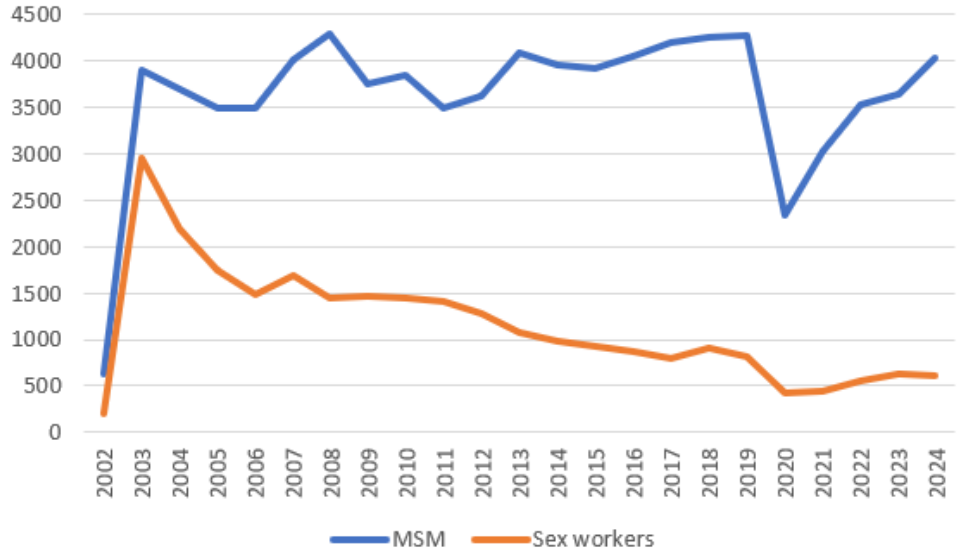


Figure 6.3.5 Number of first vaccinations per year from 2002 up to 2024 in the programme for MSM and sex workers.



6.3.3 *Epidemiology*

In 2024, 950 hepatitis B infections were reported to RIVM, 855 (90%) of which were chronic/unknown infections, and 95 (10%) were acute infections.

6.3.3.1 Acute HBV epidemiology

Since 2011, hepatitis B vaccination has been part of the national immunisation programme. Prior to this introduction, hepatitis B vaccination was offered through targeted campaigns aimed at key populations. In 2003, children of migrants from countries with a moderate or high HBV prevalence were offered hepatitis B vaccination as part of the national immunisation programme. The number of notified acute HBV infections was 95 in 2024, comparable to 2023 when 94 cases were notified. The incidence of acute HBV notifications in 2024 was 0.53 per 100,000 population, 0.85 per 100,000 among men and

0.21 per 100,000 among women (Figure 6.3.1). The mean age of patients with acute HBV infection was 47 years (range: 18–83) and was higher in men (48 years) than in women (44 years). One case of acute hepatitis B was reported among 0–20-year-olds; this patient was 18 years old and was unvaccinated (Figure 6.3.2). Out of all 82 cases with a known vaccination status, 10 were vaccinated at least once (12%). One case had received 1 dose, 4 cases had received 2 doses and 5 had received 3 doses or more. The youngest vaccinated patient was born in 1999, well before universal hepatitis B vaccination. In 2024, most acute HBV infections (52%) were acquired through sexual contact. For 41% of the reports of acute HBV infection, the most likely route of transmission remained unknown despite source tracing. The majority of patients with acute hepatitis B were born in the Netherlands (78%). Twenty-one (23%) patients with acute hepatitis B were admitted to the hospital in 2024. None of the patients died.

6.3.3.2 Chronic HBV epidemiology

The number of chronic HBV notifications was around 1000–1100 per year from 2014 to 2019 (incidence 5.8–6.4 per 100,000) but declined to 724 cases in 2020 and 747 cases in 2021, after which it increased again to 851 cases in 2022 and 848 in 2023 (Figure 6.3.1). The number of chronic HBV notifications was 831 in 2024 (incidence of 4.6 per 100,000). In 2024, 91% of the chronic HBV patients, whose country of birth was known, were born abroad. The number of newly diagnosed chronic HBV infections among people born abroad is about 60 times higher than among people born in the Netherlands (28.5 compared to 0.5 per 100,000 population, respectively). The number of notifications per country of birth fluctuates over time. In 2024, the most frequently reported countries of birth were China (n=87, 11%), the Netherlands (n=72, 9%), Syria (n=65, 8%), Türkiye (n=62, 8%), and Poland (n=38, 5%). A large proportion of cases (42%) acquired chronic HBV infection through vertical transmission. In 44% of the reports of chronic HBV infection, the most likely route of transmission was unknown. Sexual contact was the source of infection for 6%. Transmission also occurred via other routes, such as needle stick injuries (1%), via injecting drug use (IDU, 1%), and other (7%). Among the cases who acquired their infection vertically (n=346), two cases were reported in young children. One of these children, who was born in the Netherlands in 2023, had a breakthrough hepatitis B infection despite the recommended set of vaccinations and antibodies administered post birth. The other case was a child born in Thailand in 2022, for whom it is unknown whether the recommended set of vaccinations and antibodies were offered and administered at birth.

6.3.4 Pathogen

Samples for genotyping are collected from all acute HBV infections, from chronic infections in MSM, and in people detected through the vaccination programme for behavioural risk groups. In 2024, 86 samples out of the 94 acute HBV cases (91%) and 16 out of the 16 chronic HBV cases from risk groups were requested to be sent in for molecular typing. PCR amplification and sequencing provided results for 65 samples of acute HBV infections for the full-length genome and for 5 of the chronic cases. An optimised maximum parsimony tree of these sequences by the most likely transmission route is shown in

Figure 6.3.3. In 2024, 6 different genotypes were found among notified acute cases (Genotype A: 44, B: 2, C:2, D:9, E:2, F:6) and 4 different genotypes among notified chronic cases of HBV (Genotype A: 1, D:2, E:1, F:1). As in previous years, the most widely detected genotype was A (Figure 6.3.4).

6.3.5 (Inter)national developments

6.3.5.1 Low coverage of hepatitis D virus testing in individuals with hepatitis B virus and HIV, the Netherlands, 2000 to 2022 [1]

In this study, data from a longitudinal cohort study was used to assess the changes in Hepatitis D virus (HDV) testing between 2000 and 2022 in all individuals with HBV/HIV in care in the Netherlands. Individuals with hepatitis B virus, which causes a chronic viral disease that can lead to liver cancer, are at substantial risk of hepatitis D virus infection (HDV). HDV is a satellite virus that requires HBV co-infection for replication. Having a co-infection with HBV and HDV is associated with the highest risk of fatality among all hepatitis viruses. Only 15% (249/1715) of individuals with HBV/HIV co-infection were tested for HDV, indicating suboptimal testing coverage. Even though individuals with risk factors that would make them susceptible to hepatitis D virus, such as a person who injects drugs, originates from regions where hepatitis D virus is common, or has severe liver damage, were more frequently tested, many individuals with HBV/HIV who were clearly at risk of hepatitis D virus were not tested.

6.3.5.2 HBV vaccination programme for risk groups

In the Netherlands, the number of first vaccinations given as part of the HBV vaccination programme for groups engaging in high-risk behaviour has been different for MSM and sex workers over the years up to 2019 (Figure 6.3.5), i.e. for MSM this has been relatively constant around 4000 but for sex workers this decreased to approximately 800. The decrease in vaccinations in 2020 and 2021 is probably related to the COVID-19 pandemic. In 2022, 2023, and 2024, the number of vaccinations (in 2023: 4020 first vaccinations were given to MSM) rose again for MSM and reached similar levels as in the years before 2020, when more than 4000 first vaccinations were given on an annual basis. Regarding sex workers this stabilised around 500 since 2020.

6.3.5.3 Antenatal screening

In 2023, 0.19% of pregnant women (319/167,762) tested positive for hepatitis B in the Netherlands [2]. Additionally, 99.6% of babies born to hepatitis B-positive mothers were immunised with hepatitis B immunoglobulin in 2023 to prevent mother-to-child transmission.

6.3.5.4 Reaching Syrian migrants through Dutch municipal registries for hepatitis B and C point-of-care testing [3]

Syrian migrants are the largest non-European migrant group in the Netherlands with HBV and HCV prevalence rates above 2%. This study aimed to reach Syrian migrants for HBV and HCV testing using point-of-care tests (POCT). Of the study population (n=832), 32.3% (n=269) attended the testing. The mean age of participants was 36 years (range 16–70), 59.1% were men, and 66.5% were unemployed. None tested HBsAg- or anti-HCV-positive.

6.3.6 Literature

1.* Boyd A, Smit C, van der Eijk AA, Zaaijer H, Rijnders BJ, van Welzen B, et al. Low coverage of hepatitis D virus testing in individuals with hepatitis B virus and HIV, the Netherlands, 2000 to 2022. Euro Surveill. 2025;30(7).
2.* C.P.B. van der Ploeg (TNO) YS, J.A.M. Odijk (RIVM), M. van Lent (RIVM). Prenatale Screening Infectieziekten en Erytrocytenimmunisatie (PSIE). Procesmonitor 2023.: TNO/RIVM2025.
3.* Moonen CPB, Brouwers E, Hoebe C, Dukers-Muijrers N, Bouchaara J, van Loo IHM, et al. Reaching Syrian migrants through Dutch municipal registries for hepatitis B and C point-of-care testing. PLoS One. 2025;20(1):e0316726.

*Publication with RIVM authors.

6.4 Human papillomavirus

6.4.1 Key points

- Invasive cervical cancer and cervical intraepithelial neoplasia grade 3 or worse (CIN3+) were strongly reduced in fully vaccinated compared with unvaccinated women who were born in 1993 and were offered HPV vaccination at the age of 16 years (cumulative risk ratio of 0.085 for invasive cervical cancer and 0.19 for CIN3+).
- The vaccine effectiveness (VE) of the bivalent human papillomavirus (HPV) vaccine (2vHPV) against genital persistent vaccine-targeted HPV types 16 and 18 remained high (≥97%) up to 14 years after vaccination with a 3-dose regimen, and up to 10 years after vaccination with a 2-dose regimen (100%).
- In unvaccinated women an indirect effect of approximately 70% in reducing incident HPV16 infections and approximately 50% for HPV18 infections was observed. No statistically significant indirect effects were observed for HPV31, HPV33 and HPV45.
- The VE estimates of 2vHPV against genital HPV16/18 prevalence among female sexual health clinic clients who had been eligible for the catch-up campaign at the age of 13–16 years (92.2%) were comparable to the estimates among those eligible for routine vaccination at the age of 12 years (91.8%).
- At 7 months post-vaccination, geometric mean concentrations (GMCs) of antibodies against HPV16 were higher in boys vaccinated at the age of 9–10 years than in girls vaccinated at the age of 12–13 years, while the GMC for HPV18 was similar. In contrast, GMCs for HPV16 and HPV18 were slightly lower in boys than in girls at two years post-vaccination.
- The penile prevalence of hrHPV measured in swabs collected in 2023-2024 was 8.2% in men born from 1996 to 2003 and 6.5% in urine samples. Urine is currently not a feasible method to monitor HPV-vaccination effects in young men.
- The number of anogenital wart consultations at general practitioners in persons aged ≥15 years increased from 52,060 in 2016 to 76,130 in 2023. Most consultations in men were among those aged 25–29 years, while in women most consultations were among those aged 20–24 years.

6.4.2 Tables and figures

Table 6.4.1 Vaccine effectiveness against incident and persistent HPV infections (twelve months) in young women, born in 1993/1994, eligible for three doses of HPV vaccination in the HAVANA study up to fourteen years after vaccination (2009/2010–2023/2024).

	Adjusted* VE (95% CI)	
	Incident infections	Persistent infections
Vaccine types (16/18)	78% (70–84%)	97% (91–99%)
Cross-protective types (31/33/45)	47% (33–59%)	67% (34–72%)
hrHPV types (16/18/31/33/35/39/ 45/51/52/ 56/58/59)	16% (7–24%)	20% (7–32%)
hrHPV types 9-valent vaccine (16/18/31/33/45/52/58)	27% (9–42%)	42% (20–58%)

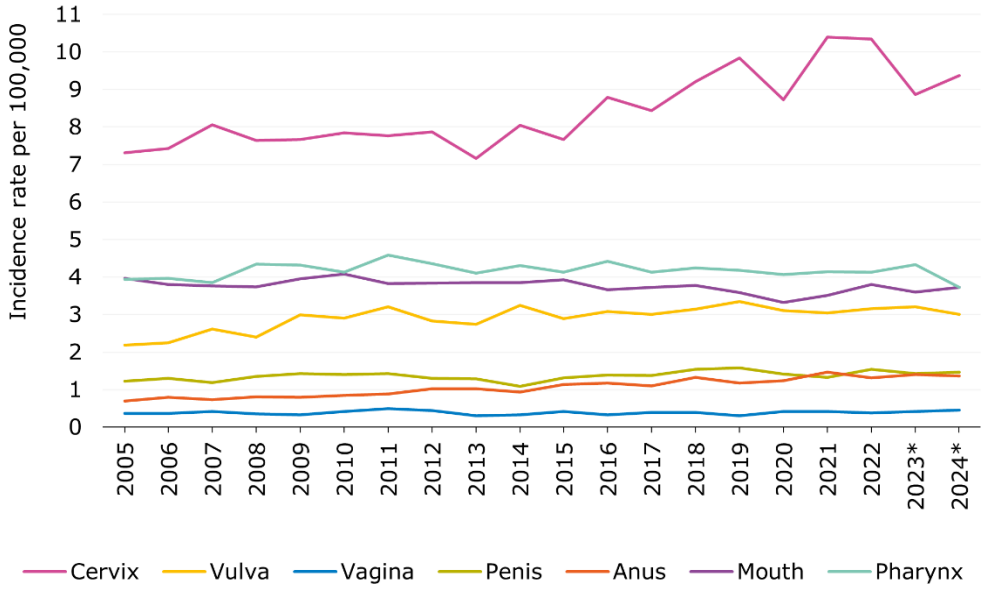
*Adjusted for age, urbanisation degree, ever used contraception, and ever had sex. CI, confidence interval; VE, vaccine effectiveness; hrHPV: high-risk HPV

Table 6.4.2 Vaccine effectiveness against incident and persistent HPV infections (twelve months) in young women, born in 2001, eligible for two doses of HPV vaccination in the HAVANA2 study up to ten years after vaccination (2014–2024).

	Adjusted* VE (95% CI)	
	Incident infections	Persistent infections
Vaccine types (16/18)	90% (75-96%)	100%
Cross-protective types (31/33/45)	39% (8-59%)	71% (20-90%)
hrHPV types (16/18/31/33/35/39/ 45/51/52/ 56/58/59)	13% (-1–24%)	26% (5–43%)
hrHPV types 9-valent vaccine (16/18/31/33/45/52/58)	34% (18–47%)	51% (30–66%)

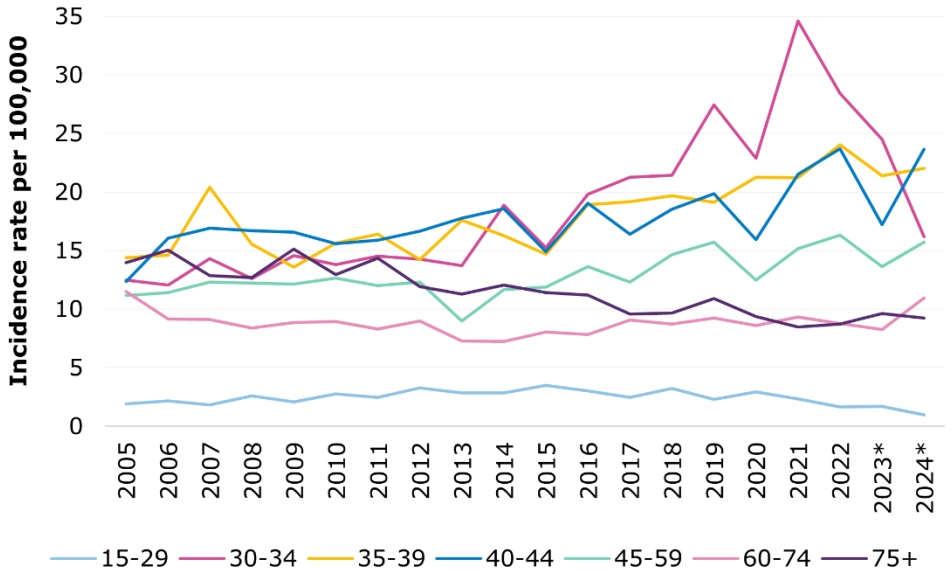
*Adjusted for age, urbanisation degree, ever used contraception, and ever had sex. CI, confidence interval; VE, vaccine effectiveness; hrHPV: high-risk HPV

Figure 6.4.1 Incidence rates[a] (per 100,000, standardised by European standardised rates) of cervical, vulvar, vaginal, penile, anal, mouth/oral, and pharyngeal cancer in the Netherlands, 2005–2024.



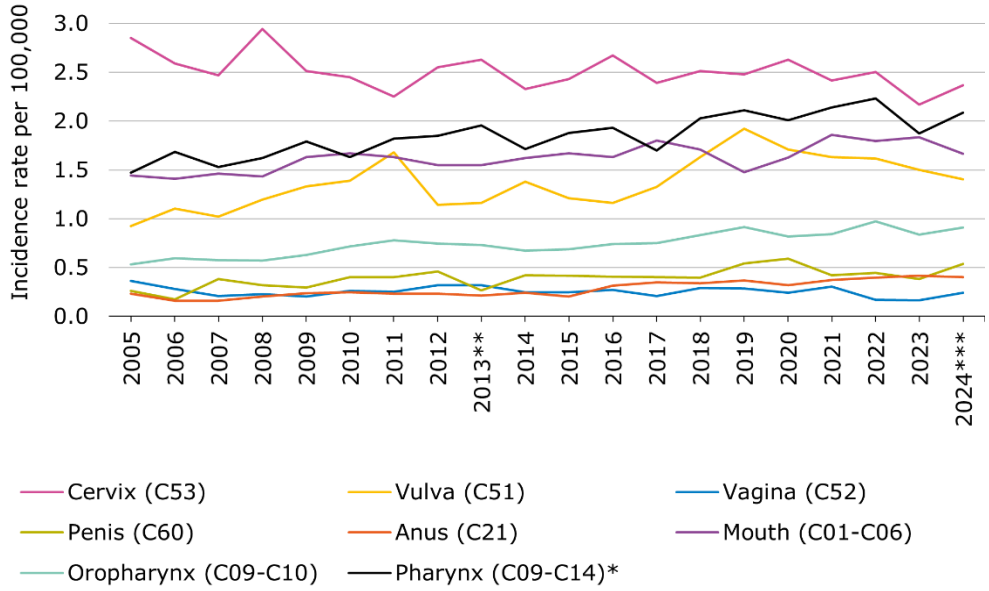
*Preliminary incidence rates. [a]Incidence rates were obtained from the Netherlands Cancer Registry, IKNL (iknl.nl/nkr-cijfers, accessed 6 June 2025).

Figure 6.4.2 Incidence rates[a] (per 100,000, standardised by European standardised rates) of cervical cancer in the Netherlands by age group, 2005–2024.



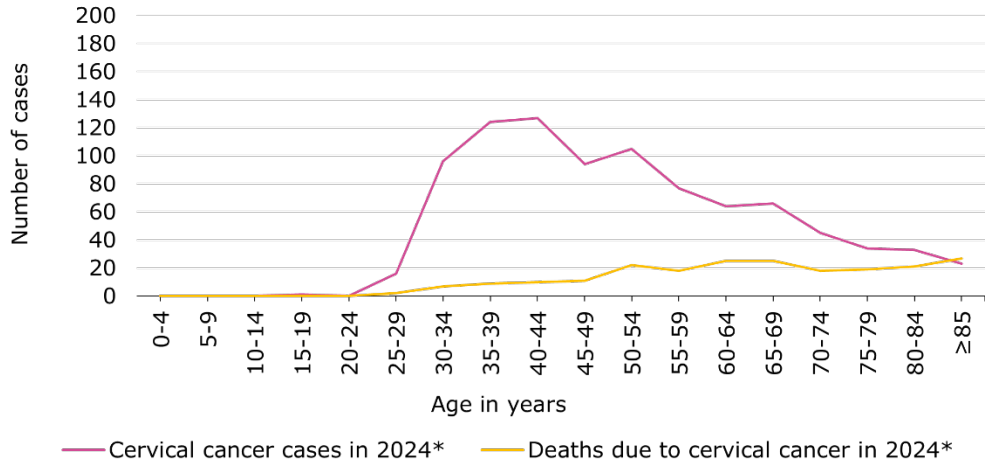
*Preliminary incidence rates. [a]Incidence rates were obtained from the Netherlands Cancer Registry, IKNL (iknl.nl/nkr-cijfers, accessed 6 June 2025).

Figure 6.4.3 Incidence rates per 100,000 of deaths related to cervical, anogenital, mouth, oropharyngeal, and pharyngeal cancers in the Netherlands, 2005–2024.



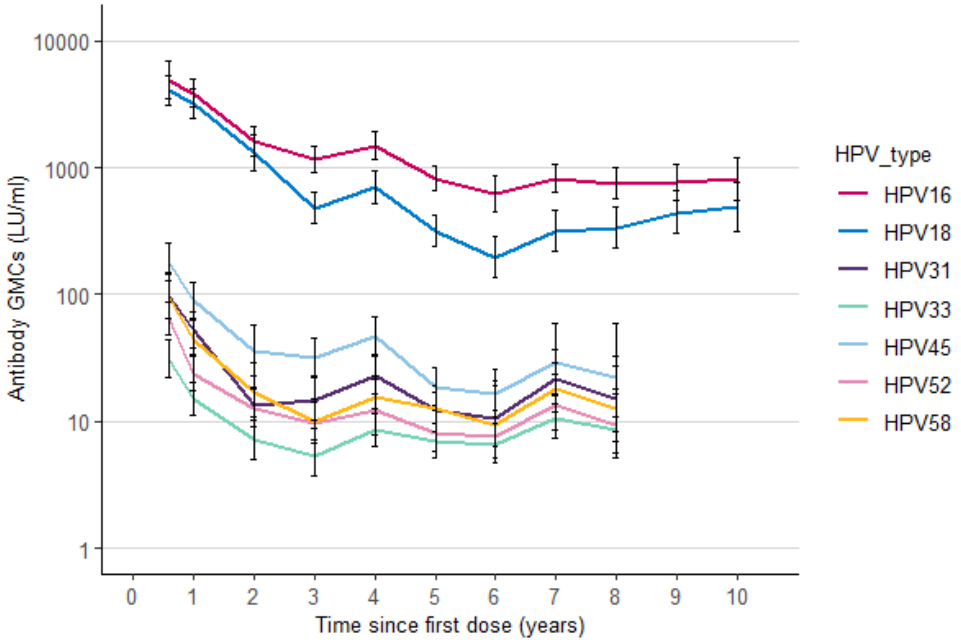
*The number of deaths due to pharynx cancer includes the number of oropharynx cancer deaths.
**In 2013, CBS started using international software for automatically coding causes of death to make the data more reproducible and internationally comparable. Due to this change, there have been some significant shifts in the causes of death.
***Preliminary incidence rates.

Figure 6.4.4 Absolute number of newly diagnosed cervical cancer cases and absolute number of deaths due to cervical cancer by age group in 2024.*



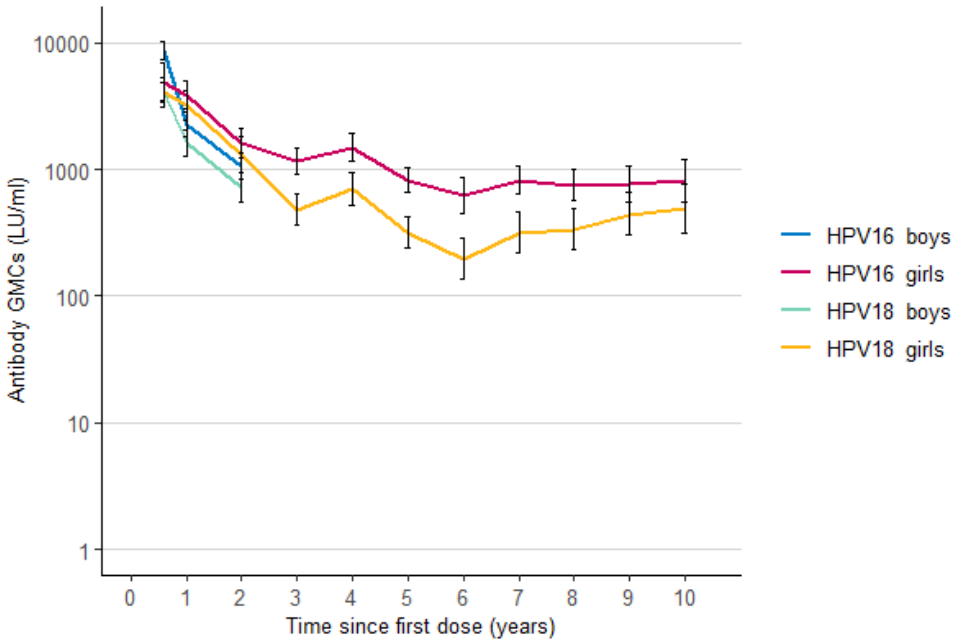
*Preliminary data.

Figure 6.4.5 Antibody geometric mean concentrations (GMCs; LU/mL) of HPV types 16/18/31/33/45/52/58 up to 10 years after the first dose among fully vaccinated girls in the HPV2D study.*



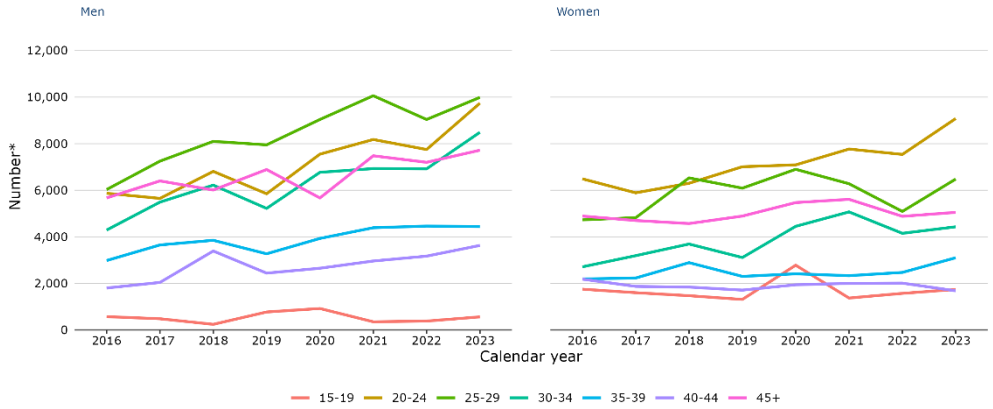
* Preliminary data.

Figure 6.4.6 Antibody geometric mean concentrations (GMCs; LU/mL) of HPV types 16 and 18 up to 10 years after the first dose among fully vaccinated girls and up to 2 years after the first dose in fully vaccinated boys in the HPV2D study.*



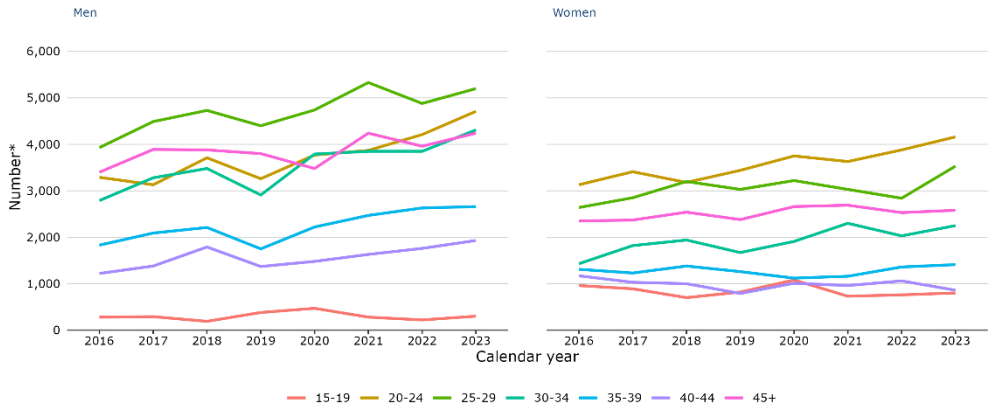
*Preliminary data. Girls were vaccinated at the age of 12–13 years; boys were vaccinated at 9–10 years of age.

Figure 6.4.7 Number of anogenital wart consultations by sex, age, and calendar year.



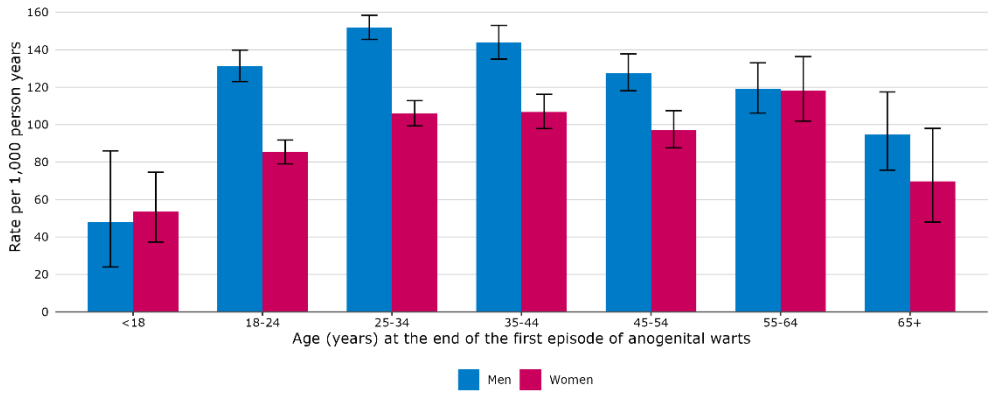
*Number standardised by sex, age, and urbanisation level of the general Dutch population. Numbers are rounded to tens.

Figure 6.4.8 Number of unique persons[a] with at least one anogenital wart consultation by sex, age, and calendar year.*



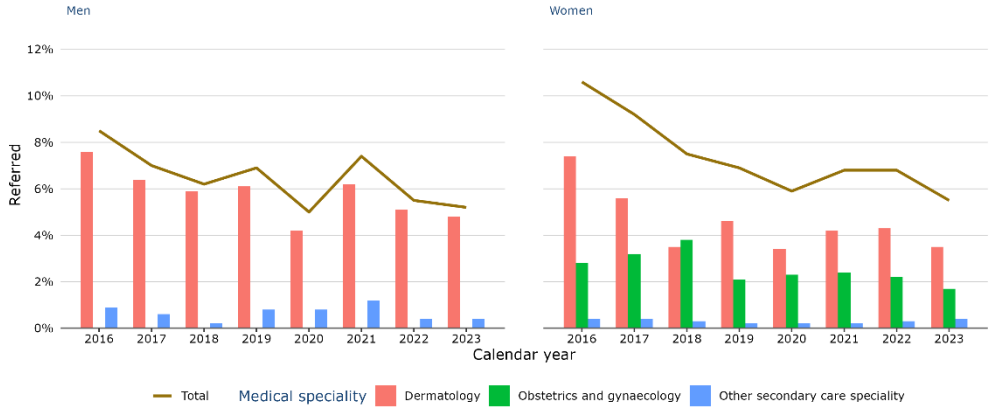
*Number standardised by sex, age, and urbanisation level of the general Dutch population. Numbers are rounded to tens.
[a]A person with multiple consultations for anogenital warts in the specific calendar year is counted once for these numbers.

Figure 6.4.9 Number of subsequent anogenital wart episodes, by sex and age, per 1000 person years over 2016–2023.[a,]*



[a]Unstandardised data. The error bars represent the 95% confidence interval. The mean individual follow-up time for all men was 4.9 years vs. 4.8 years for all women.
*Persons were included and attributed person years if they had at least one episode in 2016–2021. Subsequent anogenital wart episodes were counted up to and including 2023.

Figure 6.4.10 Percentage of anogenital wart episodes referred to secondary care by sex and calendar year.[a]



[a]Unstandardised data.

6.4.3 *Epidemiology*

In 2024, the incidence rates of HPV-related cancers in the Netherlands ranged from 0.45 new diagnoses per 100,000 women for vaginal cancer to 9.37 new diagnoses per 100,000 women for cervical cancer (preliminary data, Figure 6.4.1) [1]. The overall incidence rate of cervical cancer was slightly higher in 2024 than in 2023 (8.87 per 100,000 women, Figure 6.4.1), although the incidence rate strongly declined among women aged 30–34 years and to a lesser extent among women aged 15–29 years (Figure 6.4.2). Women in the age group 15–29 years in 2024 had all been offered HPV vaccination (between 2009–2021, depending on the year of birth), while only part of the women in the age group 30–34 years had been offered HPV vaccination.
Preliminary mortality rates in 2024 were estimated at 2.37 per 100,000 women for cervical cancer, which was slightly higher than in 2023 (2.17 per 100,000), albeit lower than in the years before 2023 (Figure 6.4.3) [2]. The decrease in mortality due to vulvar cancer, which began in

2019, continued in 2024. The mortality rates of vaginal, anal, penile, (oro)pharyngeal, and oral cancers remained comparable to the years before 2024. The absolute number of newly diagnosed cervical cancers in 2024 peaked at 35–39 and 40–44 years with 124 and 127 cases, respectively, and then decreased with increasing age. The number of deaths gradually increased with age, with ~20 deaths per age group from 50–54 years (Figure 6.4.4).

6.4.4 Current/ongoing research

6.4.4.1 Vaccine effectiveness of three doses

Recently, the results of the effect of bivalent HPV (2vHPV) vaccination against cervical cancer and cervical intraepithelial neoplasia grade 3 or worse (CIN3+) in the Netherlands were published [3]. The vaccination status of women born in 1993 who were eligible for HPV vaccination in 2009 (n=104,661) were linked to outcomes recorded in the Dutch nationwide pathology databank (Palga). Cumulative risks of invasive cervical cancer and CIN3+ were estimated for fully vaccinated (3 doses or 2 doses ≥150 days apart) and unvaccinated women. Cumulative risk ratios (CRRs) were adjusted for differences in screening participation between vaccine groups. Among women who were vaccinated at the age of 16 years, the CRR was estimated at 0.085 (95%CI: 0.025, 0.24), corresponding to a VE of 92%. The CRR for CIN3+ was 0.19 (95% CI 0.16, 0.23), corresponding to a VE of 81%.

The vaccine effectiveness (VE) of the 2vHPV vaccine against incident and persistent infections is determined every year, using data of a prospective cohort study (HAVANA) among vaccinated and unvaccinated 14- to 16-year-old girls. The study started in 2009 and ended in 2024, as the women participating in the study received their invitation for the cervical cancer screening programme in 2023/24. Vaginal self-swabs collected in this cohort were tested for HPV DNA. Up to 14 years post-vaccination, a high VE against both incident and 12-month persisting HPV16/18 infections was observed (78% and 97% respectively, Table 6.4.1). Moreover, the VE against cross-protective HPV types 31/33/45 was 47% (95%CI 33–59%) against incident infections and 67% (95%CI 34–72%) against 12-month persisting infections. Type-specific VE estimates up to 14 years after vaccination against 12-month persistent infections were 96% (95%CI 88–99) for HPV16, 100% (model did not converge due to absence of persistent HPV18 infections among vaccinated participants) for HPV18, 78% (95%CI 59–89) for HPV31, -1% (95%CI -103–50) for HPV33, and 55% (95%CI -52–87) for HPV45. The VE estimates against incident infections with HPV types 16, 18, and 45 ranged between 74% and 85%. The VE estimates against incident HPV31 and HPV33 infections were 52% (95%CI 33–65) and 43% (95%CI 15–62), respectively.
[3, 4]

6.4.4.2 Vaccine effectiveness of two doses

In 2016, a second prospective cohort study (HAVANA2) was initiated among vaccinated and unvaccinated girls who had been eligible for the two-dose HPV vaccination schedule in 2014 (birth cohort 2001). A follow-up of this cohort is performed annually, in which the girls are invited to complete a questionnaire and hand in a vaginal self-swab. VEs could be estimated up to ten years post vaccination. This resulted in a

VE of 90% (95%CI 75 – 96) against incident vaccine type (HPV types 16/18) infections (Table 6.4.2). The VE estimate for 12-month persistent HPV16/18 infections was 100% (the model did not converge due to absence of persistent HPV16/18 infections among vaccinated participants). Moreover, the VE against cross-protective HPV types 31/33/45 was 39% (95%CI 8–59) for incident infections and 71% (95%CI 20–90) for 12-month persisting infections. Type-specific VE estimates up to 10 years post vaccination against incident infection were 87% (95%CI 62–95) for HPV16, 97% (95%CI 74–100) for HPV18, 53% (95%CI 20–73) for HPV31, 18% (95%CI -58–58) for HPV33, and 77% (95%CI 14–94) for HPV45. We did not observe persistent type-specific HPV16/18/31/45 infections among vaccinated participants. For persistent HPV33 infections, the VE estimate was -8% (95%CI -212–63).

In 2023, unvaccinated HAVANA2 participants were invited to receive the HPV vaccine as part of a catch-up campaign. A sensitivity analysis where we censored women in 2024 who were previously unvaccinated but received the vaccine during the catch-up campaign did not affect the VE estimates described above.

6.4.4.3 Indirect effect of HPV vaccination

We assessed the indirect effect of the Dutch HPV vaccination programme on incident HPV infections using longitudinal data collected from the HAVANA and HAVANA2 studies [5]. Data from unvaccinated HAVANA participants 8–13 years after the introduction of vaccination in 2009 was compared to data from unvaccinated HAVANA-2 participants 1–7 years after introduction. Two different regression approaches were used to explore the robustness of the indirect effect estimates. First, the incidence rate ratio (IRR) for a vaccine or cross-protective type in HAVANA2 versus HAVANA was calculated by Poisson regression and compared to the IRR for the non-cross protective types (HPV types 35, 39, 51, 52, 56, 58, or 59). The indirect vaccine effect was defined as 1-ratio of the IRRs. Second, we performed Cox regression with infection by vaccine type(s) or cross-protective type(s) as endpoint and calculated the hazard ratio (HR) for HAVANA2 versus HAVANA while adjusting for time-varying sociodemographic variables. The indirect effect was defined as 1-HR. A significant reduction in incident HPV16 infections by 71% (95%CI 48–84) and by 73% (95%CI 53–85) was observed in the two regression approaches, respectively. Similarly, for HPV45, a significant decrease by 67% (95%CI 9–88) and by 70% (95%CI 15–89) was found. For HPV18, HPV31, and HPV33, the indirect effects were not statistically significant.

We recently updated the indirect effect analysis by incorporating an additional year of data from both cohorts [6]. Preliminary findings indicate a statically significant indirect effect of approximately 70% in reducing incident HPV16 infections in both regression approaches. For HPV18, we observed an indirect protective effect of around 50%. For HPV31, HPV33, and HPV45, the indirect effects were not statistically significant. The updated analysis revealed a smaller and non-significant indirect effect for HPV45 compared to our previous findings [5], which might be due to the low number of HPV45 infections (n=32). Therefore,

continued evaluation of indirect effects is essential to determine whether they remain consistent over time.

6.4.4.4 Vaccine effectiveness in high-risk groups (PASSYON)

PASSYON is a Dutch biennial repeated cross-sectional (2011–2021) study among sexual health clinic clients aged 16–24 years. Women provided self-collected vaginal samples, questionnaires on demographics and sexual behaviour were administered, and women self-reported HPV vaccination status. Type-specific and grouped VE estimates, adjusted with propensity score stratification, were assessed against genital positivity for 14 HPV types [7, 8]. VE for targeted and non-targeted genotypes were compared between women who had been eligible for the catch-up and those who had been eligible for routine vaccination. The study included 4488 female participants who had been eligible for HPV vaccination and provided genital swabs (1561 eligible for catch-up, 2927 for routine vaccination). Very high VE against genital HPV16 and HPV18 was observed (93.5% and 89.5%, respectively) and significant cross-protection against six other genotypes (HPV31/33/35/45/52/58), ranging from 18.0% (HPV52) to 79.6% (HPV45). VE estimates were comparable between women who had been eligible for the catch-up campaign at the age of 13–16 years and those eligible for routine vaccination at the age of 12 years: VE HPV16/18: 92.2% (95%CI 87.9–94.9) vs. 91.8% (95%CI 86.0 – 95.2). In this real-world setting, the VE of 2vHPV is high against targeted genotypes, with cross-protection against 6 other genotypes. Catch-up campaigns up to the age of 16 years can be as effective as routine vaccination at the age of 12, although it is recommendable to provide HPV vaccination at an age at which most girls are probably not sexually active yet.

6.4.4.5 Immunogenicity of a two-dose schedule (HPV2D)

A cohort study was initiated in 2014 to monitor the quantity and quality of the immune response in girls (born in 2001) who received two doses of the 2vHPV at the age of 12–13 years. Since 2022, boys have also been invited to receive routine HPV vaccination at the age of 9–10 years. Consequently, a similar cohort study was launched in 2022 among boys (born in 2012). Participants in both cohort studies were requested to complete a web-based questionnaire annually and to provide a self-collected finger-prick blood sample each year. Among girls/women, the seropositivity for vaccine types HPV16/18 was 100% up to 10 years after the first dose. For boys, for whom data is available up to two years after the first dose, seropositivity for HPV16/18 was also 100%. In the first three years after the first dose of vaccination, the geometric mean concentrations (GMCs) of HPV16 and HPV18 declined in girls (Figure 6.4.5). At seven months post-vaccination, the GMC of HPV16 was higher in boys (8671 LU/mL) than in girls (4896 LU/mL) (Figure 6.4.6). The GMC for HPV18 was comparable between boys and girls at 7 months post-vaccination (4035 LU/mL in boys; 4070 LU/mL in girls). At two years post-vaccination, the GMCs for HPV16 and HPV18 were slightly lower in boys than in girls (1065 versus 1618 LU/mL for HPV16, and 719 versus 1299 LU/mL for HPV18).

6.4.4.6 Genital and urinary prevalence of HPV in young adult men [*preliminary results*]

Since 2022, a gender-neutral vaccination (GNV) policy is implemented in which boys and girls are invited for HPV vaccination in the year they turn 10 years. In 2023, a catch-up campaign took place for unvaccinated or partly vaccinated individuals born in 1996 up to and including 2003. Such changes in HPV vaccination policy specifically require monitoring and evaluation. While for women, the effectiveness of the catch-up campaign can be studied using information from the national population-based cervical cancer screening, for men no such screening for HPV-related cancer and (pre-)cancerous lesions exists so far. At this moment, only projections resulting from, for instance, modelling studies can provide insight into the future expected impact of the catch-up campaign for men. Information on the prevalence of HPV in the general population, especially for men, is limited but relevant for such modelling studies. Linking the genital prevalence of high-risk human papillomavirus (hrHPV) in a representative male cohort to individual vaccination status following the completion of the catch-up campaign, allows assessing whether specific high-risk subgroups were vaccinated more or less frequently during the campaign. HPV prevalence in men is commonly measured through penile self-swabs. Considering the young age at which GNV is offered, collecting penile self-swabs some years after GNV may be less feasible (i.e. mainly in terms of expected response rates) given the still relatively young age for instance, around sexual debut. To evaluate the GNV programme, alternative sampling methods could be explored and (first void) urine is under consideration as a potential easily accessible tool to measure HPV. Hence in 2023-2024, in a cross-sectional study, the genital (hr)HPV prevalence was estimated in men born in 1996–2003 in the general Dutch population. In addition, the hrHPV prevalence was linked to the HPV vaccination status following completion of the catch-up campaign. Moreover, it was explored whether HPV measured in urine can be used as a detection method to measure genital HPV prevalence in men and whether it might be an applicable indicator of the impact of HPV vaccination in boys to be used in future monitoring studies. A random sample of 63,492 men were invited for participation through regular mail. Participation involved taking a penile self-swab from the outer part of the penis, completing an online questionnaire, and optionally collecting a first-void urine sample. After DNA extraction and quality controls of the samples, HPV genotyping was performed using the SPF10 PCR-DEIA-LiPA25 platform (Version 1, Cerba Research, the Netherlands), which is able to detect 12 hrHPV types and 13 types not considered hrHPV. A total of 1869 men provided written informed consent to participate in the study (response rate: 2.9%), of whom 1512 submitted a penile swab. Most of these participants also provided a urine sample (n=1216). Part of the samples were of insufficient quality for HPV genotyping (i.e. β-actin absent) and excluded from the analyses. HPV test results were obtained for 1444 penile swabs and 1214 urine samples. Most of the participants were highly educated (69.3%), sexually active (75.9%), heterosexual (79.2%), and born in the Netherlands (89.7%). Vaccination data was available for 1216 individuals, of whom 939 (77.2%) were fully vaccinated, 102 (8.4%) were partially vaccinated (i.e. 1 dose or 2 doses <150 days apart), and 175 (14.4%) were unvaccinated. Most vaccinated participants (n=930,

64.4%) collected their penile swab sample after receiving their first vaccine dose. In 216 out of the 1444 penile swabs, one or multiple HPV types were detected, corresponding to a prevalence rate of 15.0% (95% CI 13.2–16.9%). HrHPV prevalence equalled 8.2% (95% CI 6.8–9.7%). HPV16 and HPV18 were detected in two versus one penile swab, respectively. The most prevalent HPV types were HPV 6, 51, 52, and 66 (prevalences ranging from 2.1–3.5%). Among the men with a hrHPV-positive penile sample, 78 (66.1%) were fully vaccinated, 9 (7.6%) were partly vaccinated, 13 (11.0%) were unvaccinated, and 18 (15.3%) had an unknown vaccination status at the end of the study. In 140 out of the 1214 urine samples, one or multiple HPV types were detected (prevalence rate 11.5%; 95% CI 9.8–13.5%), whereas hrHPV was detected in 79 samples (prevalence rate 6.5%; 95% CI 5.2–8.0%). HPV16 and HPV18 were detected in two versus one urine sample, respectively. HPV types 51, 52, and 66 were the most prevalent HPV types in urine as well (prevalence rates 2.1–2.6%). Paired penile swab and urine samples with HPV test results were available for 1159 men. Full concordance between the two sample types was noted in 1000 (86.3%) paired samples, including 940 (81.1%) negative pairs (no HPV type detected) and 13 (1.1%) non-typable pairs (HPV DNA detected by DEIA, but no types identified by LiPA). Out of the 47 concordant swab-urine pairs in which a least one HPV type was identified, 32 represented single-type infections, 10 involved dual-type infections (i.e. both types detected in swab and urine), and 5 involved infections with 3 or 4 types. Partial concordance (i.e. at least one identical genotype between swab and urine) was observed in 29 swab-urine pairs. Complete discordance (i.e. no shared genotypes between swab and urine) was identified in the remaining 130 pairs. These mostly comprised pairs with an HPV-positive swab and HPV-negative urine. The genital prevalences of any HPV and hrHPV observed in this study were lower than in previous studies among Dutch men, in which the prevalence of any HPV and hrHPV were estimated at 44% and 26%, respectively among healthy adult men and 65% and 42%, respectively among visitors of STI clinics in 2011–2012 [9, 10]. However, these estimates originate from the period shortly after HPV vaccination was introduced in the NIP, whereas Kusters et al. observed a decline in genital prevalence of several high-risk HPV types among heterosexual male STI clinic attendees from 2009 to 2021 [11]. Urinary prevalence of any HPV was estimated at 29% among male visitors of STI clinics in the Netherlands in 2011 [10]. In women, urine contains exfoliated materials (epithelial tissues, cells, debris) from the cervix or uterus, thereby providing a possible means for detection of cervical or urinary HPV [12]. In contrast, in men, a urinary sample contains exfoliated materials from the urethral areas, however, not from the outer part of the penis. Given the low genital and urinary prevalence of hrHPV that we found in this study among men aged 20-27 years, necessitating the collection of numerous samples, urine is currently not considered a feasible alternative source for monitoring effects of HPV-vaccination in young men.

6.4.4.7 Anogenital warts in the Netherlands 2016–2023

An anogenital infection with the low-risk HPV types 6 and/or 11 can cause anogenital warts (AGWs). This is a benign condition but can be a burden to those affected. HPV vaccination with the bivalent vaccine, as used in the NIP, is not targeted at preventing HPV6/11 infections. The

quadrivalent and nonavalent HPV vaccine are registered to prevent HPV6/11 infections. Knowledge about the occurrence of AGWs is relevant, considering the Health Council's reconsideration of the HPV vaccine programme in the Netherlands upon request of the Ministry of Health, Welfare and Sports. The absolute number and number of episodes per 1000 persons aged 15-64 years (reporting rate) are reported in the annual RIVM report Sexually transmitted infections in the Netherlands. The total number of AGW episodes at general practitioners (GPs) was 48,600 in 2023 and 45,800 in 2022 [13]. From 2019 until 2023, the reporting rate of AGWs ranged between 4.0 and 4.2 per 1000 persons.

Additional data regarding GP consultations for AGWs, subsequent AGW episodes, and referrals to secondary care was requested from Nivel Primary Care Database (Nivel-PCD). Nivel-PCD contains longitudinal, pseudonymised extracts from electronic health records data of, among others, general practitioners (GPs) in the Netherlands [14]. Nivel-PCD contains patient characteristics, such as sex, age, and health problems, which are recorded using the international Classification of Primary Care (ICPC-1). A representative sample of GPs, covering about 10% of the Dutch population, contribute to Nivel-PCD. Neither obtaining informed consent from patients nor approval by a medical ethics committee is obligatory for this type of observational studies, which contain no directly identifiable data (art. 24 GDPR implementation Act jo art. 9.2 sub j GDPR). The research application has been approved according to the governance code of Nivel Primary Care Database, under number NZR-00325.006.

ICPC codes Y76 and X91 were used to select GP consultations for AGWs. A consultation for AGWs with a contact-free interval of at least 16 weeks with the previous consultation for AGWs within the same individual is seen as a subsequent episode [15]. One episode can consist of multiple consultations.

The number of anogenital wart consultations was calculated for each calendar year from 2016 up to and including 2023, standardised by the sex, age, and urbanisation level of the Dutch population. Additionally, standardised numbers of unique individuals with a genital wart consultation by calendar year and sex are presented. The standardised numbers of AGW consultations and unique individuals with an anogenital wart consultation are presented both in absolute numbers and as the rate per 1000 persons of the population [16]. Among those with at least one anogenital wart episode, the rate of subsequent anogenital wart episodes by sex and age group was calculated across the 2016–2023 period. We also calculated the percentage of referrals to secondary care by sex and calendar year.

The number of anogenital wart consultations in men aged ≥15 years increased from 27,120 in 2016 to 44,570 in 2023. Most consultations were for men aged 25–29 years (Figure 6.4.7). An increase over time was mainly observed for men aged 15–34 and 45+ years. For women aged ≥15 years, the number of anogenital wart consultations increased from 24,940 in 2016 to 31,560 in 2023. The majority of the anogenital wart consultations for women were in those aged 20–24 years (Figure

6.4.7). The largest increase over time was seen in women aged 20–24 and 30–34 years. The rate of anogenital wart consultations per 1000 persons was 3.7 in 2016 and 5.1 in 2023 (data not shown). The rate increased over time for men aged 20–24, 25–29, 30–34, and 40–44, while it remained relatively stable in the other age groups. For women, the rate increased for women aged 20–24 years, but remained relatively stable in the other age groups.

In those aged ≥15 years, 16,740 men and 12,990 women had at least one consultation for AGWs in 2016 vs. 23,350 men and 15,590 women in 2023. The absolute numbers were highest for men aged 25–29 years and women aged 20–24 years (Figure 6.4.8). Men aged 40–44 years and women aged 30–34 years had the largest relative increase over time. The rate of unique persons with at least one consultation for AGWs per 1000 persons was 2.1 in 2016 and 2.6 in 2023 (data not shown). For men aged 15–19 and 45+ years, the rate remained stable over time while it increased for men in the other age groups. For women, the rate slightly increased for those aged 20–24 and 30–34 years but remained stable in the other age groups.
Among those with at least one consultation for AGWs, the mean number of anogenital wart consultations by calendar year ranged from 1.7 to 1.9 for men with a mean of 1.8 for men and from 1.9 to 2.1 for women with a mean of 2.0 for women.

The overall rate of subsequent anogenital wart episodes was 138.6 (95% CI 134.9, 142.5) per 1000 person years for men and 97.9 (95% CI 94.3, 101.6) per 1000 person years for women. By age group, the rates ranged between 48.1 to 151.8 per 1000 person years in men and from 37.3 to 101.9 per 1000 person years in women (Figure 6.4.9). The rate was higher in men than in women if the first episode ended between the age of 18 and 54 years.

The percentage of referrals to secondary care for persons with at least one episode of AGWs declined between 2016 and 2023 for both men and women (Figure 6.4.10). Men and women were mostly referred to dermatology while for women, referrals to obstetrics and gynaecology also occurred. A very small proportion, i.e. ≤1.2%, was referred to another medical speciality.

6.4.5 (Inter)national developments

Recently, the Dutch Health Council provided an updated advice about the HPV vaccination programme regarding vaccine type and number of vaccine doses. Relevant international developments can be found in this advice [17] or the corresponding background document [18]. Within the background document, relevant information was summarised regarding the impact, efficacy, and effectiveness of HPV vaccination, and the immunogenicity and safety of HPV vaccines up to about February 2025. Below, relevant international literature is mentioned that has been published after these documents were created.

6.4.5.1 Global cervical cancer burden

Based on Global Cancer Observatory (GLOBOCAN) data of 2022, the global age-standardised cervical cancer incidence rate (ASIR) is 14.12 per 100,000 women (662,044 cases) while the age-standardised

mortality rate (ASMR) is 7.08 per 100,000 women (348,708 deaths) [19]. This corresponds to cervical cancer being the fourth cause of cancer morbidity and mortality worldwide. Both ASIR and ASMR of cervical cancer decreased with increasing Human Development Index (HDI) of countries. Similar decreasing trends were observed by HDI of the country for both early-onset (0–39 years) and late-onset (≥40 years) cervical cancer. Both ASIR and ASMR of overall cervical cancer showed decreasing trends in the course of the 2003–2012 period (estimated annual percentage change (EAPC): 0.04% and -1.03%); however, upward trends were observed for early-onset cervical cancer (EAPC: 1.16% and 0.57%). If national incidence and mortality rates in 2022 would remain stable, the estimated cases and deaths from cervical cancer are projected to increase by 56.8% and 80.7% up to 2050. Moreover, the projected increase of early-onset cervical cancer is mainly observed in countries with a low or medium HDI, while decreased burden is expected in countries with a high or very high HDI. Hence, cervical cancer remains a common cause of cancer death in many countries, especially in countries with a low or medium HDI. Unless these countries scale up preventive interventions, HPV vaccination, and cervical cancer screening, as well as systematic cooperation within government, civil societies, and private enterprises, the global burden of cervical cancer would be expected to increase in the future.

6.4.5.2 Impact of HPV vaccination

In Northern Norway, the impact of the catch-up HPV vaccination programme on the incidence of HPV and CIN2+ was assessed among women aged 26–30 years [20]. Additionally, HPV type incidence changes over time were assessed among women aged 25–69 years who participated in cervical cancer screening. Records of HPV test results and cervical cytology and histology results were linked individually to Norway's national vaccination registry. Both the 2vHPV (birth cohorts 1991–1996 and 2005–2006) and quadrivalent HPV vaccine (birth cohorts 1997–2004) have been offered within the national immunisation programme since 2009 and the catch-up programme for women aged 20–25 years in 2016–2019. Twenty percent of the women aged 26–30 years in 2017 belonged to birth cohorts that were invited for HPV vaccination. Hence, the actual vaccine uptake of these women in 2017 was low with 12.0%. All women aged 26–30 years in 2023 were invited for HPV vaccination with a vaccine uptake of 71.0%. For women aged 26–30 years between 2017 and 2023, the CIN2+ incidence of 61.3 per 1000 screened women in 2017 decreased by 33.4% to 40.8 per 1000 women in 2023. For CIN3+, a decrease of 63.4% was observed (from 25.7 per 1000 screened women in 2017 to 9.4 per 1000 in 2023). Additionally, the proportion of HPV16/18-associated CIN2+ lesions significantly decreased from 56.8% of all CIN2+ lesions in 2017 to 40.7% in 2023 in vaccinated women, representing a 55.8% reduction in absolute numbers (i.e. 104 cases in 2017 vs. 46 in 2023). In contrast, the number of cases with CIN2+ lesions associated with other hrHPV types decreased by 15.2% from 79 to 67 during the same time period. Comparing women aged 25–26 years in 2016 (i.e. women not belonging to vaccinated cohorts) to women aged 25–26 years in 2023 (i.e. women belonging to vaccinated cohorts), HPV16-positivity in cervical cancer screening tests decreased from 5.1% to 1.5%, and HPV18-positivity decreased from 3.3% to 0.7%. HPV16- and HPV18-positivity was even

lower among the vaccinated women aged 25–26 years in 2023 with 0.1% for HPV16 and 0.0% for HPV18. The authors conclude that their findings demonstrate the effectiveness of HPV vaccination programmes in reducing HPV infections and associated cervical lesions.

In Sweden, the type-specific HPV prevalence among women screened for cervical cancer was monitored over time from 2014 until 2023 [21]. Cervical cancer screening is offered to women aged 23-64 years in Sweden. HPV-based cervical screening has been implemented by age group from 2012 onwards. Since the autumn of 2019, it has been implemented for all age groups. All primary screening samples in the Stockholm region from 2014–2023 were identified. HPV vaccination coverage (i.e. having received at least one dose) among women by calendar year and birth year was obtained from the Swedish National Vaccination Register. The impact of changing HPV prevalences on the number needed to screen (NNS) to detect and prevent 1 cervical cancer case was calculated. HPV vaccination coverage was 82%–83% among women born in 1999–2000. Before 2019, the HPV16/18 prevalence was highest among the youngest women. During 2020–2023, the prevalence consistently decreased among the birth cohorts offered organised school-based vaccination. There was a 98% decline in HPV16 prevalence (odds ratio (OR) 0.02, 95%CI 0.01–0.04) and a 99% decline in HPV18 prevalence (OR, 0.01, 95%CI 0.00–0.04) among the 2000 birth cohort compared to the 1984 birth cohort. The declining HPV16/18 prevalences resulted in major increases in the NNS to detect and to prevent 1 case of cervical cancer. For HPV16-associated cervical cancer, the NNS would increase from 24,518 (95%CI 21,594 – 28,004) among pre-vaccination cohorts to 229,377 (95%CI 202,136 – 262,182) among school-based HPV vaccination birth cohorts and from 49,036 (95%CI 39,801 – 63,603) to 773,085 (95%CI 631,410 – 1,005,942) for HPV18-associated cervical cancer, respectively. The authors conclude that the declines of HPV16/18 were considerably larger than the vaccination coverage, which is suggestive of herd immunity. Additionally, the changing epidemiology of HPV types impacts screening needs, necessitating updated screening programmes.

6.4.5.3 Immunology

In England, residual serum samples from hospital laboratories were used to evaluate the seropositivity to HPV6/11/16/18/31/33/45/52/58 [22]. Samples were selected on the basis of the individual's age at the time of collection and the time since HPV vaccination was offered (2–4, 7–9, 12–14, and 17–19 years ago). Depending on the age and sex at sample collection, bivalent vaccination in a three-dose schedule or quadrivalent vaccination in a three- or two-dose schedule was offered to the person that provided the sample. HPV vaccine coverage in England has been high although it decreased during and after the COVID-19 pandemic. Seropositivity rates were high for HPV16 (74–94%) and HPV18 (68–86%) regardless of the time since vaccination was offered, vaccine type, sex and number of offered doses. The lowest HPV16-seropositivity of 74% was observed in men 2–4 years after being offered quadrivalent vaccination in a 2-dose schedule and the highest of 94% in women 2–4 years after being offered quadrivalent HPV vaccination in a 2-dose schedule. The lowest HPV18-seropositivity of 68% was observed in women 2–4 years after being offered bivalent vaccination in a 3-dose

schedule while the highest (86%) was seen in women 2–4 years after being offered quadrivalent HPV vaccination in a 2-dose schedule. HPV16 ($P_{Fisher's\ exact\ test}$ = 0.660) and HPV18 ($P_{Fisher's\ exact\ test}$ = 0.619) seropositivity rates were similar up to 7–9 years postvaccine offer for women who were offered bivalent of quadrivalent vaccine in a 2- or 3-dose schedule. Seropositivity rates at 2–4 years postvaccine offer of the quadrivalent vaccine in a 2-dose schedule was similar between men and women for HPV16 ($P_{Fisher's\ exact\ test}$ = 0.062) and HPV18 ($P_{Fisher's\ exact\ test}$ = 0.300). Their findings were consistent with data from clinical trials supporting durability of high vaccine-induced antibody levels through to adulthood.

The immunogenicity and duration of antibodies up to three years after nonavalent vaccination with a two-dose schedule (5 to 12 months apart) was evaluated among Alaska Native children aged 9–14 years [23]. For 227 boys and girls, sera were collected 6 months after receiving the first dose, and at 1 month, 1 year and 3 years after receiving the second dose. The sera were used to measure type-specific immunoglobulin G concentrations for the HPV types targeted by the nonavalent vaccine, i.e. HPV types 6/11/16/18/31/33/45/52/58. The median age of study enrolment was 11.0 (range 9.0–14.6) years. One month after the second dose, all participants were seropositive for all measured HPV types while 92% remained seropositive up to 3 years after the second dose. GMCs peaked for all types at one month post dose two and remained higher at three years post dose two compared to six months post dose one. GMCs for HPV types 16/31/33/45 were higher in girls than in boys at three years post dose two. The authors conclude that a two-dose series of the nonavalent vaccine is highly immunogenic in their cohort.

Studies on the durability of vaccine responses have focused on antibodies, while fewer have analysed memory immune cells that could provide protection even when antibody levels are low. Hence, Carter et al. studied the long-term immune response in persons who were given two or three doses of nonavalent HPV vaccination [24]. Trial participants who received 2 doses (at 0 and 6 or 12 months, children) or 3 doses (at 0, 2, and 6 months; children aged 9–14 years and women aged 16–26 years) were given an additional vaccine dose. Participants provided a blood sample at enrolment, just before receiving the additional vaccine dose, and one week and one month later. The additional vaccine dose was provided approximately three or approximately ten years after the participant enrolled in the clinical trial. Changes in numbers of HPV specific memory B cells (Bmem) at one month and plasmablasts (PB) at one week, relative to baseline at the additional dose, were compared among groups. Changes in the geometric mean titers of HPV-specific antibodies relative to baseline were also assessed. Statistically significant ($p < 0.05$) increases in the numbers of PB, Bmem, and antibody levels were seen among subjects receiving an extra vaccine dose relative to baseline. Increases in the number of PB and Bmem were not significantly different whether subjects received two or three doses. The authors conclude that robust immune responses were observed which did not differ significantly among subjects vaccinated with two or three doses.

6.4.6 Literature

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*Publication with RIVM authors.

6.5 Measles

6.5.1 *Key points*

- In 2024, 205 cases were reported in the Netherlands (incidence: 1.14 per 100,000 per year), a large increase compared to the previous years.
- Reported cases in 2024 were predominantly in children below the age of 13 years (n=157, 77%), and unvaccinated (83%).
- In 2024, 6% of the cases concerned a breakthrough infection. These were either in cases with two vaccinations (n=12) or in a case with three vaccinations.
- In the first four months of 2025, the number of reported measles cases had further increased to 388 cases (extrapolated annual incidence of 6.45 per 100,000). More recent data can be found online at https://www.rivm.nl/mazelen/actueel.
- In June 2025, a fatal case was reported in a once vaccinated adult with underlying diseases.
- Starting in 2025, the second dose of MMR will be offered around the 3rd birthday instead of at the age of 9 years. This applies to children born from 1 January 2016 onwards.

6.5.2 *Tables and figures*

Figure 6.5.1 Annually reported measles cases since 1976. For 2025, reported cases were included up to and including 30 April 2025.

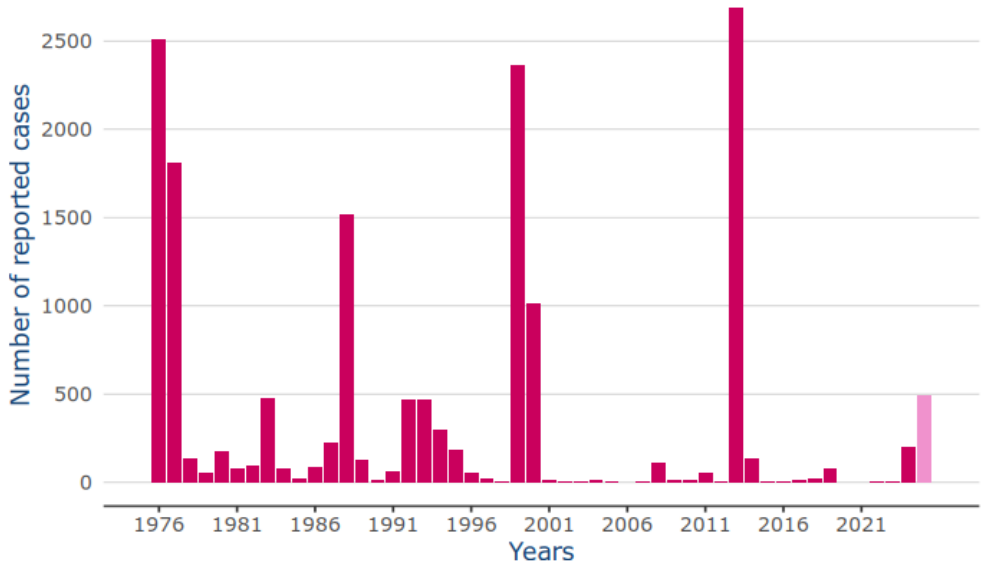


Figure 6.5.2 Age distribution and vaccination status of measles cases reported in 2024, the Netherlands (n=205).

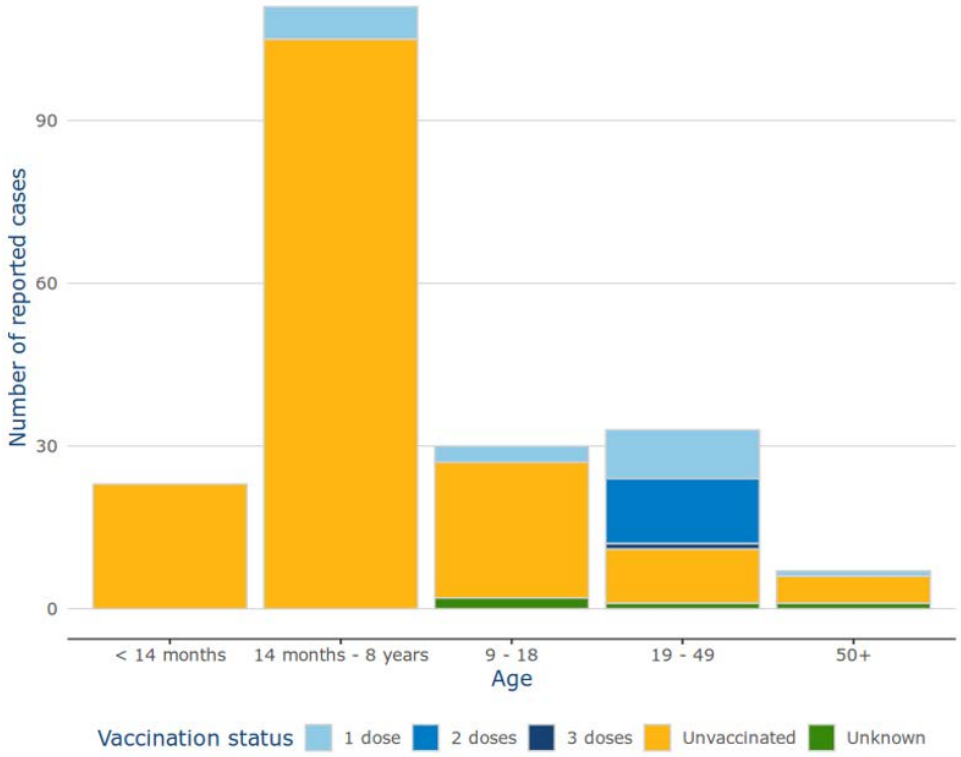


Figure 6.5.3 Measles incidence in 2024 per 100,000 population in the Netherlands by GGD region.

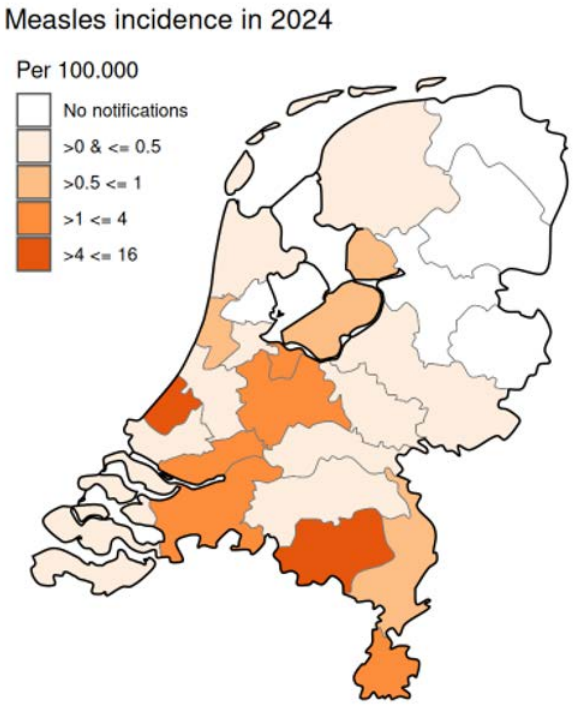
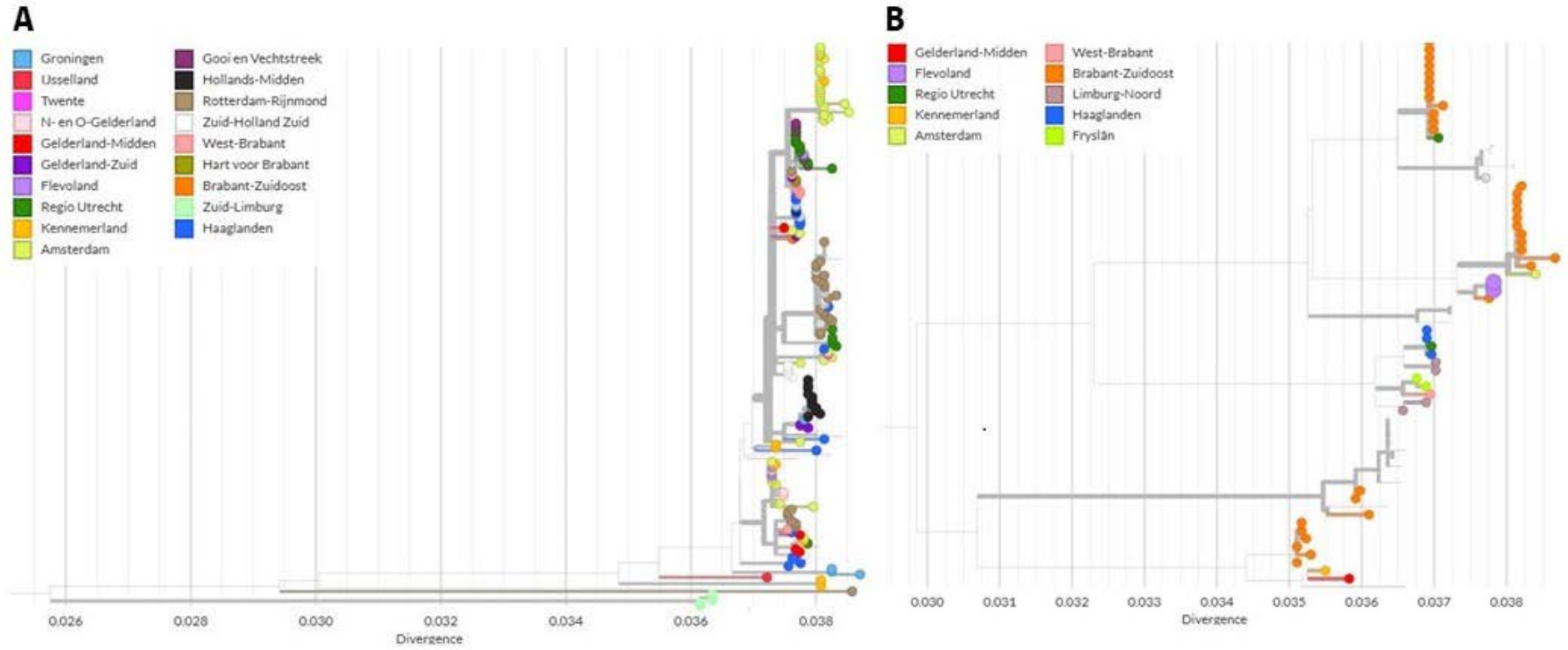
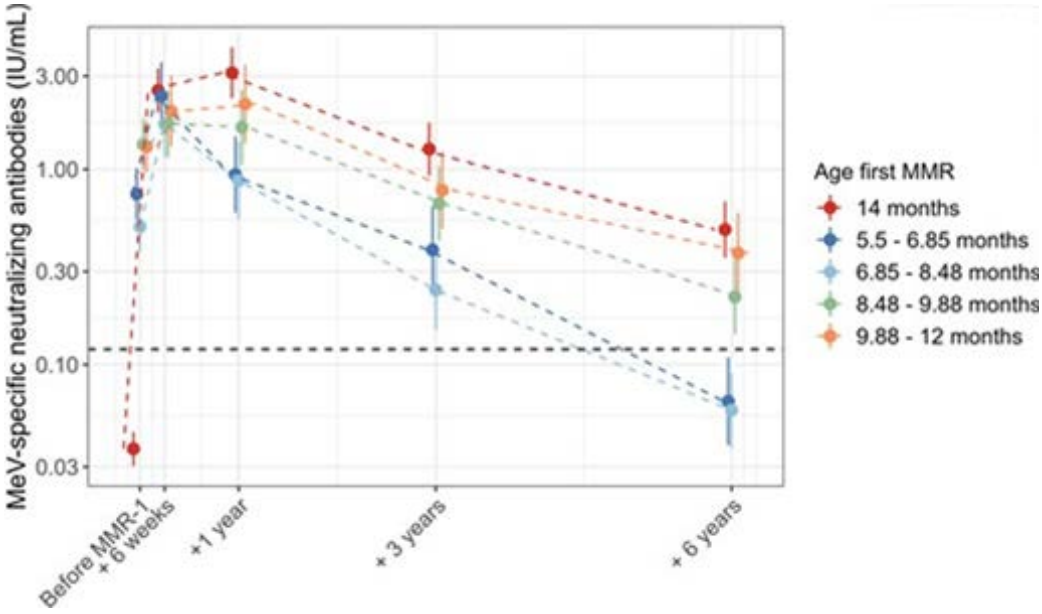


Figure 6.5.4 Phylogenetic analyses of the complete measles virus genomes genotype B3 (A) and D8 (B) detected in the Netherlands in 2024 and the first 4 months of 2025 using Nextstrain.



Measles viruses are indicated by small circles; the colour of the circle indicates the public health service region of cases' residences.

Figure 6.5.5 Measles-specific neutralising antibody levels by age at first MMR, predicted with a linear mixed-effects model [1].



The averages are shown with 95% CI. The horizontal dashed line represents the assumed cutoff for protection against measles (0.12 IU/mL). Source data: EMI study RIVM.

6.5.3 *Epidemiology*

Prior to 2024, the number of reported cases was low with 0 in 2021, 6 in 2022, and 7 in 2023. In 2024, a total of 205 cases were reported (Figure 6.5.1, Incidence: 1.14 per 100,000 per year). This represents a large increase compared to the previous years since the most recent large outbreak in 2013/2014. In 2025 the increase continued, with 388 reported cases in the first four months (incidence 2.15 per 100,000 per year). Recent data of measles transmission is frequently updated on the RIVM website. Among the cases reported in 2024, the median age was 6 years (range: 3 months to 56 years). Most cases (n=111, 54%) were aged 14 months to 8 years (Figure 6.5.2). Out of the reported cases, 94 (46%) were in men and 110 (54%) were in women. The highest incidence was observed in GGD Haaglanden (4.0 per 100,000) and GGD Brabant-Zuidoost (7.8 per 100,000). Among the reported cases, 110 (54%) had a critical attitude towards vaccination, for 50 patients (24%) no particular risk group was known, 3 (1%) patients were part of the anthroposophical community, no patients were reported as orthodox Protestants, and lastly, for 3 cases (1%) the risk group was unknown. The setting of the infection was for most cases reported to be other (41%, 82 out of 200 with a reported setting), followed by transmission within the family (n=72, 36%), elementary school (n=30, 15%), child day care centre (n=12, 6%) and hospital (n=4, 2%). Out of all cases, 136 (67%) were lab-confirmed, and 68 (33%) had an epidemiological link.

The vaccination status was known for 201 out of 205 reported cases. Among these, 141 (70%) were unvaccinated, 23 (11%) were either not yet eligible for vaccination or too old (n=5, 2%) to have been eligible, 25 (12%) were vaccinated according to the NIP schedule, and 7 (3%) were insufficiently vaccinated. Stratified by number of doses: 169 (84%) had received 0 doses, 19 (9%) had received one dose, 12 (6%) had

received two doses and one (0%) had received three doses of MMR. Further in-depth analyses have been performed into the vaccine effectiveness (VE) of a two-dose schedule using the screening method, which can be found below.
Regarding the severity of the cases reported in 2024, out of 192 cases with data on the occurrence of complications, 172 (90%) reported no complications. For 20 (10%) cases, the following complications were reported: pneumonia (n=13), otitis media (n=2), and other (n=6). Out of the 20 cases with reported complications, 15 (75%) required admission to hospital. Among the cases (n=200) with data on hospital admission, 32 (16%) cases reported a hospital admission. The severity profile of cases in 2025 will be reported in the next edition of this report. However, it is important to note that in June 2025, a fatal case was reported in a once vaccinated adult with underlying diseases.
Out of the reported cases, the country of infection was usually the Netherlands: 183 (90%). Twenty-one cases reported having travelled abroad prior to developing measles. The visited countries were Morocco (n=12), Romania (n=4), Saudi Arabia (n=2), France (n=1), Poland (n=1), and Malawi (n=1). In total, 140 cases were related to these 21 import cases (15 out of the 21 index cases were not vaccinated, one case had received two doses, three cases had received one dose, and for 2 cases, the vaccination status was missing or unknown). Forty-three cases had no known association with imported cases.
Two large clusters took place from February up to April 2024 in GGD region Brabant-Zuidoost. These clusters started simultaneously; one cluster was initiated after a measles patient had returned from Saudi Arabia. The other cluster lacked evidencing of the source. Together, the two clusters included 63 cases either linked by epidemiology or by sequencing [2]. Another set of epidemiologically linked clusters (7 epidemiologically linked clusters, totalling 41 cases) started in the region of GGD Haaglanden towards the end of April and lasted until the end of July 2024. Beside cases belonging to these epidemiological clusters, another 13 cases reported by GGD region Haaglanden coincided. During the summer of 2024, another cluster was observed, associated with an anthroposophical school in the South of Limburg (n=9). A large family cluster (n=20) occurred in November and December among which most cases were reported by GGD region Utrecht. The index case had travelled to Morocco. Another family cluster resulting from an index case travelling to Morocco, was centred in GGD region West-Brabant (n=10).
During the first four months of 2025, 388 cases (extrapolated annual incidence of 6.45 per 100,000) were reported. Similar to in 2024, most cases were in children: 303 (78%) were below the age of 12 years, 24 (6%) were aged between 12 and 19 years, and 61 (16%) were aged 19 years or over. Also, most cases were unvaccinated: 281 (75%) were unvaccinated, 48 (13%) were vaccinated according to the NIP schedule, and 9 (2%) were insufficiently vaccinated. For 10 cases, the vaccination status was unknown or missing and 40 (11%) were too young or too old to have been vaccinated. Ten per cent of the cases was associated with travels abroad. Out of these, 37 had information on the country of infection: 30 (82%) were imported from Morocco, 4 (11%) from Romania, and 3 from 3 other countries.

6.5.3.1 Vaccine effectiveness (VE) of a two-dose schedule using the screening method.

The screening method is a relatively simple method to give an indication of the VE. The two requirements for an estimate are (i) the vaccination coverage among the reported cases, and (ii) the vaccination coverage in the population. This population should be representative of the population from which the cases are derived. To estimate the VE for two doses, we limit our analyses to reported cases of individuals who were either unvaccinated or received two doses and to individuals who were eligible for two doses in 2024, namely those who were born either between 1978 and 2014, except for individuals born in 1983–1985, as they were offered three doses of MMR. Among the reported cases, we observed 43 who were eligible for two doses. Among these, 11 were vaccinated with two doses, amounting to 26% (11/43) vaccination coverage among the reported cases. The vaccination coverage of two doses in the same birth cohort is 90.2%. Therefore, the VE was 95% (95%CI: 91–98%). Stratifying these results by birth cohort, results in the following estimates: for individuals born between 1978 and 1990, the VE was 81% (95%CI: 26–94), for individuals born from 1991 to 2006, the VE was 96% (95%CI: 86–99%), finally the youngest birth cohort, born between 2007 to 2014, the VE was 100% (confidence interval not estimated due to lack of vaccinated cases).

Interpretation should be paired with caution; the screening method is considered to be a simple and rapid way of estimating VE to see whether a further investigation is warranted. Here, we have highlighted a few pitfalls. First, these estimates are based on a low number of cases (11 out of 43). Second, the screening method is imprecise when percentages are high (vaccination coverage among the cases born from 1978 to 1990 was 64%, and the vaccination coverage of the population 90%), and last, the screening method assumes equal exposure between the vaccinated and unvaccinated groups. The latter might not be the case, as older age groups have more intense exposure (in the household) than younger age groups (at school). Considering these limitations of the screening method, we can conclude that overall, the VE is very high with 95% and we might be observing the first signs of waning immunity among the oldest vaccinated birth cohorts.

6.5.3.2 Measles Clusters in Primary Schools in the Netherlands, 2013–2025

We reviewed nationwide measles notification data from between January 2013 and April 2025 to determine the number and size of primary school clusters, by denomination, as extracted from notification data notes and a public database on school denominations. A primary school cluster was defined by at least two measles cases considered most likely to be infected at a primary school, with a rash onset in subsequent cases occurring within 21 days of the previous. We identified 67 primary school clusters between January 2013 and April 2025, out of which 48 (72%, sizes: 2–24 cases) occurred in orthodox Protestant schools, eight in Islamic schools (12%, 3–21), seven (10% 2–6) in Protestant schools, two in schools with anthroposophical affiliations (5–8), two (3–7) in specialised schools (e.g. Montessori), and one (4 cases) in a public primary school. All clusters in orthodox Protestant and Protestant schools occurred during the 2013/14 outbreak. One out of eight clusters in Islamic schools occurred in 2013, the other seven were reported in 2024–25. This shows that in recent years, in addition to orthodox

Protestant and anthroposophical schools, Islamic schools have also been at risk. These results are consistent with results from school-level vaccination coverage analyses carried out in the Detervax project (see the previous NIP report, chapter 2 Vaccination coverage [3]).

In summary, 2024 saw a large increase in the incidence of measles compared to previous years, particularly in unvaccinated children, mainly occurring in school and family clusters. Import from Morocco, related to the large outbreak in this country [4] , resulted in 12 import cases in 2024, 2 of which played a role in large clusters. The findings of a VE assessment indicate that the overall VE of a two-dose measles vaccination schedule is high, while possible first signs of some waning immunity in older age-groups are observed. An analysis spanning 2013 and 2025 (up to April 2025) has newly identified Islamic schools as at risk of measles outbreaks, in addition to orthodox protestant and anthroposophical schools. The percentage of infections in fully vaccinated individuals will be closely monitored and further studied.

6.5.4 Pathogen

A genotype was determined for measles viruses detected in 103 (50%) out of the 205 cases reported in 2024. In 62 patients (60%), genotype D8 was detected, while in 41 patients (40%) genotype B3 was detected. In the first 4 months of 2025, a genotype was determined for measles viruses detected in 144 out of the 388 (37%) reported measles cases. In 125 patients (87%), measles virus genotype B3 was detected, while in 19 patients (13%) measles genotype D8 was detected.
Analysis of the sequence data indicated that both in 2024 and in the first 4 months of 2025, 1 measles virus genotype B3 sequence variant (MVs/Quetta.PAK/44.20) of the N450 sequence was detected in 32 and 78 of the measles cases, respectively, from which a genotype was obtained (45% of the total). Other sequence variants were less frequently detected, in 21 or fewer of the measles cases.
To increase the molecular resolution, measles viruses in 2024 and 2025 were analysed with whole genome sequencing. Phylogeographic analysis of the complete genomes of the detected measles viruses using Nextstrain [5] supported the epidemiological data to a large extent. Minimal or no sequence variation was observed in viruses within the epidemiological clusters or in viruses from individual cases, while generally, more sequence variation was detected in virus genomes across the various clusters or the individual cases (Figure 6.5.4).

6.5.5 Research

6.5.5.1 Impact of genotypic variability of measles virus T-cell epitopes on vaccine-induced T-cell immunity [6]

While community-wide vaccination remains the most effective strategy for preventing measles, understanding how prevalent measles virus genotypes may adapt in populations with suboptimal vaccination coverage is critical. Specifically, it is important to evaluate whether these circulating strains have acquired mutations that enable them to evade vaccine-induced immunity. In recent RIVM research, blood samples from three young adults (18–20 years) were analysed for 28 days ± 1 day after a third measles-mumps-rubella (MMR3) vaccination, as were samples from two adults (25–50 years) at 3–12 months after natural infection with MeV B3 genotype. The recently

vaccinated subjects were participating in a Dutch intervention study in which young adults received an MMR-3, and the subjects with natural measles infection were participating in a Dutch observational longitudinal study (ImmF@ct). In recent investigations, amino acid sequence variations in 73% of the 37 functional T cell epitope regions analysed in wild-type measles viruses were found [4]. Crucially, we found that these mutations can indeed hinder the ability of vaccine-induced CD4+ T cells to recognise and respond to currently circulating measles viruses. This underscores the impact that mutations may have on the efficacy of vaccine-induced T-cell immunity, which could contribute to breakthrough infections even in fully vaccinated individuals.

6.5.5.2 Long-term Dynamics of Measles Virus–Specific Neutralizing Antibodies in Children Vaccinated Before 12 Months of Age [1]

A study that was carried out during the latest measles outbreak in 2013/2014 (the EMI study), and is still ongoing, aims to investigate the immunogenicity of measles vaccination given under the age of 12 months (MMR-0). Results showed that early vaccination comes at the expense of a more rapid loss of acquired immune protection in the long term, especially for those vaccinated under the age of 8.5 months. These children exhibited a markedly faster antibody decay and lost their protective antibody levels in the course of 6 years (Figure 6.5.5, [1]). At the age of 9 years, these children had received MMR2 according to the national immunisation programme. Current measurements show that the age of first measles immunisation is still of significant influence of the MeV-specific neutralising antibody levels two years post-MMR2 (data in progress). In-depth cellular analysis is still ongoing to shed more light on the blunted response in relation to age at the first dose of MMR-0.

6.5.5.3 What is the current evidence base for measles vaccination earlier than 9 months of age?: Report from an informal technical consultation of the World Health Organization [7]

Due to the concerns about possible reduced vaccine performance, WHO hosted an informal technical consultation on 6–7 December 2023 in Geneva, Switzerland, to evaluate recent evidence on early MCV1 and identify evidence gaps for policy making. The recent evidence suggests a robust humoral immune response shortly after early MCV1 at the age of 5–8 months. Immune blunting of a routine second MCV dose (e.g. MCV2) after early MCV1 was not demonstrated in the presented data. However, 3–7 years after MCV1, children receiving early MCV1 had lower measles antibodies than children receiving routine MCV1, suggesting faster waning of immunity. The totality of evidence on immune blunting remains inconsistent. The meeting participants concluded that evidence is lacking in the following subjects: understanding measles disease burden and severity in infants; early MCV1 effectiveness and duration; vaccine-induced cellular immunogenicity; whether measles in infants is acquired from other infants, older children, or adults; and the extent of blunting of routine MCV2 following early MMR1. Ensuring high MCV1 and MCV2 coverage remains the priority in measles control.

6.5.6 *International developments*

In 2024, a total of 35,212 measles cases were reported to ECDC across the EU/EEA, marking a notable (ten-fold) increase compared to the 3973 cases reported in 2023 [8]. The overall notification rate in 2024 was 77.4 cases per 1,000,000 population, which was substantially higher than the 9.1 per 1,000,000 in 2023. Romania reported the highest incidence at 1610.7 cases per 1,000,000 population per year, accounting for approximately 87% (30,692) of all EU/EEA cases, followed by Austria (59.5), Belgium (44.9) and Ireland (39.6) per 1,000,000 population. Similar to in the Netherlands, most cases were in children up to the age of 10 years (62%) and unvaccinated persons (87%).

In the WHO European region, the highest number of cases was reported in more than 25 years [9]. According to an analysis by WHO and the United Nations Children's Fund (UNICEF), 127,350 measles cases were reported in the European Region for 2024, double the number of cases reported for 2023 and the highest number since 1997. The WHO European Region accounted for a third of all measles cases globally (359,521) in 2024. After Romania, Kazakhstan reported the highest number of cases with 28,147 cases.

Since late 2023, Morocco has been experiencing a widespread measles outbreak [4]. Cases have been recorded across all regions of the country, particularly among unvaccinated children. From 1 October 2023 through 13 April 2025, more than 25,000 suspected measles cases were reported from all 12 regions, out of which 13,706 were laboratory-confirmed cases and 184 cases were fatal.

6.5.7 *Literature*

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*Publication with RIVM authors.

6.6 Meningococcal disease

6.6.1 Key points

- In 2024, a total of 138 invasive meningococcal disease (IMD) cases were reported, out of which 121 (88%) cases were caused by serotype B (IMD-B).
- IMD incidence was 0.77 per 100,000 in 2024. The incidence was 0.67 per 100,000 for IMD-B and 0.06 per 100,000 for IMD-ACWY.
- The IMD-B incidence in 2024 remained higher than in 2015–2019 and was slightly higher than in 2023. The number of IMD-B cases in the first four months of 2025 was slightly lower than in 2024. The incidence of IMD-ACWY was similar to previous years, and has been low since MenACWY vaccine introduction in 2018.
- IMD-B incidence in 2024 was highest among <2-year-olds (6.6 per 100,000; n=22), followed by 15–24-year-olds (1.4 per 100,000; n=30) and 2–4-year-olds (2.3 per 100,000; n=9). In 2024, 4 out of the 10 IMD-ACWY cases were in <25-year-olds.
- The Health Council of the Netherlands is expected to publish an advice on the inclusion of MenB vaccines in the national immunisation programme (NIP) by the end of this year. To support this advice, RIVM published a background document containing updated information on MenB vaccines and IMD-B in the Netherlands.
- Several IMD cases related to Umrah pilgrimage have been reported in the UK, the US, and France. Some of these isolates were ciprofloxacin-resistant.

6.6.2 *Tables and figures*

Figure 6.6.1 Incidence of invasive meningococcal disease by serogroup, 1992–2024.

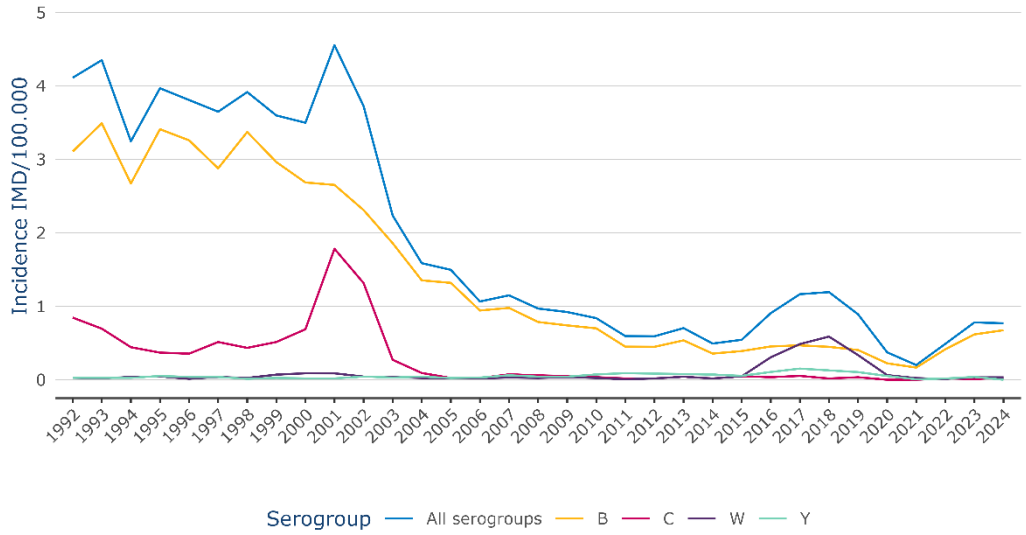
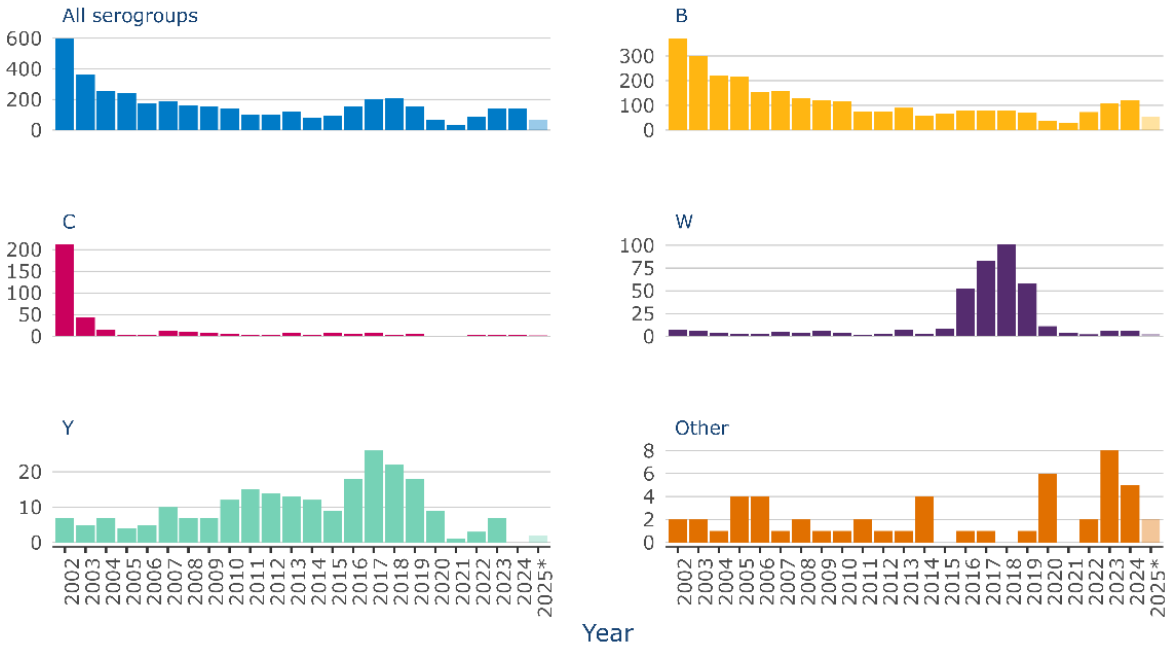


Figure 6.6.2 Number of cases of invasive meningococcal disease by serogroup, 2002–2025.*



*Data for 2025 is based on the first four months only.
Please note the different y-axis ranges.

Figure 6.6.3 Age-specific incidence of invasive meningococcal disease caused by the vaccine-preventable serogroup A, C, W, or Y combined by year, 2017–2024.

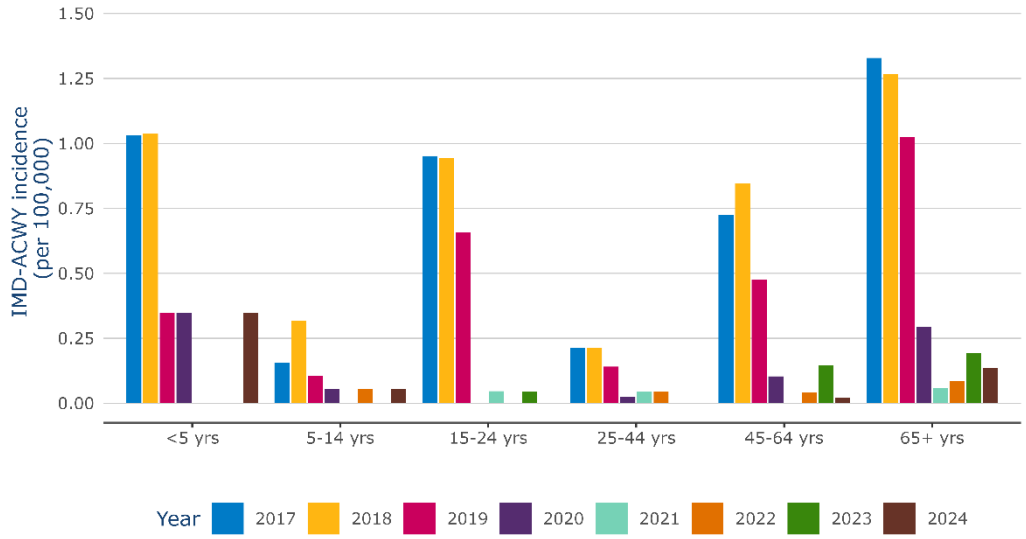
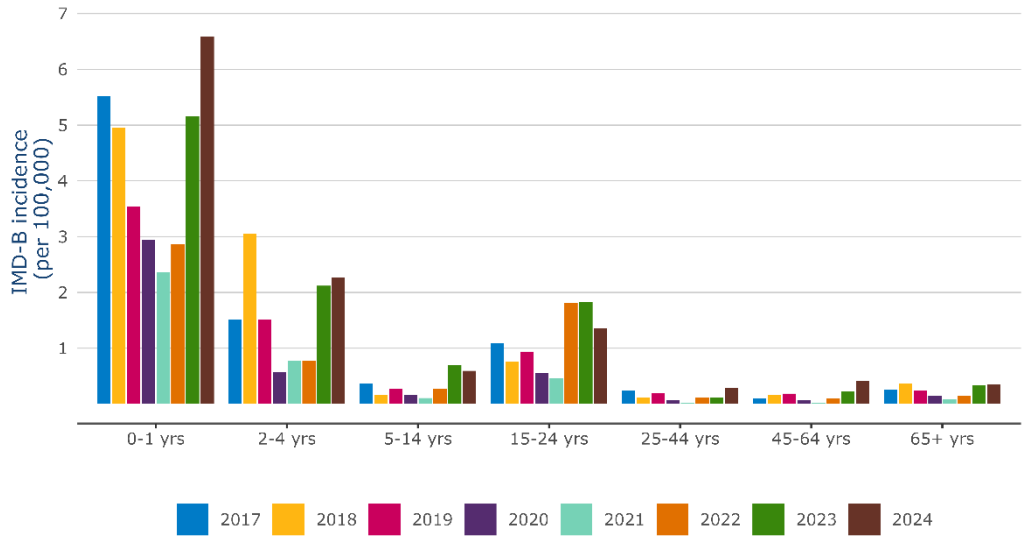


Figure 6.6.4 Age-specific incidence of invasive meningococcal serogroup B disease by year, 2017–2024.



6.6.3 Epidemiology

6.6.3.1 Surveillance of invasive meningococcal disease

For a detailed explanation of surveillance methodology, see Appendix 1. As of 2024, several changes were implemented in the analysis of surveillance data of invasive meningococcal disease (IMD). This includes the selection of the date that is used for statistics. Previously, dates were based on the date of isolate receipt by the National Reference Laboratory for Bacterial Meningitis (NRLBM). Now, the date used for statistics is the first (known) date of: disease onset, culture specimen, and isolate receipt. Therefore, the presented numbers per month or year may be slightly different from what has been presented in previous reports but trends are unchanged. As isolates are received by NRLBM for

serotyping some days after the disease onset date, the most recent months described in this chapter may still be incomplete.

6.6.3.2 Meningococcal disease incidence

After a decrease in IMD incidence during the COVID-19 pandemic years 2020 and 2021, the incidence returned to pre-pandemic levels in 2023 and 2024 (Figure 6.6.1). In 2024, the IMD incidence was 0.77/100,000 (n=138 cases). In the first four months of 2025, 65 IMD cases have been reported, which is similar to the pre-COVID-19 years 2015–2019 (median of 64 cases within the first four months of the year), despite the fact that those years include the increase in cases due to the 2018–2019 outbreak of IMD-W.

6.6.3.3 Meningococcal disease caused by serogroups A, C, W, Y

Overall, the incidence of IMD caused by the serogroups ACWY was low in recent years, with an incidence of 0.06/100,000 in 2024 (n=10). Four of these IMD-ACWY cases occurred in individuals under the age of 25 years, with three IMD-W cases in <5-year-olds and one IMD-C case in a 5–14-year-old. All cases were unvaccinated. Out of the ten IMD-ACWY cases from 2024, two children and one older adult died. In January–April 2025, seven MenACWY cases (3 IMD-W, 2 IMD-Y, and 2 IMD-C) were reported. One case was a 5–14-year-old, three cases were 25–64-year-olds, and three cases were aged 65+. All were unvaccinated. None died or had any known comorbidities. Since the MenACWY catch-up campaign and the introduction of MenACWY into the National Immunisation Programme (NIP), only one vaccine failure has occurred in a vaccine eligible person up to April 2025, who was an immunocompetent child aged <5 years, who fell ill in 2019.

6.6.3.4 Meningococcal disease caused by serogroup B

Meningococcal serogroup B has been the main serogroup causing IMD in the Netherlands for decades. After a decrease in IMD-B incidence during the COVID-19 pandemic, the incidence increased again from 2022 onwards and surpassed pre-pandemic levels in 2023 (0.62/100,000, n=110) and 2024 (0.67/100,000, n=121). In January–April 2025, 55 IMD-B cases were reported. Pre-COVID-19 (2015–2019), 25 to 35 cases were reported during those months.

The incidence of IMD-B in 2024 was highest among <2-year-olds (Figure 6.6.4) with 6.6 per 100,000 (n=22), followed by 2–4-year-olds (2.26 per 100,000; n=9) and adolescents (1.36 per 100,000 in 15–24-year-olds; n=30).In 2024, the incidence was higher for all age groups compared to pre-COVID years (2015-2019) and compared to 2022 and 2023. In the first four months of 2025, most cases were reported among 15–24-years-olds, similar to the first four months of 2023 and 2024. There were no cases among 65+-year-olds during this period, while the first four months of 2023 and 2024 both averaged six cases.

Since 2015, 38 out of 735 (5%) IMD-B cases with information on disease outcome have died. In 2024, seven deaths were reported among IMD-B cases (6%; 3 were aged <5 years) and two in January–April 2025 (4%; none were aged <5 years). All fatal cases in 2024 were infected with a different finetype.

6.6.3.5 Disease caused by other meningococcal serogroups

In the January 2024–April 2025 period, seven IMD cases were caused by a non-B and non-ACWY serogroup. One IMD-E, three IMD-X, and two non-groupable IMD cases were reported. IMD-X has been reported 12 times since 2006, about one case every 1–2 years. Between 2001 and 2023, a total of 12 IMD-E cases were reported, 3 of which were reported in 2023. Note that the number of IMD-E cases presented in the 2023–2024 NIP report for the 2001–2022 period was too low and is corrected here.

6.6.4 Pathogen

6.6.4.1 Variability of finetypes

In surveillance, the finetype of the meningococcus causing IMD is used to identify potential clustering. There were 66 different finetypes observed among the 122 cases with finetype information in 2024, compared to 64 out of 120 cases in 2023. In January–April 2025, 39 different finetypes among 54 isolates with known finetype have been observed. Among the 2024 isolates, the most commonly observed finetypes were P1.22,14:F5.5 (n=9; all IMD-B), P1.22,9:F1-55 (n=7; IMD-B), and P1.22,14:F3-3 (n=6; IMD-B). Other finetypes were observed among one to five cases each, with no clustering. The most common finetpye in the first four months of 2025 was also P1.22,14:F5.5 (n = 6), followedd by P1.22,9:F5.12 (n = 5).
Similar to in 2023, the most common finetype among IMD-W isolates in 2024 was P1.5,2:F1-1 (n=4 out of 6). This finetype caused the IMD-W outbreak in 2018–2019, but annual numbers of this finetype have been very low since 2021.

6.6.4.2 Strain coverage meningococcal serotype B isolates

In the 2023–2024 NIP surveillance report, the predicted strain vaccine coverage, i.e. the proportion of IMD(-B) strains that match the MenB vaccine antigens, was estimated on the basis of whole-genome sequences from isolates received between February 2023–16 January 2024 [1]. This analysis was repeated in 2024 using IMD-B isolates from January 2022–June 2024 (n=167, 6 yielded no MenB-fHbp results). More details on methods and results can be found in the 2025 IMD-B background document for the Health Council of the Netherlands [2].

Overall, the proportion of strains categorised as insufficient (i.e. not available in the test database) was 53% for 4CMenB and 31% for MenB-fHbp. This means that the presented results are uncertain and that the actual proportion of strains covered by the respective MenB vaccines are likely to be higher than reported here. For 4CMenB, 34% of IMD-B isolates were predicted to be covered. For MenB-fHbp, this amounted to 66%. The proportion of patients infected with a (theoretically) 4CMenB-covered strain was 34% among <5-year-olds, 24% for those aged 5–14 years, and 31% for 15–24-year-olds. For MenB-fHbp the strain coverage was 64% for those aged <5 years, 59% for those aged 5–14 years, and 68% for 15–24-year-olds. However, MenB-fHbp is not licensed for use in individuals under 10 years.

6.6.5 Current/ongoing research at RIVM

6.6.5.1 Cost effectiveness analysis of MenB vaccination in the Netherlands

We investigated the cost-effectiveness of including vaccination against IMD-B for infants and adolescents in the Dutch NIP [2]. For infants (age 0; 2+1 schedule), the cost-effectiveness of 4CMenB was investigated. For adolescents (age 15, 1+1 schedule), the cost-effectiveness of 4CMenB, MenB-fHBp, and a MenABCWY vaccine was investigated. All analyses used the current standard of care, no MenB vaccination, as a comparator. The evaluation was conducted using a single-cohort Markov model with monthly model cycles over a lifetime horizon. The model included costs (based on list price) and effects of vaccination, incidence, clinical manifestations and sequelae of IMD-B, productivity losses, costs for special education as a result of IMD-B sequelae, and costs for patients and their families. The model results are presented as incremental cost-effectiveness ratios (ICERs). The ICER is interpreted as the ratio between additional costs and effects that the intervention adds to the current standard of care. Costs are presented in €, while effects are presented in quality-adjusted life-years (QALYs). Thus, the ICER is expressed as costs in € per QALY gained. The ICER is compared to a cost-effectiveness threshold that represents the willingness-to-pay of society to ‘buy’ a year in perfect health (one QALY). In the Netherlands, the commonly used cost-effectiveness threshold values for preventive measures range from €20.000 to €50.000 per QALY gained. However, cost effectiveness according to these thresholds is not a strict requirement when deciding on the introduction of a vaccine. The estimated ICER was 592,279 €/QALY for use of 4CMenB in infants, 885,701 €/QALY for 4CMenB use in adolescents, 716,312 €/QALY for MenB-fHBp use in adolescents, and 720,740 €/QALY for the use of a hypothetical MenABCWY in adolescents. The estimated ICERs in this study far exceed the commonly used cost-effectiveness threshold values, rendering vaccination not cost effective. We conducted a systematic uncertainty assessment, including transparent identification, analysis, and communication of uncertainties. While the ICERS varied substantially as a result of the probabilistic, deterministic, and scenario analyses, the conclusion that vaccination was not currently cost-effective proved robust throughout all analyses.

6.6.6 (Inter)national developments

In 2026 the Health Council of the Netherlands will publish an updated recommendation on the inclusion of MenB vaccines in the NIP. An overview of recent studies on immunogenicity, persistence, vaccine effectiveness, reactogenicity, and adverse events of monovalent MenB and pentavalent MenABCWY vaccines can be found in the 2025 IMD-B background document published by RIVM to support this advice [2].

6.6.6.1 Impact of the COVID-19 pandemic

The IRIS consortium analysed data from 19 countries for the 2018–2023 period (n = 8670 IMD cases) and analysed the overall and serogroup-specific IMD incidence over time, exploring the impact of the COVID-19 pandemic using interrupted time series. After an increase in incidence following withdrawal of the COVID-19 containment measures, the incidence decreased to below the pre-pandemic level in 2023 (incidence rate ratio (IRR) for 2023 compared to the pre-pandemic period 0.61 (95%CI 0.54–0.69) [3]. For IMD-B, the incidence for 15–24-year-olds

and 25–44-year-olds returned to pre-pandemic levels in 2023, but remained lower for other age-groups. Note, however, that IMD-B vaccination was introduced post-pandemic in some of the included countries (in France for instance). As mentioned in Paragraph 6.6.3.4, the IMD-B incidence in the Netherlands did not follow this trend, as it has been higher than pre-pandemic levels for all age groups since 2023.

6.6.6.2 IMD-B outbreak in elderly care home in the UK

A cluster of two IMD-B cases among elderly care home residents in November 2023 was reported by Heymer et al. [4]. The outbreak strain had sequence type ST-9316. Three meningococcal carriers, including two with the outbreak strain, were identified in the care home before antibiotic prophylaxis was given. As the outbreak strain is potentially covered by 4CmenB, residents and staff of the care home were offered 4CMenB vaccination. Following vaccination, fewer and less severe adverse events were reported by elderly residents than by to younger staff.

6.6.6.3 IMD cases in the US, the UK, and France related to Umrah pilgrimage

A report on IMD cases in the US, the UK, and France related to Umrah pilgrimage was published by Vachon et al [5]. Outbreaks of IMD-related to Hajj and Umrah pilgrimages to the Kingdom of Saudi-Arabia (KSA) have occurred in the past. Since 2002, KSA requires travellers to the Hajj to be vaccinated with MenACWY. Among Umrah pilgrims, MenACWY coverage has been estimated to be 41%. Twelve IMD cases that occurred between January and May 2024 were found to be Umrah-related on the basis of the travel history of the patients. Five cases were reported in the US, four in France, and three in the UK. Out of these cases, 11 were IMD-W and one was IMD-C, nine patients were unvaccinated, while the vaccination status of the remaining three patients was unknown. Two isolates were found to be ciprofloxacin-resistant. Therefore, rifampicin, ceftriaxone, or azithromycin chemoprophylaxis of close contacts of Umrah-related cases was recommended. In the first four months of 2025, one (unvaccinated) IMD-W case in the Netherlands was notified with country of infection KSA.

6.6.6.4 Increase in ciprofloxacin resistant IMD in France

A research letter by Deghmane et al. detailed an increase of ciprofloxacin resistance among IMD isolates in France [6]. Data from the national IMD surveillance on antibiotic susceptibility and genotype, including whole genome sequencing, from 2017 to 2023 was analysed. Out of the 2373 IMD isolates, 10 (0.4%) were ciprofloxacin-resistant. Six of these resistant isolates were isolated in 2022 and 2023, and one resistant isolate per year was found between 2018 and 2021. Serogroup B was most common among ciprofloxacin resistant isolates (n=4), other serogroups included C, Y, and non-groupable. These isolates also belonged to several clonal complexes and were not exclusively linked to travellers or asylum seekers. As a result, the authors suggest ciprofloxacin resistance may have emerged locally.

6.6.6.5 Vaccine effectiveness of 4CMenB vaccines against gonococcal infections

A study on long-term vaccine effectiveness (VE) of 4CMenB vaccines against gonococcal infection in South Australia was published by Wang

et al. [7] This publication included both a case-control and a cohort study to evaluate vaccine effectiveness and impact, respectively. Data on laboratory confirmation, sociodemographic factors, sex at birth, and disease outcome collected through national surveillance was used, as well as immunisation records from the national immunisation register. Vaccine effectiveness was determined using a case-control design and included cases aged 15–19 years. Gonococcal cases were matched with chlamydia controls and VE was calculated using conditional logistic regression. The VE was also estimated by means of the screening method, using logistic regression. The impact was calculated for adolescents aged 15–26 years using a binomial regression model, comparing eight pre-vaccine programme study years to four programme years. Two-dose VE against gonococcal infection was 44.3%. VE was slightly higher in females than in males (48.7% vs 38.0%) and in those with a shorter time since vaccination (<48 months) (46.0% vs 26.2%). The impact estimation resulted in an incidence rate ratio of 0.635 with an observed 36.5% reduction in gonococcal infections in adolescents aged 15–17 years where vaccine uptake was high (68.8% two-dose coverage). In the age groups 18–20 years and 21–26 years, where vaccine uptake was lower, no statistically significant reductions were found.

A clinical trial in France aimed to assess the effectiveness of 4CMenB vaccination against gonococcal infections in men who have sex with men (MSM) who use HIV post-exposure prophylaxis (PreP) [8]. The trial was halted prematurely after interim analysis and only included 544 out of the intended 720 participants. Reduction in gonococcal infections was calculated using a Cox proportional hazards model and found an adjusted hazard ratio of 0.78 (95% CI 0.60–1.01) of 4CMenB against gonococcal infection. The authors note that the study was probably underpowered for assessing vaccine effectiveness due to the smaller sample size.

6.6.7 Literature

1.* Roon Av, Lanooij S, Melker Hd. The National Immunisation Programme in the Netherlands. Surveillance and developments in 2023-2024: RIVM2024 30–01–2025.
2.* Knol M, Montessori LM. Meningococcal disease serogroup B. Updated information for the Dutch Health Council. Bilthoven, the Netherlands: RIVM2025 20–05–2025.
3. Shaw D, Abad R, Almeida SCG, Amin-Chowdhury Z, Bautista A, Bennett D, et al. Quantifying the impact of the COVID-19 pandemic on invasive bacterial diseases across 27 countries and territories: prospective surveillance by the IRIS Consortium. 2025.
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*Publication with RIVM authors.

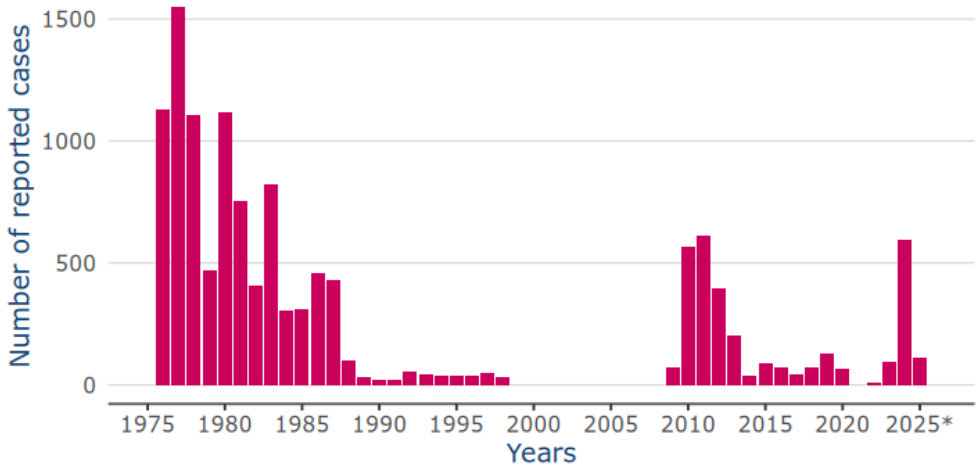
6.7 Mumps

6.7.1 *Key points*

- A total of 597 cases were reported in 2024 in the Netherlands (incidence: 3.32 per 100,000). This was much higher than in 2023, when 93 cases of mumps were reported (incidence: 0.52 per 100,000).
- Of the reported cases in 2024, 3.4% required a hospital admission due to mumps. The cases were mostly aged 15 years or under (51%), unvaccinated (69%), and predominantly resident in the Bible Belt region (59%).
- Starting in 2025, the second dose of MMR will be offered around the 3rd birthday instead of at the age of 9 years. This applies to children born from 1 January 2016 onwards.

6.7.2 *Tables and figures*

Figure 6.7.1 Number of notified mumps cases since 1976.



In the 1999–2008 period, mumps was not notifiable.
*Cases up to and including 30 April 2025.

Figure 6.7.2 Age distribution and vaccination status of cases reported in 2024 in the Netherlands.

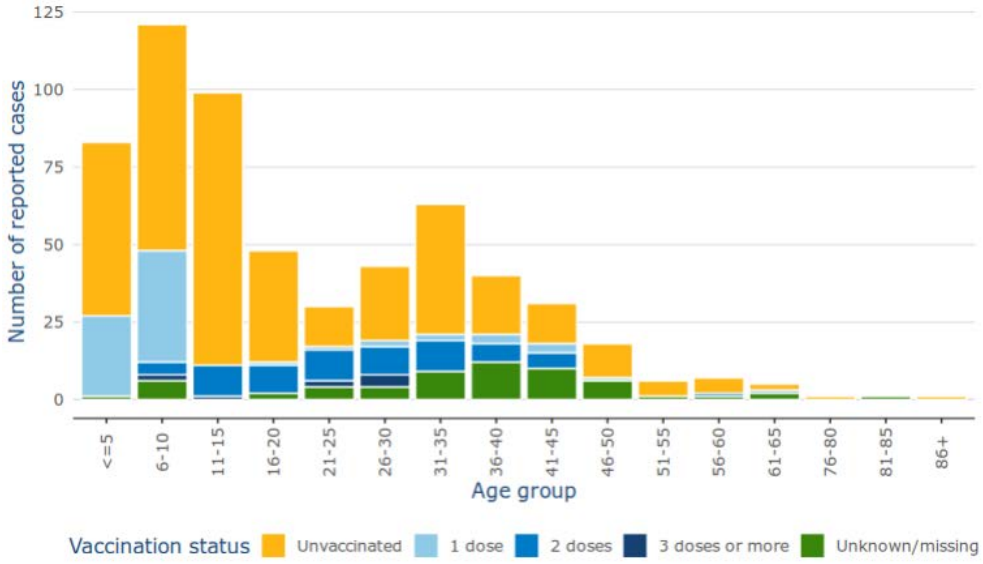


Figure 6.7.3 Number of notified mumps cases by month from the beginning of 2023 until April 2025, the Netherlands.

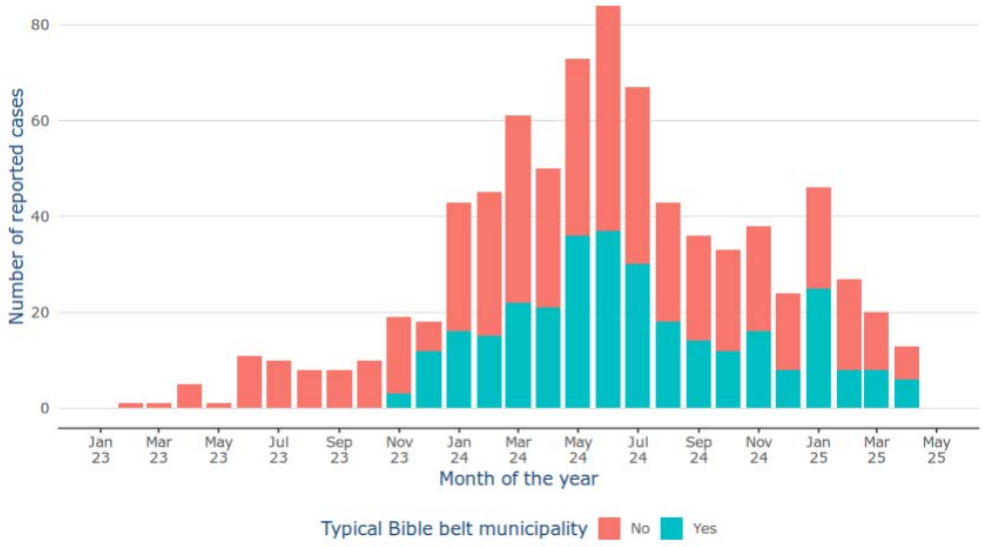
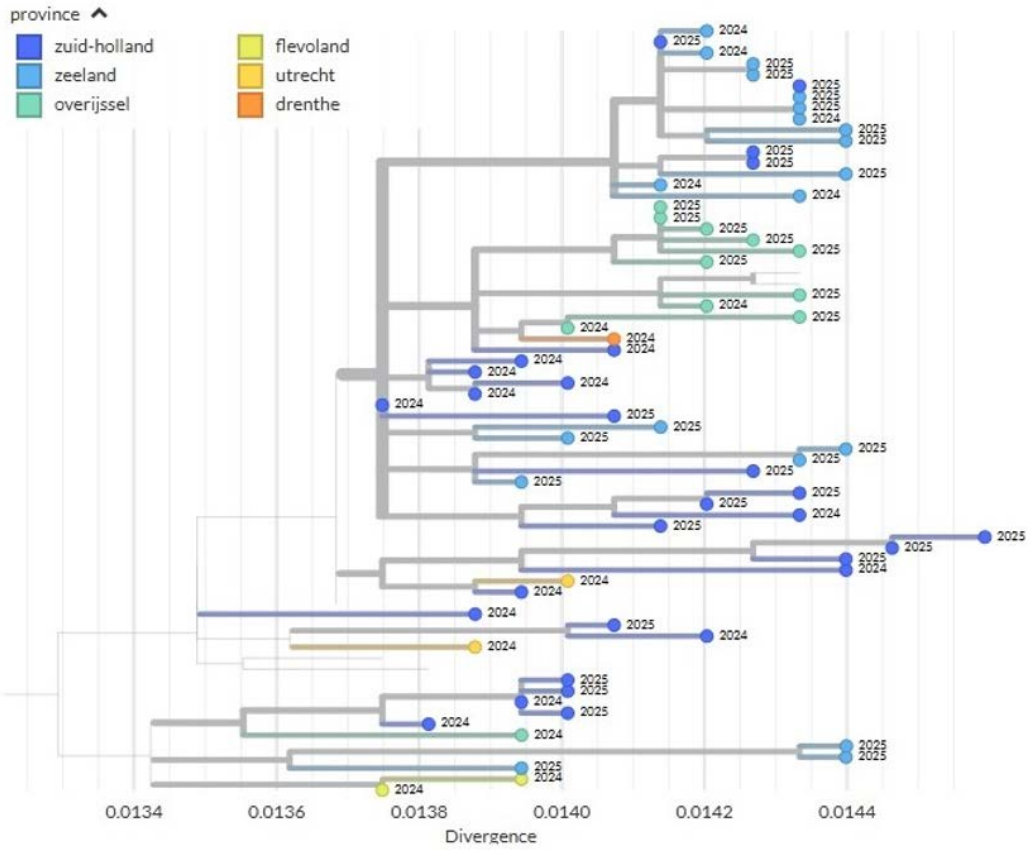


Figure 6.7.4 Geographical spread of reported mumps cases in 2024, the Netherlands.

Typical Bible belt municipalities are marked with a black border. Each point is a case, centred in municipality of residence with random jitter.

Figure 6.7.5 Phylogenetic analysis of mumps genotype G virus of the MuVs/Gelderland.NLD/45.23[G] variant with 1 or 2 nucleotide changes detected in 2024 or the first four months of 2025.



Indicated are mumps viruses with small circles and year of sample collection, colour of the circle indicates province in the Netherlands where mumps case was located.

6.7.3 *Epidemiology*

In 2024, 597 cases of mumps (incidence: 3.32 per 100,000) were reported (Figure 6.7.1), which was much more than in the previous 10 years (1-205 cases annually). Among cases reported in 2024, the median age was 15 years, and the ages ranged from 0 to 100 years (Figure 6.7.2). Of all cases, 69% was not vaccinated (389 out of 563 with a reported vaccination status). Out of the reported cases, 2 patients were below the age of 14 months and unvaccinated (not eligible for MMR vaccination via NIP schedule). Of the patients aged 14 months to 8 years (n=161) and eligible for one dose of MMR, 63% was unvaccinated. Of the cases aged 9 to 18 years (n=178) and eligible for two doses of MMR, 84% was unvaccinated. Of the cases in adults from 19 to 39 years (n=180), 67% was unvaccinated. Those who were not vaccinated (n=389), were so because of the following reasons: 223 (57%) because of religion (orthodox Protestants), 75 (19%) for unknown reasons, 49 (13%) because of critical attitude towards vaccination, 38 (10%) without a specific reason, and 4 (1%) because of an anthroposophical view on life. Of the patients aged 40 years and over (n=76), 75% was unvaccinated. In 2024, 305 out of 597 cases (51%) were in men. For nearly all cases (n=557), the most likely country of

infection was the Netherlands. For 20 cases, this was unknown and for 20 cases, this was abroad. Among the cases that had acquired their infection abroad, most had visited Morocco (n=7), followed by Belgium (n=2) and Indonesia (n=2).
For cases with available data (589 out of 597), none was deceased due to mumps in this period. Data on complications were available for 565 cases, out of which 50 (8.8%) reported complications. Reported complications concerned encephalitis (n=3), meningitis (n=10), orchitis (n=29), pancreatitis (n=4), and other complications (n=9). The number of cases hospitalised was 20 out of 589 (3.4%) cases with available data on hospitalisation.
As can be seen in Figure 6.7.3, cases reported in 2024 were preceded by an increase in cases in 2023, up to a peak in July in 2024, after which the monthly reported number of cases decreased going into 2025.
A large share of the reported cases (39%) was observed in typical municipalities located in the Bible Belt in 2024, as shown in Figure 6.7.4.
In the first four months of 2025, the epidemic continued to decrease with a total of 103 cases reported up to the first of May (incidence: 0.57 per 100,000). The average age was 26. The youngest was 1 year old and the eldest 78 years. Out of the cases, 51 are in men, and 52 in women. Comparable to the data in 2024, most cases in 2025 were not vaccinated (71 out of 95 with data on vaccination status). None of the cases were hospitalised. Out of the reported cases, 47 (81% among cases with data on risk group) were in individuals reported to be part of the orthodox Protestant community.

6.7.4 Pathogen

From 2009 until 2023, most mumps cases in the Netherlands were caused by infection with genotype G mumps viruses. In 2024, a genotype was obtained for mumps viruses detected in 184 patients, and in 43 patients during the first four months of 2025. Mumps virus genotype G virus was detected in 169 patients (92%) in 2024 and 42 patients (98%) in 2025. Other mumps virus genotypes detected in 2024 and the first four months of 2025 were genotype H (11 cases), C (2 cases), J (2 cases), and D (1 case).
The molecular variant MuVs/Gelderland.NLD/45.23[G] was detected in 106 cases in 2024, while the molecular variant MuVs/Zuid-Holland.NLD/22.23[G] was detected in 24 cases. The molecular variant MuVs/Noord-Holland.NLD/9.24[H] was detected in 6 mumps cases. In 2025, all mumps genotype G viruses belonged to the molecular variant MuVs/Gelderland.NLD/45.23[G] with one or two nucleotide changes at most.
Phylogeographic analysis of complete genomes of 70 mumps genotype G viruses (n=70), detected in 2024 and 2025 using Nexststrain, suggested the circulation of local variants of MuVs/Gelderland.NLD/45.23[G] (Figure 6.7.5).

6.7.5 (Inter)national developments

The World Health Organization has data on mumps until 2023 [1]. In that year, most reported cases came from the African region (n=317,304), followed by the South-East Asia Region (n=29,282), the Region of the Americas (n=15,938) and the European Region (n=9,588). In previous years, the number of reported mumps cases in

the WHO European region increased slowly from 3751 in 2021, and 7042 in 2022 to 9588 in 2023.

The reemergence of mumps among vaccinated young adults continues to raise concerns regarding the necessity of a third dose of the MMR vaccine [2]. However, there is currently limited data on real-life effectiveness of the third-dose MMR vaccine in preventing mumps. To address this gap, researchers employed a mathematical modelling approach to assess a large outbreak at the University of Iowa, where a third MMR dose was administered as a mitigation strategy. Results from that model suggest that, while the overall impact of the vaccination campaign was moderate, it provided crucial protection to high-risk individuals and contributed to a reduction in transmission. Analyses of varying vaccination timing demonstrated that earlier rollout could have had a substantial impact on limiting outbreak size, even with lower population uptake.

The World Health Organization released an updated position paper on mumps vaccination, incorporating new epidemiological data and recommendations [3]. Its main position is as follows: Vaccination with a mumps-containing vaccine is the most effective and established method to prevent mumps illness. WHO recommends the use of MMR vaccines for countries with mature immunisation programmes, in accordance with the coverage targets recommended for MMR vaccination.

6.7.6 Literature

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3. WHO. Weekly Epidemiological Record2024 Contract No.: 11.

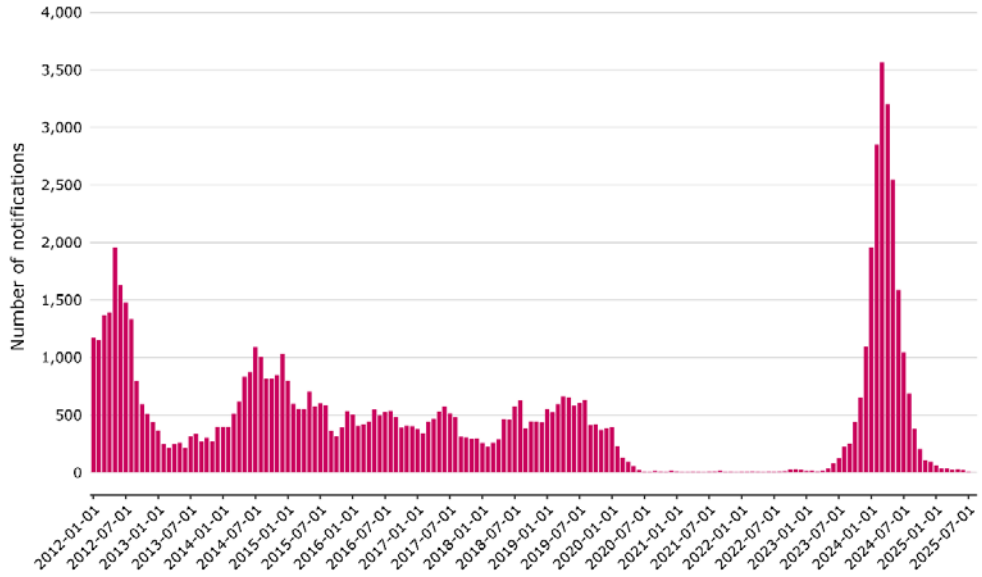
6.8 Pertussis

6.8.1 Key points

- The pertussis epidemic that started towards the end of 2023 (2944 cases and an incidence of 17 per 100,000) reached its peak in March 2024 and then decreased again. In total there were 18,208 cases reported in 2024 (incidence of 102 per 100,000). This is the highest number recorded since pertussis became notifiable in 1976.
- The highest incidence was observed among infants (573 and 446 per 100,000 for 0–5-month-olds and 6–11-month-olds, respectively), followed by teenagers (202 per 100,000).
- Since 1964, between 0 and 3 individuals a year have died from pertussis infections. In 2024, 5 infants and 3 individuals aged over 60 years died from a pertussis infection.
- The vaccine effectiveness (VE) estimate of maternal Tdap vaccination against notification of pertussis infection among 0–2-month-olds with disease onset between 1 April 2020 and 14 August 2025 was 91% (95% CI: 88 to 93%).
- The VE estimates of the complete infant vaccination series have consistently remained high up to the booster dose given at the age of 4 years (90–99%). Following the booster, VE gradually declined.
- Based on the seroepidemiological PIENTER Corona study, the overall cumulative incidence of pertussis infections in the Netherlands during 2023-2024 was 6.3%, with highest incidence in 6-18 year-olds (35%). Infected individuals showed lower FHA antibody concentrations pre-infection, which suggests a protective role of these pertussis-specific antibodies.
- As of 2025, the NIP vaccination schedule was optimised, including a change of the Tdap-IPV booster dose at the age of 4 years to a Tdap booster dose at the age of 5 years. In addition, the dose of the DTaP-IPV-Hib-HBV vaccine moves up from the age of 11 months to 12 months.

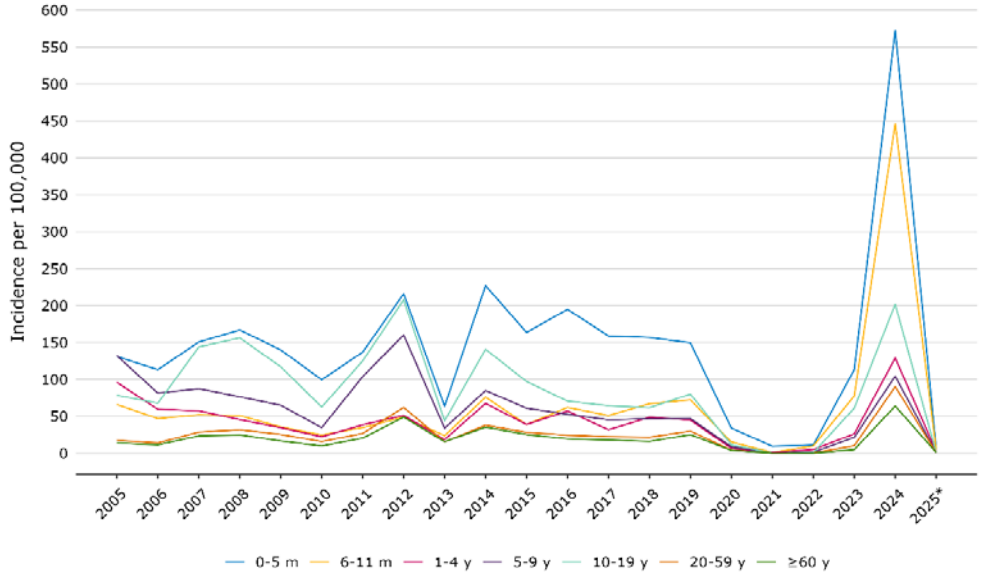
6.8.2 Tables and figures

*Figure 6.8.1 Absolute number of pertussis notifications by month of symptom onset, for 2012–2025 *.*



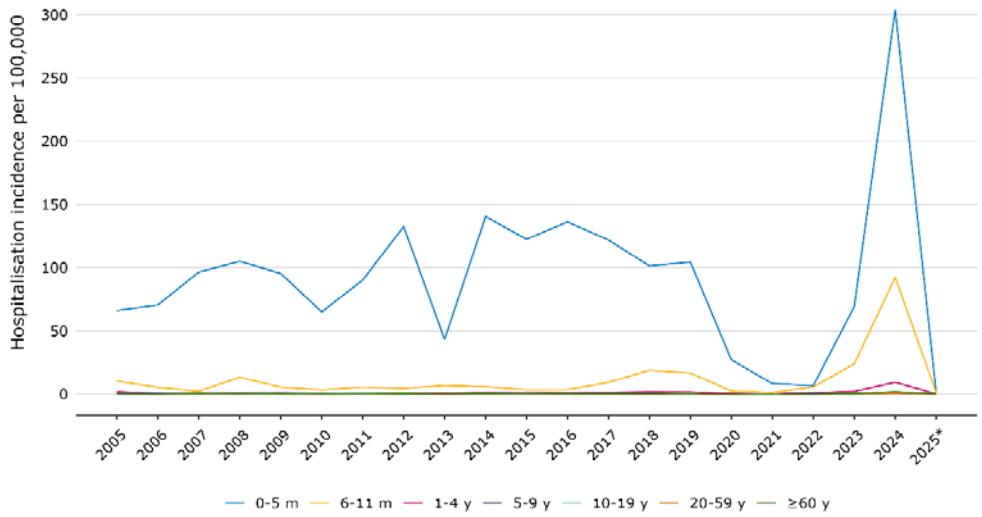
* For 2025, notifications are depicted for the period up to and including 14 August.
Source: Osiris

Figure 6.8.2 Pertussis notifications per 100,000 persons, per age category and by year of symptom onset, for 2005–2025.*



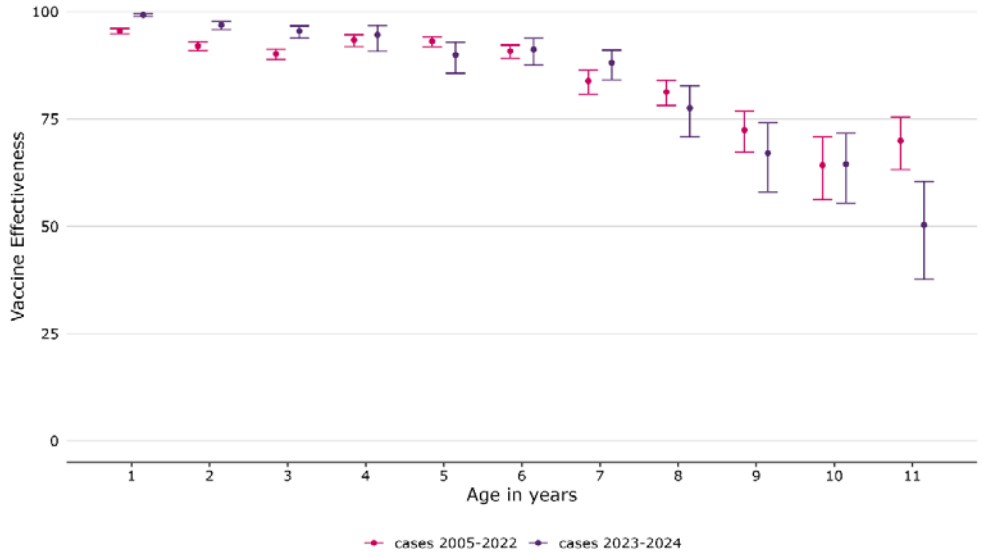
* For 2025, notifications are depicted for the period up to and including 14 August.
Source: Osiris

Figure 6.8.3 Pertussis hospitalisations per 100,000 persons, per age category and by year of symptom onset, for 2005–2025.*



* For 2025, notifications are depicted for the period up to and including 14 August. Source: Osiris

Figure 6.8.4 Vaccine effectiveness of the primary pertussis vaccination series (1-, 2-, and 3-year-olds) and the booster dose (4- to 11-year-olds, with birth cohorts >= 2005) with a mean VE estimate for cases from 2012–2022 and 2023–2024.



For all separate birth cohorts, the registered population coverage of the primary (1-, 2-, 3-year-olds) and booster (4–11-year-olds) vaccination was used, as retrieved from the National vaccination coverage report [1], when available. Otherwise, the coverage of the nearest birth cohort was used. Source: Osiris.

Figure 6.8.5 Pertactin expression and genotype distribution over time. Proportion and absolute number (written in bars) of pertussis isolates with pertactin deficiency over a 10-year time period, plotted per year.

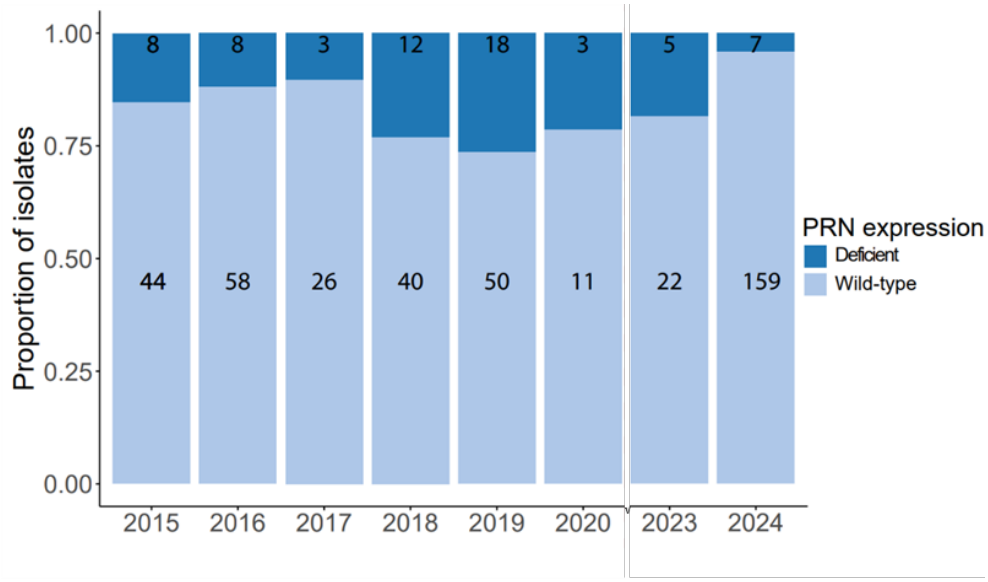
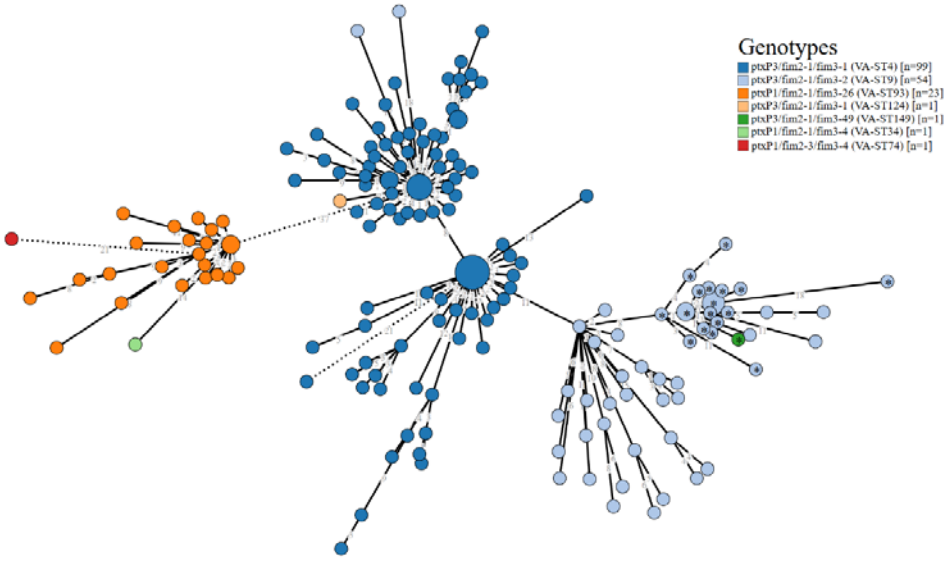
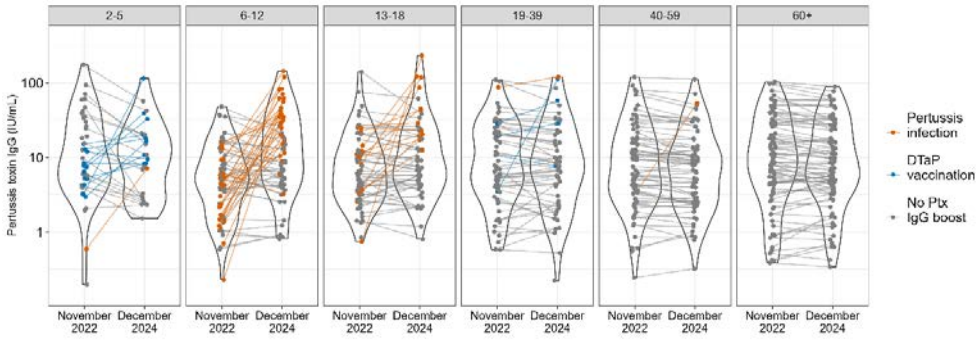


*Figure 6.8.6 Minimum spanning tree based on cgMLST typing**



* Pairwise distances excluding missing alleles were used to determine a minimum spanning tree between unique cgMLST profiles. The numbers on the branches indicate the number of allelic differences between cgMLST profiles and branches longer than 11 AD have been drawn as dotted lines. Each circle represents a cgMLST profile, the diameter of circles represents the number of isolates of this profile (excluding missing loci). Colours represent the different genotypes; ptxP1/fim3-26 in dark orange, ptxP3/fim3-1 in dark blue, and ptxP3/fim3-2 in light blue.

Figure 6.8.7 Ptx IgG concentration in November 2022 and December 2024 per age group, in paired samples.



6.8.3 Epidemiology

6.8.3.1 Disease

The pertussis epidemic that started towards the end of 2023 reached its peak in March 2024, with 3562 notifications in that month. A total of 18,208 cases were reported in 2024 (Figure 6.8.1) with an incidence of 102 per 100,000. In 2023, 2944 cases were reported, with an incidence of 17 per 100,000. In 2024, the highest incidence was observed among infants (573 and 446 per 100,000 for 0–5-month-olds and 6–11-month-olds, respectively), followed by teenagers (202 per 100,000) (Figure 6.8.2). From March 2024 onwards, the monthly number of notifications gradually declined, reaching very low levels in 2025. In 2025, up to and including 14 August, the total number of notifications was 213, amounting to an incidence of 1 per 100,000. In 2025, the incidence remained highest among infants (7 and 5 per 100,000 for 0–5-month-olds and 6–11-month-olds, respectively).
It should be noted that differences in incidence across age groups may partly reflect variation in health care-seeking behaviour and in whether or not pertussis diagnostics is performed.

The large 2023–2024 epidemic probably resulted from the limited infection-derived immunity acquired since March 2020 (due to low circulation of *B. pertussis* because of COVID-19 measures) combined with waning vaccine-derived immunity following the booster dose, leading to an increased number of susceptible individuals. The high number of pertussis cases increased the infection pressure, particularly affecting infants who were not (yet) vaccinated or whose mothers had not received the pertussis vaccination during pregnancy.

6.8.3.2 Hospitalisation and mortality

According to notification data (Osiris), a total of 563 people were hospitalised due to or with pertussis in 2024. The majority (n=326, 58%) were infants, followed by individuals aged 60 years and over (n=87, 15%) and children aged 1–4 years (n=65, 12%).
The incidence of hospitalisations was highest among 0–5-month-olds (304 per 100,000), followed by 6–11-month-olds (92 per 100,000; Figure 6.8.3).

In 2024, 53% (250/471) of notified infants aged 0–5 months and 21% (76/367) of those aged 6–11 months were hospitalised. In 2025, up to

and including 14 August, these percentages were 17% (1/6) and 25% (1/4) for 0–5-month-olds and 6–11-month-olds, respectively.
The proportion of 0–5-month-old cases who were hospitalised in 2024 was lower than in previous (non-epidemic) years: 53% in 2024 versus a weighted average of 69% in 2014–2023. Among 6–11-month-old cases, the proportion hospitalised in 2024 (21%) was similar to previous years (weighted average of 19% in 2014–2023). Since pertussis is particularly severe in young infants, the lower proportion of hospitalised cases in 0–5-month-olds in 2024 may be explained by increased (media) attention for the pertussis epidemic, which could have led to more parents seeking medical care and to increased diagnostic testing by healthcare providers.

Since 1964, between 0 and 3 individuals a year have died from pertussis infections. In 2024, 8 pertussis deaths were reported in the notification data. They comprised 5 infants and 3 individuals over the age of 60 years.

6.8.3.3 Vaccination status and vaccine effectiveness estimates

6.8.3.3.1 *Maternal vaccination*

In 2024, 83% (199/241) of notified infants aged 0–2-months, whose maternal vaccination status was known, were born to mothers who had not been vaccinated during pregnancy. Among the remaining 17% (42/241) of infants whose mothers were vaccinated during pregnancy, 11 were born prematurely, and 4 term born infants had mothers who were vaccinated less than two weeks before birth.

The vaccine effectiveness (VE) estimate of maternal Tdap vaccination against notification of pertussis infection among 0–2-month-olds is based on 316 infants with a known maternal vaccination status and disease onset between 1 April 2020 and 14 August 2025 (eligible for maternal Tdap vaccination). Out of these, 54 (17%) had mothers who received maternal Tdap vaccination. Using an estimated maternal vaccination coverage of 70% [2], the VE was estimated at 91% (95% CI: 88 to 93%) by the screening method. The VE against infection with *B. pertussis* was estimated at 92% (95% CI:89 to 94%) based on 295 cases (48 of whom received maternal Tdap vaccination). VE against infection with *B. parapertussis* was estimated at 69% (95% CI: 4 to 90%) based on 12 cases (5 of whom received maternal Tdap vaccination).

6.8.3.3.2 *Infant series and booster dose*

In 2024, among the notified infants aged 0–3 months with a known vaccination status (292/338), 63% (183/292) had not received the number of vaccinations recommended for their age according to the vaccination schedule (including maternal vaccination). For infants aged 4–5 months with a known vaccination status (105/133), this was 79% (83/105), and for infants aged 6–11 months with a known vaccination status (280/367), it was 88% (246/280). Among notified children aged 1–4 years with a known vaccination status (774/903), 83% (639/774) had not received the age-appropriate number of vaccinations. For children aged 5–8 and 9–11 years with a known vaccination status ((548/600) and (1195/1249), respectively), this was 36% (200/548) and 12% (147/1195) respectively.

Figure 6.8.4 shows the VE estimates of the complete infant vaccination series during the use of the acellular pertussis vaccine (2005–2022 and 2023–2024 separately) and booster dose administered at the age of 4 years. The VE estimates have consistently remained high up to the booster dose given at the age of 4 years (90–96% and 96–99% for 1–3-year-old cases with disease onset in 2005–2022 and 2023–2024, respectively). Starting around 3 years after the booster given at the age of 4 years, VE gradually declines. At the age of 7 years, VE estimates are 84% and 88% for cases in 2005–2022 and 2023–2024, respectively. The decline continues to much lower VE estimates by the age of 11 years (70% and 50% for cases in 2005–2022 and 2023–2024, respectively).

The percentage of notifications with an unknown vaccination status was higher in 2024 than in previous years, both among cases up to the age of 5 years and cases aged 12 years and older. As this could affect the VE estimates, we performed a sensitivity analysis in which we assumed that all cases with an unknown vaccination status were actually vaccinated (the 'worst-case' scenario). This resulted in VEs of 97%, 94%, and 92% for 1-,2-,3-year-olds for the years 2023–2024, respectively, compared to the current estimates of 99%, 97%, and 96%. For the booster dose, this resulted in VEs of 90%, 82% and 25% for 4-, 7-, and 11-year-olds for the years 2023–2024, respectively, compared to the current estimates of 95%, 88%, and 50%.

6.8.4 Pathogen

The Dutch NIP makes use of an acellular pertussis (aP) vaccine consisting of 5 pertussis antigens, i.e. fimbriae 2 and 3 (Fim2 and Fim3), pertussis toxin (PTx), filamentous hemagglutinin (FHA), and pertactin (Prn). The re-emergence of pertussis has been attributed to several factors, including bacterial strain adaptation due to vaccine pressure. Hence, careful monitoring of bacterial expression of vaccine targets, in particular Prn, is essential. Therefore, Dutch medical microbiology laboratories are asked to submit their *B. pertussis*-suspected samples to RIVM.

To investigate pertactin deficiency, the most common vaccine escape mechanism, we determined pertactin expression on the basis of WGS data. Consistent with trends in many other European countries, the Netherlands observed a modest increase in pertactin-deficient strains in the 2015–2020 period. In 2015–2017, 13% of isolates was pertactin-deficient, and this increased to 25% in 2018–2020. In 2021 and 2022, no strains were received for strain surveillance, which is in line with the low number of pertussis notifications in that period. The unusually high incidence of pertussis in 2023–2024 has been accompanied by a high influx of isolates for surveillance since September 2023. Remarkably, 7% of strains circulating in 2023–2024 was pertactin-deficient (Figure 6.8.5).

In addition, all 2023–2024 strains were typed on the basis of the vaccine antigen genes, namely the combination of alleles from the toxin subunits and promotor region, both fimbriae genes, and the variable region of filamentous hemagglutinin. These classical genotypes are defined analogously to multilocus sequence typing (MLST). In a

minimum spanning tree representation of the cgMLST data (Figure 6.8.6), the different levels of genetic diversity within the classical genotypes can be observed. The genotypes with a higher internal diversity ptxP3/fim3-1 (dark blue) and ptxP3/fim3-2 (light blue) split into multiple clusters, while the ptxP1/fim3-26 isolates (orange) appear as one cluster. PtxP1 strains are associated with reduced fitness in the acellular vaccine (ACV) era compared to ptxP3 strains . PtxP1 isolates were not detected between 2015–2020 in the Netherlands and there was only limited detection in other European countries in 2023–2024. These findings may suggest a single recent introduction of the ptxP1/fim3-26 genotype into Europe, and future pathogen surveillance will have to show whether this genotype will continue to circulate in Europe.

Notably, several European countries have reported macrolide-resistant *B. pertussis* (MRBP) strains, including amongst recent isolates. The most commonly found resistance mechanism is an A2047G mutation in the 23S rRNA gene. Thus far, none of the Dutch pertussis isolates have harboured this 23S rRNA mutation. We are currently implementing a molecular assay that allows rapid and accurate identification of this mutation in clinical samples.

6.8.5 Research

6.8.5.1 Pertussis antibody concentrations during 2022–2024

Following the relative absence of pertussis circulation in the Netherlands during the COVID-19 pandemic, notifications were substantially elevated in 2023–2024 (Figure 6.8.1). The prospective population-based seroepidemiological cohort PIENTER-Corona (PICO) was used to study the extent of this outbreak and to provide further immunological insights. In the PICO study, ~10,000 participants across the Netherlands provided a small blood sample during thirteen study rounds from the start of the pandemic till the end of 2024. Serum samples from 418 randomly selected PICO participants (aged 2–87 years) collected at multiple timepoints were tested for pertussis-specific antibodies. The nationwide incidence of *B. pertussis* infections was estimated on the basis of boosting pertussis toxin-specific IgG antibodies[2]. Moreover, the potential role of declining immunity was studied for all pertussis antigen-specific antibodies.

Participants between the ages of 6–12 years had significantly lower pertussis toxin–specific antibody concentrations in late 2022 compared to all other age groups (Figure 6.8.7). Age group 6-18 years was also highly affected by pertussis infections, with a cumulative incidence of 35% during the study period (November 2022–October 2024). Most of these individuals did not report coughing symptoms, which suggested that individuals in our cohort were sufficiently protected against severe disease. The overall nationwide cumulative incidence (among 2–87-year-olds) was estimated to be 6.3% (95% CI 4.4–8.2). The increased incidence was related to waning immunity, particularly in individuals aged 6–18 years, who were primed by acellular pertussis (aP) vaccination and received the aP booster vaccination at the age of 4 years and probably had a limited history of infections due to the prolonged absence of circulation during and after the COVID-19 pandemic. The data of reduced antibody concentrations corroborated

findings from a systematic literature review of thirteen studies, showing that the COVID-19 pandemic probably resulted in more profound waning of pathogen-specific antibodies for several pathogens, including *B. pertussis*, with a larger decrease in children than in adults [3]. An important role was also observed for anti-FHA antibodies. FHA is a cell surface protein involved in adhesion of *B. pertussis* to the host epithelial cells that line the respiratory tract. Infected individuals showed lower FHA concentrations pre-infection compared to matched uninfected individuals. This data suggests a protective role of FHA antibodies and a possible marker for predicting susceptibility to a *B. pertussis* infection [manuscript in preparation].

6.8.5.2 Optimisation of pertussis vaccination in the Netherlands

A literature review and evidence-based evaluation of the Dutch national immunisation schedule indicated that pertussis immunity in aP primed children could be prolonged by increasing the time interval between the primary series and booster dose given around school entry [4].This evaluation underpinned the Health Council's Advice to implement changes in the NIP vaccination schedule [5]. These changes have been implemented as of 2025, including a postponement of the preschool Tdap-IPV booster dose at the age of 4 years to a Tdap booster at the age of 5 years. In addition, the dose of the DTaP-IPV-Hib-HBV vaccine that used to be given at the age of 11 months, is now given at the age of 12 months.

6.8.5.3 (Maternal) pertussis vaccination in developing countries

All pertussis vaccines currently in use in the NIPs of most western countries, including in the Netherlands, are acellular pertussis (aP) vaccines, containing purified *B. pertussis* antigens at higher (infants) or reduced (booster vaccines for children and pregnant women) doses. In developing countries, the infant vaccine type is often still a more reactogenic whole-cell vaccine and maternal immunisation may not have been introduced. In a single-centre, randomised, controlled, double-blind, phase 4 trial, the effect of pertussis vaccination in pregnancy on the immunogenicity of acellular or whole-cell pertussis vaccination in Gambian infants (GaPS study) was compared and antibody levels were measured using the RIVM multiplex immune assay platform [6]. Administering Tdap-IPV to pregnant women proved safe and was well tolerated. The vaccine increased both the amount and quality of pertussis antigen-specific antibodies in infants. While there was relative blunting of the infants' immune response to their routine DTwP vaccinations, the quality of pertussis antigen-specific antibodies and memory B cell responses remained intact, regardless of which vaccine mothers received during pregnancy.

The RIVM-based serology mulitiplex immune assay platform is also used in the GatesFoundation-funded OptIMMS trial [7]. Longitudinal serum samples from 900 children in Nepal and Uganda are used to compare antigen-specific antibodies, including anti-pertussis toxin IgG antibodies as a primary endpoint, across five different vaccination schedules. Preliminary data indicates that reducing the number of doses leads to inferior levels of antibodies. Further data analysis is ongoing and will support optimisation of vaccination schedules and products in these countries.

6.8.5.4 Cellular immunity to B. pertussis

In view of the worldwide circulation of *B. pertussis* despite vaccination, further research to identify elusive serological and cellular correlates of protection are still needed. Assessing not only quantity but also quality of pertussis-antigen immune mechanisms requires novel in vitro assays. Together with partners in the international Periscope consortium, RIVM developed a novel whole blood assay to quantify the release of T cell-associated cytokines in response to *B. pertussis* antigens [8]. This assay was made suitable to determining the profile of antigen-specific cytokine responses in typically very small blood volumes sampled from infants and was applied in various infant pertussis vaccination cohorts of the Periscope consortium [the first data has been presented at the ESPID 2025].

6.8.6 International developments

As reported last year, there was a sharp increase in pertussis notifications across the EU/EEA and worldwide in 2023–2024. In many countries, the number of notifications peaked in 2024 and gradually declined to low levels by the end of 2024 or into early 2025, as observed in the Netherlands, the UK, Austria, and France. However, some countries still experience a growing number of cases in 2025. For instance, the USA experienced a rise in cases in 2024, indicating a return to pre-COVID-19 pandemic patterns, with a continuation of this rise in 2025. In the first three months of 2025, four times as many cases were reported as in the same months in 2024. In Australia, the number of cases in 2024 (n=>57,000) was highest since they started monitoring in 1991. But also in the beginning of 2025, an unusual number of pertussis cases was reported in Australia, with almost 5000 cases in January.

6.8.7 Literature

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*Publication with RIVM authors.

6.9 Pneumococcal disease

6.9.1 Key points

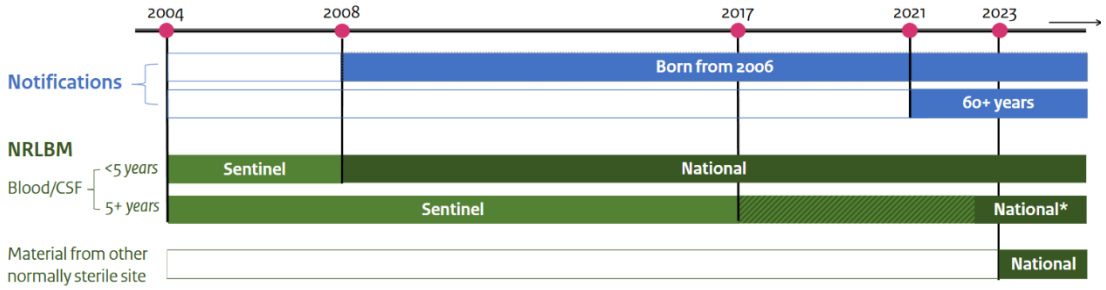
- A total of 2279 invasive pneumococcal disease (IPD) cases were reported in the epidemiological year 2024–2025 (June to May). Out of these cases, 2232 had a positive blood or CSF sample; the remaining 47 cases were identified in other normally sterile sites.
- The incidence of IPD was 12.6 per 100,000 in 2024–2025, and 12.4 per 100,000 when only including patients with a positive blood or CSF sample.
- The overall incidence of IPD has been relatively stable since 2022–2023, with an average incidence of 12.7 per 100,000. This is slightly lower than before the COVID-19 pandemic (average incidence 15.0 per 100,000 in 2015–2019)
- The incidence among <5-year-olds was lower in 2024–2025 than in 2023–2024 and similar to pre-pandemic years. In those aged 5–49 years, the incidence was similar to the previous two years, although an increase in PCV10 serotypes was observed. In those aged 50–64 years, the incidence was lower than in 2023–2024 and in pre-pandemic years. Among those aged 65+ years, the incidence was highest of all age groups, and was similar to 2023–2024 and lower than in pre-pandemic/pre-PPV23 years (PPV23 was introduced in autumn 2020).
- PCV15 replaced PCV10 in the NIP as a booster dose in September 2024 and for all doses since approximately January 2025. No PCV15-IPD has been observed among PCV15-vaccinated children up to and including May 2025. Vaccine effectiveness (VE) for childhood immunisation with PCV10 was estimated at 80% (95%CI 48-93). VE for PPV23 in older adults was estimated at 41% to 63%.
- As per 1 January 2025, the recommended age for the booster dose is moved up from the age of 11 months to 12 months. This applies to children born from 1 January 2024 onwards.

6.9.2 *Tables and figures*

Table 6.9.1 Number of IPD (invasive pneumococcal disease) cases and incidence of IPD in 2023–2024 and 2024–2025 by age group and by normally-sterile sites in which the pneumococcus was detected.

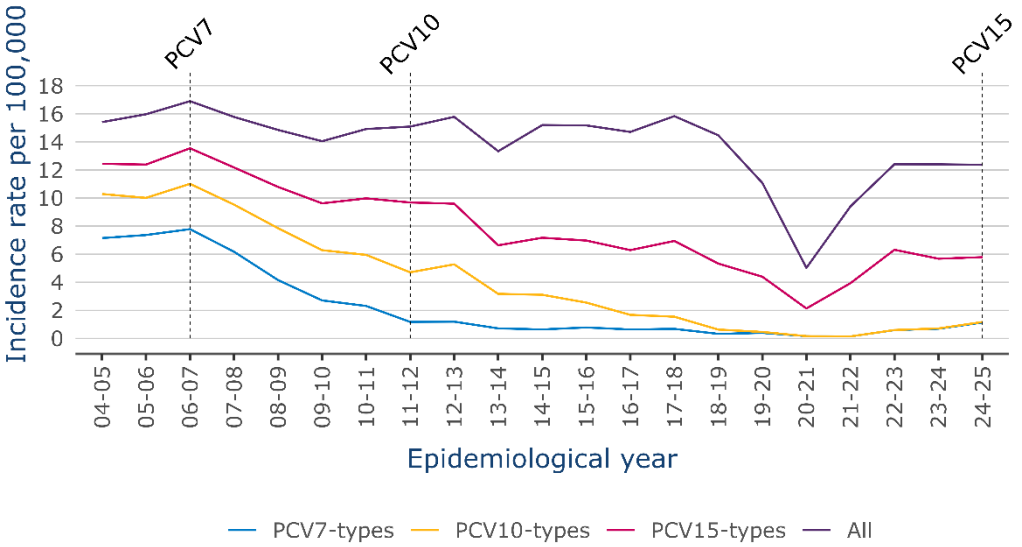
	Number of IPD cases			Incidence (per 100,000)	
	Blood/CSF	Other sites	Total	Blood/CSF	Total
2024–2025					
<5 years	58	9	67	6.9	7.8
5–49 years	332	5	337	3.4	3.5
50–64 years	519	8	527	14.1	14.3
65+ years	1323	25	1348	35.2	35.9
Total	2232	47	2279	12.4	12.6
2023–2024					
<5 years	73	7	80	8.5	9.2
5–49 years	309	4	313	3.2	3.2
50–64 years	547	6	553	14.7	14.9
65+ years	1296	11	1307	35.2	35.5
Total	2225	28	2253	12.4	12.6

Figure 6.9.1 Timeline of changes in the surveillance of IPD in the Netherlands.



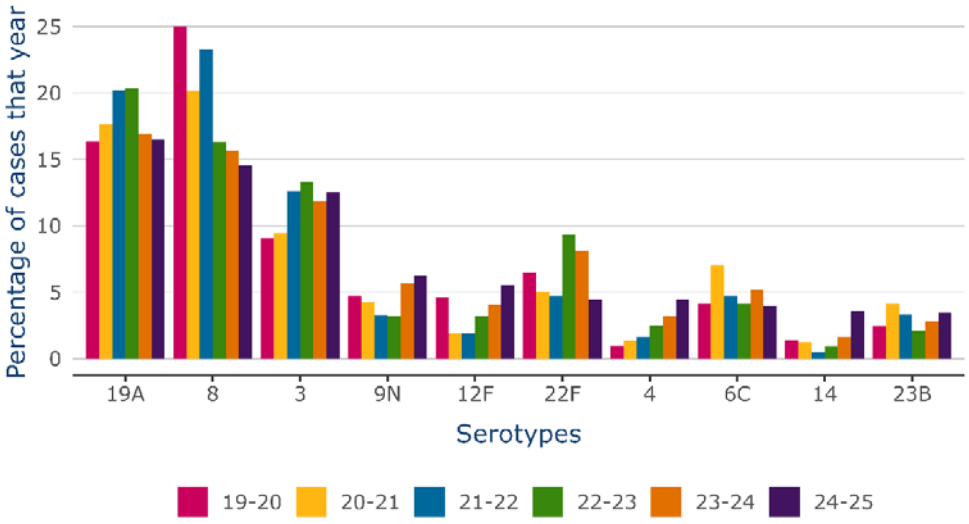
*Since 2017, all laboratories in the Netherlands have been asked to submit samples from all age groups, but only since the epidemiological year 2022–2023 national data has been used in surveillance.

Figure 6.9.2 Incidence of invasive pneumococcal disease (IPD) in all ages by vaccine serotype (PCV7 serotypes, PCV10 serotypes, PCV15 serotypes), as well as all IPD, presented by epidemiological year (e.g. 04–05 = June 2004–May 2005).



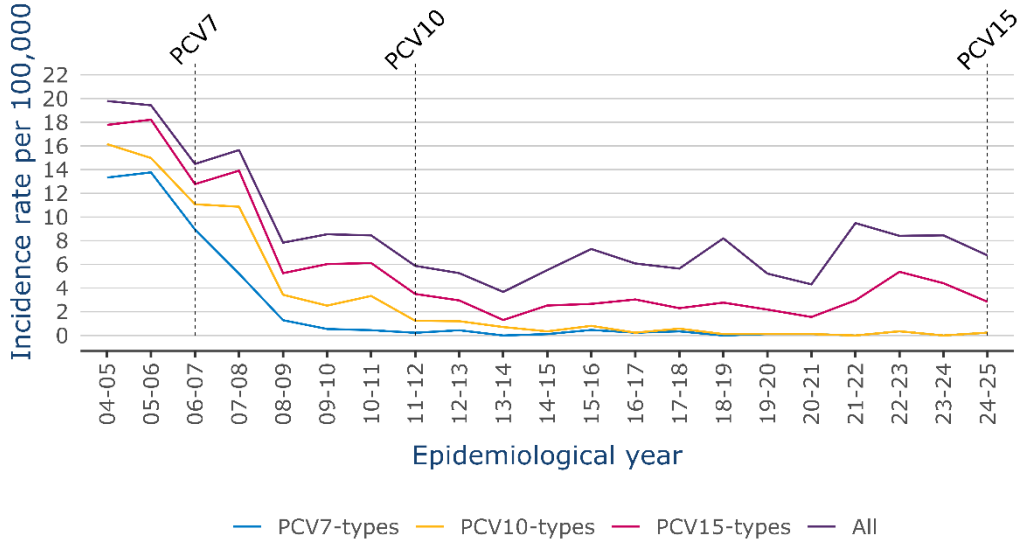
PCV7 was introduced in the NIP in June 2006, PCV10 in May 2011, and PCV15 in September 2024. Note that PCV15 was first introduced for the booster only; since approximately January 2025, all doses in the NIP are with PCV15. PPV23 was introduced in the National Programme Pneumococcal Vaccination in autumn 2020 for those born in 1941–1947, in autumn 2021 for those born in 1948–1952, in autumn 2022 for those born in 1953–1956, in autumn 2023 for those born in 1957–1960, and in autumn 2024 for those born in 1961–1964.
From 2004–2005 to 2022–2023, sentinel surveillance data was used and extrapolated to the Dutch population. National surveillance data has been used from 2022–2023 onwards. Only IPD cases diagnosed on the basis of blood or CSF samples have been included.

Figure 6.9.3 The percentage of IPD cases caused by the 10 most common serotypes in 2024–2025, shown for the epidemiological years 2019–2020 to 2024–2025.



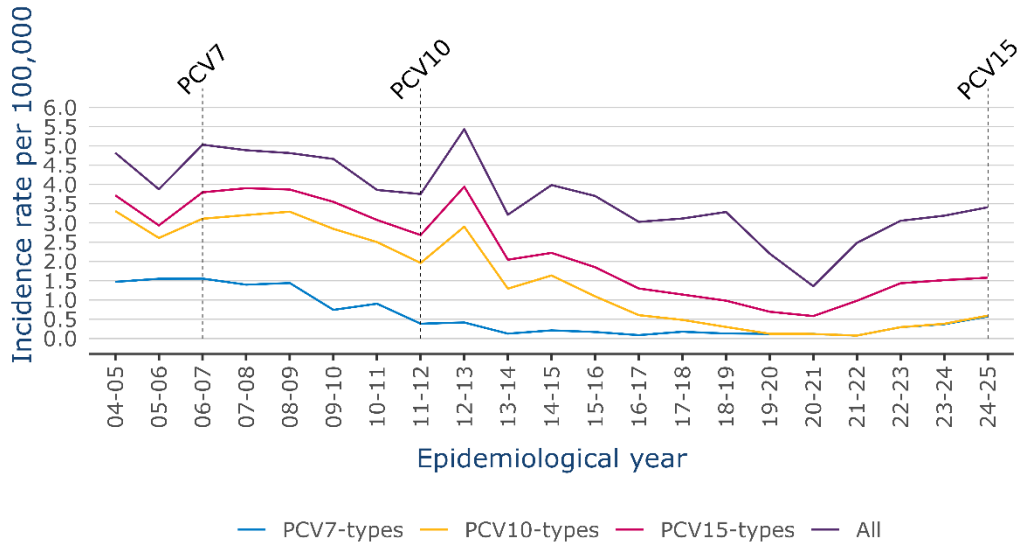
National data has been used and only IPD cases diagnosed on the basis of blood or CSF samples have been included.

Figure 6.9.4 Incidence of IPD in children aged <5 years by vaccine serotype (PCV7 serotypes, PCV10 serotypes, PCV15 serotypes,), as well as all serotype IPD, presented by epidemiological year (e.g. 04–05 = June 2004–May 2005).



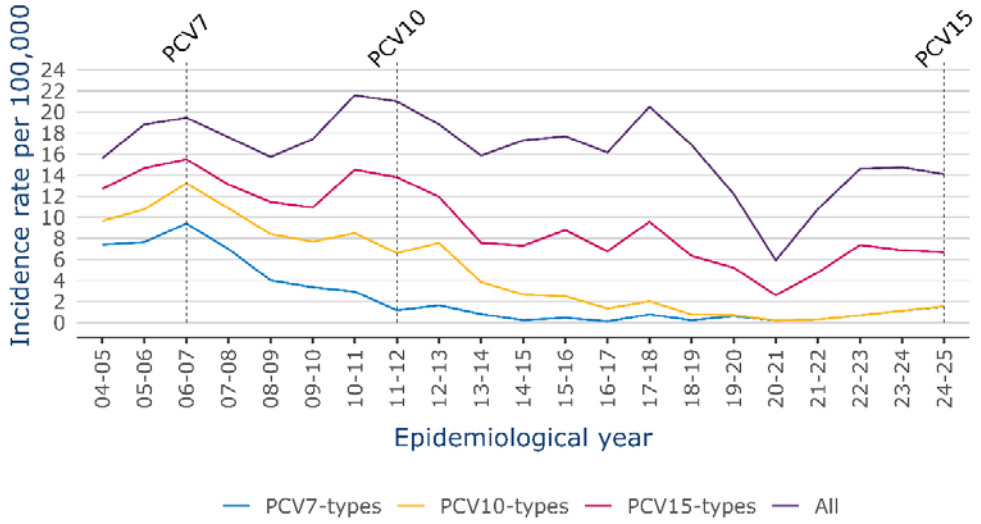
From 2004–2005 to 2007–2008, sentinel surveillance data was used and extrapolated to the Dutch population. From 2008–2009 onwards, data of national surveillance has been used and only IPD cases diagnosed on the basis of blood or CSF samples have been included.

Figure 6.9.5 Incidence of IPD in persons aged 5–49 years by vaccine serotype (PCV7 serotypes, PCV10 serotypes, PCV15 serotypes), as well as all serotype IPD, presented by epidemiological year (e.g. 04–05 = June 2004–May 2005).



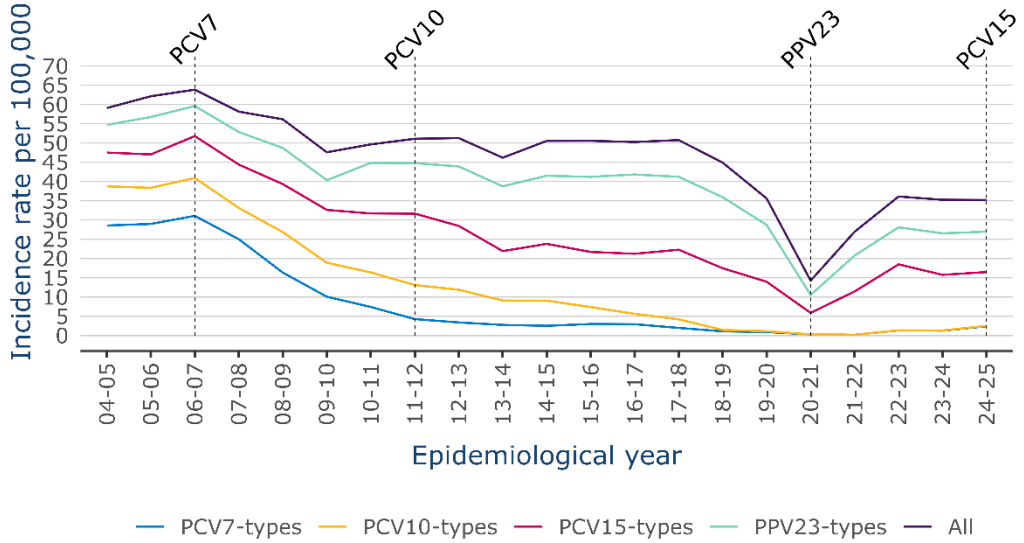
Sentinel surveillance data has been used and extrapolated to the Dutch population until 2022–2023, afterwards national data was used. Only IPD cases diagnosed on the basis of blood or CSF samples have been included.

Figure 6.9.6 Incidence of IPD in persons aged 50–64 years by vaccine serotype (PCV7 serotypes, PCV10 serotypes, PCV15 serotypes,), as well as all serotype IPD, presented by epidemiological year (e.g. 04–05 = June 2004–May 2005).



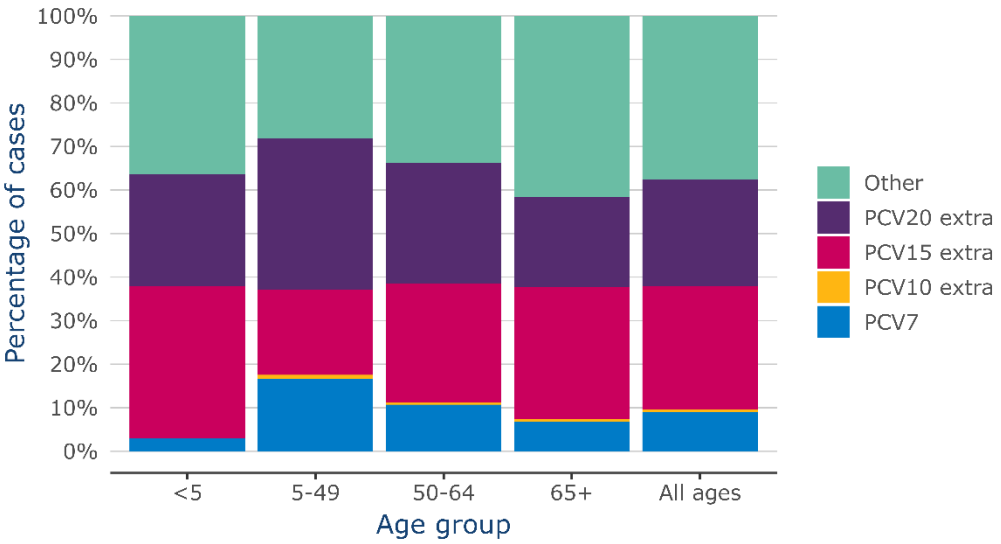
Sentinel surveillance data has been used and extrapolated to the Dutch population until 2023, afterwards national data was used. Only IPD cases diagnosed on the basis of blood or CSF samples have been included.

Figure 6.9.7 Incidence of IPD in persons aged 65 years and over, by vaccine serotype (PCV7 serotypes, PCV10 serotypes, PCV15 serotypes, PPV23 serotypes), as well as all serotype IPD, presented by epidemiological year (e.g. 04–05 = June 2004–May 2005).



PPV23 was introduced in the autumn of 2020 for those born in 1941–1947, in the autumn of 2021 for those born in 1948–1952, in the autumn of 2022 for those born in 1953–1956, in the autumn of 2023 for those born in 1957–1960, and in the autumn of 2024 for those born in 1961–1964. Sentinel surveillance data has been used and extrapolated to the Dutch population until 2023, afterwards national data was used. Only IPD cases diagnosed on the basis of blood or CSF samples have been included.

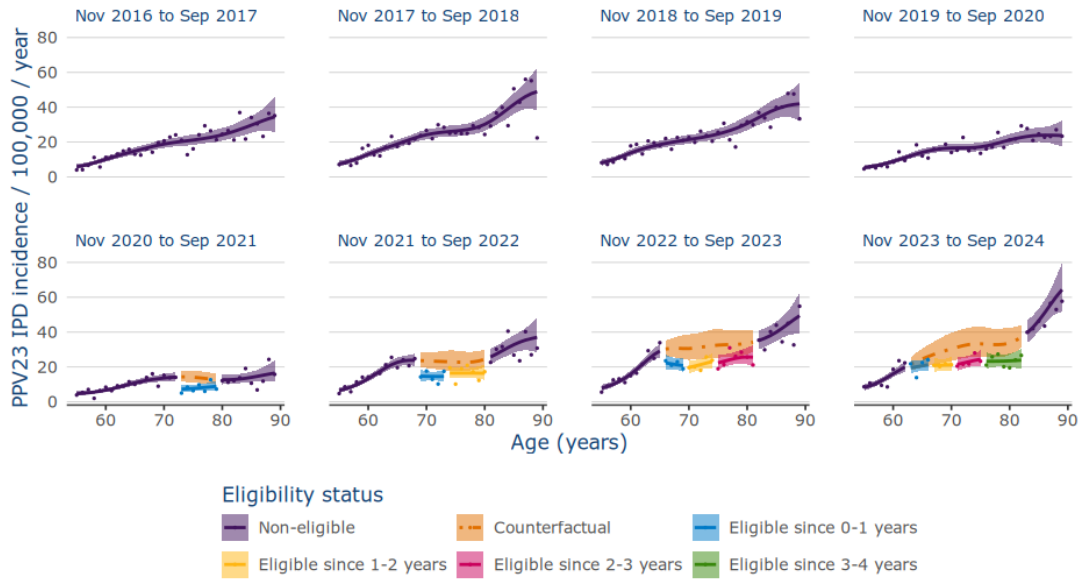
Figure 6.9.8 Vaccine coverage of IPD cases with known serotype per age group in the epidemiological year 2024–2025.



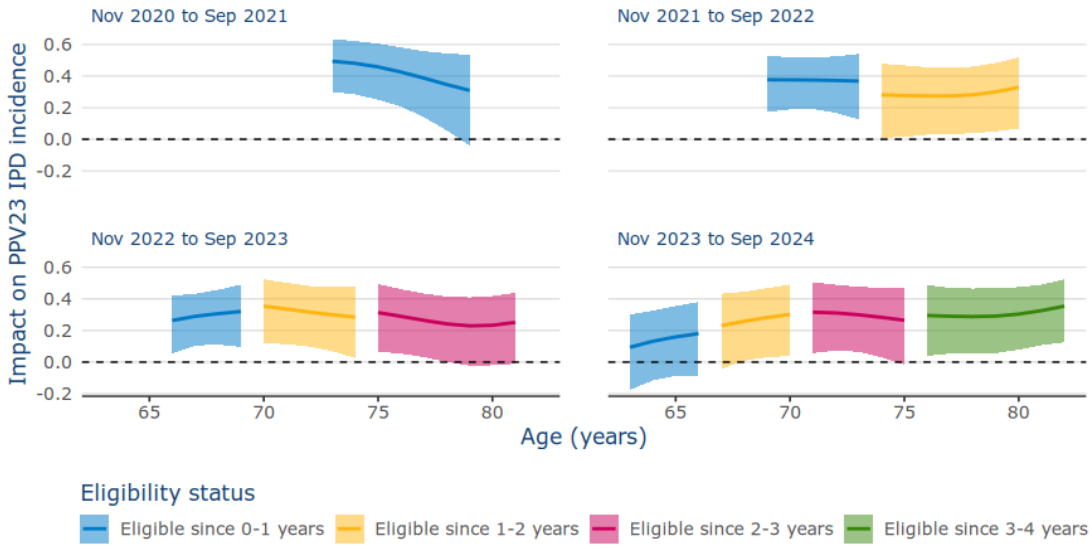
PCV10 coverage includes serotype 6A and PCV15 coverage includes serotype 6C. Serotype 3 is excluded from PCV15/20 coverage (see Table 6.9.2). National surveillance data has been used of IPD cases diagnosed from any normally sterile site.

Figure 6.9.9 A: The incidence of PPV23-type IPD per epidemiological year among age groups, by the eligibility status for the National Programme Pneumococcal Vaccination and B: Impact estimates of PPV23 vaccination on PPV23-type IPD incidence among age groups by the number of years since eligibility for vaccination.

A:



B:



The impact resembles the modelled percentage of PPV23-type IPD cases prevented by vaccination in the age group targeted for vaccination. The non-PPV23-type IPD cases were jointly modelled to optimise the model fit for the coefficient age.

Table 6.9.2 Serotypes included in the different pneumococcal vaccines that are licensed by EMA or FDA.

	Vaccine						
Serotype	**PCV7**	**PCV10**	**PCV13**	**PCV15**	**PCV20**	**PCV21**	**PPV23**
4	X	X	X	X	X		X
6B	X	X	X	X	X		X
9V	X	X	X	X	X		X
14	X	X	X	X	X		X
18C	X	X	X	X	X		X
19F	X	X	X	X	X		X
23F	X	X	X	X	X		X
1		X	X	X	X		X
5		X	X	X	X		X
7F		X	X	X	X	X	X
3 #			/	/	/	/	/
6A *		(X)	X	X	X	X	
6C *			(X)	(X)	(X)	?	
19A			X	X	X	X	X
22F				X	X	X	X
33F				X	X	X	X
8					X	X	X
10A					X	X	X
11A					X	X	X
12F					X	X	X
15B					X		X
2							X
9N						X	X
17F						X	X

	Vaccine						
Serotype	PCV7	PCV10	PCV13	PCV15	PCV20	PCV21	PPV23
20						X	X
15A						X	
15C						X	
16F						X	
23A						X	
23B						X	
24F						X	
31						X	
35B						X	

PCV15 has been used in the NIP from autumn 2024 onwards and PCV20 is used in the National Programme Pneumococcal Vaccination for adults from autumn 2025 onwards. Note that PCV7 is no longer on the market, and that PCV10 is licensed for children but not for adults.
* PCV13, PCV15 and (probably) PCV20 protect against 6C through cross-protection of the 6A antigen. PCV10 protects against 6A through cross-protection of the 6B antigen [1].
# Although PCV13/15/20 and PPV23 include serotype 3 in their license, the vaccine effectiveness is likely to be (very) limited. Therefore, it is not included in the vaccine-specific coverages presented in the text [1, 2].

6.9.3 Epidemiology

Note that as samples are received later than the disease onset date, the most recent months described here may still be incomplete. For further details on surveillance methodology, see Appendix 1.

6.9.3.1 Changes in the vaccination programme

In the autumn of 2024, the 15-valent Pneumococcal Conjugate Vaccine (PCV15, see Table 2 for covered serotypes) replaced the 10-valent PCV10 in the NIP; first replacing the booster dose resulting in combined schedules (2 primary doses of PCV10 and a booster dose of PCV15), but from approximately January 2025, PCV15 replaced PCV10 for all doses. The 23-valent Pneumococcal Polysaccharide Vaccine (PPV23) has been used in the National Programme Pneumococcal Vaccination (NPPV) since the autumn of 2020. From the autumn of 2025, PCV20 will be offered to persons aged 60 years and over in the NPPV. Persons who received PPV23 earlier as part of the NPPV will be offered PCV20 five years after they received PPV23. Also, persons born in 1940 or earlier (who were not eligible for PPV23 previously) will be offered PCV20.

6.9.3.2 Overall

In 2024–2025, 2321 cases of Invasive Pneumococcal Disease (IPD) were reported (12.9 per 100,000 population). Out of these cases, 2273 had a positive blood or cerebrospinal fluid (CSF) sample (12.6 per 100,000), which was similar to the number in 2023–2024 (n=2225; 12.4 per 100,000, Table 6.9.1).
Looking at the incidence over time (based on blood or CSF only), the overall IPD incidence has been quite stable in the epidemiological years 2004–2005 to 2018–2019, with an average incidence of 15.2 per 100,000 (range: 13.3 to 16.9 per 100,000) per epidemiological year (epi-year) (Figure 6.9.1). Following a decrease in incidence during the COVID-19 pandemic, the incidence stabilised at ~12.4 per 100,000 during 2022–2023 to 2024–2025, which is slightly lower than the average in the 5 years prior to the COVID-19 pandemic (15.0 per 100,000). It is too early to say whether this is an actual decrease,

similar to those seen in other countries, or whether it is due to a switch from sentinel to national surveillance (Appendix 1) [3]. The incidence caused by serotypes included in PCV10 decreased over time following the introduction of PCV7 and PCV10 for children, with a temporal additional decrease during the COVID-19 pandemic, while IPD due to non-PCV10 serotypes has increased over time since PCV10 introduction. The 10 most common serotypes in 2024–2025 were 19A (16% of all cases), 8 (15%), 3 (13%), 9N (6%), 12F (6%), 4 (5%), 22F (4%), 6C (4%), 14 (4%), and 23B (4%) (Figure 6.9.2). Compared to 2023–2024, the dominance of serotypes 19A, 8, and 3 remained the same, but 22F was less common. In 2024–2025, the increase in percentage of IPD caused was highest for serotypes 9N (3%), 14 (2.7%), 12F (2%), and 4 (2%), while the percentage caused by serotype 22F decreased considerably (from 8 to 4%). Out of the top 10 serotypes, 19A, 22F, 4, 14, and 6C are covered by PCV15 (the latter through cross-protection [1, 6], see also Table 6.9.2), while serotypes 8 and 12F are covered by PCV20. Notably, serotypes 4 and 14 have been covered by the NIP since PCV7 introduction in 2006–2007. Overall, PCV10 serotypes (plus 6A) represented 10% of IPD cases, PCV15 (plus 6C, minus serotype 3) 38%, and PCV20 (plus 6C, minus serotype 3) covered 62% of IPD cases in 2024–2025 (Figure 6.9.8).

6.9.3.3 Children aged <5 years (Figure 6.9.4)

In 2024–2025, 58 IPD cases aged <5 years with a positive blood or CSF sample were reported, resulting in an incidence of 6.8 per 100,000 (Table 6.9.1). Additionally, in 9 cases aged <5 years, pneumococci were detected in normally sterile sites other than blood or CSF (overall IPD incidence: 7.8 per 100,000). This was slightly lower than in 2023–2024, when 80 cases (incidence 8.5 per 100,000) were reported, out of which 73 had positive blood or CSF samples.

Following the introduction of PCV7 in 2006 and the switch to PCV10 in 2011, the IPD incidence in children aged <5 years decreased and stabilised from 2015–2016 onwards, averaging 6.8 per 100,000 up to 2019–2020 (Figure 6.9.4). After a notable decrease during the COVID-19 pandemic, the incidence increased to beyond pre-pandemic levels during 2021–2022 to 2023–2024 (8–9 per 100,000) and decreased to pre-pandemic level in 2024–2025 (6.8 per 100,000). IPD caused by PCV10 serotypes has become rare among those aged <5 years. Two cases with PCV10-IPD were diagnosed in 2024–2025. IPD caused by PCV15 serotypes decreased from 42 cases in 2023–2024 to 27 cases in 2024–2025.

In 2024–2025, the most common serotype in this age group was serotype 19A (23%, n=15), which is covered by PCV15. Other common serotypes were 12F (11%, n=) and 23B (9%, n=6), which are not covered by PCV15. Overall, PCV15 serotypes (including 6C, excluding serotype 3) caused 42% of IPD cases among children aged <5 years in 2024–2025 (Figure 6.9.7), which was lower than in 2023–2024 (63%). Of the IPD cases in 2024–2025 with known clinical presentation (n=63, 94%), 21 patients (33%) suffered from meningitis with or without sepsis, 14 (22%) had pneumonia or empyema, 5 (8%) had septic arthritis, 2 died (3%), 1 case had mastoiditis, 1 had otitis media, and 19

(30%) had sepsis or bacteraemia without focus (this cannot always be distinguished in the notifications).

In the period from June 2014 to May 2025, 700 IPD cases among children aged under 5 years were reported nationally. For 547 cases (78%), the mortality status was known. Out of those 547 patients, 33 (6.0%) died of the infection. None of the deceased patients was infected with a PCV10 serotype and 10 were infected with a PCV15 serotype. The most common serotypes among deceased children were serotype 8 (n=6), serotype 19A (n=6), and serotype 6C (n=6). Out of the 33 patients who died, 28 were aged <2 years, 6 of whom had known comorbidities (4 were humoral/cellular immunosuppressed). In 2024–2025, 4 children aged <5 years died, one of whom was humoral/cellular immunosuppressed.

6.9.3.4 Persons aged 5–49 years (Figure 6.9.5)

In 2024–2025, 337 IPD cases aged 5–49 years were reported nationally, 332 of which on the basis of blood or CSF samples and 5 on the basis of other material. This resulted in an overall incidence of 3.5 per 100,000 (Table 6.9.1). When looking at longer time trends (in blood or CSF samples), the estimated incidence in 2024–2025 (3.4 per 100,000) was similar to pre-pandemic levels (on average, 3.3 per 100,000 in 2015–2019) (Figure 6.9.5). The incidence of IPD caused by PCV10 serotypes was 0.6 per 100,000 in 2024–2025, which was higher than in 2023–2024 (0.4 per 100,000) and similar to pre-pandemic levels (on average, 0.6 per 100,000 in 2015–2019). The five most common serotypes among persons aged 5–49 years in 2024–2025 were serotypes 8, 19A, 3, 4, and 12F, which was similar to last year. Of all cases in this age group, 18% were covered by PCV10, 37% by PCV15 and 72% by PCV20 (Figure 6.9.7).

6.9.3.5 Persons aged 50–64 years (Figure 6.9.6)

In 2024–2025, 527 IPD cases aged 50–64 years were reported nationally (incidence 14.3 per 100,000), 519 of which on the basis of blood or CSF samples and 8 on the basis of other material. The incidence was slightly lower than in 2023–2024 (n=553, incidence 14.9 per 100,000). When looking at longer time trends (in blood or CSF samples), the estimated incidence for 2024–2025 (14.1 per 100,000) was lower than the pre-pandemic average (mean 17.8 per 100,000) (Figure 6.9.6). The incidence of PCV10-IPD in this age group was higher in 2024–2025 than in 2023–2024 (1.6 and 1.1 per 100,000 respectively), and similar to the pre-pandemic average (1.7 per 100,000). The five most common serotypes were serotypes 19A, 8, 3, 12F and 4, which was similar to 2023–2024. Of all cases in this age group, 11% was covered by PCV10, 38% by PCV15, and 66% by PCV20 (Figure 6.9.7).

6.9.3.6 Persons aged 65 years and over (Figure 6.9.7)

In 2024–2025, 1348 IPD cases aged 65 years and over were reported nationally (incidence 35.9 per 100,000), 1323 of which on the basis of blood or CSF samples and 25 on the basis of other material (Table 6.9.1). The incidence was similar to in 2023–2024 (1307, incidence 35.5 per 100,000). When looking at longer time trends (in blood or CSF samples), the estimated incidence for 2024–2025 (35.9

per 100,000) was lower than the pre-pandemic average (mean 49.1 per 100,000). PPV23 vaccination was introduced in the autumn of 2020. In 2024–2025, the PPV23-IPD incidence was 27.0 per 100,000, which was similar to in 2023–2024 (26.5 per 100,000) but lower than before the introduction of PPV23 (average of 40.0 per 100,000 between the epi-years 2015–2016 and 2019–2020). The estimated impact of PPV23 vaccination in the eligible age-groups is discussed in Paragraph 6.9.3.9. The most common serotypes in 2024–2025 were 19A (17%), 3 (13%), 8 (12%), 9N (7%) and 22F (5%), all of which are covered by PPV23 (though effectiveness against serotype 3 is probably low) [2]. Of all IPD in this age group, 8% of the cases were caused by a PCV10 serotype, 38% by PCV15(+6C-3) serotypes, 59% by PCV20(+6C-3) serotypes, and 76% (including serotype 3) was covered by PPV23 (Figure 6.9.8).

According to the notification data, 108 (9%) out of the 1171 IPD cases aged 65 years and over, that were diagnosed in 2024–2025 and had data on the outcome of the infection available, died because of the infection, which was similar to 2023–2024 (11%). Of the 1348 diagnosed IPD cases, 1032 (78%) had information on comorbidity, of which 780 (76%) had known medical comorbidities. Of the 1348 IPD cases, 1011 were PPV23 eligible (75.0%). The vaccination status was reported for 857 of these eligible cases (85%), of which 403 (47%) were reported to be vaccinated.

6.9.3.7 Vaccine failure after childhood vaccination

For PCVs in childhood vaccination, vaccine failure is defined as having an IPD diagnosis and having received 2 or more doses when aged <12 months or, if aged ≥12 months, having received the primary series and a booster dose or at least one dose beyond the age of 12 months. In all cases, the last dose should have been given at least 2 weeks before disease onset. Since the introduction of PCV7, 59 cases of vaccine-type IPD have been reported among vaccine-eligible children, i.e. children born after 1 April 2006 and aged 2 months and over, or born after 1 January 2020 and aged 3 months and over. In 2020, the PCV schedule changed from 2, 4, 11 months to 3, 5, 11 months. Furthermore, as per 1 January 2025, the timing of the booster was changed to 12 months. Since the schedule change in 2020, one vaccine failure occurred in children eligible for the new schedule. This case occurred in 2024–2025 in a non-humoral/cellular immunosuppressed child vaccinated with PCV10. Out of all 59 eligible children with IPD, 35 were considered vaccine failures. The other 24 cases had not yet received two or more doses of pneumococcal vaccine. Overall, serotype 19F was the most common serotype among vaccine failure cases (n=10, 29%), a serotype known to require relatively high antibody levels for protection [4].

6.9.3.8 Vaccine effectiveness (VE) of childhood vaccination with PCV10 against IPD

The VE of PCV10 was calculated using the indirect cohort (or Broome) method, in which the odds of vaccination in patients infected with a vaccine serotype are compared to the odds of vaccination in patients infected with a non-vaccine serotype. Here, we include all reported IPD patients for the period from June 2011 up to and including May 2025, who had a known serotype and vaccination status and were aged

5 months and over. Patients were assumed to be correctly vaccinated if vaccination according to age occurred at least 14 days before the date used for statistics (see above for the definition for vaccine failure).

A total of 25 PCV10-patients and 559 non-PCV10 patients were included in the analysis. Out of the PCV10-cases, 18 were correctly vaccinated (72%). Out of the non-PCV10 cases, 505 were correctly vaccinated (90%). On the basis of these numbers, the VE was estimated to be 80% (95%CI 48-93) for at least two doses of PCV10 compared to no vaccination.

6.9.3.9 Impact and VE of PPV23 in the National Programme Pneumococcal Vaccination (NPPV) among older adults

In October 2020, the NPPV was started for adults aged 60–79 years and rolled out in phases, starting by vaccination of the oldest cohorts. To assess the impact of the NPPV on the incidence of PPV23-type IPD, a regression discontinuity analysis was performed [5]. In such an analysis, the number of IPD cases is modelled as a function of age, serotype group (PPV23-vaccine-type vs non-PPV23-vaccine-type), eligibility for vaccination, and number of years since PPV23 eligibility. This design controls for unmeasured confounding, and for the effect of the control measures against the COVID-19 pandemic on the IPD incidence [3]. Season-years were modelled from November to October.
Age groups eligible for vaccination were consistently found to have a lower PPV23-IPD incidence than what was expected on the basis of their age (Figure 6.9.8A). The impact of the vaccination programme on PPV23-IPD in the eligible age groups ranged from 14% to 43% (Figure 6.9.8B); the corresponding VE against PPV23-IPD ranged from 41% to 63%.

6.9.4 Current/ongoing research at RIVM

6.9.4.1 Antimicrobial resistance in Streptococcus pneumoniae in the Netherlands

Antimicrobial resistance (AMR) in *S. pneumoniae* complicates the treatment of pneumococcal infections and is a threat to global health. Monitoring AMR is essential to optimise empiric therapy guidelines. Therefore, we explored the longitudinal evolution of pneumococcal resistance in the Netherlands, using data from the Dutch surveillance system of antimicrobial resistance (ISIS-AR) [6]. We specifically examined resistance to antibiotics included in the Dutch treatment guidelines for pneumococcal infections (i.e. (benzyl)penicillin and third-generation cephalosporins) and those classified as high priority by WHO (e.g. macrolides) [7].

We included routinely tested antimicrobial susceptibility data from 28 clinical microbiology laboratories that had provided complete data between 2013 and 2023. In total, 46,000 pneumococcal infection-related isolates were included in the analysis, of which 28% originated from blood/CSF (i.e., from IPD), 61% from the respiratory tract and 12% from other non-invasive sources. Resistance levels were highest for macrolides (9.9%; erythromycin), and low for the β-lactams (benzyl)penicillin (0.2%) and third-generation cephalosporins (0.04%; cefotaxime/ceftriaxone). Susceptibility to macrolides and third-generation cephalosporins did not change significantly over time. For

(benzyl)penicillin, we found a significant increase in both resistant (0.1% in 2013 to 0.3% in 2023; p=0.020) and less susceptible isolates (i.e. isolates that are susceptible but need higher antibiotic dosages) (3.5% in 2013 to 8.5% in 2023; p<0.001). These results indicate that even though β-lactam resistance is low, there is a reduction in (benzyl)penicillin-susceptibility over time. This can have implications for the treatment of pneumococcal infections, considering that (benzyl)penicillin is generally the first-choice antibiotic for both invasive and non-invasive pneumococcal infections in the Netherlands. The stable but high macrolide resistance discourages monotherapy with macrolides as a first-choice therapy, which is consistent with the current Dutch guidelines.

6.9.4.2 Cost-effectiveness analysis of PCV15 and PCV20 in children

The cost-effectiveness of replacing PCV15 (2 primary and 1 booster doses; 2+1) by PCV20 (3+1 doses as licensed) in the Dutch NIP was evaluated, taking into account indirect effects as well as the NPPV with PCV20 for older adults [8, 9].

A multi-cohort Markov model was developed to estimate societal costs and quality-adjusted life years (QALYs) for IPD and hospitalised non-invasive pneumococcal pneumonia in the Dutch population over 10 years. Incidence data were based on PCV10 use in infants, with projections made for switching to either PCV15 or PCV20. Indirect effects and serotype replacement were modelled using trends observed after previous PCV10/13 programmes for infants. For individuals aged 60 to 79 years, the model included the NPPV with PCV20, assuming coverage rates between 55% and 70%. A scenario analysis also considered the use of PCV21 in older adults. Vaccine list prices were used in the analysis.

Switching from PCV15 (2+1) to PCV20 (3+1) would save 212 QALYs among children aged <15 years over 10 years. However, indirect effects would lead to a shift in disease from PCV20 serotypes to non-PCV20 serotypes, reducing the impact of the NPPV, and vaccine costs would increase. As a result, a net health loss of 2,400 QALYs and €182 million in additional costs was found for the total population. Switching to PCV21 for older adults could prevent the net health loss associated with PCV20 (3+1) use in infants, however, the cost per QALY gained would be €160,000, which would not be cost-effective in terms of conventional Dutch cost-effectiveness thresholds.
Despite health gains in children, this analysis suggests that switching from PCV15 (2+1) to PCV20 (3+1), alongside a PCV20-NPPV, would result in a net health loss for the total population and higher overall costs when indirect effects as those observed after introducing PCV10/13 in infants were assumed. While a PCV21 programme for older adults could prevent this net health loss, it would not make PCV20 (3+1) cost-effective at its current price level.

6.9.4.3 Rise of non-vaccine serotype 38 in neighbouring countries

We studied the epidemiological and molecular data on non-vaccine serotype 38 isolates from IPD in Germany, Poland, and the Netherlands in the 2013–2024 period [10]. Surveillance data revealed an increase in the percentage of serotype 38 in IPD in Germany and Poland in the epi-

year 2023–2024, compared to the previous period. The increase was most pronounced among children aged 0–4 years (from 4.3% to 17.1% and 4.0% to 15.8% of IPD cases, respectively) and adults aged ≥60 years (from 1.5% to 7.0% and from 0.7% to 2.9%, respectively). No rise in serotype 38 IPD was observed in the Netherlands.
To examine potential causes, 136 isolates were selected for sequencing from Germany (n=35, 2018–2024), Poland (n=71, 2014–2024), and the Netherlands (n=30, 2017–2024). Of these isolates, 98% belonged to sequence type 393, the same type that was recently reported to increase in IPD among Danish children [11]. A phylogenetic analysis showed that recent isolates from Germany, Poland and the Netherlands mostly emerged from previously circulating strains in the respective countries. No significant changes in (virulence) gene content were found and the isolates carried few antimicrobial resistance genes.
Serotype 38 is not included in any marketed vaccine or vaccine candidate. This study highlighted the importance of monitoring serotype trends within and between countries, to inform vaccine development and to guide policy decisions.

6.9.5 (Inter)national developments

6.9.5.1 (Effect of) childhood vaccination

The global project PSERENADE determined the effect of use of PCV10 and PCV13 in NIPs on pneumococcal *meningitis* in all age groups [12]. The study included surveillance data from 42 sites in 30 countries for the pre-PCV period and six years post-PCV10/13 on the incidence of CSF-positive IPD cases. Using Bayesian multi-level mixed effects Poisson regression, it was estimated that, across products, the incidence of pneumococcal meningitis decreased by 48-74% in children under the age of 5 years, by 35–62% in those aged 5–17 years and by 0–36% in those aged 18 years and over. There was no difference in the impact on vaccine-type meningitis between PCV10 and PCV13. While for IPD in general (all clinical presentations, e.g. sepsis, bacteraemia, meningitis, invasive pneumonia), serotype replacement has, at least partly, balanced out the preventive effect of vaccination in non-vaccinated age groups. This effect was not seen for pneumococcal meningitis, as the increase in non-vaccine type meningitis was generally low or absent for all age-groups.

In England, a 1+1 PCV13 schedule (vaccination at the ages of 12 weeks and 1 year) has been used in the NIP since 2020. National surveillance data was used to compare the characteristics of children eligible for the 1+1 schedule (born in 2020–2022) who developed IPD between April 2022–March 2023, i.e. aged <2 years, to those of children from three equivalent birth cohorts (2015/16, 2016/17, and 2018/19) eligible for the 2+1 schedule who developed IPD during 2017–18, 2018–19, and 2019–20, respectively [13]. In total, 702 IPD episodes in 697 children were included. There were no differences between the 1+1 and 2+1 cohorts in either overall IPD incidence (8.99/100,000 and 9.39/100,000, respectively) or PCV13-type IPD incidence (incidence rate ratio 1.21 (95%CI 0·71–2.00)). Furthermore, characteristics of the IPD cases, including the presence of comorbidity (22% versus 27%), vaccine failure (6.9% versus 3.2%), and fatal outcome (5.7% versus 3.7%), was similar between the 1+1 and 2+1 cohort, respectively. Overall, the 1+1

schedule was non-inferior to the 2+1 schedule in preventing IPD in 2-year-olds.

In Israel, a *post-hoc* analysis of an RCT in infants, comparing the immunogenicity of PCV7 to that of PCV13, was performed to investigate whether the immunological response may be lower for vaccines administered during the respiratory season than in the rest of the year [14]. Participants were classified into groups on the basis of the timing/season of the vaccination. Comparing 188 in-season and 217 out-season children vaccinated with PCV7 to 179 in-season and 225 out-season children vaccinated with PCV13, they showed a reduced IgG level at 7 months for in-season PCV13-vaccinated children for 10 out of 13 serotypes compared to the children vaccinated outside the respiratory season. Following the booster, at 13 months, such a difference was still present for 2/13 serotypes. No such effect was observed for PCV7. The authors suggested that higher-valent PCVs had a higher susceptibility to respiratory viral immune blunting compared to lower-valent PCVs.

The data from the RCT described above was analysed together with immunogenicity data from other clinical trials to estimate the association between serotype-specific IgG levels and their protection against pneumococcal colonisation [15]. A longitudinal study measured IgG concentrations with ELISA 1 month after a booster dose of PCV7 or PCV13. Pneumococcal colonisation was also determined by culturing and serotyping nasopharyngeal swabs taken at 8 intervals during the first 24 months of life. This was combined with aggregated IgG geometric mean concentrations from 20 head-to-head trials comparing 7-, 13-, 15-, and 20-valent PCVs. Risk of colonisation for PCVs in each head-to-head trial was estimated with a Bayesian change point model fitted to the longitudinal IgG and carriage data and then pooled for each PCV comparison. For PCV15 and PCV20, a lower effectiveness against colonisation was predicted compared to PCV7 and PCV13. While risk of colonisation declined with increasing IgG levels for all serotypes, the associations differed for each serotype.

6.9.5.2 Adult vaccination

In addition to PCV13/PCV15 followed by PPV23, the National Health Care Institute of the Netherlands (ZIN) also recommended reimbursing the use of (solely) PCV20 to prevent pneumococcal disease in medical risk-groups [16]. Its use had already been recommended in the guidelines. Following this advice, the Ministry of Health, Welfare and Sports implemented PCV20 reimbursement for medical risk groups from July 2025 onwards [17].

PCV21, which covers eight serotypes that are not covered by the other licenced PCVs, nor by PPV23, was approved by the European Commission for use in individuals aged 18 years and over [18]. PCV21 is recommended in the US for adults with underlying medical risks or those aged 65 years and over [19].

In 2020, PPV23 vaccination among older adults (65+ years) in Australia was changed to PCV13 in those aged 70 years and over. The short-term safety was compared for PPV23 and PCV13 for the period just before

and just after the change (2016–2022)[20]. The study includes data from 300 immunisation providers, who reported any adverse event during the seven days after vaccination. Using mixed-effect logistic regression, the odds ratio (OR) for adverse events was determined for PCV13 versus PPV23. Including 91,116 encounters, PCV13 recipients reported 51% (95%CI 0.47-0.55) fewer events than PPV23 recipients. When receiving concomitant vaccination (mostly influenza, or zoster), the odds of reporting adverse events following pneumococcal vaccination was higher for either type (1.6; 95%CI 1.5-1.7).

In Belgium, a prospective study was performed in 2020–2023 to assess serotype distribution in non-invasive pneumococcal disease (NIPD) cases. Serotype and antimicrobial susceptibility data from NIPD samples was received from 23 participating medical laboratories, resulting in a total of 1008 included samples. Approximately 75% had lower respiratory infections, 18% had otitis media, and 6% had sinusitis; overall about 50% was hospitalised. The serotype distribution and antimicrobial susceptibility data was compared to data on invasive pneumococci from the passive surveillance system [21]. Serotype 3 was the most prevalent serotype found among the non-invasive isolates (29%). The potentially cross-reacting serotype 6C was also often observed (8%). Non-PCV20 serotypes 11A (8%) and 23B (7%) were other commonly observed types among non-invasive isolates. Serotypes not included in PCV20 were significantly more common among the non-invasive isolates than among the IPD isolates. Penicillin non-susceptibility was also more common among non-invasive serotypes (39%) compared to invasive isolates (16%).

Differences in case-fatality rates in IPD caused by PCV13 serotypes or PCV20-non-13 serotypes were investigated in Israel [22]. This study used national surveillance data on 3035 individuals aged 18+ years with IPD reported between 2009–2018. The odds ratios for PCV20-non-13 serotypes and non-PCV20 serotypes compared to PCV13 serotypes for patient mortality were estimated using binary logistic regression. The case fatality rates for PCV13, PCV20-non-13, and nonPCV20 serotypes were 21%, 16%, and 29%, respectively. Patient mortality was found to be more common with non-PCV20 serotypes than with PCV13 serotypes (OR 1.35, 95% C.I. 1.0–1.70). For PCV20-non-13 serotypes there was no significant difference in patient mortality compared to PCV13 serotypes (OR 0.85, 95% C.I. 0.63–1.08).

6.9.5.3 Antimicrobial susceptibility

As presented above (Paragraph 6.9.4.1), in the Netherlands, the susceptibility to macrolides and third-generation cephalosporins did not change significantly over time while an increase was seen in resistant and less susceptible isolates to (benzyl)penicillin. In Italy, AMR among pneumococcal isolates of IPD patients was investigated in the Piedmont region for the 2008–2022 period [23]. Overall, 2076 isolates were included, mainly from (older) adults (<10% children). Among older adults, they observed an increased proportion of isolates being resistant to (benzyl)penicillin, starting from 2020 onwards. The study suggested a potential association with the introduction of PPV23 among older adults (since 2017). No such association was observed among children. The serotype distribution of non-/less susceptible isolates was not presented.

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*Publication with RIVM authors.

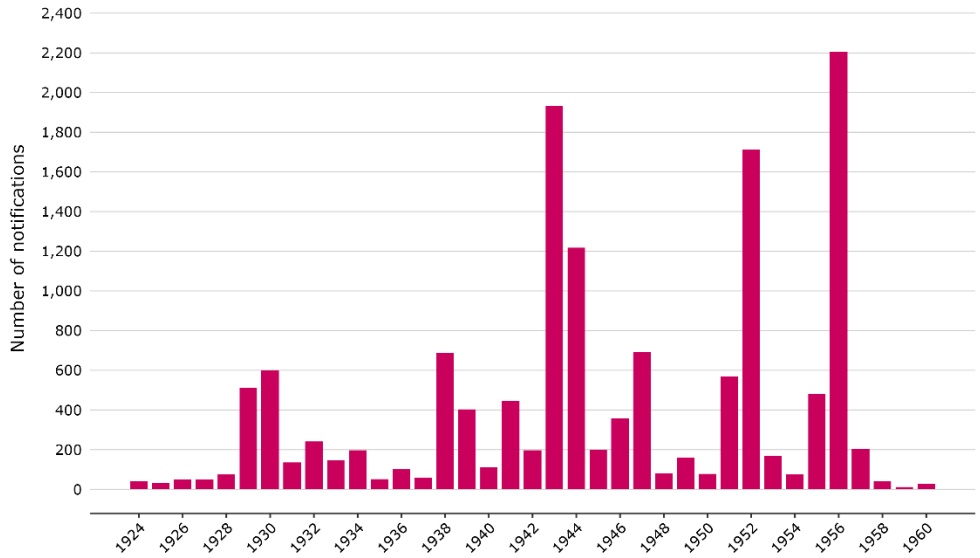
6.10 Poliomyelitis

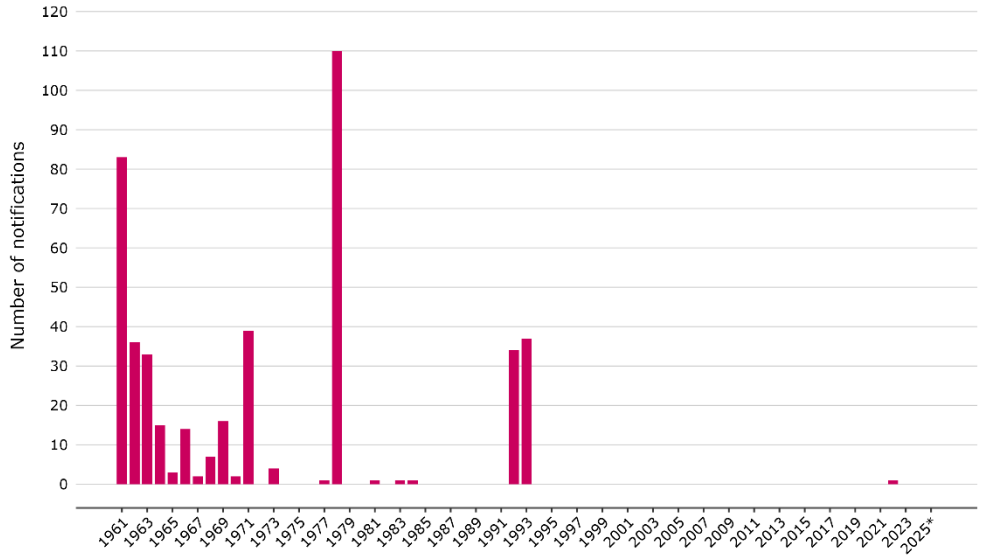
6.10.1 *Key points*

- In 2024, no cases of poliomyelitis were reported in the Netherlands.
- Since 1994, no cases of poliomyelitis have been reported.
- Enterovirus (EV) surveillance in the Netherlands showed that in 96% of the total stool samples analysed in 2024, poliovirus was shown to be absent. From the remaining 4%, the majority was not typed or had an invalid test result. No poliovirus was detected in any sample.
- The percentage of EV-positive stool samples where poliovirus was excluded by the detection of non-polio EVs increased from 59% in 2023 to 63% in 2024. From the remaining 37% samples in 2024, the majority was not typed and therefore, no non-polio EV could be demonstrated.
- Afghanistan and Pakistan remained polio-endemic countries in 2024 and up to and including 19 May 2025.
- For the second year in a row, the global number of circulating vaccine-derived poliovirus type 2 (cVDPV2) cases decreased, with 297 cases in 2024 versus 395 in 2023.
- cVDPV2 detections in sewage samples were reported by Finland, Poland, Spain, and the United Kingdom in 2024 and by Germany in 2024 and up to and including calendar week 23 of 2025. No cVDPV2 cases were reported in these countries and no cVDPV2 was detected in the Netherlands during this period.
- From 2025 onwards, vaccination doses for polio are given at the ages of (2)-3-5-12 months and 14 years instead of at the ages of (2)-3-5-11 months, 4 years and 9 years.

6.10.2 *Tables and figures*

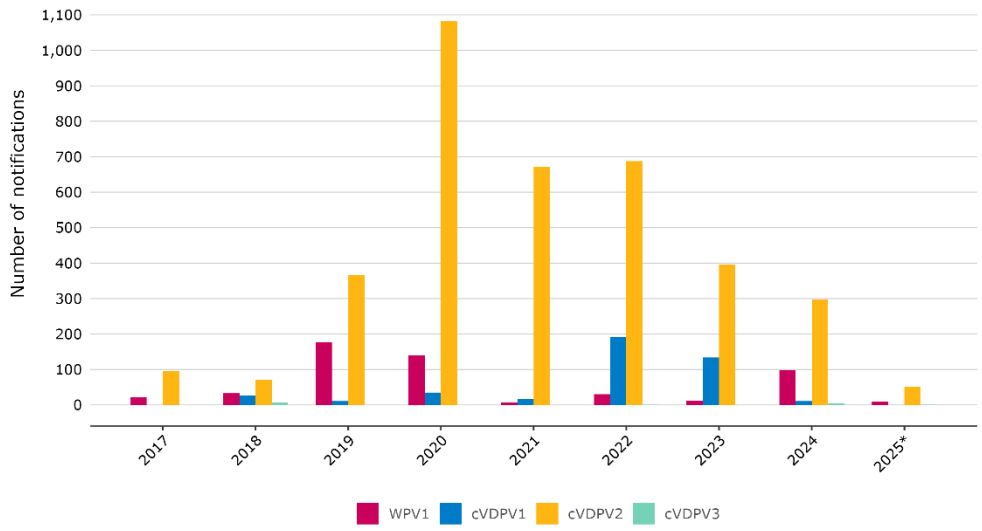
Figure 6.10.1 Notifications of poliomyelitis (acute flaccid paralysis cases and other severe symptoms) in the Netherlands from 1924–1960 (above) and 1961–2025 (below).





In 2022, an asymptomatic poliovirus infection was notified.
*Notifications for the period up to 20 May are included.

Figure 6.10.2 Total number of global polio cases from 2017 to 2025 as reported to WHO (Vaccine-derived Poliovirus and Wild Poliovirus).



* Data is reported for the period up to 20 May 2025.

6.10.3 Epidemiology and pathogen

6.10.3.1 Epidemiology

In 2024 and up to 20 May 2025, no cases of poliomyelitis were reported in the Netherlands.

6.10.3.2 Polio-free status

In 2002, the World Health Organization European Region (WHO EU) was declared wild poliovirus (WPV)-free. Until all six WHO regions have been declared poliovirus-free, establishing and/or maintaining high vaccination coverage and performing high-sensitive surveillance of polio

cases are key. For countries with a strong healthcare system, high levels of sanitation, and a long period of non-endemicity, such as the Netherlands, other surveillance strategies, including enterovirus and environmental surveillance, are also approved.

6.10.3.3 Enterovirus surveillance

For the year 2024, nationwide coverage of enterovirus (EV) surveillance was obtained, as data was received from 42 virological diagnostic laboratories across the country. One laboratory did not report any data. In total, 15,472 stool samples were tested for the presence of EV in order to exclude poliovirus presence. Stool sampling yielded 1367 EV positives, resulting in an average EV positivity rate of 8.8% [1]. According to the Global Polio Laboratory Network, an effective EV surveillance system detects between 5 and 25% of enteroviruses in all stool samples tested annually. Exclusion of poliovirus presence on the basis of EV surveillance can be defined at two levels: the percentage of stool samples for which the presence of poliovirus is excluded and the percentage of EV-positive samples for which the presence of poliovirus is excluded. Poliovirus in EV-positive samples is excluded by the detection of non-polio EVs through sample sequencing. In 96% (14,849/15,472) of the total stool samples analysed in 2024, poliovirus was shown to be absent. From the remaining 4%, the majority was not typed or had an invalid test result. However, no poliovirus was detected in any sample. Poliovirus presence was excluded in 62.8% (858/1367) of EV-positive stools [1]. This percentage is slightly higher than in 2023 (58.5%) [2]. Of the remaining 37% samples in 2024, the majority was not typed and therefore, no non-polio EV could be demonstrated.

6.10.3.4 Environmental surveillance

Environmental surveillance for poliovirus has been in place in the Netherlands since 1997 and, in combination with the system for enterovirus surveillance, has provided clear documentation on the absence of poliovirus circulation in the country (more specifically, in the Bible Belt) over the years. In 2024, 1 out of the 146 sewage samples from residential areas and school sites tested positive for poliovirus: a Sabin-like 3 strain with 3 mutations in polio virus protein 1 (VP1) was detected. All of the 67 sewage samples at Polio Essential Facility (PEF) premises tested negative for infectious poliovirus [3]. In response to the detection of circulating Vaccine Derived Polio Virus type 2 (cVDPV2) in waste water samples in different European countries [4], and the recognition of decreased vaccination coverage in the larger Dutch cities [5], extra environmental surveillance was performed. From the sewage treatment plants (STPs) from Amsterdam (n=2), Den Haag (n=2), Rotterdam (n=4) and Utrecht (n=1) samples were collected twice per week. These samples were analysed for the presence of enterovirus, Sabin 1-2-3 or cVDPV2 emerge group NIE-ZAS-1. RNA was extracted from a total of 155 samples collected between 18/11/2024 and 30/12/2024, and samples were analysed by polymerase chain reaction (PCR). All tested negative for poliovirus [3].

To summarise, in combination with the system for EV surveillance, environmental surveillance activities performed in the Netherlands in 2024 have, again, documented the absence of poliovirus circulation in the country [1, 3].

6.10.4 *Research*

In collaboration with WHO EU, the European Non Polio Enterovirus Network (ENPEN) reviewed the data submitted to WHO regarding acute flaccid paralysis (AFP) cases and the detection of poliovirus reported to three surveillance systems (AFP surveillance, clinical enterovirus, and environmental surveillance) in the European region in the 2015–2022 period [6]. The study revealed the synergy between and the complementary nature of the three surveillance systems. During the study period, all three poliovirus types were reported in the Netherlands, out of which poliovirus type 3 was the dominant type and most of which were vaccine related. Wild type poliovirus (WPV) was only reported from environmental surveillance, where the wild type poliovirus 2 and 3 (WPV2, WPV3) detections in 2017 and 2022, respectively were related to exposure within a vaccine facility in Bilthoven [7, 8].

The National Polio Laboratory (NPL) at RIVM is also a WHO Global Specialized Laboratory (GSL). It participates in several projects run by the WHO Global Polio Laboratory Network (GPLN), including development of sensitive methods for direct poliovirus detection in clinical samples and the feasibility of Next-Generation Sequencing methods to detect poliovirus sequences in clinical samples, sewage samples, and samples from immunocompromised children.

6.10.5 *International developments*

Endemic countries – Afghanistan and Pakistan – have never stopped the transmission of indigenous wild poliovirus. As in 2023, polio remained endemic in only these two countries in 2024 and up to and including 19 May 2025. Export of WPV1 from this endemic region to other countries did not occur in 2024 or up to 20 May 2025. In 2024, the number of cases in both Afghanistan (n=25) and Pakistan (n=74) was the highest since 2020. Moreover, the environmental surveillance detected the highest levels of WPV1 since at least 2018. No WPV1 was detected by the environmental surveillance in countries other than Afghanistan or Pakistan.

The global number of cVDPV2 cases decreased in 2024 compared to 2023 (n=297 versus n=395, respectively), while the number of cases in 2023 had already decreased compared to 2022 (n=688, Figure 6.10.2). Twenty, mainly African, countries reported cVDPV2 cases in 2024. Most cases were reported by Nigeria (n=98) and Ethiopia (n=43). Also in June 2024, cVDPV2 was detected in six environmental samples in Gaza, followed by the first confirmed case of poliomyelitis in a 10-month-old infant [9]. According to WHO, the re-emergence of polio in Gaza is a direct result of the current war, which has devastated the region's healthcare infrastructure and highlights how conflicts can undo decades of public health progress [10]. Although the global number of cases is decreasing, there is still a high risk of an international spread of cVDPV2. This was proven again between September and December 2024, when cVDPV2 detections in sewage samples were reported by Finland, Germany, Poland, Spain, and the United Kingdom [4]. In Germany, cVDPV2 continued to be detected by the environmental surveillance at least up to and including calendar week 23 2025, suggesting some degree of local transmission of cVDPV2 besides multiple separate introductions. No AFP cases were reported in any of

the five countries. According to ECDC, these sewage detections highlight the risk of reintroduction and sustained transmission of WPV and cVDPV in Europe and the importance of continued sewage and AFP surveillance. In addition, ECDC recommends maintaining high vaccine coverage in the general population and increasing the coverage in unvaccinated (sub)populations.

The eradication of polio as a global health threat may be delayed due to United States (US) funding cuts. The longer it takes to eradicate polio, the more children will be paralysed and the more expensive eradication will be. The current US administration also reduced the US Centre for disease control (CDC) activities within/for the WHO Global Polio Laboratory Network, forcing other labs to step in to maintain high quality poliovirus diagnostics and surveillance.

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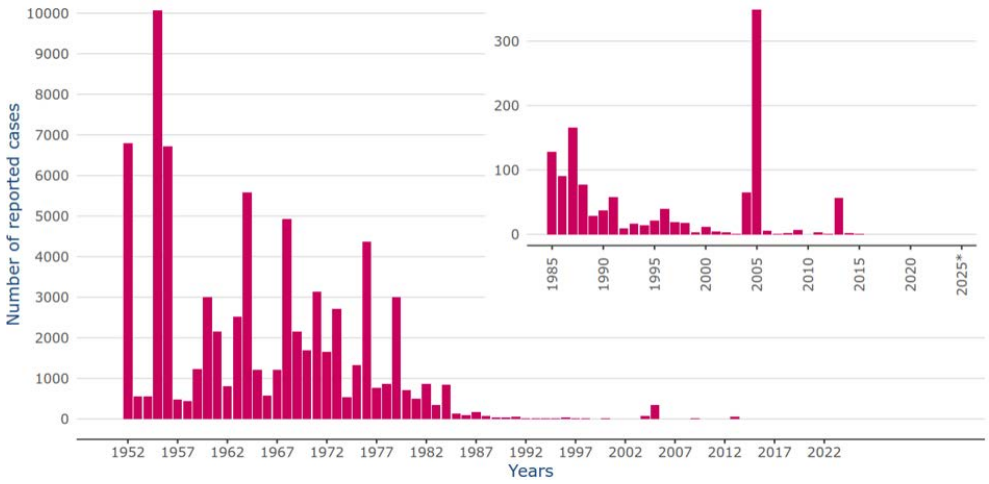
6.11 Rubella

6.11.1 *Key points*

- In 2024, no rubella cases were reported.
- Since 2015, no new cases of rubella have been reported in the Netherlands.
- In 2024, one case of congenital rubella syndrome was reported.
- Starting in 2025, the second dose of MMR will be offered around the 3rd birthday instead of at the age of 9 years. This applies to children born from 1 January 2016 onwards.

6.11.2 *Tables and figures*

*Figure 6.11.1 Annual reported rubella cases since 1952.**



* Data up to the first of May is included for 2025.

6.11.3 *Epidemiology*

Since 2015, no new cases of rubella have been reported in the Netherlands (Figure 6.11.1). In 2024, however, one case of congenital rubella syndrome (CRS) was reported. In 2024, an asylum seeker gave birth to a full-term neonate with CRS [1]. The mother reported having had a facial rash during her fifth month of pregnancy without any other symptom, while she was in Somalia. A detailed report on the CRS case can be found elsewhere [1].

6.11.4 *Pathogen*

No genotype could be obtained for the rubella virus detected in the case with congenital rubella syndrome.

6.11.5 *(Inter)national developments*

By 2023, out of 194 World Health Organization member countries, 175 (90%) had introduced a rubella-containing vaccine (RCV) into their routine immunisation programme [2]. An international modelling study of vaccination showed that in the 19 countries that have not introduced RCV and where an estimated 24,000 CRS cases occurred in 2019, universal RCV introduction would avert an estimated 986,000 CRS cases in the next 30 years (2025-2055). Out of these 19 countries, 15 are in the WHO African Region including Somalia, and four are in the WHO

Eastern Mediterranean Region. On the basis of these estimates and other considerations, in 2024, the World Health Organization recommended universal RCV introduction in these 19 countries.

From 1 May 2024 to 30 April 2025, 30 EU/EEA Member States reported a total of 136 cases of rubella, 16 (1.0%) of which were laboratory confirmed [3]. Twenty-two countries reported zero cases. The highest number of cases were reported by Poland (n = 119), Germany (n = 9), and Sweden (n = 4). The latest available data at the time of writing made clear that out of the 29 countries who routinely report rubella data to ECDC, 27 countries reported rubella data for April 2025, and that five cases were reported by two countries, namely Poland and Italy.

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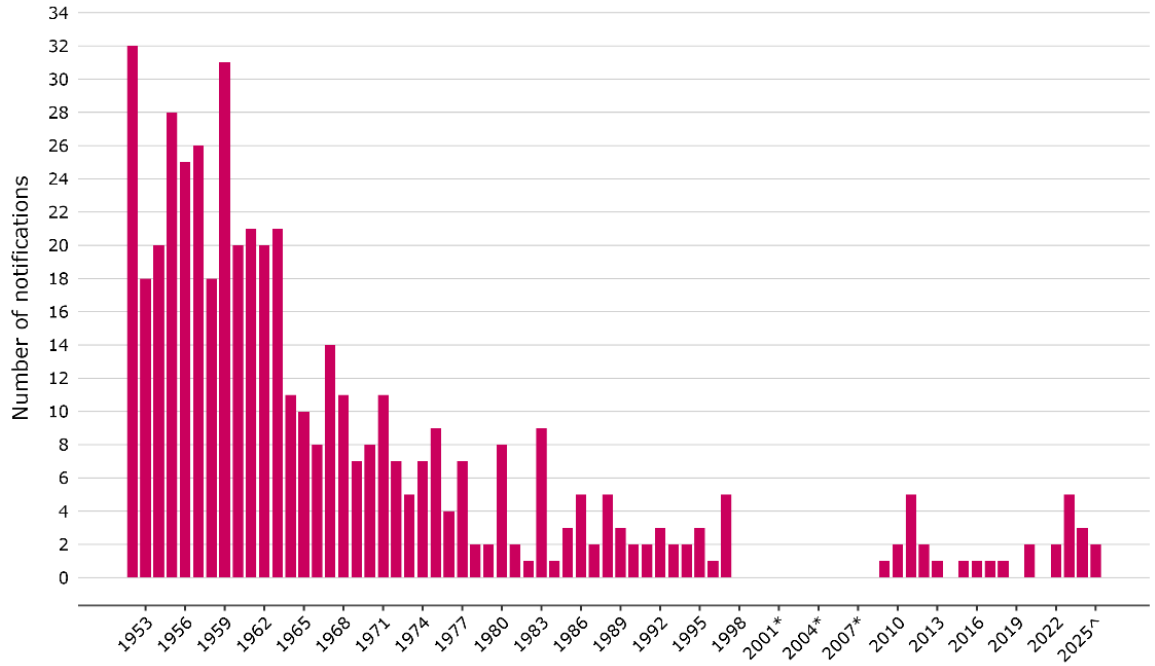
6.12 Tetanus

6.12.1 Key points

- Three tetanus patients were reported in the Netherlands in 2024 (0.02 per 100,000). One of the patients died due to the tetanus infection.
- One patient reported in 2024 was unvaccinated. The other patients were born before the introduction of the National Immunisation Programme (NIP).
- In 2009–2024 between 0 and 5 tetanus patients were notified annually.
- From 2025 onwards, vaccination doses for tetanus are given at the ages of (2)-3-5-12 months, 5 years, and 14 years instead of at the ages of (2)-3-5-11 months, 4 years, and 9 years.

6.12.2 *Tables and figures*

Figure 6.12.1 Reported cases of tetanus in the Netherlands by year, 1952–2025.



Patients are classified by year in order of availability of data: date of symptom onset, date of diagnosis, date of notification.
* Between 1999 and 2008, tetanus was not notifiable.
^ For 2025, notifications for the period up to June were included.

6.12.3 *Epidemiology in the Netherlands*

Three tetanus patients were reported in 2024 and two in 2025 up to June. One patient reported in 2024 was unvaccinated and consulted a physician with a wound. The guideline for PEP administration was not met during this consultation. The patient was hospitalised and recovered. The other four patients were born before the introduction of childhood tetanus vaccination. They suffered a wound, for which two of them consulted a doctor. The guideline for PEP administration was not met during these consultations. The patients were hospitalised and one of them died due to the infection. One of the other two elderly patients was hospitalised and recovered. The remaining one was not hospitalised and died due to the tetanus infection.

6.12.4 *Pathogen*

The diagnosis of tetanus is usually made on clinical recognition; laboratory diagnosis is not often made. *Clostridium tetani* is rarely isolated from suspected patients. In 2024 and 2025, up to and including May, no isolates were received at RIVM for the tetanospasmin gene polymerase chain reaction (PCR). Serological diagnosis is not possible, as infection does not result in a detectable antibody response; the presence of a protective antibody level in a blood sample taken before immunoglobulins are given, will make a tetanus diagnosis unlikely.

6.12.5 *International developments*

There were no significant international developments regarding tetanus in 2024 and 2025 up to June.

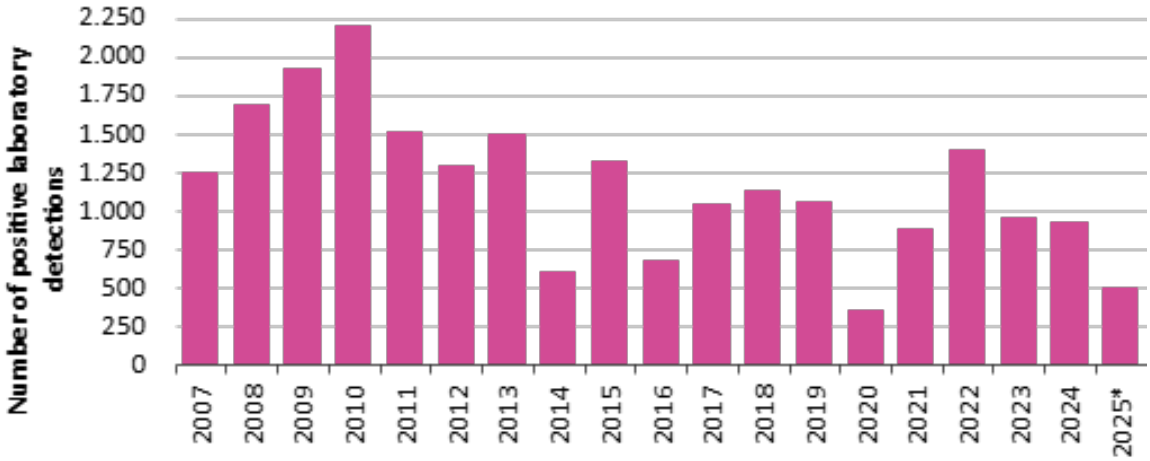
6.13 Rotavirus

6.13.1 *Key points*

- In 2024, 921 rotavirus laboratory detections were reported, which is slightly lower than the average of 977 in 2016–2019 (range: 679–1129), as well as in 2023 (n=959).
- Similar to 2022 and 2023, rotavirus genotype G3P8 was most prevalent in 2024 (57%).

6.13.2 *Tables and figures*

Figure 6.13.1 Number of reported laboratory rotavirus detections in the virological laboratory surveillance per year in the Netherlands, 2007–2025.*



* Until week 25 of 2025

Figure 6.13.2 Number of general practice all-cause gastroenteritis consultations in children aged <5 years per week in the Netherlands, 2014–2024.

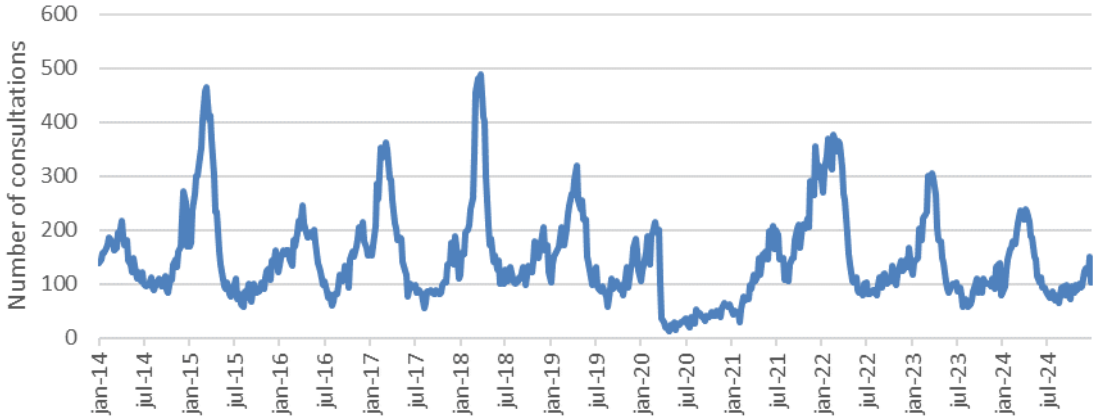
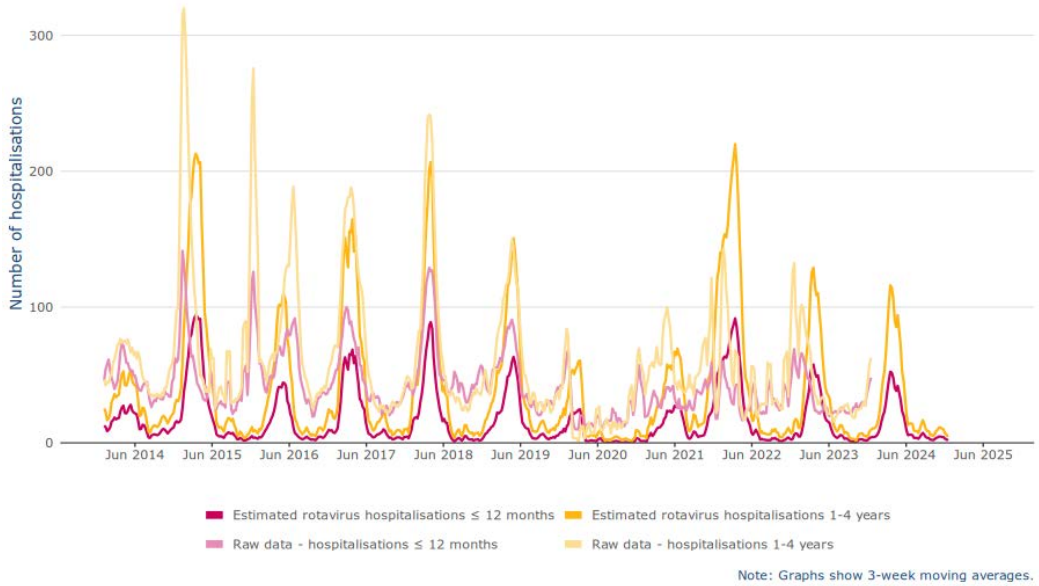


Figure 6.13.3 3-week moving averages of the number of hospitalisations for (rotavirus) gastro-enteritis in children aged <5 years in the Netherlands, 2014–2024.



Hospital admissions with ICD-10 codes A0, A09, K52, and K529 (raw data) were used to estimate the number of rotavirus hospitalisations.

Table 6.13.1 Number of rotavirus samples typed per year and identified genotypes in the Netherlands, 2020–2024.

Type	2020		2021		2022		2023		2024		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
G12P8	0	0	2	3	5	6	1	2	1	2	9	3
G1P8	2	9	13	17	7	8	8	15	8*	15	38	13
G2P4	5	23	11	15	2	2	2	4	1	2	21	7
G3P8	3	14	19	25	65	74	37	69	41	77	165	57
G4P8	0	0	0	0	0	0	0	0	0	0	0	0
G9P8	11	50	29	39	8	9	5	9	0	0	53	18
G9P4	1	5	1	1	0	0	0	0	1	2	3	1
Other	0	0	0	0	1	1	1	2	1	2	3	1
Total	**22**	**100**	**75**	**100**	**88**	**100**	**54**	**100**	**53**	**100**	**292**	**100**

* One isolate of G1P8 was typed as the vaccine strain. Another isolate could not be typed using sequence analysis, but was positive in the vaccine-specific PCR

Table 6.13.2 Number of reported laboratory rotavirus detections and number of hospitalisations for (rotavirus) gastro-enteritis in children aged <5 years in the Netherlands, 2014–2024.

	Laboratory detections	Raw data - hospitalisations <5y	Estimated rotavirus hospitalisations <5y
2014	609	5300	2170
2015	1318	8108	4721
2016	679	6392	2451
2017	1047	6348	3629
2018	1129	6856	3662
2019	1053	5532	3254
2020	350	2413	1139
2021	872	4648	2839
2022	1391	4744	4528
2023	959	3691	2852
2024	921	-	2739

Hospital admissions with ICD-10 codes A0, A09, K52, and K529 (raw data) were used to estimate the number of rotavirus hospitalisations.

6.13.3 Epidemiology

In 2024, universal rotavirus vaccination was added to the NIP. A two-dose schedule is being used with Rotarix®. All babies born on or after 1 January 2024 are offered vaccination at 6–9 weeks and again at 3 months. The vaccine is not administered as an injection, but via drops in the mouth from a small tube. Rotavirus infections are not notifiable in the Netherlands. Therefore, we used the weekly virology laboratory surveillance, the Nivel Primary Care Database, and the estimated number of rotavirus hospitalisations to describe the epidemiology of rotavirus.

6.13.3.1 Laboratory detections

In 2024, 921 rotavirus laboratory detections were reported, which is slightly lower than the average of 977 in 2016–2019 (range: 679–1129) (Figure 6.13.1). The numbers are almost comparable with 2023 (n=959), but lower than in 2022, when 1391 rotavirus detections were reported. The 2022 rotavirus season started early, with an increase in October 2021, instead of its usual start in February. This was probably the result of an increase in the number of children susceptible to rotavirus due to the absence of a rotavirus season in 2020 and a mild season in 2021. The implementation of universal rotavirus vaccination in 2024 did not have an observable effect on the number of laboratory detections, for which no data is available with regard to age, but probably mainly represents hospitalised young children. The lack of vaccine effect is likely because only newborns have been vaccinated until now, leaving the majority of young children susceptible to infection. However, preliminary data for 2025 show a marked decrease in rotavirus laboratory detections, with 498 detections in the first 25 weeks of 2025 compared to 774 detections in the same period in 2024.

6.13.3.2 Consultations in primary care

Nivel Primary Care Database provided data on all-cause gastroenteritis (GE) in children under the age of 5 years consulting their general practitioner. GE was defined as a diagnosis of presumed gastrointestinal infection (ICPC code D73). In 2024, 6610 all-cause GE consultations were reported per 100,000 children aged <5 years (on average 127 per 100,000 per week). This was similar to 2023 (7012 per 100,000 children), but lower than in 2022 and 2021 (8851 and 8237 per 100,000, respectively) and in 2016–2019 (range: 7829–9840 per 100,000). It was higher than in 2020, which was a year with an exceptionally low number of GE consultations (3449 per 100,000). Consultations in 2024 followed the usual seasonal pattern.

6.13.3.3 Hospitalisations

Hospitalisations for rotavirus are estimated on the basis of ICD-10 codes A0, A09, K52, and K529 registered in the Dutch Hospital Data (DHD). These registrations, however, also include hospitalisations for gastro-enteritis cases that are not caused by rotavirus. This is corrected by using a Poisson regression analysis, or a negative binomial regression in case of overdispersion, with hospital admissions for the aforementioned ICD-10 codes per age category as the outcome variable, and the number of rotavirus laboratory detections from the weekly virology laboratory surveillance as the predictor. Resulting coefficients are used to estimate the number of rotavirus hospitalisations by multiplying them by the number of reported rotavirus laboratory detections. All estimations are based on DHD data registered in 2014–2023. Figure 6.13.3 illustrates this procedure. Corrected estimates are notably lower compared to raw data, especially outside of the rotavirus seasons, where the proportion of non-rotavirus-related AGE is higher and rotavirus activity is low. In 2024, 3404 rotavirus-related hospitalisations were estimated. Out of these, 2739 hospitalisations (80%) occurred in children aged <5 years. These numbers are comparable with 2023 when it was estimated that 2852 hospitalisations involved children aged <5 years. The estimated number of admissions in 2024 was 16% lower than in 2016–2019, when an average of 3249 admissions (ranging from 2451 to 3662) was estimated in children aged <5 years, and lower than the estimate from 2022 (4528 estimated admissions). However, the 2024 estimate was higher than in 2020 (1139 estimated admissions) and 2021 (2839 estimated admission), years that were characterised by exceptionally low rotavirus endemicity related to COVID-19 pandemic measures.

6.13.4 Rotavirus genotypes

IDS/RIVM receives faecal samples throughout the year from the Working Group Clinical Virology laboratories for rotavirus genotyping. The results per calendar year are presented in Table 6.13.1. In 2024, G3P8 was the most prevalent genotype (41/53, 77%), which is in line with 2023 (69%) and 2022 (74%). The prevalence of this genotype was higher than in 2020 and 2021 (2020=14%; 2021=25%), when G9P8 was most prevalent. Although the target strain of Rotarix is G1P8, it also offers protection against other circulating genotypes, albeit with varying effectiveness [1].

6.13.5 Research

6.13.5.1 Rotavirus vaccine effectiveness (ROVI study)

In February 2025, the ROVI study was initiated to assess the vaccine effectiveness (VE) of rotavirus vaccination against severe, laboratory-confirmed rotavirus gastroenteritis (RVGE) in children under the age of two years in the Netherlands, evaluating the actual implementation of rotavirus vaccination in the National Immunisation Programme from 2024 onwards. The ROVI study uses a test-negative design and currently involves recruitment of participants at six hospitals across the Netherlands. Patients are eligible for the study if they were born after 1 January 2024 (when rotavirus vaccination was introduced in the Netherlands) and are present at the emergency department or are hospitalised for acute gastroenteritis. Faecal samples from participants are analysed at the RIVM laboratory for a panel of viruses commonly associated with acute gastroenteritis (AGE), including rotavirus, parechovirus, sapovirus, adenovirus, norovirus, astrovirus, and enterovirus. Vaccination status is obtained through a questionnaire and the vaccination registry, Praeventis. Vaccine effectiveness will be estimated by comparing the vaccination status between children testing positive for rotavirus and children testing negative for rotavirus. As of June 2025, 16 children have been recruited of whom 3 tested positive for rotavirus. Recruitment for the ROVI study is planned to continue for at least one additional rotavirus season.

6.13.5.2 Hospital length of stay during and after low-endemic rotavirus seasons

A study was conducted examining the impact of low-endemic rotavirus seasons (2014, 2016, and the COVID-19 pandemic) on hospital length of stay (LOS) for AGE in children under the age of five years in the Netherlands between 2014 and 2022, prior to the introduction of universal rotavirus vaccination. National Hospital Register Data was analysed using multivariable negative binomial models to compare LOS in 2014, 2015, 2016, 2017, and during the COVID-19 pandemic (2020–2022) to the 2018–2019 period. Analyses were adjusted for age, gender, and the type of hospital (academic or general). Additionally, age-stratified analyses were performed.

Compared to 2018–2019, a 26% (IRR: 1.26, 95% CI: 1.21–1.31), 8% (IRR: 1.08, 95% CI: 1.04–1.11) and 7% (IRR: 1.07, 95% CI: 1.03–1.11) higher LOS was observed in 2014, 2015, and 2016, respectively. Furthermore, LOS in 2017 did not significantly differ from that in 2018–2019 (IRR: 1.01, 95% CI: 0.97–1.05). During the COVID-19 pandemic years, LOS was 6% (IRR: 0.94, 95% CI: 0.91–0.97) lower in comparison to 2018–2019. When stratified for age, similar trends were observed in 0- and 1-year-olds, with differences being most pronounced in 0-year-olds. No significant changes in LOS were observed among children aged 2–5 years, except for during the COVID-19 pandemic years, when LOS was 8% lower compared to 2018–2019.

Overall, a decreasing trend in LOS over the years has been observed. Rather than showing an effect of low endemicity, the decline in LOS may reflect changes in hospital policy. This is consistent with the broader decreasing trend in LOS in Dutch hospitals which was already observed between 1980 and 2010 [2, 3].

6.13.6 (Inter)national developments

By the end of 2024, 127 countries had included vaccination against rotavirus infection in their NIPs. Still, few countries with a high burden and mortality of rotavirus disease, such as Somalia, Guinea, and the Central African Republic, have yet to introduce rotavirus vaccination [4].

6.13.6.1 Genotypes

A systematic literature review assessed rotavirus genotype circulation in Europe and the Middle East per country and across three time periods (2006–2010, 2011–2015, and 2016–2021) [5]. Rotavirus genotypes varied greatly across time and geographical area, with G1P8, G2P4, G3P8, G4P8, and G9P8 being the most prevalent genotypes. This review, however, did not differentiate between countries on the basis of whether rotavirus vaccination had been introduced. In another systematic review, genotypes were compared between countries that had introduced rotavirus vaccination and those without rotavirus vaccination [6]. Here, a higher prevalence of G2P4 was observed in countries that had introduced rotavirus vaccination. This could be attributed to G2P4 being a non-vaccine type for the Rotarix vaccine. Because RotaTeq includes G2 in its formulation, it provides better coverage against G2P4 than Rotarix, but still less compared to G1P8 [1]. Longitudinal data from the Americas showed that this increase in G2P4 prevalence did not persist over time, which suggests that the increase may only be transient after rotavirus vaccine introduction. There is no evidence of a long-term vaccine-driven impact on circulating rotavirus genotypes.

6.13.6.2 Vaccine efficacy and effectiveness

A meta-regression analysis was performed to estimate rotavirus vaccine efficacy and effectiveness for four internationally licensed vaccines, on the basis of data from randomised controlled trials reporting vaccine efficacy against severe RVGE and case-control and data from cohort studies reporting vaccine effectiveness against hospitalisation with RVGE in children aged <5 years. Model predictions for 194 countries indicated vaccine efficacy ranging from 18.6% to 94.3% and vaccine effectiveness ranging from 42.7% to 85.7%, with generally better vaccine performance observed in high-income and low-child-mortality countries. In Europe, the predicted vaccine effectiveness was 80.7% (95% CI: 72.0%–86.6%) [7].

Another study combined datasets from 25 test-negative case control studies conducted in 24 countries and calculated rotavirus VE by <5 year-old mortality rates (U5M) strata to study heterogeneity in vaccine performance [8]. Adjusted VE for a complete-series was significantly higher within the low and middle U5M stratum (74%, 95% CI: 64%–81%) compared to high U5M strata (ranging from 52%, 95% CI: 42%–60% to 46%, 95% CI: 31%–57%).

A large test-negative study from the U.S., a high-income, low U5M setting, studying data from 16,188 children aged <5 years between 2009 and 2022, observed an overall VE of 78% (95% CI: 75%–80%) of receiving at least one dose of the rotavirus vaccine against ED visits and hospitalisations for AGE [9]. Further stratification showed that VE

increases with disease severity with a VE of 94% (95% CI: 90%–97%), 80% (95% CI: 77%–83%) and 59% (95% CI: 49%–67%) against very severe, moderately severe, and mild disease, respectively. VE analyses for specific genotypes revealed overall high protection (VE ≥ 78%) against the most common genotypes (G3P[8], G12P[8], G1P[8], and G9P[8]. VE of the Rotarix vaccine against G2P[4] was lowest with 58% (95% CI: 40%–71%). Also, age-stratified analyses revealed a sustained protection against ED visits and hospitalisation in children aged <5 years (VE: 78%, 95% CI: 75%–80%) but a lower VE in children aged ≥5 years (53%, 95% CI: 38%–64%), which suggests waning immunity over time.

Lastly, a narrative systematic review studied the indirect effects of rotavirus vaccination by compiling evidence from 44 studies [10]. Results showed a reduction in RVGE admissions (median IRR: 0.62, interquartile range [IQR]: 0.40–0.82), RVGE outpatient attendances (median IRR: 0.74, IQR: 0.16–0.98)), all-cause AGE admissions (median IRR: 0.56, IQR: 0.56–0.86), and stool rotavirus positivity (median IRR: 0.42, IQR: 0.31–0.57), but not all-cause AGE outpatient attendances (0.92, 0.78–1.17), in unvaccinated children aged <5 years [10]. Vaccine coverage varied across studies; however, the magnitude of the indirect effects did not seem to be largely affected by vaccine coverage. Indirect effects appeared to be greater in higher-income countries and settings with lower under-five mortality rates, but the reasons for this are not well understood.

6.13.7 Literature

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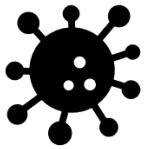
*Publication with RIVM authors.

6.14 COVID-19

6.14.1 Key points



- The primary aim of the COVID-19 vaccination programme in the Netherlands is to prevent serious illness and death from SARS-CoV-2 infections.
- In the autumn of 2024, a new vaccination round started for adults aged 60 years and over, people aged 18 years and over who were also eligible for the seasonal flu vaccine, other children and adults with severe health conditions that put them at higher risk of severe COVID-19, and healthcare workers who have contact with vulnerable patients, and/or clients.
- The Health Council of the Netherlands advised vaccination during the autumn of 2025 for people aged 60 years and over, people aged 50–59 years who were also eligible for the seasonal flu vaccine, other children and adults with severe health conditions that put them at higher risk of severe COVID-19, and healthcare workers who have contact with vulnerable patients, and/or clients. The Minister of HWS decided to adopt this advice.
- During the winter of 2023–2024 and the summer of 2024, about a quarter of vaccinated individuals in the Dutch population experienced a breakthrough infection (28% and 23%, respectively) (source: PIENTER Corona (PICO) study). By the end of 2024, practically all inhabitants, including the oldest age groups, had been infected at least once and/or acquired hybrid immunity.
- Antibody concentrations to XBB.1.5 wane after a month post-vaccination, but one year post-vaccination, levels are still significantly higher than pre-vaccination.
- For the autumn round of 2024 it was not possible to calculate the VE against hospitalisation in the Netherlands due to a lack of data. Studies from the US and Denmark found a moderate (45–46%) to high (70% for Comirnaty ® and 84.9% for Moderna) effectiveness of JN.1 vaccination against hospitalisation.
- The estimated VE against infection was 13% among people aged 60 years and over who received a vaccination during the autumn of 2024 compared to people aged 60+ who had only received their primary series and at least one booster (but not during the autumn of 2024) (source: VASCO study).

6.14.2 *Tables and figures*

Table 6.14.1 Characteristics of the COVID-19 vaccines used in the 2024 autumn round in the Netherlands (16 September 2024 – 6 December 2024).

Vaccine	Type	Offered to ages (years)	Dose
Comirnaty® Pfizer/BioNTech JN.1	mRNA	0.5–4	3 µg (0.2 ml)
Comirnaty® Pfizer/BioNTech JN.1	mRNA	5–11	10 µg (0.3 ml)
Comirnaty® Pfizer/BioNTech JN.1	mRNA	12+	30 µg (0.3 ml)

Figure 6.14.1 Weighted SARS-CoV-2 infection-induced ('Inf', dashed lines) and total ('Tot', i.e. infection and/or vaccination, solid lines) seroprevalence (with 95% confidence intervals) in the general population of the Netherlands in 2023 (April & November) & 2024 (April & October) (following the PICO study rounds 10–13), by age (smoothed in years).

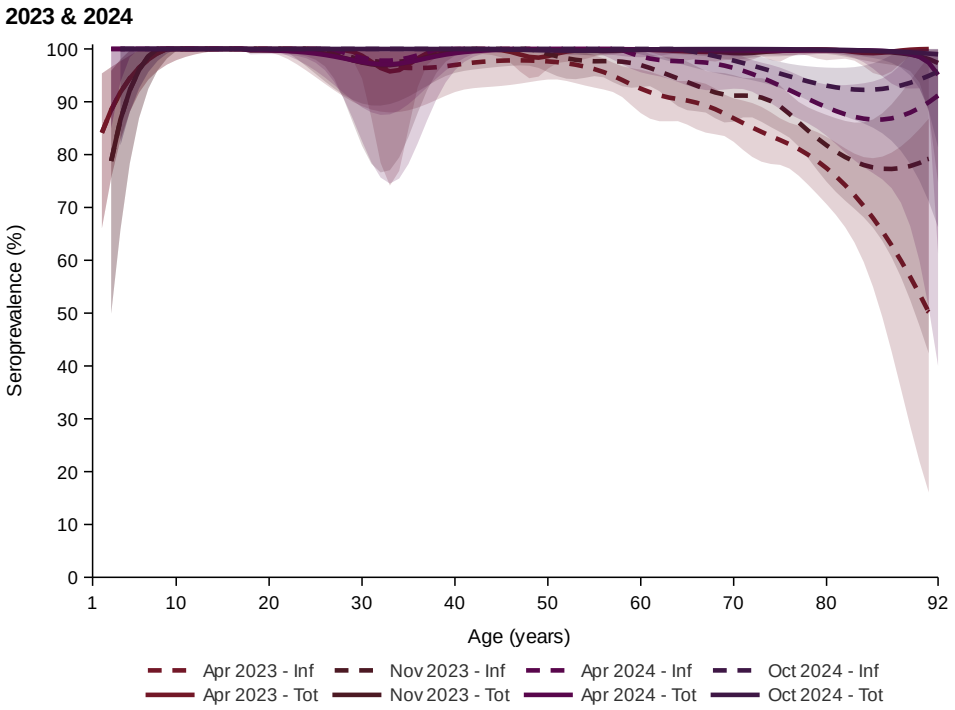


Figure 6.14.2 Weighted SARS-CoV-2 breakthrough infections among vaccinated persons in the general population of the Netherlands during winter 2023/2024 (a) and summer 2024 (b) (following the PICO study), by age categories (years) and reinfection status.

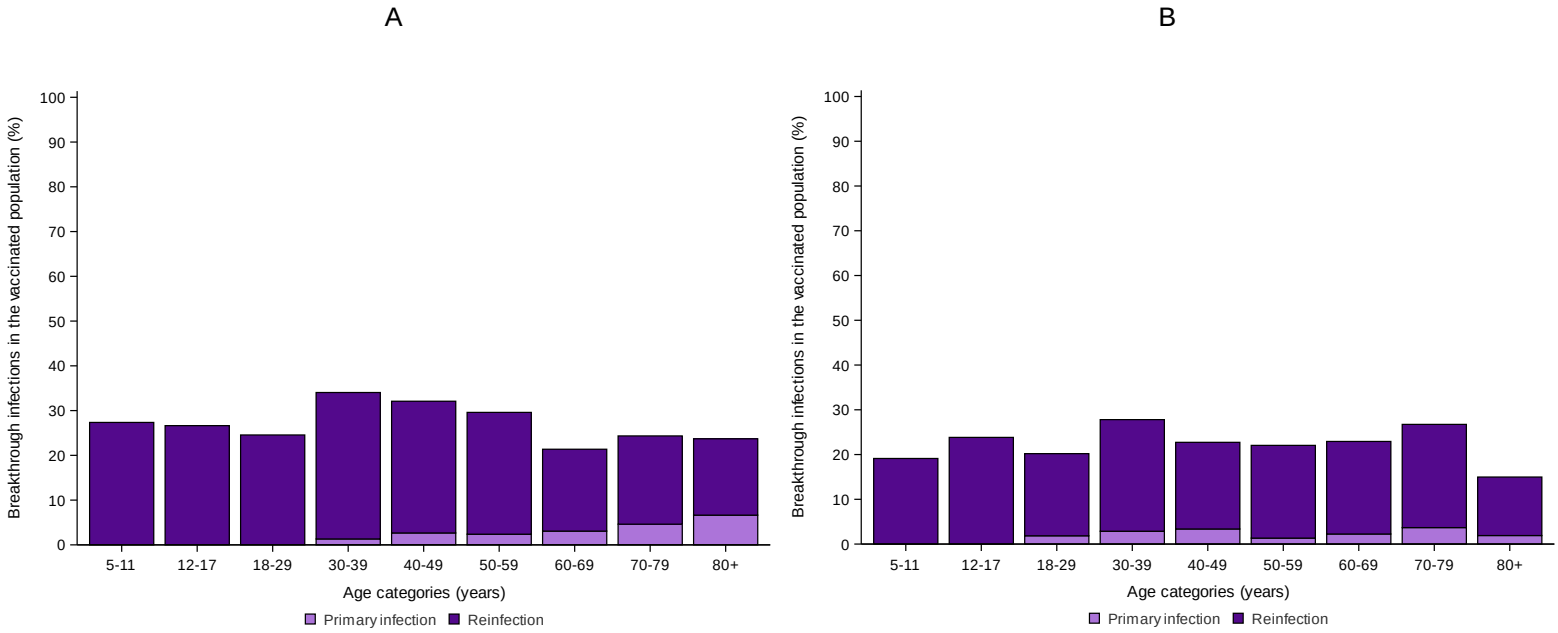
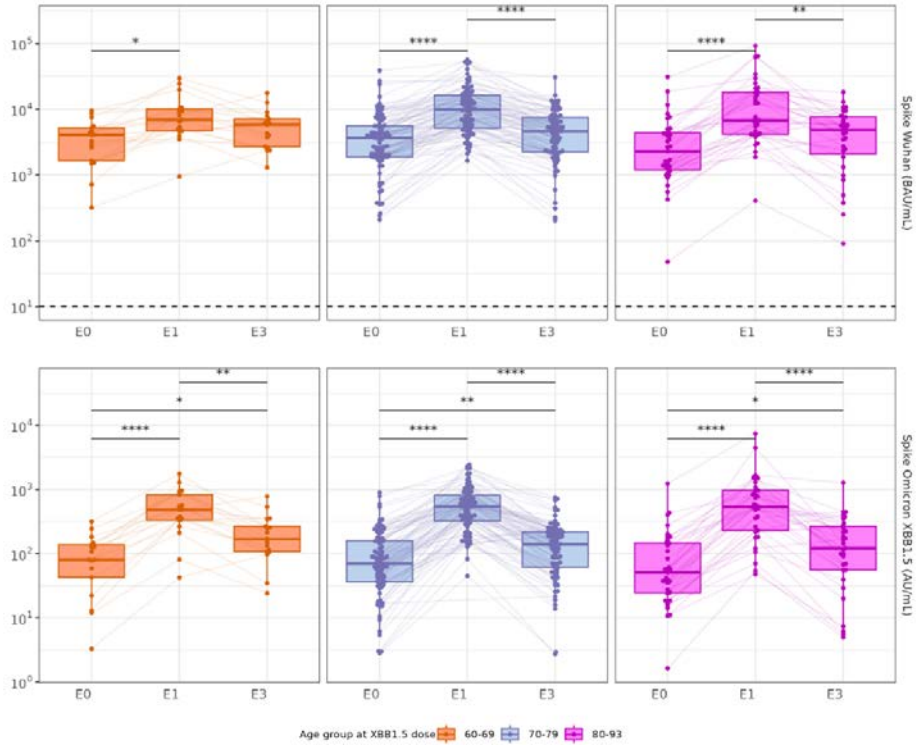
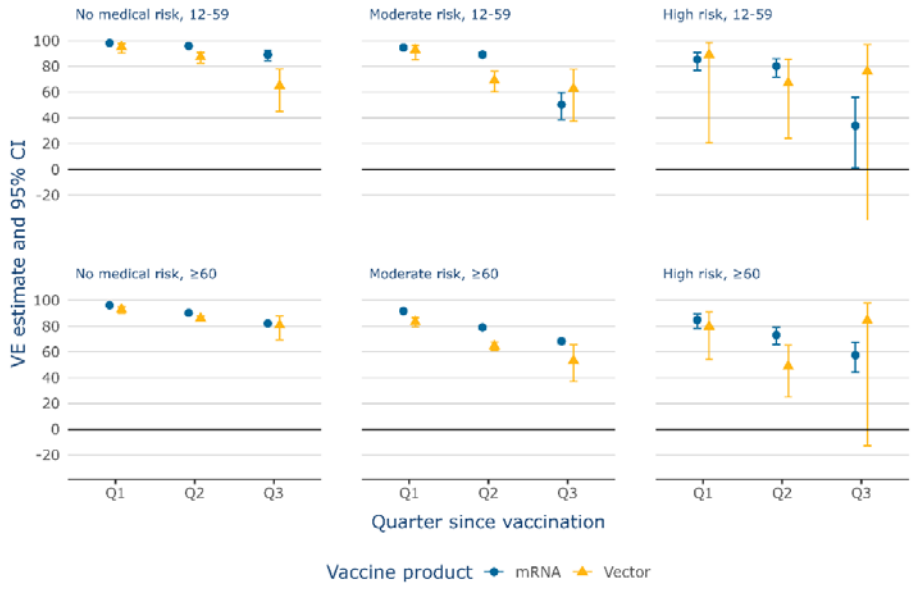


Figure 6.14.3 Spike S1-specific IgG binding antibody concentrations in serum pre-vaccination (E0), and at 1 month (E1) and 1 year (E3) after XBB.1.5 booster vaccination (autumn 2023) for Wuhan (BAU/mL) and Omicron variant XBB.1.5 (AU/mL) across age groups.



The dashed horizontal lines represent the threshold for seropositivity for Wuhan S1 antibodies. The cut-off for Omicron XBB.1.5 remains to be established. BAU: Binding antibody Units; AU: Arbitrary Units. Comparisons E0 vs E1 or E3 and E1 versus E3 were made with paired Wilcoxon signed ranked test (**** p-value (p)<0.0001; *** p<0.001; ** p<0.01; * p<0.05).
Data source: Corona Vaccination Trials

Figure 6.14.4 Vaccine effectiveness (VE) of the second dose against COVID-19 hospitalisation, by vaccine product, age (12–59, ≥60), medical risk group and year-quarter (Q) since vaccination [1].



6.14.3 *Epidemiology and pathogen*

The coronavirus SARS-CoV-2 does not (yet) have a stable seasonal pattern and increased circulation was observed in both the summer and the autumn of 2024. From the beginning of 2025 until the end of the respiratory season (week 20 2025), circulation of the virus remained at a low level. During the last two peaks in 2024, fewer patients with a SARS-CoV-2 infection were admitted to the hospital per week than during peaks in previous years. For more details on the surveillance of SARS-CoV-2 in the Netherlands, please see the overview for the respiratory season 2024/2025 on the webpage Surveillance of respiratory infections – COVID-19.

6.14.4 *Vaccination strategy 2024 and 2025*

The aim of the Dutch vaccination strategy in 2024 was the same as in previous years: to prevent severe illness and death due to COVID-19. Once the vaccination round (from January 2024 until September 2024) had finished, vaccination was only available for adults and children in high medical risk groups who were referred by their treating physician to get a COVID-19 vaccination.

6.14.4.1 Autumn round 2024

The Health Council of the Netherlands advised vaccination during the autumn of 2024 for people aged 60 years and over, people aged 18 years and over who were also eligible for the seasonal flu vaccine, other children and adults with severe health conditions that put them at higher risk of severe COVID-19, and healthcare workers who have contact with patients, and/or clients. The Health Council advised that vaccination during pregnancy is no longer needed, except for pregnant people who belong to one of the risk groups (link to advice). The Minister of Health, Welfare and Sport (HWS) decided to adopt this

advice. We refer to the NIP reports from the last three years for a full overview of the vaccination rounds before 2024.

The autumn round 2024 took place from 16 September onwards. Persons aged 60 years and over received a personal invitation letter for vaccination. People who had also been vaccinated during the autumn of 2023 received a pre-booked COVID-19 vaccination appointment. The pre-booked COVID-19 vaccination appointment included a pre-booked vaccination date, a timeslot, and a location for vaccination, which could be changed if necessary. If it was not possible to schedule a pre-booked appointment, these people received a regular invitation letter instead. Health care workers were informed by their employer. Adults and children in the medical high-risk groups were recommended by their treating physician to get a COVID-19 vaccination. The seasonal flu vaccine group was mainly informed of their eligibility for COVID-19 vaccination through a general communication campaign. They did not receive a personal invitation.

6.14.4.2 Autumn round 2025

In preparation for the advice of the Health Council to the Ministry of HWS regarding a new COVID-19 vaccination campaign, RIVM has prepared a report containing the most recent information about SARS-CoV-2 in the Netherlands [2]. The Health Council advised vaccination during autumn 2025 for people aged 60 years and over, people aged 50–59 years who were also eligible for the seasonal flu vaccine, other children and adults with severe health conditions that put them at higher risk of severe COVID-19, and healthcare workers who have contact with vulnerable patients and/or clients (link to advice). The Minister of HWS decided to adopt this advice.

6.14.5 Research

6.14.5.1 Seroepidemiology: PIENTER Corona study

The PIENTER Corona (PICO) study, a derivative of the PIENTER-3 study that was conducted in 2016/2017, is a Dutch nationwide prospective population-based cohort study that was set up during the early stages of the COVID-19 pandemic [3]. Its primary aim was to assess levels of antibodies to SARS-CoV-2 in consecutive blood samples of over 10,000 unique participants across all ages and regions representative of the Dutch population. In total, thirteen study rounds have been performed up to the end of 2024. A thorough description of the (design of the) study and findings can be found in previous NIP reports from 2020–2024 and multiple scientific publications (e.g. [4-6]). Outcomes of the study have been widely used during the course of the COVID-19 pandemic. For instance, to estimate the proportion of the population that was infected and/or vaccinated, to determine risk factors and trends over time, as input for modelling purposes, and to provide insights into long-term complaints and health-related quality of life. Concurrently, the cohort is being utilised to disentangle the epidemiological changes of other (respiratory) pathogens during the pandemic, such as pertussis (see also Chapter 6.8). The latest SARS-CoV-2 seroepidemiological results are described below.

Throughout the first years of the pandemic, infection-induced seroprevalence in the Dutch population has been highest in those aged

under 60 years (predominantly in adolescents and young adults), and had reached nearly 100% in all adults up to the age of 60 years in the spring of 2023. Overall infection-induced seroprevalence and hybrid immunity were 95% and 94%, respectively, in the spring of 2023; by the end of 2023, both had increased to 97%. By then, 90% of those with comorbidities (compared to 86% in the spring of 2023) had evidence of (at least one) infection (vs. 99% of those without), and congruently, this was the case for over 90% of 70-year-olds and 80% of 80-year-olds (Figure 6.14.1).

During the winter of 2023/2024, over a quarter of vaccinated individuals in the general Dutch population had (serological) evidence of breakthrough infections (28%), which were mostly re-infections (91%). Although the incidence was similar between those with and without underlying conditions (26% vs 28%, respectively), vaccinated individuals in age groups from 60 years were relatively less often infected (21–24%) compared to those under the age of 60 years (25–34%) (Figure 6.14.2a). Overall, infection-induced seroprevalence and hybrid immunity of (at least once-) vaccinated individuals (comprising 84% of the population) had both risen to 100% (95% CI 97–100) in the spring of 2024. The increase in infection-induced seroprevalence since late 2023 was particularly noticeable among men (95% to 99%), those with comorbidities (90% to 96%), and those of older age (e.g. among 70-year-olds it rose to over 95%, and among 80-year-olds it rose to 90%) (Figure 6.14.1). Between the spring and autumn of 2024, a lower proportion of breakthrough infections was observed (23%, of which 90% was a re-infection) than during the previous winter (28%), with those aged 80 years and over least often infected (15%) (Figure 6.14.2b). Infection-induced seroprevalence and hybrid immunity remained at 100% (95% CI 98–100) in the autumn of 2024. Among persons with comorbidities, 98% had evidence of (at least one) infection (vs. 100% of those without). This was also reflected by the infection-induced seroprevalence stratified by age (Figure 6.14.1), reaching nearly 100% in those aged 70 years and over. Similar to our findings, a Dutch blood donor study also observed that the majority of (older) individuals who were uninfected before mid-2022 became infected during the study period that lasted into 2024 [7].

6.14.5.2 Immunogenicity

The Corona Vaccination Trials monitor and evaluate the immunological responses induced by the vaccines delivered as part of the national COVID-19 vaccination programme in healthy participants of all ages eligible for vaccination. Previous results can be found in the earlier NIP reports and updates of the COVID-19 vaccination evidence for the Health Council.

Recently, samples of the one year follow-up timepoint following the autumn 2023 vaccination round have been analysed. Amplitude and kinetics of SARS-CoV-2 Spike S1-specific total binding antibody (IgG) concentrations were measured in serum and mucosal lining fluid from the nose collected before and at 1 and 12 months after vaccination in healthy individuals aged 60 years and over who were vaccinated with the monovalent Omicron variant XBB.1.5-based mRNA vaccine (Comirnaty® (Pfizer/BioNTech)) in the autumn of 2023. Antibody concentrations to Wuhan and the Omicron variant XBB.1.5 were

measured and any waning has been assessed at different time points up to one year post-vaccination in persons aged 60–69, 70–79 and 80+ years. In all three age groups, serum antibody concentrations to XBB.1.5 wane after a month post-vaccination, but a year post-vaccination they are still significantly higher than pre-vaccination (Figure 6.14.3).

6.14.5.3 Vaccine effectiveness (VE)

6.14.5.3.1 *VE against COVID-19 hospitalisation*

The most recent VE estimates concern the risk of COVID-19 hospitalisation among individuals who received a COVID-19 booster vaccination in the 2023 autumn booster round compared to individuals who previously received at least one COVID-19 vaccination, but none in the 2023 booster round [8, 9]. As more recent data on COVID-19 hospitalisations is not yet available at the national level, it is not possible to provide more up-to-date estimates. RIVM is working on setting up the data infrastructure required to resume monitoring of VE against hospitalisation for COVID-19 (and other diseases).

Of note is that a new retrospective study has been conducted, in which VE of one and of two doses of COVID-19 vaccination against first-time COVID-19 hospitalisation from 06-01-2021 to 31-12-2021 in persons aged ≥12 years without registered previous SARS-CoV-2 infection was estimated by age group, medical risk group, and vaccine type [1]. During the pandemic, it was not possible to stratify VE analyses using national level data by medical risk group or previous SARS-CoV-2 infection in the Netherlands, because population-wide medical risk data and SARS-CoV-2 test results were not available for linkage to the national COVID-19 vaccination (CIMS) and hospitalisation (NICE) registries. Such analyses are important for vaccination programmes, for example, because VE may be lower or wane more quickly over time in clinically vulnerable individuals, as suggested by studies from other countries [10-12]. The new study also compared the risk of hospitalisation after one vaccination following a SARS-CoV-2 infection to two vaccinations without a previous infection [1]. Both options were regarded as a completed primary vaccination series in the Netherlands. The study was performed using population-wide register data within the protected environment of Statistics Netherlands.

The study confirmed that two COVID-19 vaccination doses effectively protected against COVID-19 hospitalisation among individuals without a previous registered SARS-CoV-2 infection in 2021. VE was above 90% in the first quarter after vaccination in all age and medical risk groups. Vaccination remained protective at least until three quarters after vaccination, although effectiveness did decrease somewhat over time (Figure 6.14.4). Among persons at moderate/high medical risk, vaccination was also effective, but lower VE and stronger waning of effectiveness were observed (Figure 6.14.4). Therefore, targeting medical risk populations for booster vaccinations to maintain protection, as was done in the Netherlands, was important to protect these individuals at higher risk of severe COVID-19 and to reduce the burden on hospitals. VE of two doses was similar between the age groups 12–59 and ≥60 years. VE with an mRNA vaccine as the second dose generally was somewhat higher than VE with a vector vaccine as the second dose.

The risk of COVID-19 hospitalisation in the first quarter after vaccination was not significantly different between those who received one vaccine dose following a registered SARS-CoV-2 infection and those who received two vaccine doses without a previous registered infection. In the second and third quarter after vaccination among persons without a medical risk condition or in the moderate medical risk group, one dose following an infection was associated with a lower risk of hospitalisation compared to two doses without an infection. This suggests that the policy in the Netherlands to offer one vaccine dose following a SARS-CoV-2 infection for the primary vaccination series was appropriate.

6.14.5.3.2 *VE of maternal vaccination*

COVID-19 vaccination during pregnancy was recommended in the Netherlands between April 2021 and March 2024, mainly because pregnant people had a higher risk of severe COVID-19 than non-pregnant people and because studies showed an increased risk of adverse neonatal health outcomes such as preterm birth among women who had a SARS-CoV-2 infection during pregnancy [13, 14]. Maternal vaccination could protect pregnant people as well as their infants against COVID-19 hospitalisation due to placental antibody transfer [15]. As of March 2024, the Health Council no longer recommended vaccination for pregnant people. They considered the current risk of becoming severely ill or giving birth prematurely following a SARS-CoV-2 infection in pregnancy to be low, because of the high level of immunity against the Omicron variant in the Dutch population [16].

We performed a retrospective nationwide register-based study aiming to assess vaccine effectiveness (VE) of maternal COVID-19 vaccination against COVID-19 hospitalisation in infants aged <6 months and in pregnant people in the Netherlands (unpublished data). The study population consisted of 1) infants born after at least 24 weeks' gestation and 2) all women whose pregnancy started and reached ≥24 weeks of gestation between September 2021 and December 2022 in the Netherlands. For this study, data from the national perinatal registry (Perined), COVID-19 vaccination (CIMS) and COVID-19 hospitalisation (NICE) registries was linked in the protected environment of Statistics Netherlands.

Out of the 81,416 pregnant people and 139,452 infants included in this study, 418 women and 1200 infants were hospitalised for COVID-19. Preliminary results show that no association was found between COVID-19 vaccination during pregnancy and COVID-19 hospitalisation during pregnancy, with an estimated VE of –1% (95% CI: -33–23%). Vaccination during pregnancy was associated with a reduced risk of infant COVID-19 hospitalisation among infants of mothers who did not receive any COVID-19 vaccination before pregnancy (VE=54% (95% CI: 7–77%) and VE=54% (95% CI: 44–62%) for infants of mothers who did and who did not have a SARS-CoV-2 infection before pregnancy, respectively). VE against infant COVID-19 hospitalisation did not differ between trimesters of vaccination. No significant VE of vaccination during pregnancy against infant hospitalisation was observed among infants of mothers who were also vaccinated before pregnancy. Possibly, vaccination during pregnancy has little added benefit when infants are

already protected by antibodies that their mother developed after a vaccination received before pregnancy [17].

6.14.5.3.3 *VE against SARS-CoV-2 infection*

VE of Omicron JN.1 vaccination against SARS-CoV-2 infection was investigated between September 2024 and February 2025 in VASCO (VAccine Study COvid-19), a prospective cohort study that started in May 2021. Questionnaires and serology data are regularly collected and self-tests are provided to participants. JN.1 vaccine-eligible participants (aged ≥60 years, with a medical risk condition, or healthcare workers), who had previously received primary vaccination and at least one booster vaccination, were included in the analyses. VE against SARS-CoV-2 infection was estimated using Cox regression with JN.1-vaccination as time-varying exposure and adjustment for age group, sex, education level, medical risk condition and SARS-CoV-2 infection history. SARS-CoV-2 infection was based on self-reported positive self-tests and/or anti-nucleoprotein antibody results. The variant of infection was determined by whole genome sequencing of viral genetic material in positive self-tests. VE was estimated separately for JN.1 subvariants KP.3.1.1 and XEC using multinomial logistic regression. Out of 4490 JN.1-vaccine eligible participants <60 years of age, 1283 (29%) were vaccinated. Out of 19,349 participants ≥60 years, 14,401 (74%) were vaccinated. During follow-up, 2142 infections occurred, of which the majority was self-reported (1548, 72%). VE was 16% (95%CI:-11–36) in participants <60 years and 13% (2–22) in participants ≥60 years. VE against KP.3.1.1 (n=251; 27%) did not differ significantly from the VE against XEC (n=195; 5%) (OR: 1.3; 0.8–2.1).

6.14.5.3.4 *VE against PostCOVID*

VE of the Omicron XBB.1.5 vaccination against post-COVID-related symptoms was assessed using symptom, infection and vaccination data from the VASCO study [18]. Participants were classified as infected if they reported a positive SARS-CoV-2 self-test during the autumn 2023 infection wave, i.e. between 25 September 2023 and 7 January 2024. The eligible population for the XBB.1.5 vaccination that was considered, were those aged 60 years and over, having a medical risk condition, or being a healthcare worker. In the analysis, infected participants who received the XBB.1.5 vaccination prior to infection were compared to eligible infected participants who did not receive the booster. The prevalence of at least one newly developed post-COVID-related symptom post- versus pre-infection was considered for both groups at 90-day intervals post-infection. At none of the timepoints a significant difference in the prevalence of at least PCC-related symptom was observed. The difference, however, did increase minimally over time; i.e. 0.7% (-2.2–3.5) lower for the booster group at 90 days to 1.7% (-0.9–4.4) at 360 days. These findings are in line with earlier estimates of the effect of a booster vaccination against long-term fatigue following infection [19].

Post-COVID prevalence following the autumn 2023 infection wave was determined as the excess prevalence of at least one newly-developed symptom between SARS-CoV-2 infected participants and matched, contemporaneous participants who were SARS-CoV-2 uninfected in the six months prior to and during the infection wave. The estimated post-COVID prevalence at 90 days was 0.2% (-1.9–2.3), and at 180, 270,

and 360 days this was 0.5% (-1.6–2.6), 0.7% (-1.3–2.8) and 0.0% (-2.1–2·1), respectively. Numerous studies have examined the protective effect of the primary vaccine series against post-COVID. One such study found that the apparent lower incidence rate of PCC from pre-Omicron to Omicron was largely (72%) attributable to vaccination [20]. Interestingly, this protection appears to be most pronounced in preventing post-infectious loss of smell or taste and less so against other symptoms such as fatigue and cognitive problems [21, 22]. If this is the case, the reduction in newly developed post-COVID conditions compared with the early pandemic, could be explained primarily by substantial anosmia and ageusia-specific vaccine-induced protection, and secondarily by a combination of (hybrid) immunity and era-related factors, such as decreased viral pathogenicity affecting other symptom profiles.

6.14.6 (Inter)national developments

6.14.6.1 Vaccine effectiveness

VE of Omicron JN.1 vaccination against COVID-19-associated hospitalisation in immunocompetent adults aged 65 years and over was estimated in two networks in the US using a test-negative case-control design [23]. During the period from September 2024 to January 2025, VE was 45–46% during the first 120 days after vaccination.

A Danish nationwide register-based cohort study assessed effectiveness of two Omicron JN.1 vaccines (Comirnaty® (Pfizer/BioNTech) and Moderna vaccine) against COVID-19-associated hospitalisation and death in the period from October 2024 to January 2025 [24]. Estimated VE of the Comirnaty® (Pfizer/BioNTech vaccine was 70% (95% CI 62–77%) against hospitalisation and 76% (63–85%) against death. And estimated VE of the Spikevax ® (Moderna) vaccine was 84.9% (70.9–92.2%) and 95.8% (69.2–99.4%) against hospitalisation and death, respectively. Protection against JN.1 sublineages KP.3.1.1 and XEC was similar.

6.14.6.2 Risk groups for severe disease and burden of disease

Age remains a very important risk factor for severe COVID-19. Data from the United Kingdom on COVID-19 emergency care, (severe) hospitalisations and deaths between September 2023 and September 2024 shows a steep increase in risk of severe outcomes by age [25]. A meta-analysis published in September 2025 found an increased risk for severe COVID-19 (hospitalisation, ICU admission, or death) during the Omicron era for persons with cerebrovascular disease, chronic obstructive pulmonary disease, diabetes, obesity, respiratory diseases, heart disease, heart failure, or hypertension [26]. In this review, the majority of studies (>50%) that reported vaccination status included fully vaccinated individuals. Most of the results included in the meta-analyses were adjusted for age, comorbidities, and vaccination status. A recent study described the hospital and mortality burden of COVID-19 and influenza in Denmark between May 2022 and June 2024 [27]. It found that COVID-19 was associated with a higher disease burden than influenza, particularly in the first year of the study period (May 2022–May 2023), in the summer and among older people (aged >65 years). Risk factors for more serious COVID-19 disease compared to influenza were being unvaccinated in the past 6 months, having comorbidities,

and being male. The study does not provide information on the burden stratified by comorbidities.

6.14.7 Literature

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*Publication with RIVM authors.

7 Immunisation programme in the Caribbean part of the Kingdom of the Netherlands

7.1 Key points

- In general, vaccination coverage of the NIP for newborns, toddlers, schoolchildren, and adolescents in the Caribbean part of the Kingdom of the Netherlands is high. However, due to differences in target groups and vaccination schedules, data on vaccination coverage is not always easy to compare.
- Overall, the vaccination coverage for COVID-19 vaccination among people aged 60 years and over was low, <15% on all islands. COVID-19 vaccination coverage was highest on Saba.
- There were several changes in the vaccination schedules of all islands in 2025 compared to 2024. Changes differed per island. Among others, rotavirus vaccination was added to the schedules of Bonaire, St. Eustatius and Saba. The booster vaccination for DTaP-IPV-Hib-HBV vaccination is now given at the age of 12 months instead of 11 months. The fifth polio vaccination is given at the age of 14 years instead of 9 years.

7.2 Tables and figures

Table 7.2.1 Immunisation schedule for Aruba in 2025.

Age or school year	Vaccination 1	Vaccination 2
1 month	HBV 1	
2 months	DTaP-IPV-Hib 1	Pneu 1
3 months	HBV 2	
4 months	DTaP-IPV-Hib 2	Pneu 2
6 months	DTaP-IPV-Hib 3	
9 months	HBV 3	
12 months	MMR 1	Pneu 3
15 months	DTaP-IPV-Hib 4	MMR 2
4 years	DTaP-IPV 1	
10 years	DTaP-IPV 2	
11 years	HPV*	

*for girls only.
Abbreviations: HBV: hepatitis B; D: diphtheria; T: tetanus; aP: whooping cough; IPV: polio; Hib: *Haemophilus influenzae* type b; Pneu: pneumococci; MMR: mumps, measles, rubella; HPV: Human papillomavirus.

Table 7.2.2 Immunisation schedule for Bonaire in 2025.

Age or school year	Vaccination 1	Vaccination 2	Vaccination 3
6–9 weeks	Rota	DTaP-IPV-Hib-HBV*	
3 months	Rota	DTaP-IPV-Hib-HBV	Pneu 1
5 months	DTaP-IPV-Hib-HBV	Pneu 2	
12 months	DTaP-IPV-Hib-HBV	Pneu 3	
14 months	MMR-V 1	MenACWY 1	
18 months	MMR-V 2		
5 years	DTaP		
9 years	HPV 1		
9.5 years	HPV 2		
14 years	DTaP	MenACWY 2	

* Only if the mother has not been vaccinated against whooping cough during pregnancy (maternal whooping cough vaccination), and in special situations.
Abbreviations: Rota: rotavirus; D: diphtheria; T: tetanus; aP: whooping cough; IPV: polio; Hib: *Haemophilus influenzae* type b; HBV: hepatitis B; Pneu: pneumococci; MMR: mumps, measles, rubella; V: varicella zoster; MenACWY: meningococcal disease type ACWY; HPV: Human papillomavirus.

Table 7.2.3 Immunisation schedule for Curaçao in 2025.

Age or school year	Vaccination 1	Vaccination 2	Vaccination 3
2 months	DTaP-Hib-HBV 1	Polio 1 (IPV)	
3.5 months	DTaP-Hib-HBV 2	Polio 2 (IPV)	Pneu 1 (13-valent)
5.5 months	DTaP-Hib-HBV 3	Polio 3 (bOPV)	Pneu 2 (13-valent)
>12 months	MMR 1		Pneu 3 (13-valent)
15 months	DTaP-Hib-HBV 4	Polio 4 (bOPV)	MMR 2
4 years	DT 1 (paediatric)	Polio 5 (bOPV)	
9 years	DT 2 (adult)	HPV 1 (4-valent)	
9.5–10 years	HPV 2 (4-valent)		

Abbreviations: D: diphtheria; T: tetanus; aP: whooping cough; Hib: *Haemophilus influenzae* type b; HBV: hepatitis B; IPV: inactivated polio vaccine; bOPV: bivalent oral polio vaccine; Pneu: pneumococci; MMR: mumps, measles, rubella; HPV: Human papillomavirus.

Table 7.2.4 Immunisation schedule for Saba in 2025.

Age or school year	Vaccination 1	Vaccination 2	Vaccination 3
6–9 weeks	Rota	DTaP-IPV-Hib-HBV*	
3 months	DTaP-IPV-Hib-HBV	Pneu 1	Rota
5 months	DTaP-IPV-Hib-HBV	Pneu 2	
12 months	DTaP-IPV-Hib-HBV	Pneu 3	

Age or school year	Vaccination 1	Vaccination 2	Vaccination 3
14 months	MMR-V 1	MenACWY 1	
3 years	MMR-V 2		
5 years	DTaP		
10 years	HPV 1		
10.5 years	HPV 2		
14 years	DTaP	MenACWY 2	

* Only if the mother has not been vaccinated against whooping cough during pregnancy (maternal whooping cough vaccination), and in special situations.
Abbreviations: Rota: rotavirus; D: diphtheria; T: tetanus; aP: whooping cough; IPV: polio; Hib: *Haemophilus influenzae* type b; HBV: hepatitis B; Pneu: pneumococci; MMR: mumps, measles, rubella; V: varicella zoster; MenACWY: meningococcal disease type ACWY; HPV: Human papillomavirus.

Table 7.2.5 Immunisation schedule for St. Eustatius in 2025.

Age or school year	Vaccination 1	Vaccination 2	Vaccination 3
6–9 weeks	Rota	DTaP-IPV-Hib-HBV*	
3 months	DTaP-IPV-Hib-HBV	Pneu 1	Rota
5 months	DTaP-IPV-Hib-HBV	Pneu 2	
12 months	DTaP-IPV-Hib-HBV	Pneu 3	
14 months	MMR-V 1	MenACWY 1	
18 months	MMR-V 2		
5 years	DTaP		
10 years	HPV 1		
10.5 years	HPV 2		
14 years	DTaP	MenACWY 2	

* Only if the mother has not been vaccinated against whooping cough during pregnancy (maternal whooping cough vaccination), and in special situations.
Abbreviations: Rota: rotavirus; D: diphtheria; T: tetanus; aP: whooping cough; IPV: polio; Hib: *Haemophilus influenzae* type b; HBV: hepatitis B; Pneu: pneumococci; MMR: mumps, measles, rubella; V: varicella zoster; MenACWY: meningococcal disease type ACWY; HPV: Human papillomavirus.

7.2.6 Immunisation schedule for Sint Maarten in 2025.

Age or school year	Vaccination 1	Vaccination 2
2 months	DTaP-IPV-Hib 1	HBV 1
3 months	DTaP-IPV-Hib 2	HBV 2
4 months	DTaP-IPV-Hib 3	Pneu 1
6 months	HBV 3	Pneu 2
12 months	DTaP-IPV-Hib 4	MMR 1
15 months	MMR 2	Pneu 3
4 years	DT-IPV	
9 years	DT-IPV	HPV1*
9.5 years	HPV 2*	

*For girls only.
Abbreviations: D: diphtheria; T: tetanus; aP: whooping cough; IPV: polio; Hib: *Haemophilus influenzae* type b; HBV: hepatitis B; Pneu: pneumococci; MMR: mumps, measles, rubella; HPV: Human papillomavirus.

Table 7.2.7 (continues on the next page) Vaccination coverage[a,b] in the Netherlands Caribbean region.

Newborns (aged 2 years)

	Aruba	Bonaire	Curaçao	Saba	St. Eustatius	St. Maarten
Number in cohort 2022	*948*	*242*	*	*20*	*32*	*
Number DTa(P)-IPV-Hib(-HBV)	[d] 879	209	*	20	24	*
% DTa(P)-IPV-Hib(-HBV)	92.7%	86.4%	*	100%	75.0%	*
Number HBV	[d] 898	n.a.	n.a.	n.a.	n.a.	*
% HBV	94.7%	n.a.	n.a.	n.a.	n.a.	*
Number Polio	n.a.	n.a.	*	n.a.	n.a.	n.a.
% Polio	n.a.	n.a.	*	n.a.	n.a.	n.a.
Number Pneu	[d] 888	216	*	20	24	*
% Pneu	93.7%	89.3%	*	100%	75.0%	*
Number MMR(V)1	[d] 894	222	*	20	27	*
% MMR(VZV)1	94.3%	91.7%	*	100%	84.4%	*
Number MMR(V)2	n.a.	172	*	n.a.	n.a.	n.a.
% MMR(V)2	n.a.	[h] 71.1%	*	n.a.	n.a.	n.a.
Number MenACWY	n.a.	217	n.a.	20	27	n.a.
% MenACWY	n.a.	89.7%	n.a.	100%	84.4%	n.a.

Toddlers (aged 5 years)

	Aruba	Bonaire	Curaçao	Saba	St. Eustatius	St. Maarten
Number in cohort 2019	*1235*	*266*	*	*18*	*34*	*
Number DT(aP)(IPV)	[d] 1059	171	*	18	12	*
% DT(aP)(IPV)	85.7%	64.3%	*	100%	35.3%	*
Number MMR(V)2	[d] 1040	n.a.	n.a.	18	12	*
% MMR(V)2	84.2%	n.a.	n.a.	100%	35.3%	*

Schoolchildren (aged 10 years)

	Aruba	Bonaire	Curaçao	Saba	St. Eustatius	St. Maarten
Number in cohort 2014	[e] *1422*	*297*	*	*21*	*52*	*
Number DT(aP)(IPV)	1154	44	*	21	40	*
% DT(aP)(IPV)	81.2%	[i] 14.8%	*	100%	76.9%	*
Number MMR2	1345	129	n.a.	21	n.a.	n.a.
% MMR2	[f] 94.6%	[i] 43.4%	n.a.	100%	n.a.	n.a.

Adolescent girls (aged 10 years)

	Aruba	Bonaire	Curaçao	Saba	St. Eustatius	St. Maarten
Number in cohort 2014	[g] *728*	*163*	*n.a.*	*<10*	*22*	*
Number HPV	494	20	n.a.	<10	12	*
% HPV	67.9%	[i] 12.3%	n.a.	100%	54.5%	*

Table 7.2.7 (continued) Vaccination coverage[a,b] in the Netherlands Caribbean region.

Adolescent boys (aged 10 years)

	Aruba	Bonaire	Curaçao	Saba	St. Eustatius	St. Maarten
Number in cohort 2014	*n.a.*	*n.a.*	*n.a.*	*12*	*20*	*
Number HPV	n.a.	n.a.	n.a.	12	8	*
% HPV	n.a.	n.a.	n.a.	100%	40%	*

Adolescents (aged 15 years)

	Aruba	Bonaire	Curaçao	Saba	St. Eustatius	St. Maarten
Number in cohort 2009	*n.a.*	*n.a.*	*n.a.*	*20*	*31*	*n.a.*
Number MenACWY	n.a.	n.a.	n.a.	13	8	n.a.
% MenACWY	n.a.	n.a.	n.a. [c]	65.0%	25.8%	n.a.

* Not reported in time/ due to circumstances reporting was not possible.

a The registration systems in the Netherlands Caribbean region (with the exception of Aruba) are not linked to the national population register. As a result, immigration and emigration cannot be monitored as precisely as in the European Netherlands. The figures in this table provide the closest possible approximation.

b Vaccination status at the age of 2 years: DTaP-IPV/MMR/MenACWY = basic immunity, Hib/HBV/PCV = completed; at the age of 5 years: DT(aP)- IPV = revaccinated, MMR = completed; at the age of 10 years: DTaP/MMR/HPV = full participation; at the age of 15: MenACWY = full participation.

c Interim vaccination coverage: the vaccination is linked to school year, not birth year. Part of these children will be offered vaccination in 2025.

d On Aruba, this concerns all children born in 2022 and 2019, respectively, who received the correct number of vaccinations for their age before or on 31 December 2024.

e On Aruba, the DT(aP)-IPV is provided in year 7 of regular education, regardless of age, and at the age of 10 years in special education. These figures relate to the schoolyear 2023–2024 rather than to cohort 2014, at age 10.

f As from cohort 2008, MMR2 vaccination has been brought forward, meaning that the percentage of children vaccinated for MMR2 is higher than that of DTaP at this age.

g On Aruba, HPV vaccination is given to girls in year 8, regardless of age. These figures relate to schoolyear 2023–2024, rather than to cohort 2014, at age 10

h As from 2019, Bonaire has moved its MMR2 vaccination from 9 years to 18 months.

i The relatively low vaccination coverage observed in the 2014 cohort may be attributable to the presence of children who are registered within the administrative system but are not actively accounted for by Youth Health Care (YHC). This could, for instance, result from these children residing predominantly in the Netherlands for extended periods of time.

Source (in Dutch): Vaccinatiegraad Rijksvaccinatieprogramma Nederland. Verslagjaar 2025.

Table 7.2.8 COVID-19 vaccination coverage in the Netherlands Caribbean region[1]

Island	Number and percentage 60+
Aruba[2]	-
Bonaire	12%
Curaçao	<5%
Saba	13%
St. Eustatius	<5%
St. Maarten	<5%

[1] Data sources: DVG (Aruba), OLB-PG (Bonaire), UO G&Gz (Curaçao), Public Entity Saba (Saba), Public Entity Sint Eustatius (Sint Eustatius), CPS (Sint Maarten).

2 Due to changes in registration policy, no data on COVID-19 vaccination is available for Aruba.

7.3 Immunisation schedules

The immunisation schedules for the islands in the Caribbean part of the Kingdom of the Netherlands are presented in Tables 7.2.1–7.2.6. See the recent and upcoming changes to immunisation schedules of the islands below.

7.3.1 Recent and upcoming changes to the immunisation schedules

As from 2025, some changes in the NIP schedule have been implemented. On Bonaire, rotavirus vaccination has been added to the schedule. The booster vaccination for DTaP-IPV-Hib-HBV and Pneu is administered at the age of 12 months instead of 11 months. Also, as from 2025, DTaP vaccination is administered at the age of 5 years instead of 4 years. No polio vaccination is given together with DTaP at the age of 5 years. DT-IPV vaccination is not given at the age of 9 years, but at 14 years.

On Saba, rotavirus vaccination has been added to the schedule at the ages of 6–9 weeks and 3 months from 2024 onwards. As from 2025 some changes in the NIP schedule have been implemented. The booster for DTaP-IPV-Hib-HBV and Pneu is given at the age of 12 months instead of 11 months. MMR-V and MenACWY vaccinations are given at the age of 14 months instead of 12 months. MMR-V vaccination is given at the age of 3 years of age instead of 4 years for children born in 2022 onwards. DTaP-IPV vaccination changed to DTaP vaccination and is given at the age of 5 years instead of 4 years for children born from 2021 onwards. HPV vaccination is given at the age of 10 years instead of 9 years for children born from 2016 onwards. DTaP vaccination is given at the age of 14 years instead of 9.5 years for children born from 2016 onwards. For children born in 2025, Saba is expected to start with RSV immunisation from August/ September or October 2025 onwards. On St. Eustatius, rotavirus vaccination has been added to the vaccination schedule at the ages of 6–9 weeks and 3 months in 2025. As of 2025, the booster vaccination for DTaP-IPV-Hib-HBV and Pneu is given at the age of 12 months instead of 11 months. MMR-V and MenACWY vaccinations are given at the age of 14 months instead of 12 months. The second MMR-V vaccination is given at the age of 18 months instead of 4 years. DTaP vaccination is given at the age of 5 years instead of 4 years, without polio vaccination. DT-IPV vaccination is given at the age of 14 years instead of 9 years.

On Aruba and St. Maarten (Dutch part of the island) the second MMR vaccination has been given at the age of 15 months instead of 4 years from 2024 onwards.

On Curaçao the pneumococcal vaccine has changed from PCV10 to PCV13 from 2024 onwards. The HPV vaccine has changed to a 4-valent vaccine.

7.4 Vaccination coverage

7.4.1 Childhood vaccinations

In general, vaccination coverage in the Caribbean part of the Kingdom of the Netherlands is high (Table 7.2.7). However, due to differences in target groups and vaccination schedules, data on vaccination coverage

is not always easy to compare. The method used for determining vaccination coverage often results in an underestimation for schoolchildren, as vaccinations are usually offered per school year regardless of a child's year of birth. As a result, the age limits of 5, 10, and 15 years are not always met. Due to circumstances, it was not possible to provide data on Curaçao and St. Maarten in time.

7.4.2 COVID-19

In the Netherlands Caribbean region, the same risk groups are eligible for vaccination as in the European Netherlands. The COVID-19 vaccination coverage among people aged 60 years and over is low in the Netherlands Caribbean region (the highest vaccination coverage was 13% in Saba) compared to the European Netherlands (vaccination coverage was 46.6%) (Table 7.2.8).

7.5 Epidemiology of diseases included in the NIP

Surveillance data in the Caribbean part of the Kingdom of the Netherlands has been available from 2017 onwards for Bonaire and Saba, and from 2021 for Sint Maarten. In those eight years, there have been two pertussis cases on Bonaire, one in 2017 and one in 2018. Additionally, one case of invasive pneumococcal disease was reported on Sint Maarten in 2022.

In 2024, three cases of hepatitis B were reported on Bonaire, two of which concerned chronic hepatitis B. This aligns with the average observed between 2014 and 2023, when 2–3 cases were reported annually. Most cases concern import cases; hepatitis B detections among locals occur sporadically. In recent years, the population of Bonaire has grown substantially, resulting in changes in its demographic composition. There has been a notable influx of individuals from other Caribbean countries, Latin America, Europe, and Asia. In addition, health screening has become more rigorous in recent years, and reporting practices of notifiable diseases have improved. As a result, reporting of (chronic) hepatitis B is likely to become more frequent on Bonaire.

In 2024, one case of parapertussis was reported on Saba. However, the case was not notifiable due to lack of typical symptoms. In 2024, four hepatitis B cases were reported on Sint Maarten. For Curaçao, St. Eustatius, and Aruba, it was not possible to provide data on cases of diseases included in the NIP in 2024.

8 Potential NIP target diseases

8.1 Hepatitis A

8.1.1 Key points

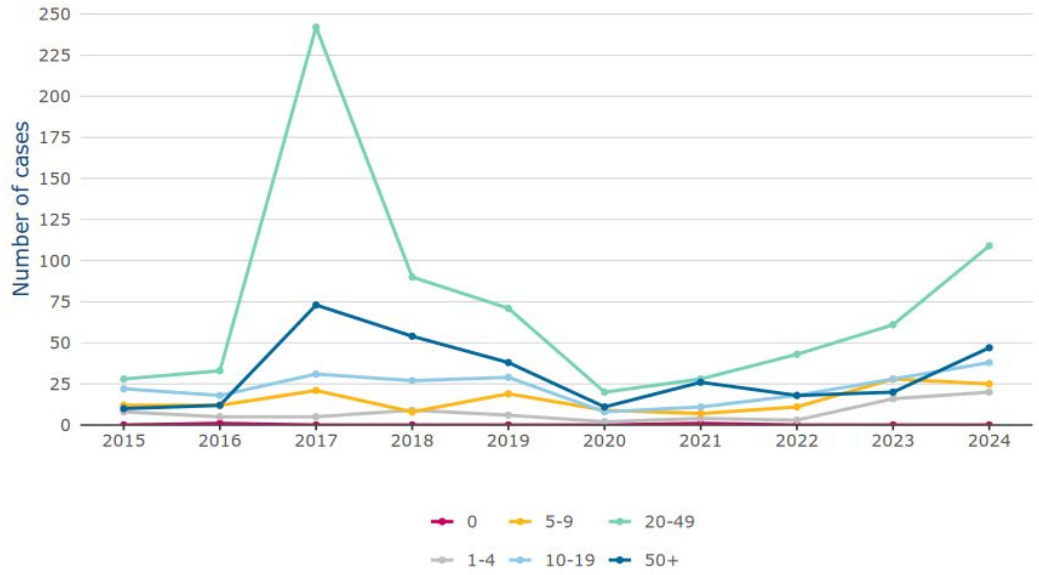
- In 2024, 238 hepatitis A cases were reported, corresponding to 13.3 cases per million population. Since 2020 (50 patients), the number of patients has increased every year. Compared to 2023 (153 patients), the increase amounted to 56%.
- Infections were mainly seen in the 20-49 years age group.
- In 2024, 59 patients (25%) were hospitalised, compared to 22–32% in 2015–2023.
- In 2024, the proportion of travel-related cases amounted to 34%, which is comparable to pre-pandemic and 2022 percentages (2015–2019 mean: 37%; 2022: 35%).

8.1.2 Tables and figures

Figure 8.1.1 Number of reported, hospitalised and travel-related cases of hepatitis A, 2015–2024.

Source: Osiris

Figure 8.1.2 Age distribution of hepatitis A cases, 2015–2024.



Source: Osiris

8.1.3 *Epidemiology*

In 2024, 238 hepatitis A cases were reported, corresponding to 13.3 cases per million population. This is an increase since the low numbers in 2020 (n=50 cases; Figure 8.1.1/Appendix 2). The number of reported patients has increased by 56% compared to 2023 (153 patients). Apart from the peak in cases in 2017 (373 patients), caused by a large international hepatitis A outbreak with 243 outbreak-related cases in the Netherlands two-thirds of whom were men who have sex with men (MSM) [1], such high numbers have not been seen since 2011. A clear cause of the current increase has not been found yet. The age distribution over the 2015–2024 period is shown in Figure 8.1.2. Infections were mainly seen in cases aged 20 to 49 years. In total, 59 patients were hospitalised (25%), which is comparable to the average percentage of hospitalisation seen in previous years (2015–2023: 22–35%; mean: 26%). The last case reported to die from hepatitis A dates back to 2007.

In 2024, the proportion of travel-related cases amounted to 34%, which is comparable to pre-pandemic and 2022 percentages (2015–2019; mean: 37%; 2022: 37%), but higher than in 2020 (18%) and 2021 (23%). Most travel-related cases had been in Africa (37/80 cases) or Asia (27 cases), followed by Europe (n=9), Central America (n=3), and North and South America (each n=2). Countries mentioned most often were Morocco (n=24), India (n=6), and Syria (n=5).

In 2024, 26 epidemiological clusters, involving a total of 92 patients, and 45 microbiological clusters, involving a total of 153 patients, were identified [2]. Out of these, 70 patients from the epidemiological clusters also belonged to a microbiological cluster. Consequently, in 2024, 175 out of 238 patients were part of a cluster. Twenty-five isolates were found to be related to microbiological clusters from previous years. If a setting could be determined, transmission within the household/family

was most common. Four clusters took place (partly) in schools and daycare, and four others in healthcare institutions. At the end of the year, two microbiological clusters turned out to be foodborne outbreaks: one caused by contaminated frozen blueberries (13 cases in November/December 2024 and 11 cases in January/February 2025); in the other outbreak (9 cases), no specific food product could be identified.

8.1.4 Pathogen

Hepatitis A virus (HAV)-specific IgM-positive samples can be sent to IDS at RIVM for typing as part of the molecular surveillance of this virus. In addition, samples can be sent in for PCR detection in cases of doubtful serology or in recently vaccinated people. Increasingly, PCR stool samples are requested for potential cases without symptoms. Positive cases detected by PCR only can now be reported in Osiris.

In 2024, RIVM tested a total of 417 serum and faecal samples of 387 unique persons. HAV RNA was detected in 224 samples (54%) and 184, of the cases also reported via the notification could be typed, which resulted in 78 unique sequences. A total of 155 cases could be assigned to clusters of two or more cases. These concerned 135 molecular clusters ranging between 2 and 13 cases in the Netherlands in 2024. Some clusters extended into 2025, including one of the foodborne outbreaks.

8.1.5 Research

The protocol for whole genome sequencing (WGS) has been extended to HAV type III.A, in addition to types I.A and I.B. We were able to determine complete genomes for 7 out of 8 type III.A samples that were tested. The protocol was used to determine 126 complete genome sequences in 2024. In several cases, WGS allowed discrimination of recent strains from older strains that showed 100% identity in the 460nt typing region. This illustrates the added value of WGS analysis by providing higher resolution.

8.1.6 International developments

Overall, hepatitis A vaccination is highly immunogenic in healthy individuals, but in immunocompromised populations, vaccination sometimes works less well. Within the Centre of Tropical Medicine and Travel Medicine at Amsterdam UMC, a prospective cohort study was performed to evaluate serological responses to hepatitis A vaccination in persons living with HIV or patients on immunosuppressive drugs [3]. Participants, aged ≥18 years, received two doses of inactivated hepA vaccine (Avaxim, Havrix or VAQTA adult®) at 0 and 6–12 months. In case of the use of the combination vaccination against hepatitis A and B (Twinrix), 3 doses were administered at 0, 1, and 6–12 months. A total of 150 participants were selected from the 190 recruited individuals. Reasons for exclusion were being anti-HAV-positive at baseline, loss to follow-up, and change in medication during follow-up. The participants comprised 41 persons living with HIV, 40 patients on immunosuppressive monotherapy, 35 on immunosuppressive combination therapy, and 34 controls. Following one vaccination, and two and six months after completing the full series, the seroconversion rates were 58%, 97%, and 97% (persons living with HIV), 53%, 94%,

and 88% (patients on immunosuppressive monotherapy), 35%, 83%, and 69% (patients on immunosuppressive combination therapy), and 94%, 100%, and 97% (controls), respectively. Geometric mean antibody concentrations (GMCs) two months after a full vaccination series were significantly lower in all immunocompromised participants than in controls (range 71.08 to 221.55 versus 544.24 mIU/ml), with the lowest GMCs in patients on immunosuppressive combination therapy. At 6 months after completion of the vaccination series, 31 participants had antibodies below 50 mIU/ml, out of which 25 agreed to a booster vaccination. All non-responders following the booster were patients on combination therapy, of whom three had not had any serological response to the primary vaccination series either.

A hospital in the United States tested whether a dose of oral vitamin A has an effect on immune responses when receiving a booster pneumococcal vaccine and a hepatitis A vaccine (HAVRIX) [4]. Twenty healthy children aged 1–4 years, who had previously received at least two doses of the pneumococcal vaccine and who had not yet received a hepatitis A vaccine, were enrolled in 2019–2020 or 2023–2024. Half the children received a supplement with 10,000 IU vitamin A at the time of vaccination. Four participants were excluded from analysis due to unavailability of samples or positivity prior to vaccination. At 21 days post-vaccination, 10 participants showed vaccine-induced immune responses. No significant association between response and vitamin levels was found in these predominantly retinol-sufficient children.

8.1.7 Literature

1.* Friesema IHM, Sonder GJ, Petrignani MWF, Meiberg AE, Van Rijckevorsel GG, Ruijs WL, et al. Spillover of a hepatitis A outbreak among men who have sex with men (MSM) to the general population, the Netherlands, 2017. Euro Surveill. 2018;23(23):pii=1800265.
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*Publication with RIVM authors.

8.2 Respiratory Syncytial Virus

8.2.1 *Key points*

- In 2024–2025, the RSV season ran from week 46, 2024 to week 16, 2025 with a peak in week 1, 2025, similar to in 2022–2023 and the seasons before the COVID19- pandemic.
- In March 2025 the Health Council of the Netherlands judged that, in view of disease burden in elderly and medical risk groups, RSV vaccination needs to be considered and that available vaccines are effective and safe. However, they find it relevant that more information on the duration of protection becomes available.
- A systematic review including real-world data on nirsevimab immunisation from different countries shows a pooled effectiveness estimate of 83% against RSV-related hospitalisation among infants aged <1 year.
- Real-world data on maternal RSV vaccination from Argentina shows effectiveness of 77–79% against RSV-related hospitalisation among infants a<6 months.
- Real-world data on RSV vaccination among older adults from the US shows effectiveness of 75–91% against RSV-related hospitalisation among adults aged 60 years and over.
- In September 2025, RSV immunisation of children aged <1 year with the monoclonal antibody nirsevimab was introduced in the NIP in the Netherlands for children born from April 2025 onwards.

8.2.2 *Epidemiology and pathogen*

In the respiratory season 2024–2025, the RSV season started in week 46, 2024 and ran until week 16, 2025 with a peak in week 1, 2025. The peak moment was similar to the one in 2022–2023 and the seasons before the COVID-19 pandemic. In 2023–2024, the peak was relatively early; in week 48. In all age groups, RSV-B was dominant throughout the RSV season. For more information and data on the epidemiology of RSV in the Netherlands, we refer to the webpage 'Annual reporting on surveillance of acute respiratory infection in the Netherlands, 2024/2025 - RSV', and the RIVM website on RSV surveillance (only available in Dutch).

8.2.3 *RSV immunisation/vaccination in the Netherlands*

On the basis of the advice by the Health Council published in February 2024, RSV immunisation with the monoclonal antibody nirsevimab was introduced in the NIP in the Netherlands in September 2025. Children born from October 2025 up to March 2026 (primary group) will be offered immunisation within 14 days after birth. Children born from April up to September 2025 (catch-up group) will be offered immunisation in September and October 2025.

In March 2025, the Health Council of the Netherlands judged that, in view of the disease burden in elderly and medical risk groups, RSV vaccination needs to be considered and that available vaccines are effective and safe. Therefore, they concluded that offering programmatic RSV vaccination to persons aged 75 years and over and to persons aged 60-75 years who have a medical risk condition or live in a long-term care facility could be recommended. However, they find it relevant that more information on the duration of protection becomes available. Also,

the current cost-effectiveness is unfavourable for a vaccination programme. The RIVM gathered background information to support this advice.

8.2.4 Research

Within PROMISE, a consortium that focusses on RSV prevention, treatment and immunisation in Europe, RIVM contributed to a study in which the significance of serum immunoglobulin A (IgA) as a specific biomarker of first RSV infection in infants was investigated (Loewenkids cohort). This study involved 135 infants under 2 years with proven RSV infection. It re-established the previously modelled IgA threshold from the Pienter serosurvey [1, 2] to be valid for confirmed cases of RSV infections with the potential aim to investigate baseline immunity of (trial) subjects, in order to assess the impact of active (e.g. maternal or elderly vaccination) or passive (e.g. nirsevimab) RSV immunisation [3].

Also within PROMISE, the burden of RSV hospitalisation in children under 18 years during 2016–2023 was assessed in six European countries including the Netherlands [4]. Data was used from national registries of Denmark, England, Finland, the Netherlands, and Scotland, and from a hospital surveillance network of Spain. In the Netherlands, 23,491 hospitalisations for respiratory tract infections were recorded per year during the 2016/17 to 2020/21 period, out of which 2222 (9.5%) were RSV-coded.
However, non-systematic testing and differences in coding practices affect the number of RSV-coded hospital admissions. This is why a modelling study was performed to estimate the actual burden of RSV hospitalisations by means of attribution analyses [5]. The study used age-specific respiratory tract infection data combined with virological data from Denmark, England, Finland, the Netherlands, and Spain from the years 2016–2023. The attributed incidence of RSV per 100,000 children aged 0–2 months ranged from 1715 in Denmark to 3842 in England. In older adults, the attributed RSV incidence was approximately 100 per 100,000 in adults 65–74 years to 200 per 100,000 persons aged 75–84 years and 500 per 100,000 persons aged 85 years and over. In the Netherlands, the annual number of RSV-attributed hospitalisations was ~2100 in children aged <1 year, ~900 in children aged 1–2 years, and ~5400 in adults aged 65 years and over. The latter numbers were calculated by using all diagnoses for respiratory tract infections (main, primary, and secondary diagnoses). An attribution analysis performed earlier, which was restricted to main diagnoses, only found a lower estimate for adults aged 65 years and over of ~2900 [6].

To evaluate the nirsevimab immunisation programme for children aged <1 year in the Dutch NIP (see Paragraph 8.1.5.1), two studies will be performed, starting in the autumn of 2025.
The ERIN study will assess the effectiveness of nirsevimab against RSV-associated severe acute respiratory infection (SARI) in children aged <1 year. This test-negative case-control study will collect data in ~10 hospitals in the Netherlands during the RSV seasons (Oct–Feb) of 2025/26, 2026/27 and 2027/28. Data on nirsevimab use, maternal vaccination, and clinical outcomes will be collected. Furthermore, a respiratory sample of RSV-positive children will be typed and sequenced.

The IRIS study will assess the immune response to RSV infection in healthy children who did and those who did not receive nirsevimab. Also, it will assess the kinetics of RSV-specific serum antibodies following RSV immunisation (website). To this end, blood and nasal fluid will be collected from 150 infants aged 0–3 months who receive nirsevimab as from the autumn of 2025 at regular time points up to the age of 12–15 months. Moreover, at inclusion, blood and nasal fluid will be collected from 100 children aged 12–15 months who have not received nirsevimab.
To gain better insight into genetic diversity and possible genetic drift and antigenic evolution, a more structured genetic monitoring of RSV will be implemented. RSV-positive specimens from microbiology laboratories throughout the country will be collected in addition to RSV positive specimens from GP surveillance (Nivel Primary Care Database) as well as participatory community surveillance (infection radar). The random selection of RSV-positive samples will be enriched by RSV-positive specimens from children who have received nirsevimab to investigate these breakthrough infections. Whole genome sequences will be obtained throughout the respiratory season and evaluated in view of possible antibody escape and generic antigenic evolution.

8.2.5 (Inter)national developments

8.2.5.1 Monoclonal antibodies

As of July 2025, EMA has approved two monoclonal antibody products: nirsevimab (AstraZeneca/Sanofi), which is registered for all infants, and palivizumab (AstraZeneca), which is only registered for medical risk groups. FDA approved a third monoclonal antibody, clesrovimab (Merck) on 9 June 2025. In a phase 2b/3 trial among 3599 infants aged <1 year, clesrovimab reduced RSV-associated hospitalisations by 84% over a period of 5 months.

Several countries worldwide have introduced nirsevimab in their NIPs and have estimated the impact or effectiveness of RSV immunisation. A systematic review assessing real-world effectiveness of nirsevimab included 32 observational studies from five countries (France, Italy, Luxembourg, Spain, and the US) published between January 2023 and February 2025 [7]. Pooled effectiveness of nirsevimab among infants aged <1 year was 83% (77–88%) against RSV-related hospitalisation, 81% (71–88%) against ICU admission, and 75% (67–81%) against incidence of lower respiratory tract infections.
A study from Western Australia, which was not yet included in the meta-analysis, included 284 children who were hospitalised with acute respiratory infection between April and October 2024, of whom 184 were RSV-positive cases and 100 were RSV-negative controls [8]. Coverage of nirsevimab was 23% in cases and 60% in controls. The overall effectiveness was 88% (95% CI: 74–95%).

A study from Spain described clinical and demographic characteristics of infants who were hospitalised due to RSV-related lower respiratory tract infection between September 2023 and April 2024 and compared infants who received nirsevimab (breakthrough cases; n=45) and infants who did not receive nirsevimab (non-breakthrough cases, n=24) [9]. They found no significant differences in clinical characteristics, timing, or outcomes between breakthrough and non-breakthrough cases with a

median gestational age of 39 weeks, 23% of all cases having a high-risk condition, 22% of all cases being admitted to the ICU, and no deaths.

In a phase 1b/2a randomised placebo-controlled trial, the safety, tolerability, and pharmacokinetics of clesrovimab was studied in 183 healthy preterm and full-term infants [10]. The incidence of RSV-associated medically attended lower respiratory tract infection and hospitalisation was also studied up to 150 days after clesrovimab administration, although the trial was not powered to assess these endpoints. No treatment-related serious adverse events were reported and the half-life of clesrovimab serum concentrations was 45 days. Estimated efficacy against RSV-associated medically-attended lower respiratory tract infection was 74% (95% CI: -93;97%). There were no RSV-associated hospitalisations in the clesrovimab group and 3 in the placebo group, resulting in an efficacy estimate of 100% (95% CI: 38–100%).

8.2.5.2 Maternal vaccination

EMA has registered one RSV vaccine for pregnant women, a prefusion F protein subunit vaccine called Abrysvo, to prevent RSV infection in infants from birth through the age of 6 months. Several countries have implemented maternal RSV vaccination in their immunisation programme, including Argentina (from March 2024) and the UK (from September 2024).

Two test-negative case-control studies investigated the effect of maternal RSV vaccination on the prevention of RSV-associated hospitalisations in infants aged <6 months in Argentina [11, 12]. Gentile et al. included 187 children who were hospitalised for a respiratory infection between March and October 2024 and who were born after 15 March 2024, of whom 91 tested RSV-positive and 96 tested RSV-negative [11]. Maternal RSV vaccination was reported in 18% of RSV cases and in 45% of controls, resulting in an effectiveness estimate of 79% (95% CI: 51–91%) after adjustment for age, prematurity, and chronic respiratory disease.
Perez Marc et al. included 505 children hospitalised with lower respiratory tract disease, of whom 286 were RSV-positive and 219 were RSV-negative [12]. The mother received RSV vaccination between 32 to 36 weeks of gestation in 18% of RSV cases and in 50% of controls, resulting in an effectiveness estimate of 77% (95% CI: 45–93%) after adjustment for confounding.

8.2.5.3 Older adults

For adults aged 60 years and over, EMA has registered two prefusion F subunit vaccines (Arexvy and Abrysvo) and a mRNA vaccine (mResvia). Austria, Belgium, Germany and Sweden have recommendations for RSV vaccination in adults aged 60 or 75 years and over (with certain medical conditions), but vaccination is not funded by the National Health System [13]. In September 2024, the UK started an RSV vaccination programme for adults turning 75 years with a catch-up campaign for those aged 75–79 years. In June 2023, the Advisory Committee on Immunisation Practices (ACIP) of the US recommended that adults aged 60 years and over may receive a single dose of an RSV vaccine, using shared clinical decision-making [14]. This was updated in June 2024 to

recommend RSV vaccination for all adults aged 75 years and over and for adults aged 60–74 years who are at increased risk for severe RSV disease [15].
Five studies from the US have been published estimating the effectiveness of RSV vaccination in older adults [16-20]. All studies included persons of 60 years and over, assessed the 2023–2024 respiratory season (Sept/Oct/Nov–March/April), had RSV-related hospitalisations as outcome, and took into account potential confounders including age, sex, race/ethnicity, comorbidity, and calendar time. Four of the studies used a test-negative case-control design and included a range of 367–53,963 RSV-positive cases and a range of 804–733,859 RSV-negative controls [16, 18-20]. One study used a cohort approach emulating four matched sequential trials [17]. The estimated vaccine effectiveness ranged from 75% (95% CI: 50–87%) to 91% (59–98%). In the four studies that reported estimates by age group [16, 17, 19, 20], there was no indication of differences in VE by age group.

8.2.6 Literature

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8.3 Varicella zoster virus

8.3.1 *Key points*

- In 2024, Dutch general practitioners (GPs) recorded about 54,000 varicella episodes (300 per 100,000 population) with the highest incidence in children aged 0-4 years. This was higher compared to 2023 when GPs recorded about 30,000 varicella episodes (170 per 100,000 population).The lower varicella incidence in 2023 compared to 2022 and pre-COVID years probably reflects a lower number of susceptible children following a surge in cases in 2022 following low varicella transmission during the COVID-19 pandemic.
- In 2024 there was an increase of Herpes Zoster (HZ) incidence compared to previous years – especially among those aged 65 years and older – with 110,000 GP episodes (610 per 100,000 population). This increase may be linked to heightened media attention on HZ and vaccination rather than an actual increase in disease incidence. In 2023 there were 100,000 GP episodes recorded (560 per 100,000 population), and 3.4 hospitalisations per 100,000 population which was also a slight increase compared to previous years.

8.3.2 *Tables and figures*

Figure 8.3.2.1 Estimated incidence per 100,000 population of episodes of varicella (ICPC code A72) and herpes zoster (ICPC code S70) in 2023 and 2024 versus mean 2013–2022 by age group, Nivel Primary Care Database.

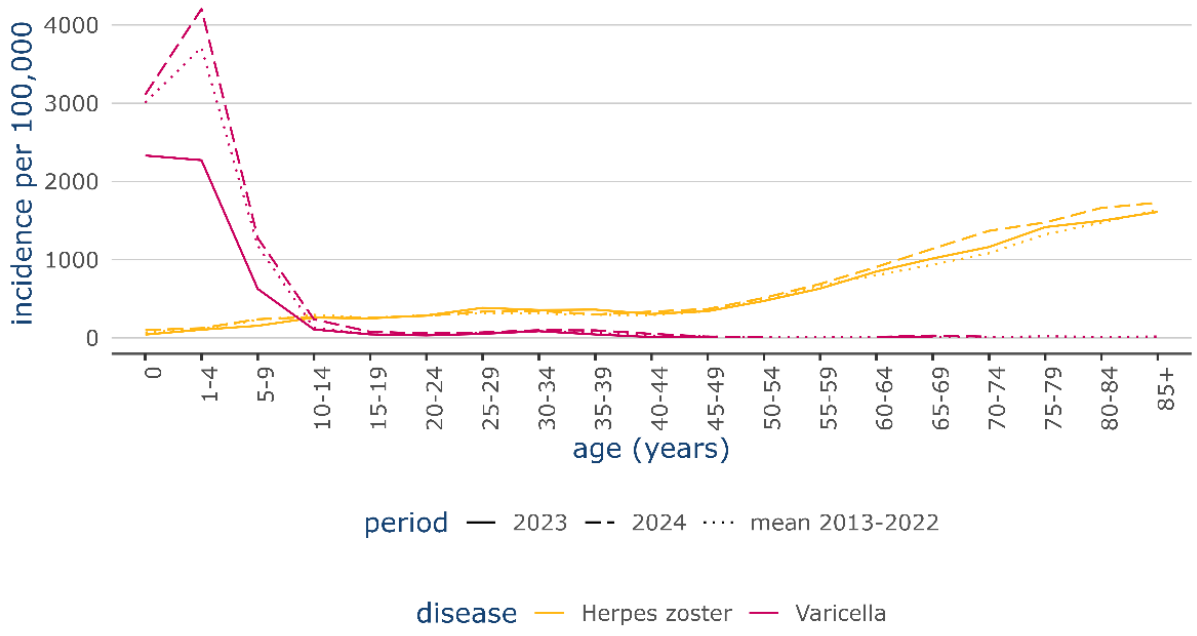

Figure 8.3.2.2 Estimated incidence per 100,000 population of episodes of varicella (ICPC code A72) in children aged 0, 1–4, and 5–9 years old in 2013–2024, Nivel Primary Care Database.

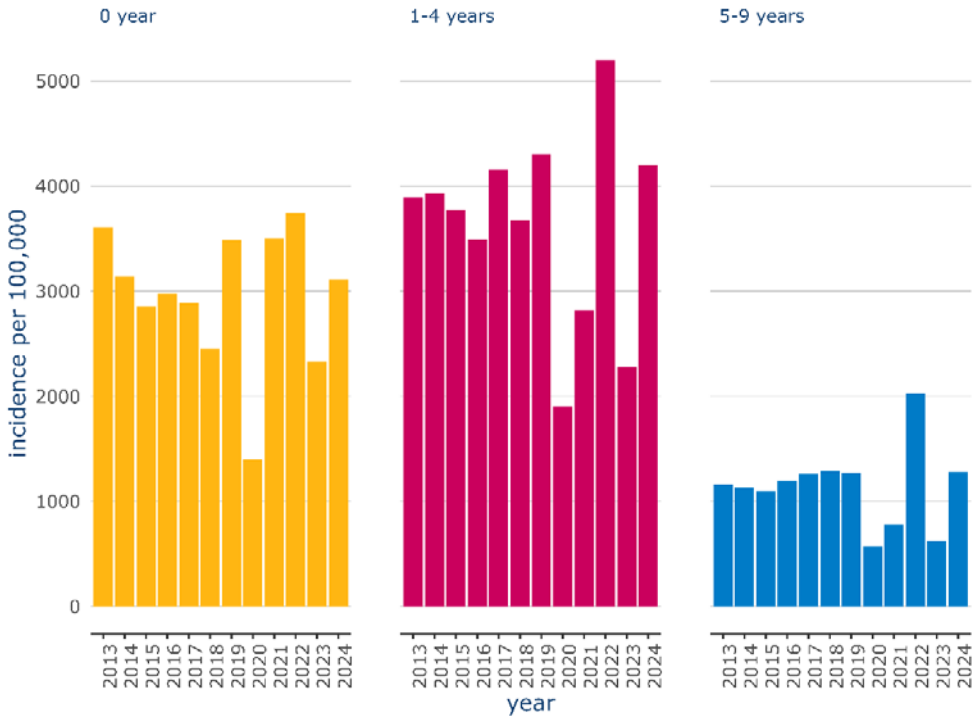

Table 8.3.2.1 Estimated incidence per 100,000 population of episodes of varicella (ICPC code A72) and herpes zoster (ICPC code S70) 2013–2024, Nivel Primary Care Database (rounded to nearest 10) [1].

Syndrome	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Varicella	280	270	250	240	280	260	300	130	190	400	170	300
Herpes zoster	510	530	530	530	530	540	550	530	540	520	560	610

In 2006/2007, a number of hospitals ceased registration, causing an underestimation of hospital admissions from 2006 until 2014. From 2015 onwards, the number of admissions were rounded off to the nearest 5. Corrected for non-participating hospitals. Data retrieved from Dutch Hospital Data/Statistics Netherlands; this may have resulted in a trend break compared to previous years (see Appendix 1).
Admissions for a single day have been excluded.
The number of admissions may be higher than the number of hospitalised patients reported here because some patients have been admitted more than once within the same year.

Table 8.3.2.2 Incidence per 100,000 population of hospitalisations due to main diagnosis of varicella (ICD-10 code B01) and herpes zoster (ICD-10 code B02), 2012–2023, Dutch Hospital Data (DHD).

Syndrome	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Varicella	1.7	1.9	1.7	1.9	1.9	1.6	1.9	0.9	1.1	2.6	1.3
Herpes zoster	2.1	2.7	2.8	2.7	2.7	3.0	3.0	2.9	2.9	2.7	3.4

In 2006/2007, a number of hospitals ceased registration, causing an underestimation of hospital admissions from 2006 until 2014. From 2015 onwards, number of admissions were rounded off to the nearest 5. Corrected for non-participating hospitals. Data retrieved from Dutch Hospital Data/Statistics Netherlands; this may have resulted in a trend break compared to previous years (see Appendix 1).
Admissions for a single day have been excluded.
The number of admissions may be higher than the number of hospitalised patients reported here because some patients have been admitted more than once within the same year.

Table 8.3.2.3 Absolute number of deaths with varicella (ICD-10 code B01) and herpes zoster (ICD-10 code B02) as a primary cause of death, 2012–2023, based on Statistics Netherlands (CBS) mortality data.

Syndrome	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024*
Varicella	1	2	2	4	3	2	3	2	4	10	5	5
Herpes zoster	21	26	33	27	33	36	32	43	37	38	41	44

*Data for 2024 are preliminary.

8.3.3 Epidemiology

Varicella Zoster Virus (VZV) infections (varicella and herpes zoster) are not notifiable in the Netherlands. Therefore, we used the Nivel Primary Care Database, the Statistics Netherlands (CBS) registers and Dutch Hospital Data (DHD) to describe the epidemiology of VZV infections (see Appendix 1) [2-4].

8.3.3.1 Varicella

In 2023, general practitioners (GPs) recorded about 30,000 varicella episodes (170 episodes per 100,000 population; Nivel Primary Care Database, under number NZR-00324.037). The number of hospitalisations and deaths in 2023 were similar to those in previous years (Tables 8.3.2.1, 8.3.2.2, and 8.3.2.3). In 2024, GPs recorded about 54,000 varicella episodes (300 episodes per 100,000; Nivel Primary Care Database, under number NZR-00325.003). The incidence in both years was highest in children aged 0–4 years (Figure 8.3.2.1). In 2023, the incidences of GP consultations due to varicella episodes were considerably lower compared to 2022 and pre-covid years. This might be due to fewer children being susceptible to varicella after 2022. In 2022, a high number of varicella episodes were recorded – with more cases in children aged 1–4 and 5–9 years than in previous years – probably as a catch-up effect following the corona years in which varicella incidence was low due to social restrictions (Figure 8.3.2.2).

8.3.3.2 Herpes zoster

The incidence of HZ in the Netherlands slightly increased in 2023 compared to previous years (Tables 8.3.2.1, 8.3.2.2, and 8.3.2.3) with around 100,000 GP consultations due to HZ (560 per 100,000 population; Nivel Primary Care Database, under number NZR-00324.037), and 3.4 hospitalisations per 100,000 population. In 2024 the number of GP consultations due to HZ increased further to about 110,000 (610 episodes per 100,000 population; Nivel Primary Care Database, under number NZR-00325.003). The increase was predominantly in individuals aged 65 years and over (Figure 8.3.2.1). The reason for this increase in GP consultations due to HZ is difficult to interpret. HZ is a reactivation of the VZV and occurs predominantly in older adults or immunocompromised individuals who experienced varicella earlier (in their childhood). Therefore, an outbreak of HZ is an unlikely explanation of the observed increase. One possible factor contributing to the reported increase could be the heightened media attention on HZ and the benefits of HZ vaccination, which may have raised awareness about the condition and the availability of vaccination. This, in turn, could have encouraged more individuals to seek healthcare, as not everyone who experiences HZ always seeks healthcare: unpublished data (2012–2023) from the Doetinchem Cohort Study shows that 65/79 (82%) individuals who experienced HZ in the previous year sought healthcare. In the autumn/winter of 2024/2025, there were several items in the newspapers and on television about HZ and the benefit of vaccination. Another possible explanation for the increase is related to registration practices: some individuals who received a vaccination against HZ have been recorded as having both a vaccination and an HZ infection episode at the same time. The SFK (Dutch Foundation for Pharmaceutical Statistics) subsequently reported increased distributions of HZ vaccination from November 2024 onwards, with 3600 HZ vaccines distributed via outpatient pharmacies in October 2024 to 11,100 HZ vaccines in November 2024, increasing further to more than 50,000 HZ vaccines distributed in April 2025.
In 2024, 44 deaths were registered with HZ as the primary cause of death. However, Mahamud et al. found that national death certificate data tends to overestimate the number of deaths in which HZ is the underlying or contributing cause of death. If we apply their rate of deaths for which HZ was validated as the underlying cause of death (0.25 (range 0.10–0.38) per 1 million population) to the Dutch population in 2024, we would expect 4 deaths (range 2–7), instead of the 44 deaths reported in 2024 (Table 8.3.2.3)[5].

8.3.4 International developments

8.3.4.1 Varicella

8.3.4.1.1 *Cost of varicella*

Understanding the total (societal) costs of a disease is relevant information when considering implementation of varicella vaccine in the NIP for children. Wittenberg et al. estimated the value of productivity loss due to adults missing work to care for children with varicella in the UK. In their study, half the children with varicella missed days at daycare/school and almost half the adults missed work to care for them, an average of 5 days per child. The authors estimated that the annual value of lost productivity due to varicella is £20–£70 million [6].

Samant et al. estimated the economic burden of varicella in France from a family and societal perspective. They estimated that children with varicella missed a median of 5 (95% confidence interval (CI) 3–7) school days, and that caregivers missed a median of 2 (95% CI 0–5) workdays. The annual societal cost due to varicella was estimated to be €450 (95% CI 357–543) million, with indirect costs, such as productivity loss, accounting for 85% [7].

8.3.4.1.2 *Vaccine effectiveness*

Barbieri et al. estimated the varicella vaccine effectiveness (VE) in children aged 14 years or under in Italy, where they implemented universal varicella vaccination in 2017 with a 2-dose schedule achieving 90% coverage in 2019. They used a population database containing data from 2004–2022. The VE was 83.4% and 94.5% in children vaccinated with one dose and two doses, respectively. After six years, the cumulative probability of experiencing varicella was 10.7% for unvaccinated children, and 2.5% and 0.4% for children vaccinated with one dose and two-doses, respectively ($p<0.001$). Barbieri et al. did not investigate whether the average age and severity of infection increased after implementation of the universal vaccination programme [8].

8.3.4.1.3 *Impact and cost-effectiveness of vaccination*

Adams et al. modelled the impact and cost effectiveness of universal childhood varicella vaccination in England, considering various vaccination strategies. In contrast to previous cost-effectiveness models, they considered the implemented adult HZ vaccination programmes. Adding the HZ vaccination programme might mitigate possible HZ incidence following the introduction of varicella vaccination due to lack of exogenous boosting.

Their results show that a 2-dose routine varicella vaccination programme at coverage levels achievable in the UK (93 % for the first dose and 86 % for the second), is expected to result in very low incidences of varicella across all age groups in the long run and may lead to elimination of the virus. Their results also showed that the vaccination programme may cause a temporary increase in zoster cases, but less so than previously believed, which is probably due to the addition of an HZ vaccination programme to the model. With exogenous boosting protection of three years, HZ incidence peaks after six years with an increase of 4.4 %. HZ incidence returned to pre-vaccination levels 11 years after varicella vaccination introduction and then declined subsequently. All vaccination strategies examined were found to be cost-effective, with routine vaccination being most beneficial. Cost-effectiveness depended primarily on the vaccine price and varicella treatment costs. Partially on the basis of these results, the Joint Committee on Vaccination and Immunisation (JCVI) in the UK recommended a universal 2-dose varicella childhood vaccination programme in November 2023 [9].

8.3.4.1.4 *Varicella and invasive group a streptococcal disease*

Several studies show that specific viral infections, such as varicella, are risk factors for developing invasive group a streptococcal disease (iGAS) in children. De Gier et al. estimated that 50% of the iGAS infections in children aged ≤ 5 years can be attributable to predisposing varicella infection [10]. Van Kempen et al. investigated epidemiological

differences between iGAS-related sudden deaths and iGAS survivors in children aged 0–18 years. They found that pre- and/or coinciding infections, mostly varicella and influenza, were present in 66% of the iGAS-related sudden deaths compared to 13% in iGAS survivors. These results suggest that children with pre- and/or coinciding varicella or influenza infection may be at greater risk of death due to iGAS [11].
RIVM estimated the burden of VZV for the years 2018, 2019, and 2022 expressed in Disability Adjusted Live Years (DALY) both with and without the impact of iGAS. Following a methodology similar to the one used in other burden of disease estimates (see Appendix A1.1.2.1 for general burden of disease methodology), a VZV outcome tree was made using the Burden of Communicable Disease in Europe (BCoDE) toolkit [12]. Results showed that the burden of VZV in children aged 0–9 years is more than 2–4 times higher when the impact of iGAS is taken into account: the number of DALYs was 188 in 2018, 228 in 2019, and 683 in 2022 with iGAS compared to 105 in 2018, 125 in 2019, and 155 in 2022 without iGAS. The burden increased predominantly due to the additional years of life lost (YLL) resulting from iGAS-related mortality: for example, in 2022, YLL was 7 without iGAS but increased to 588 with iGAS. The annual burden depended primarily on the fluctuation in iGAS epidemiology. In 2022, both chickenpox and iGAS incidences increased compared to pre-COVID years (2010–2019). In 2018, a year with slightly lower VZV and iGAS incidences, and in 2019, a year with slightly higher incidences compared to the 2010–2019 average, the VZV burden including iGAS was, on average, twice as high as the burden without iGAS (2018 ratio 1.8; 2019: ratio 2.4). DALY's per 100 VZV infections were similar in 2018, 2019 and 2022 (ranging from 0.0614 to 0.0625). When including iGAS, DALYs per 100 VZV infections were similar in 2018 (0.110) and 2019 (0.147) but increased to 0.275 in 2022. In conclusion, the burden of VZV in children aged 0–9 years was estimated to be 2–4 times higher when iGAS infections were considered, predominantly depending on the iGAS epidemiology, and in absence of routine VZV vaccination for children (unpublished results).

8.3.4.2 Herpes zoster

8.3.4.2.1 *Vaccine effectiveness*

Williams et al. reviewed the evidence on the efficacy and effectiveness of the recombinant zoster vaccine for the protection of HZ and associated complications. Vaccine efficacy against HZ in immunocompetent individuals over the age of 50 years ranged between 90 and 97%. Protection stayed above 70% for at least 10 years, with no significant differences by age or ethnicity.
Vaccine effectiveness ranged between 71 and 86%, with similar estimates for both females and males. There is limited evidence on waning immunity. One study found a vaccine effectiveness of 70% (95%CI 69–52%) with a median follow-up duration of 3.1 years after vaccination. No vaccine effectiveness studies evaluated the change in effectiveness over longer time periods.
In immunocompromised individuals, vaccine efficacy against HZ ranged between 43 and 100% (with low precision due to small sample sizes) depending on the type of underlying disease. The vaccine effectiveness against HZ in immunocompromised individuals was only studied in patients with inflammatory bowel disease and ranged between 61 and 64%.

Vaccine effectiveness against complications such as post-herpetic neuralgia was reported by one study only and amounted to 76%. Vaccine effectiveness against herpes zoster opthalmicus ranged between 67 and 93% [13].

8.3.4.2.2 *Herpes zoster vaccination and dementia*

Several studies have recently investigated the potential effect of HZ vaccination on the development of dementia [14-20]. The evidence suggests that HZ vaccination may be associated with a lower risk of developing dementia. There is no data available to suggest which type of dementia (e.g. vascular, Alzheimer) is prevented most, and more evidence is required to determine the causal effect and magnitude of the impact [21]. Most of the available data comes from studies on the Zostavax vaccine (N=6) and only two investigated the effect of Shingrix. Eyting et al. and Pomirchy et al. looked at the effect of Zostavax on the risk of developing dementia using a regression discontinuity design (RDD). This is a quasi-experimental approach using a well-defined threshold for assigning a treatment or intervention, in this case vaccination, to be able to compare two groups. The threshold in both studies was being eligible for vaccination on basis of date of birth according to the national immunisation programme. The RDD design prevents nearly all forms of confounding. Both studies describe the effect of herpes zoster vaccination (Zostavax) (eligibility) in 80-year-olds on the prevention of a new dementia diagnosis up to seven years after vaccination. Over a follow-up period of seven years, Eyting et al. observed a 1.3 (95% CI: 0.2–2.7) percentage point reduction in new dementia diagnoses in the group eligible for vaccination. In the vaccinated group, they observed a 3.5 percentage point reduction (95% CI = 0.6–7.1, P = 0.019) in new dementia diagnoses: This corresponds to a relative risk reduction of 20.0% (95% CI = 6.5–33.4) in dementia diagnoses. The effect was only found in women, thus, no effect was found in men. Being eligible for vaccination reduced new dementia diagnoses in women by 2.9 (95% CI 1.3; 5.3) percentage points compared to 0.1 (95%CI -1.9; 2.1) in men. Pomirchy et al. found that being eligible for herpes zoster vaccination significantly decreased the probability of receiving a new dementia diagnosis during 7.4 years by 1.8 percentage points (95%CI 0.4–3.3). However, they did not find a difference in effect by sex. Pomirchy et al. could not investigate the effect of being vaccinated on the risk of dementia, only eligibility. In both studies, no other incidence differences in illness or health were found before and after the age threshold of vaccination eligibility. The other four studies (Lophatananon 2023, Schnier 2022, Scherrer 2021, and Lophatananon 2021) that investigated the effect of Zostavax on dementia use different designs (cohort and case-control studies) with more chance of bias, such as selection bias, healthy vaccinee bias, and confounding. They all found that individuals who received Zostavax had significantly less chance of developing dementia compared to those who did not, with relative risk ratios ranging from 0.65 to 0.81 over a 6 to 10 years' follow-up.

Tang et al. and Taquet et al. are the only studies that investigated the effect of Shingrix using a retrospective cohort study design with a six years' follow-up. Taquet et al. found that individuals who received at least one dose of Shingrix were at lower risk of developing dementia over the next 6 years (restricted mean time lost (RMTL) ratio 0.83;

95% CI, 0.80–0.87; P < 0.0001) than individuals who received Zostavax. A RMTL ratio is not directly comparable to a relative risk ratio, as it reflects the time lost (or won in this case) due to the intervention. A RTML ratio of 0.83 translates into 17% more time lived dementia diagnosis-free, or 164 (95% CI 124–202) additional dementia diagnosis-free days, for individuals vaccinated with Shingrix compared to individuals who received Zostavax. Tang et al. found that individuals who received 2 doses of Shingrix were less likely to develop dementia than individuals who did not receive vaccination (HR 0.68; 95% CI: 0.67–0.70). In both studies, the effect was found in both men and women, but with a greater effect in women.

8.3.5 Literature

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9 Vaccines in development for other potential future NIP target diseases

9.1 Chapter overview

We present an update of information on vaccines for infectious diseases that are relevant for the Netherlands and have reached the phase of clinical testing (see the tables below). In line with last year's report, the 2024–2025 update is restricted to vaccines that have reached phase-3 clinical development, vaccine efficacy, and safety analyses, and are thus close to market authorisation. Due to this restriction, vaccines in development for the following pathogens have been removed from the tables. Bacteria: Chlamydia, Gonorrhoeae, Helicobacter pylori, Moraxella catarrhalis, Malaria, Shigella, Staphylococcus aureus, Streptococcus group A, and Streptococcus group B. Viruses: MERS-CoV, Parainfluenza type I, West Nile virus, and Zika.

In general, vaccine development takes 10 to 20 years, while only a small percentage (6%) of vaccines that have been tested in phase I reach marketing authorisation. On average, phase I clinical development takes one to two years, phase II two to three years, and phase III four to six years. However, with the SARS-CoV-2 vaccines, we have seen that, during a pandemic, it is possible to develop a vaccine, from research to market authorisation, within one year. The mRNA vaccine platform that has been successfully used for the development of SARS-CoV-2 vaccines is now also being used for the development of other vaccines, for example for influenza, RSV, CMV, and rabies, and for combination vaccines, such as SARS-CoV-2 and seasonal influenza.

The information included in the table below is based on our own inquiry among manufacturers (July 2025), vaccine development pipelines/portfolios from vaccine manufacturers, the clinicaltrials.gov website, the databases of clinical research studies and information on their results, and the WHO website.

9.2 Bacteria

	Vaccine type	Target group	Status
Clostridium difficile	Bivalent toxoid vaccine (Pfizer)	Older adults and at-risk populations	Phase 3
Escherichia coli	Conjugate vaccine 9-valent ExPEC9V (Johnsen & Johnsen, Sanofi)	Age 60 years and over	Phase 3, discontinued due to being insufficiently efficacious in preventing IED
Group B Streptococcus	Multivalent polysaccharide conjugate vaccine (Pfizer)	Maternal Prevention invasive infection	Phase 2/3
Lyme (Borrelia)	Multivalent recombinant protein subunit vaccine VLA-15 (Valneva/Pfizer)	Age 5 years and over	Phase 3, EMA submission expected 2026
N. meningitidis	MenQuadfi: conjugated vaccine A, C, W, Y (Sanofi)	Age 6 weeks and over (now 12 months and over)	Submitted to EMA
Pneumococcus	Single dose pneumococcal polysaccharide conjugate vaccine PCV-21 (Merck/MSD)	Adults aged 18 years and over Children at risk aged 2–18 years (NCT06177912)	EMA approved Completed, results expected end of 2025.
	PCV21 (Sanofi)	Infants	Phase 3 ongoing
	25-valent PCV (Pfizer)	Age 6 weeks and over	Phase 2/3
Tuberculosis	M72/ASO1 adjuvanted recombinant subunit fusion protein (GSK licensed to Gates MRI, GSKs adjuvant)	Adolescents and adults	Phase 3
	Live attenuated VPM1002 (Serum Institute India)	Infants/neonates, adolescents and adults	Phase 3

9.3 Viruses

	Type vaccine	Target group	Status
Chikungunya	Live-attenuated IXCHIQ/VLA-1553 (Valneva)	Age 12–60 years Age 12 years and under	EMA-approved Phase 3 data
	Adjuvanted Virus-like particles (VLPs) recombinant protein vaccine (Bavarian Nordic)	Age 12 years and over Age 2 to <12 years	EMA-approved Phase 4 started 2025
Cytomegalo virus (CMV)	mRNA (mRNA-1647) vaccine (Moderna)	Age 16–40 years	Phase 3 ongoing, final analyses late 2025
Dengue	Single dose live attenuated tetravalent vaccine V181 (Merck)	Healthy Participants aged 2 to 17 years, regardless of prior dengue exposure	Phase 3 recruiting
Ebola	cAd3-EBO Z vaccine (Sabine vaccine institute)		Phase 3
Noro virus	mRNA (Moderna)	Age18 years and over	Phase 3, read-out expected 2026
Respiratory syncytial virus (RSV)	Clesrovimab (Enflonsia); Long acting mAb (Merck)	Neonates and infants in their first RSV season	Positive opinion EU CHMP sept 2025, marketing authorization EC expected Nov 2025.
	Recombinant protein adjuvanted vaccine (GSK)	Age 18–49 years at increased risk	CHMP opinion expected 2026 EMA approval for 18+yrs
	mRNA (mRNA-1345) (Moderna)	Age 18–59 years high-risk (60+ EMA-approved)	Phase 3 – submitted to EMA; approval expected Q4 25
	Live-attenuated (Sanofi)	Toddlers	Phase 3

	Type vaccine	Target group	Status
RSV / human meta pneumovirus (hMPV)	mRNA (Sanofi)	Adults	Phase 3 to start
Rabies	VRVg rabies, inactivated, purified, serum free viral vaccine (Sanofi)	All age groups	File submission EMA 2025
SARS-CoV-2	mRNA (mRNA-1283) (Moderna)	Age 12 years and over	Phase 3 – submitted to EMA, approval expected January 2026
	Self-amplifying (sa) mRNA Kostaive (zapomeran) (CSL Seqirus)	Age 18 years and over	EMA approval Feb. 2025
SARS-Cov-2 / flu	mRNA vaccine mRNA-1083 (Moderna)	Age 50 years and over	Phase 3 – submitted to EMA, approval expected Q2/3 2026
	(Novavax)	Age 65 years and over	Phase 3
	mRNA (Pfizer)	Adults and risk groups	Phase 2/3
Varicella	Live attenuated new strain (GSK)	Age 12 months and over	Phase 3
Yellow fever	Vero yellow fever (Sanofi)	Age 9 months and over	Phase 3 started

10 List of abbreviations

4CMenB	multicomponent meningococcal B vaccine
2vHPV	bivalent human papillomavirus vaccine
4vHPV	quadrivalent human papillomavirus vaccine
95%CI	95% confidence interval
9vHPV	nonavalent human papillomavirus vaccine
aAAC	adjusted average annual change
AD	Alzheimer's disease
ADHD	attention deficit hyperactivity disorder
ADNKA	Antibody-dependent natural killer cell activation
AEFI	adverse event following immunisation
AEs	adverse events
AFP	acute flaccid paralysis
AFM	acute flaccid myelitis
AGW	anogenital warts
aHR	adjusted hazard ratio
aIRR	adjusted incidence rate ratio
aOR	adjusted odds ratio
aP	acellular pertussis
ARI	acute respiratory infection
aRR	adjusted relative risk
ASIR	age-standardized incidence rate
ASMR	age-standardized mortality rate
BAST	Bexsero Antigen Sequence Types
BAU/mL	binding antibody units per milliliter
BD	believes about infectious diseases
Bmem	memory B cell
bOPV	bivalent oral polio vaccine
BRP	Personal Records Database; Basisregistratie Personen
BV	believes about vaccination
CBS	Statistics Netherlands; Centraal Bureau voor de Statistiek
CC	clonal complex
CCC	childcare centres
CD4/8	cluster of differentiation 4/8
CDC	U.S. Centre for disease control
C	*Corynebacterium*
CFS	chronic fatigue syndrome
cgMLST	core-genome multilocus sequence typing
CHMP	Committee for Medicinal Products for Human Use
CI	confidence interval
CIb	Centre for Infectious Disease Control Netherlands
CIMS	COVID-vaccination Information Monitoring System
CIN	cervical intraepithelial neoplasia
CIS	Checklist Individual Strength
cLIA	competitive Luminex immunoassay
CMV	Cytomegalo virus

CoP	correlates of protection
COPD	chronic obstructive pulmonary disease
COVID-19	coronavirus disease 2019
CO_2e	carbon dioxide equivalent
CrI	credibility interval
CRM	cross-reactive material conjugate
CRPS	complex regional pain syndrome
CRR	cumulative risk ratio
CSF	cerebrospinal fluid
cVDPV2	circulating vaccine derived polio virus type 2
CVST	cerebral venous sinus thrombosis
CVTs	Corona vaccination studies
DALY	disability-adjusted life years
DAT	diphtheria antitoxin
DHD	Dutch Hospital Data
DNA	deoxyribonucleic acid
DT	diphtheria toxoid
DTP	combination of diphtheria, tetanus and pertussis vaccines
DTaP	combination of diphtheria, tetanus and acellular pertussis vaccines
DTaP-IPV	combination of diphtheria, tetanus, acellular pertussis and inactivated polio vaccines
DT-IPV	combination of diphtheria, tetanus and inactivated polio vaccines
DTP1	first dose of a combination of diphtheria, tetanus and pertussis vaccine
DTP3	third dose of a combination of diphtheria, tetanus and pertussis vaccine
DTaP-IPV-HBV-Hib	combination of diphtheria, tetanus, pertussis, inactivated polio, hepatitis B virus and *Haemophilus influenzae* type b vaccines
EAPC	estimated annual percentage change
ECDC	European Centre for Disease Control and Prevention
EEA	European Economic Area
EIA2030	European Immunisation Agenda 2030
ELISA	enzyme-linked immunosorbent assay
EMA	European Medicines Agency
EN	English
ENPEN	European Non-Polio Enterovirus Network
Epi-year	Epidemiological year (July-June)
EU	European Union
EUL	Emergency Use Listing
EV	enterovirus
EV-D68	enterovirus D68
FDA	Food and Drug Administration
FEMININE	well-informed decision-making among Turkish- and Moroccan-Dutch women regarding cervical cancer screening
FHA	filamentous haemagglutinin
FHbp	factor H-binding protein

Fim 2	serotype 2 fimbriae
Fim3	serotype 3 fimbriae
GA	gestational age
GAM	generalized additive models
GAPIII	Global Action Plan to minimize poliovirus facility-associated risk after type-specific eradication of wild polioviruses and sequential cessation of oral polio vaccine use
GBD	global burden of disease
GDPR	general data protection regulation
GE	gastroenteritis
GGD	municipal health services; gemeentelijke gezondheidsdiensten
gMATS	genomic meningococcal antigen typing system
GMC	geometric mean concentration
GMT	geometric mean titres
GNV	gender-neutral vaccination
GP	general practitioner
GPEI	Global Polio Eradication Initiative
GPLN	WHO Global Polio Laboratory Network
GSL	Global Specialized Laboratory
GVAP	Global Vaccine Action Plan
HAV	hepatitis A virus
HBsAg	hepatitis B surface antigen
HBV	hepatitis B vaccination
HC	Health Council
HCP	healthcare professionals
HCRU	healthcare resource use
HCW	healthcare workers
HepA	hepatitis A virus
HepB	hepatitis B virus
HDI	Human Development Index
Hi	*Haemophilus influenzae*
Hia	*Haemophilus influenzae* type a
Hib	*Haemophilus influenzae* type b
Hie	*Haemophilus influenzae* type e
Hif	*Haemophilus influenzae* type f
HIV	human immunodeficiency virus
HPV	human papillomavirus
HPVc	HPV vaccine, completed series
HR	hazard ratio
hrHPV	high-risk human papillomavirus
HSIL+	high-grade squamous intraepithelial lesions or worse
HSV	herpes simplex virus
HWS	The Netherlands Ministry of Health, Welfare and Sport
HZ	herpes zoster
HZO	herpes zoster ophthalmicus
IA2030	Immunisation Agenda 2030
ICD	International Classification of Diseases
ICER	incremental cost-effectiveness ratio

ICPC	International Classification of Primary Care
ICU	intensive care unit
IDS	Centre for Infectious Disease Research, Diagnostics and Screening
IDU	injecting drug use
iGAS	invasive group A streptococcal infections
IgA	immunoglobulin A
IgG	immunoglobulin G
IgM	immunoglobulin M
IKNL	Netherlands Comprehensive Cancer Organisation; Integraal Kankercentrum Nederland
ILI	influenza-like illness
IMAGINE	The development, implementation, and evaluation of narrative-based audio-visual interventions to support decision-making about cervical cancer prevention programs among Turkish- and Moroccan-Dutch women
IMD	invasive meningococcal disease
IMI-2	Innovative Medicines Initiative 2
IPD	invasive pneumococcal disease
IPP	invasive pneumococcal pneumonia
IPV	inactivated polio vaccine
IR	incidence rate
IRR	incidence rate ratio
IQR	interquartile range
IS	immunosuppressive
JGZ	youth health care; jeugdgezondheidszorg
KNCV	Royal Dutch Chemical Organisation; Koninklijke Nederlandse Chemische Vereniging
LBZ	national register hospital care
LINH	Netherlands Information Network of General Practice; Landelijk informatienetwerk huisartsenzorg
LMIC	Low or middle income country
LMR	national medical register
LYG	life-year gained
MCV1	first dose of a measles-containing vaccine
MCV2	second dose of a measles-containing vaccine
MEM	moving epidemic method
MenABCWY	pentavalent meningococcal conjugate vaccine
MenACWY	quadrivalent meningococcal conjugate vaccine
MenACWY-CRM	quadrivalent meningococcal vaccine conjugated to mutant diphtheria toxin
MenACWY-DT	quadrivalent meningococcal vaccine conjugated to diphtheria toxoid
MenACWY-TT	quadrivalent meningococcal vaccine conjugated to tetanus toxoid
MenA/B/C/W	Meningococcal serogroup A/B/C/W
METC	Medical Ethical Review Committee
MIA	Multiplex Immuno Assay
MLST	multilocus sequence typing

MMR	combination of measles, mumps and rubella vaccines
MMRV	combination of measles, mumps, rubella and varicella vaccines
MNTE	Maternal and Neonatal Tetanus Elimination initiative
mOPV2	monovalent type 2 Oral Polio Vaccine
MPV	maternal pertussis vaccination
MSM	men who have sex with men
MSW	men who have sex with women
NA	Not Available
NIBSC	National Institute for Biological Standards and Control
NICE	Dutch National Intensive Care Evaluation; Nationale Intensive Care Evaluatie
NIP	National Immunisation Programme
NIPP	non-invasive pneumococcal pneumonia
Nivel	Netherlands Institute for Health Services Research; Nederlands Instituut Voor onderzoek van de Eerstelijnstgezondheidszorg
Nivel-PCD	Nivel Primary Care Database
NK cell	Natural killer cell
NKR	Netherlands Cancer Registry
NL	Netherlands
NNS	number needed to screen
nOPV2	novel oral polio vaccine type 2
NPG	National Influenza Prevention Programme
NPL	National Polio Laboratory
NPPV	Nationaal Programma Pneumokokkenvaccinatie Volwassenen (adult pneumococcal vaccination program)
NRLBM	Netherlands Reference Laboratory for Bacterial Meningitis
nOPV2	novel type 2 oral polio vaccine
NTHi	nontypeable *Haemophilus influenzae*
NWKV	Dutch Working Group for Clinical Virology; Nederlandse Werkgroep voor Klinische Virologie
OE ratio	observed expected ratio
OMT	Outbreak Management Team
OMT-V	Outbreak Management Team Vaccination
OPA	Opsonophagocytic Assay
OPV	oral polio vaccine
OR	odds ratio
OSA	obstructive sleep apnea
OSIRIS	Dutch information system for infectious disease surveillance; Online systeem voor infectieziekten registratie binnen ISIS
PB	plasmablasts
PCA	principal component analysis
PCR	polymerase chain reaction
PCV	pneumococcal conjugate vaccine
PCV3	third dose of a pneumococcal conjugate vaccine
PCV7	heptavalent pneumococcal conjugate vaccine

PCV10	10-valent pneumococcal conjugate vaccine
PCV12	12-valent pneumococcal conjugate vaccine
PCV13	13-valent pneumococcal conjugate vaccine
PCV15	15-valent pneumococcal conjugate vaccine
PCV20	20-valent pneumococcal conjugate vaccine
PEF	Polio Essential Facility
PEG	poly ethylene glycol
PEP	post-exposure prophylaxis
PEV	parechovirus
PHN	postherpetic neuralgia
PICO	PIENTER Corona study
PICU	paediatric intensive care unit
Pneu	pneumococcal disease
PorA	porin A protein
POTS	postural orthostatic tachycardia
PPV	pneumococcal polysaccharide vaccine
PPV23	23-valent pneumococcal polysaccharide vaccine
PRAC	Pharmacovigilance Risk Assessment Committee
PrEP	pre-exposure prophylaxis
Prn	pertactin
PSSA	prescription sequence symmetry analysis
Ptx	pertussis toxin
PUAT	pneumococcal urinary antigen test
PV	poliovirus
QALY	quality-adjusted life year
qPCR	real-time polymerase chain reaction
RAI	receptive anal intercourse
RBD	receptor binding domain
RCC	Regional Certification Commission
RCT	randomized controlled trial
RD	risk difference
RIVM	Netherlands National Institute for Public Health and the Environment
RKI	Robert Koch Institute
RNA	ribonucleic acid
ROS	reactive oxygen species
RR	relative risk
RRA	Rapid Risk Assessment
RRP	recurrent respiratory papillomatosis
RSV	respiratory syncytial virus
RV	rota virus
RVC	Regional Verification Commission
RZV	recombinant zoster vaccine (Shingrix®)
SAGE	Strategic Advisory Group of Experts on Immunization
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
(r/h)SBA	(rabbit/human)Serum Bactericidal Assay
SCLS	systemic capillary leak syndrome
SDGs	Sustainable Development Goals
SEP	Socioeconomic Position
SFU	Spot Forming Units

SHCs	sexual health clinics
SIA	supplementary immunisation activity
SIDS	sudden infant death syndrome
SMMC	Sint Maarten Medical Center
SNPs	single nucleotide polymorphisms
SPR	serum protection rate
SocioVax	social science research on vaccination; sociaalwetenschappelijk onderzoek naar vaccineren
SSTI	skin and soft tissue infections
ST	sequence type
STP	sewage treatment plants
Tdap	tetanus, diphtheria and pertussis vaccine
TIG	tetanus immunoglobulin
TT	tetanus toxoid
TTS	thrombocytopenia syndrome
UK	United Kingdom
UKHSA	United Kingdom Health Security Agency
URR	upstream regulatory region
US	United States
USP	Utrecht Science Park
UVV	universal varicella vaccination
VAERS	Vaccine Adverse Event Reporting System
VASCO	Vaccination Study on the Coronavirus
VDPV	vaccine-derived poliovirus
VE	vaccine effectiveness
VITT	Vaccine Induced Prothrombotic Immune Thrombocytopenia/Vaccine-Induced Immune Thrombotic Thrombocytopenia
VLPs	virus-like particles
VNT	virus neutralizing antibody titers
VOC	variant of concern
VP1	polio virus protein 1
VPDs	vaccine preventable diseases
VWS	Ministry of Health, Welfare, and Sport; Ministerie van Volksgezondheid, Welzijn en Sport
VZV	varicella zoster virus
wgMLST	whole-genome multi-locus sequence type
WGS	whole-genome sequencing
WHO	World Health Organisation
WHO EU	WHO European Region
WHO THP	World Health Organsation Tailoring Health Programmes
wP	whole-cell pertussis
WPV	wild poliovirus
WPV1	type 1 wild poliovirus
WPV2	type 2 wild poliovirus
WPV3	type 3 wild poliovirus
WT	Wild type
WTP	willingness to pay

YHC	youth healthcare
YHCP	youth healthcare professional
ZVL	zoster vaccine live (Zostavax®)

Appendix 1 Surveillance methodology

A1.1 Disease surveillance

The impact of the National Immunisation Programme (NIP) can be monitored through mortality, morbidity, and laboratory data related to the target diseases. We describe the various data sources used for disease surveillance and the various methods used to estimate vaccine impact, vaccine effectiveness, burden of disease, and cost-effectiveness.

A1.1.1 Data sources

A1.1.1.1 Notification data

Mandatory disease notifications are an important source of surveillance data for the diseases included in the NIP. Notification of infectious diseases was introduced in the Netherlands in 1865. Since then, several changes in the notification procedures have been implemented. Not all diseases targeted by the NIP have been notifiable throughout the entire period (Table A1.1) [1]. In December 2008, a new law (Wet Publieke Gezondheid) was passed, which requires notification of all NIP-targeted diseases except human papillomavirus (HPV). Rotavirus vaccination was added to the NIP in 2024, but rotavirus infection is not (yet) notifiable in the Netherlands.
There are four notifiable disease categories. Diseases in category A have to be reported by telephone immediately following a suspected case. Diseases in categories B1, B2, and C must be reported within 24 hours or 1 working day following laboratory confirmation. However, under-reporting and reporting delays are issues with regard to several diseases [2]. In each of the first three categories (A, B1, and B2), various intervention measures can be enforced by law to prevent spreading of the disease.

Physicians and clinical laboratories are required to notify cases to the Municipal Health Centres (GGDs). The GGD in question reports cases to RIVM through the online Osiris platform. In addition to patient characteristics (e.g. year of birth, sex, postal code), epidemiological (e.g. related cases, risk factors) and clinical data (e.g. hospital admission, death, vaccination status) is collected through the notifications.

Table A.1.1 Periods and category of statutory notification for vaccine-preventable diseases (VPDs) included in the current National Immunisation Programme (NIP).

Disease	Category	Periods of notification by legislation
Diphtheria	B1	From 1872 onwards
Pertussis	B2	From 1975 onwards
Tetanus	C	1950-1999, from December 2008 onwards
Poliomyelitis	A	From 1923 onwards
Invasive *Haemophilus influenzae* type b	C	From December 2008 onwards
Hepatitis B disease	B2	From 1950 onwards
Invasive pneumococcal disease	C	From December 2008 onwards for children born in or after 2006, from March 2021 onwards for persons aged 60 years and older
Mumps	C	1975-1999, from December 2008 onwards
Measles	B2	1872-1899, from 1975 onwards
Rubella	B2	From 1950 onwards
Invasive meningococcal disease	C	From 1905 onwards
COVID-19	A	From 28 January 2020–June 2023

A1.1.1.2 Register-based data

A1.1.1.2.1 Death statistics

Statistics Netherlands (CBS) registers mortality data from death certificates on a statutory basis. The registration specifies whether a natural death, a non-natural death, or a stillborn child is concerned. In the event of a natural death, the physician is required to report the illness or disease that has led to death (primary cause), any complication directly related to the primary cause that has led to death (secondary cause), as well as additional diseases and specifics present at the moment of dying that have contributed to death (further secondary causes). CBS codes causes of death according to the International Classification of Diseases (ICD). This classification is adjusted every ten years or so, which has to be taken into account when identifying mortality trends. Since the statistical year 2013, CBS has used the IRIS programme to automatically code the causes of death [3]. One of the advantages of this procedure is that it increases the international comparability of data. The change in coding did, however, cause considerable (once-only) shifts in the statistics.

A1.1.1.2.2 Hospital admissions

Until 2010, hospital data was managed by the Prismant research institute in the National Medical Register (LMR). Since 2011, Dutch Hospital Data (DHD) has managed the LMR. Since 2013, the National

Register Hospital Care (LBZ), managed by DHD, has received the discharge diagnoses of all patients admitted to hospital. Outpatient diagnoses are not registered. Diseases, including all NIP-targeted diseases, are coded as the main or subsidiary diagnosis according to the ICD-10 coding system. Until mid-2005, coverage of this registration system amounted to about 99%. Since then, coverage has fluctuated due to changes in funding. The data presented in this report only relates to the main diagnoses of clinical admissions. From 2015 onwards, hospitalisation data has been retrieved from Statistics Netherlands. This data is corrected for non-participating hospitals, which may have resulted in a trend break from previous years. Admissions for NIP diseases are counted per year, age group, and sex, and de-duplicated to include one admission per person, year, and disease. Due to privacy regulations, data is rounded to the nearest five. Therefore, one should take into account that 0 cases is not always actually 0 but may also mean 1 or 2 cases. Data for 2024 is not yet available at the time of writing this report.

Between 2020 and 2023, the NICE COVID-19 database was used to monitor COVID-19 hospitalisations. Linkage of the NICE COVID-19 database to the CIMS vaccination register allowed for vaccine effectiveness estimates against COVID-19 hospitalisation.

A1.1.1.2.3 Primary care data

The Nivel (Netherlands Institute for Health Services Research) Primary Care Database (Nivel-PCD) includes data from routine electronic medical records of general practitioners (GPs). Nivel-PCD uses routinely recorded data from healthcare providers to monitor health and the utilisation of health services in a representative sample of the Dutch population. All symptoms and diagnoses of consulting patients are recorded, using the International Classification of Primary Care (ICPC-1) [4]. The use of electronic health records for research purposes is allowed under certain conditions. When these conditions are fulfilled, neither obtaining informed consent from patients nor approval by a medical ethics committee is obligatory for this type of observational studies, which contain no directly identifiable data (art. 24 General Data Protection Regulation (GDPR) implementation Act jo art. 9.2 sub j GDPR). Annual incidence estimates of the total number of new episodes appearing in general practices in the Netherlands are generated by extrapolating the reporting rates in these practices to the total number of Dutch residents, as obtained from CBS. For example, incidence rates of varicella and herpes zoster have been calculated on the basis of this data. The current Dutch RSV surveillance programme is based primarily on general practitioner (GP) surveillance of patients with influenza-like illness (ILI) and other acute respiratory infections (ARI). Nose swabs and throat swabs are collected from a subset of patients and sent to RIVM for virological laboratory diagnostics on influenza virus, RSV, rhinovirus, and enterovirus. Diagnostics have been extended to SARS-CoV-2 from February 2020, parainfluenza virus types 1-4, human metapneumovirus, human seasonal coronaviruses from January 2021, and adenovirus from October 2023.

A1.1.1.3 Laboratory data

Laboratory diagnostics are important in monitoring infectious diseases and the effectiveness of vaccination; approximately 75% of all infectious diseases can only be diagnosed by laboratory tests [5].

However, limited information on patients is registered and, in many cases, laboratory confirmation is not sought for self-limiting vaccine-preventable diseases. Two laboratory surveillance systems used for NIP disease surveillance are the Netherlands Reference Laboratory for Bacterial Meningitis (NRLBM) and the virological laboratories, which are part of the Dutch Working Group for Clinical Virology.

A1.1.1.3.1 Netherlands Reference Laboratory for Bacterial Meningitis (NRLBM)

The NRLBM is a collaboration between the RIVM and the Amsterdam University Medical Centre (Amsterdam UMC). On a voluntary basis, microbiological laboratories throughout the Netherlands send isolates and samples from normally sterile sites (e.g. blood and cerebrospinal fluid (CSF)) of patients with invasive diseases caused by meningococci, pneumococci, and *Haemophilus influenzae* to the NRLBM for further typing. For invasive meningococcal disease and invasive *H. influenzae* disease, there has been nationwide coverage of laboratory surveillance for a long time, at least since the introduction of vaccination for these diseases. Whereas isolate selection was first restricted to samples from CSF or blood, since 2023, laboratories have been requested to send in material from all normally sterile sites, not only from blood or CSF.

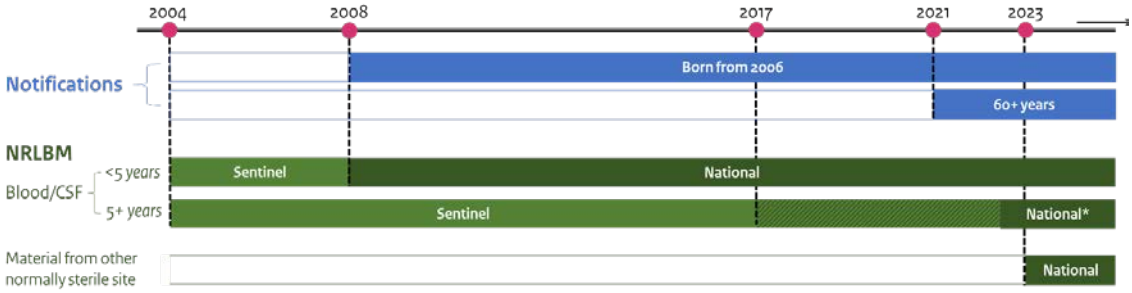
For invasive pneumococcal disease, nine sentinel clinical laboratories distributed throughout the country have sent in isolates and samples from blood or CSF positive for *Streptococcus pneumoniae* since 2004, (Figure A1.1). Up to 2020, these nine sentinel laboratories covered approximately 25% of the Dutch population; since 2020, coverage increased to 28%. For children aged under 5 years, all clinical laboratories have sent in isolates and samples from blood or CSF positive for *S. pneumoniae* since 2008, resulting in national coverage for this age group. Since 2017, all laboratories have been requested to submit isolates and samples from blood or CSF positive for *S. pneumoniae* without restrictions to the patient's age, resulting in national surveillance for all age groups. From the epidemiological year 2022–2023 onwards, national data rather than sentinel data has also been used for analyses on surveillance data for age groups >=5 years. Because of the changes in IPD surveillance over time, only IPD diagnoses based on positive blood or CSF samples are included in the analyses of long-term trends. All pneumococcal isolates are serotyped by the NRLBM, and CSF-samples are tested using PCR for confirmation of the pneumococcal infection.

For meningococci, isolates are serogrouped and further characterised by DNA sequencing based on PorA and FetA finetype. Finetype is used in surveillance to determine whether potential clusters are occurring, since isolates within an outbreak will generally have an identical finetype. Additionally, whole genome sequencing was performed in batches for IMD serogroup B isolates at least up to and including June 2024.

Haemophilus influenzae isolates are serotyped. Additionally, the biotype is determined for non-typeable *Haemophilus influenzae* isolates.

Data from the NRLBM is linked to notification data for IPD, IMD, and invasive Hib disease. For non-b *Haemophilus influenzae* infections, only limited case information is available.

Figure A1.1 Overview of surveillance of invasive pneumococcal disease over time.



National data for persons aged 5 years and over has been used in analyses of surveillance data from 2022–2023.
*Since 2017 all laboratories in the Netherlands have been asked to send in samples for all age groups, but only since the epidemiological year 2022–2023 has national data been used in surveillance.

A1.1.1.3.2 Virological laboratories

Every week, virological laboratories that are members of the Dutch Working Group for Clinical Virology send positive results of virological diagnostics to RIVM. Approximately 22 laboratories submit information on a regular basis. Aggregated results are shown on the RIVM website. For more information, also on other sources for RSV surveillance, please see the background and method document on the respiratory surveillance of 2024-2025.

It is important to bear in mind that the presence of a virus does not automatically imply the presence of disease. As from 1 December 2014, information on the total number of tests performed can be reported for each week or each year.

A1.1.1.4 Dedicated studies

In addition to the data sources described above, dedicated disease surveillance studies are performed to collect data on hospitalisation or mortality. Further details about dedicated studies can be found in the disease-specific chapters.

A1.1.1.5 Validity of the different data sources

Data from registers on mortality and hospitalisation is not always reliable. For example, cases of post-poliomyelitis syndrome are sometimes classified as acute poliomyelitis, even though they occurred many years ago. Furthermore, cases of acute flaccid paralysis (AFP) due to causes other than poliovirus infection are sometimes inadvertently registered as cases of acute poliomyelitis [6]. Thus, for poliomyelitis, notifications are a more reliable source of surveillance data.

Moreover, for invasive *H. influenzae* disease, invasive pneumococcal disease, and, to a lesser extent, invasive meningococcal disease, data on mortality and hospital admissions based on registration databases is unreliable. This is because they are syndromic diseases (meningitis, sepsis, and pneumonia) and the causative pathogen is not always correctly specified when these diseases are coded. Notification data in combination with laboratory data from the NRLBM is more reliable for these diseases.

A specific ICD-10 code is available (A08.0) for Rotavirus (RV) disease. However, this code is hardly ever used in the Netherlands, as more general ICD categories are felt to suffice. Moreover, gastroenteritis hospitalisations are often not tested in general for all causative pathogens, in particular if very young children are concerned. For this reason, the number of gastroenteritis hospitalisations attributable to RV is estimated indirectly according to a method proposed by Harris et al. [7]. Using this method, the proportion of hospitalisations for gastroenteritis attributable to RV can be estimated by comparing the weekly RV laboratory detections (surveillance virological laboratories) with the number of hospitalisations for specific gastroenteritis ICD-10 codes (A0,-A09, K52, K529) using Poisson regression analysis, or negative binomial regression in case of overdispersion. In this analysis, weekly hospital admissions for the selected ICD-10 codes per age category are used as the outcome variable, with the number of rotavirus laboratory detections from weekly virological surveillance as the predictor. The resulting coefficients from the regression model are used to estimate the number of rotavirus-attributed hospitalisations by multiplying them by the number of reported rotavirus laboratory detections. For this report, coefficients were estimated by imposing the model onto hospitalisation data and weekly laboratory detections from a five-year window, spanning two years prior to and two years after the year of interest. The COVID-19 pandemic years (2020–2022) are modelled separately with their own coefficients due to atypical patterns in hospitalisations and laboratory detections. For the most recent years, the coefficient was based on data from 2018, 2019, and 2023. This coefficient was used to estimate the RV-attributed hospital admissions for the most recent year (for which data is not yet available) by multiplying it by the RV-positive laboratory detections of that year.

From 2012 onwards, incidence rates from Nivel-PCD have been calculated using an adjusted procedure: changes were made to the definitions of disease episodes and to calculations of incidence, which caused an increased incidence for many diseases. Episode duration is defined as the time between the first and last consultation registered with the same code, plus an additional period in which patients are considered not to be susceptible (eight weeks for acute morbidities/complaints). Incidence rates are calculated using a more specific selection of patient years, resulting in a more reliable denominator [8, 9]. Because of these changes, we decided to report previously published incidence rates until 2011 on the basis of the old method [10] and incidence rates from 2012 onwards on the basis of the new method [8]. Due to the new estimation method, the data from 2012 (based on 219 practices) and onwards is not comparable to the data from previous years.

A1.1.2 Methods for disease surveillance

A1.1.2.1 Burden of disease

The disability-adjusted life year (DALY) is a composite health measure that was developed to compare the impact of diseases. The idea behind this approach is that the impact of a particular disease can be split between the number of years of life lost (i.e. premature mortality) and the number of years lived at less than full health (i.e. morbidity). The result is a single measurement unit that quantifies the years of healthy life lost due to a certain disease or infection. The full methodology used to estimate the disease burden of infectious diseases in the Netherlands, expressed in DALYs, is described in the State of Infectious Diseases in the Netherlands, 2013 [11].

A1.1.2.2 Impact of implementation of vaccination

The impact of vaccination (programmes) can be estimated by comparing disease burden following the implementation of vaccination to disease burden prior to the implementation. This can be realised quite simply by a before/after comparison of incidence. A more complex alternative is applying time series analysis, in which, for example, time trends before the implementation of vaccination, seasonality, and vaccination coverage can be taken into account. The vaccination status of individuals is not needed to estimate the impact of a vaccination programme; the vaccination coverage of the population suffices. In addition to the effectiveness of the vaccination itself, vaccination coverage, and the level of herd protection determine the impact of a vaccination programme.

A1.1.2.3 Vaccine effectiveness

To estimate vaccine effectiveness, at least the vaccination status of the cases is necessary.

Following the implementation of a vaccination in the NIP, vaccine effectiveness (VE) can be routinely estimated using the ‘screening method’ [12] with the following equation:

VE (%) = 1- [PCV / (1-PCV) * (1-PPV/PPV)], in which;

PCV = proportion of cases vaccinated;
PPV = proportion of population vaccinated;
1-PCV = proportion of cases that is either not vaccinated, partially vaccinated, or had an unknown vaccination status;
1 – PPV = proportion of population that is either not vaccinated, partially vaccinated, or had an unknown vaccination status, and;
VE = vaccine effectiveness.
It is worth noting, however, that this method is very sensitive to changes in the proportion of population and cases vaccinated. Therefore, the fact that the vaccine coverage of the population can be monitored less precisely due to the informed consent procedure affects the reliability of the VE estimates.

In addition, several study designs, including case-control and cohort studies, can be used to assess VE following implementation [13]. A specific type of case-control design used to estimate VE is the indirect cohort design or Broome method [14]. This design can be used for a

vaccine that protects against specific types of a pathogen, for example, 10-valent pneumococcal conjugate vaccine, which protects against 10 pneumococcal serotypes. Cases in which the disease is caused by a vaccine type are the ‘cases’, and cases in which the disease is caused by a type not included in the vaccine serve as ‘controls’. Vaccination status is then compared across the ‘cases’ (vaccine-type cases) and the ‘controls’ (non-vaccine-type cases). The advantage of this design is that it adjusts for ascertainment bias between cases and controls, as both cases and controls are actually ill. One assumption in this design is that vaccinated people are at the same risk of non-vaccine-type infection as unvaccinated people. This means that VE is underestimated in the case of cross-protection by the vaccine against non-vaccine-type disease. Conversely, if a replacement disease occurs only in vaccinated people, VE is overestimated.

Multiple statistical approaches are available to evaluate VE against persistent HPV infections through the use of cohort studies. These approaches differ with respect to their underlying assumptions [15]. On the basis of the available literature, absence of violations of the underlying assumptions, and the use of data throughout the follow-up, we suggest the Prentice Williams Peterson Total-Time (PWP-TT) approach as being the most valid method to evaluate vaccine effectiveness against HPV infections in cohort studies conducted among young women. The PWP-TT is a survival analysis method for recurrent events, taking into account the total time at risk. It assumes event-specific hazards, allowing the hazard to be different for each subsequent event [16]. We estimated VE as one minus the hazard ratio times 100%. If VE is estimated against a combined endpoint of multiple HPV types, being infected with one of these types at that time point is used as the outcome instead of the total number of infections.

A1.1.2.4 Pertussis vaccination coverage

Up to and including publication year 2018, standardised vaccination coverage estimates of 96% and 92% were used for the PPV to calculate vaccine effectiveness of the primary vaccination series and the booster vaccination, respectively. From publication year 2019 onwards, in response to the changes in vaccination coverage, the vaccination coverage as reported in the national vaccination coverage report has been used for each birth cohort. This results in a different PPV for each birth cohort and more accurate VE calculation. However, the fact that the vaccine coverage of the population and the vaccination status of the cases can be monitored less precisely due to the informed consent procedure, affects the reliability of the VE estimates from more recent years.

A 1.1.2.5 Epidemiological years invasive pneumococcal disease

The monthly number of IPD cases follow a seasonal pattern, with a peak during the influenza season in the winter months. Using calendar years would interrupt this seasonal pattern; therefore, epidemiological years or epi-years are used in IPD surveillance. These epi-years run from June of the first calendar year to May of the second calendar year, e.g. June 2023 – May 2024 (written as epi-year 2023–2024).

A1.2 Molecular surveillance of the pathogen

Monitoring strain variations due to differences in phenotype and/or genotype is an important part of information gathering on the emergence of (sub)types that may either be more virulent or less effectively controlled by vaccination. It is also a useful tool for increasing insights into transmission dynamics.

A1.3 Immunosurveillance

Monitoring the seroprevalence of all NIP-targeted diseases is a way to gather age-specific and sex-specific information on immunity to these diseases, acquired either through natural infection or vaccination. To achieve this, a random selection of people from the general population of the Netherlands is periodically asked to donate a blood sample and complete a questionnaire (PIENTER survey). This survey was conducted in 1995–1996 (N_{blood}=10,128) [17], 2006–2007 (N_{blood}=7904) [18], and 2016–2017 (N_{blood}=5745)[19]. People living in regions with low vaccine coverage and non-Western migrants are oversampled in order to gain greater insights into differences in immunity among specific groups.

The PIENTER Corona (PICO) study, a derivative of the PIENTER study, is a Dutch nationwide prospective population-based cohort study that was set up during the early stages of the COVID-19 pandemic [20-22]. Its primary aim was to assess levels of antibodies to SARS-CoV-2 in consecutive blood samples of over 10,000 unique participants across all ages and regions representative of the Dutch population. In total, thirteen study rounds were performed up until the end of 2024.

A1.4 Vaccination coverage

Vaccination coverage data can be used to gain insight into the NIP's effectiveness. Furthermore, this information can help identify groups with low vaccine coverage who are at increased risk of contracting one of the NIP-targeted diseases. In the Netherlands, all vaccinations administered within the framework of the NIP are registered in a central electronic (web-based) database at the individual level (Præventis) [23]. COVID-19 vaccinations are registered in CIMS, which is used to estimate COVID-19 vaccination coverage.

As from 1 January 2022, informed consent is required to exchange vaccination data containing personal data with RIVM. As a result, RIVM can no longer determine vaccination coverage exactly. Anonymous vaccinations cannot be included in vaccination coverage calculations, as year of birth, sex, place of residence, and vaccination dose are unknown. Therefore, the registered vaccination coverage is lower than the actual vaccination coverage. In addition, the DTaP-IPV-HBV-Hib figures for newborns born from August 2020 until December 2021 (reporting years 2023–2024) are negatively affected if the DTaP-IPV vaccine schedule indication is missing and the assessment of the vaccination status is too strict as a result.

The CIMS dataset only contains vaccinations of people who gave consent for registration in CIMS. Therefore, the registered vaccination coverage is lower than the actual vaccination coverage. During the autumn round of 2024, 98% of people who were vaccinated by the Municipal Health

Services gave consent for registration in CIMS. For people vaccinated by other organisations, this percentage is unknown.
The CIMS database is linked to the Personal Records Database (BRP). The numerator is updated daily and the denominator data is updated monthly, to account for vaccinated individuals who have passed away or emigrated.

A1.5 Surveillance of adverse events following vaccination

Until 2011, RIVM used passive safety surveillance through an enhanced spontaneous reporting system. An aggregate analysis of all reported adverse events following immunisation (AEFIs) was published annually. The last report, for 2010, also contains a detailed description of the methodology used and a review of trends and important findings over the previous fifteen years [24].
On 1 January 2011, this enhanced spontaneous AEFI reporting system was taken over by the Netherlands Pharmacovigilance Centre (Lareb). Detailed information is available at *www.lareb.nl*. In view of this transition, comparisons between the period before 2011 and the period from 2011 onwards should be made with caution. Furthermore, in 2011, Lareb started a campaign among parents of vaccinated children to promote the reporting of AEFIs. Until 2017, Lareb combined all injection site reactions as a single adverse event. Between 2017 and 2022, all injection site reactions were listed separately, but starting from 2023, these reactions have been combined again. Because changes to the NIP occur regularly, the effect of these changes is often not reflected in the total number of adverse events reported annually by Lareb.
In addition, the RIVM Centre for Infectious Disease Control (CIb) conducts systematic studies to monitor the vaccine coverage and vaccine effectiveness of the NIP, such as questionnaire surveys and linkage studies between different databases. When appropriate, adverse events will be included in these studies.

A1.6 Cost-effectiveness

The decision to include a certain vaccination option in the NIP is based on several factors, including vaccine safety and efficacy, avertable disease burden, acceptability, and cost-effectiveness of vaccination. Cost-effectiveness is defined as the additional cost per additional unit of health benefit produced, compared to an alternative, such as the vaccine already in use or no vaccination. In other words, economic evaluation of a vaccination programme provides information on whether the health gain associated with a new vaccine is worth the cost as compared with other options for investing in health improvements or prevention. Most commonly, cost-effectiveness is expressed in cost per quality-adjusted life year (QALY), which is a measure of disease burden comprising both the quality and quantity of life. If provided in a transparent and standardised manner, evidence of cost-effectiveness can contribute to policy recommendations for vaccinations included in the NIP.

A1.7 Methods on the Dutch Caribbean islands

Monitoring methods on the Dutch Caribbean CAS and BES islands differ from the European Netherlands as well as between islands. All islands

have their own register for notifications of diseases included in the NIP. This data is shared with RIVM upon request.

For the surveillance of vaccinations administered within the NIP, as well as COVID-19 vaccinations and population size, the islands share data with RIVM on an annual basis. It is imperative to note that local vaccination data registration systems are not linked to local population registers. As a result, immigration and emigration cannot be monitored precisely. The method used for determining vaccination coverage often results in an underestimation where school-aged children are concerned, as vaccinations are usually offered per school year regardless of a child's year of birth. In that case, the age limits of five, ten, and fifteen years, as maintained for the European Netherlands, are not always met.

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*Publication with RIVM authors.

Appendix 2 Morbidity and mortality figures

Diseases included in the current NIP

Diphtheria (ICD-10: A36)															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (source: CBS)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospitalisations ^ (source: Prismant/DHD/CBS)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notifications (source: Osiris)															
2015	0	0	0	0	0	0	0	0	4	0	1	0	5	0	5

Diphtheria (ICD-10: A36)															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
2016	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2
2017	0	0	0	0	0	0	0	0	0	1	2	1	2	2	4
2018	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
2019	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1
2020	0	0	0	0	0	0	0	0	0	2	1	0	1	2	3
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	5	1	0	0	2	0	7	1	8
2023	0	0	0	0	0	0	9	0	5	0	0	0	14	0	14
2024	0	0	0	0	0	0	0	0	1	0	1	1	2	1	3
Laboratory diagnoses (source: IDS, RIVM)**															
2015	0	0	0	0	0	0	0	0	5	1	3	2	8	3	11
2016	0	0	0	0	0	0	0	1	3	1	6	5	9	7	16
2017	0	0	0	0	0	0	0	0	4	3	4	1	8	4	12
2018	0	0	0	0	0	0	0	0	5	1	5	2	10	3	13
2019	1	0	0	0	0	1	0	1	3	2	6	1	10	5	15
2020	0	0	0	0	0	0	0	0	1	2	6	1	7	3	10
2021	0	0	0	0	0	0	1	0	5+	1	3	0	9	1	10+
2022	0	0	0	0	0	0	10×	2	0	3	3	0	13	5	20#×
2023	0	0	0	0	1	0	6	0	6	1	3	1	17$	2	20$<
2024	0	0	0	0	0	0	0	0	8	3	9	6	17	9	27<

* Preliminary figures.
^ Data corrected for non-participating hospitals and rounded off to closest five. Therefore, 0 cases can also be a few cases.
** Number of diphtheria isolates.
+ Two isolates came from the same patient, but were collected at different times and from different sample types.
× Twice, two isolates came from the same patient, were collected during the same week, and came from different sample types.
Two isolates came from the same patient (gender unknown), were collected during the same week, and came from different sample types.
$ For one isolate age was unknown.
< For one isolate sex was unknown.

Haemophilus influenzae															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Notifications (serotype b; source: Osiris)															
2015	3	0	1	3	0	0	0	0	4	0	2	0	10	3	17
2016	7	0	6	6	0	0	1	0	2	2	5	5	21	13	37
2017	1	3	2	5	2	2	0	1	4	2	5	9	14	22	37
2018	6	1	4	6	1	0	0	0	0	2	2	8	13	17	35
2019	6	3	4	3	0	0	1	1	1	4	5	10	17	21	39
2020	8	4	8	8	3	2	0	0	4	6	12	13	35	33	69
2021	5	5	11	4	1	1	1	0	1	5	17	14	36	29	67
2022	5	5	10	11	1	1	0	0	2	2	12	8	30	27	60
2023	5	5	10	8	0	0	0	0	5	3	11	9	31	25	56
2024	6	2	4	3	0	1	0	0	2	5	13	19	25	30	55
Laboratory diagnoses (serotype b; source: NRLBM)															
2015	3	0	4	7	1	0	0	0	5	0	10	6	23	13	36
2016	8	0	6	7	0	1	1	0	2	2	9	7	26	17	43
2017	1	3	2	7	2	2	0	1	5	2	10	13	20	28	49
2018	7	1	4	6	1	0	0	0	2	4	4	12	18	24	42
2019	6	3	4	3	0	0	1	1	1	4	5	10	17	21	38
2020	8	4	8	8	3	2	0	0	4	6	12	13	35	33	68
2021	5	5	12	4	1	1	1	0	2	6	17	16	38	32	70
2022	5	5	10	12	1	1	0	0	2	2	12	8	30	28	58
2023	5	5	10	8	0	0	0	0	5	3	12	9	32	25	57
2024	6	2	4	3	0	1	0	0	2	6	12	19	24	31	55
Laboratory diagnoses (all serotypes; source: NRLBM)															
2015	11	6	6	9	3	1	1	0	15	13	64	65	102	97	199
2016	14	4	7	8	1	1	1	0	8	12	49	75	80	100	184
2017	6	6	7	12	4	2	2	2	11	23	63	90	93	136	233
2018	14	5	8	6	3	0	4	3	8	24	76	79	113	118	235
2019	11	5	8	7	0	0	2	2	10	27	75	75	106	116	223

Haemophilus influenzae															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
2020	13	6	13	9	4	2	1	4	5	18	63	60	99	99	200
2021	7	11	14	6	2	4	3	1	5	18	50	49	81	89	171
2022	12	8	19	16	5	2	1	1	15	29	103	110	155	167	325
2023	14	10	13	11	3	2	7	3	13	22	117	100	167	149	317
2024	9	4	9	8	3	1	4	1	20	34	113	125	158	173	332

Hepatitis B															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (ICD-10: B16: Acute; source: CBS)															
2015	0	0	0	0	0	0	0	0	0	1	2	0	2	1	3
2016	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
2021	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2
2022	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1
2023	0	0	0	0	0	0	0	0	2	0	0	0	2	0	2
2024*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospitalisations (source: Prismant/DHD/CBS)															
2015	0	0	0	0	0	0	0	0	10	5	15	5	25	15	40
2016	0	0	0	0	0	0	0	0	10	15	20	0	30	15	45
2017	0	0	0	0	0	0	0	0	10	10	15	5	25	15	35
2018	0	0	0	0	0	0	0	0	10	5	10	10	20	15	35
2019	0	0	0	0	0	0	0	0	5	5	10	5	10	10	25
2020	0	0	0	0	0	0	0	0	10	5	10	5	20	10	30
2021	0	0	0	0	0	0	0	0	15	5	10	5	25	10	35
2022	0	0	0	0	0	0	0	0	10	5	10	5	20	10	25
2023	0	0	0	0	0	0	0	0	15	5	15	0	25	5	35
Notifications (Acute; source: Osiris)															
2015	0	0	0	0	0	0	0	1	52	14	33	10	85	25	110
2016	0	0	0	0	0	0	2	3	40	16	46	7	88	26	114
2017	0	0	0	0	0	0	1	2	47	15	43	7	91	24	115
2018	0	0	0	0	0	0	0	2	52	13	32	6	84	21	105
2019	0	0	0	0	0	0	0	2	40	20	37	6	77	28	105
2020	0	0	0	0	0	0	1	0	46	17	28	4	75	21	96

Hepatitis B															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
2021	0	0	0	0	0	0	2	3	38	4	24	3	64	10	74
2022	0	0	0	0	0	0	0	0	40	11	32	4	72	15	87
2023	0	0	0	0	0	0	0	0	41	15	35	3	76	18	94
2024	0	0	0	0	0	0	2	1	43	13	33	5	76	19	95
Notifications (chronic; source: OSIRIS)															
2015	0	0	1	0	0	1	14	17	433	327	152	71	600	416	1017
2016	1	0	0	0	0	0	25	12	396	298	184	90	606	400	1006
2017	0	0	0	1	0	1	20	18	439	357	171	97	630	474	1105
2018	0	0	0	0	0	0	21	19	427	325	157	87	605	431	1036
2019	0	0	1	3	3	1	20	11	447	310	192	90	663	415	1079
2020	0	0	0	0	0	0	8	7	280	228	146	53	434	288	724
2021	0	0	0	0	1	1	10	8	305	212	134	75	450	296	747
2022	0	0	0	1	0	1	10	4	378	217	170	70	558	293	851
2023	0	0	1	3	1	0	10	7	343	257	153	73	508	340	848
2024	1	0	1	2	0	1	7	8	327	246	143	95	477	352	831

*Preliminary figures.

Human papillomavirus ICD-10: C53															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (cervical cancer; source: CBS)															
2015	-	0	-	0	-	0	-	0	-	49	-	158	-	207	207
2016	-	0	-	0	-	0	-	0	-	50	-	179	-	229	229
2017	-	0	-	0	-	0	-	0	-	44	-	162	-	206	206
2018	-	0	-	0	-	0	-	0	-	50	-	167	-	217	217
2019	-	0	-	0	-	0	-	0	-	45	-	171	-	216	216
2020	-	0	-	0	-	0	-	0	-	52	-	178	-	230	230
2021	-	0	-	0	-	0	-	0	-	48	-	165	-	213	213
2022	-	0	-	0	-	0	-	0	-	53	-	170	-	223	223
2023	-	0	-	0	-	0	-	0	-	36	-	159	-	195	195
2024*	-	0	-	0	-	0	-	0	-	39	-	175	-	214	214
Registrations (cervical cancer; source NKR)															
2015	-	0	-	0	-	0	-	0	-	388	-	321	-	709	709
2016	-	0	-	0	-	0	-	0	-	449	-	356	-	805	805
2017	-	0	-	0	-	0	-	1	-	436	-	337	-	774	774
2018	-	0	-	0	-	0	-	0	-	469	-	376	-	845	845
2019	-	0	-	0	-	1	-	0	-	513	-	394	-	908	908
2020	-	0	-	0	-	0	-	0	-	454	-	352	-	806	806
2021	-	0	-	0	-	0	-	0	-	563	-	385	-	948	948
2022	-	0	-	0	-	0	-	0	-	547	-	407	-	954	954
2023*	-	0	-	0	-	0	-	0	-	468	-	375	-	843	843
2024*	-	0	-	0	-	0	-	1	-	457	-	447	-	905	905

*Preliminary figures.

Human papillomavirus ICD-10: C51															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (vulva cancer; source: CBS)^															
2015	-	0	-	0	-	0	-	0	-	8	-	95	-	103	103
2016	-	0	-	0	-	0	-	0	-	0	-	99	-	99	99
2017	-	0	-	0	-	0	-	0	-	2	-	112	-	114	114
2018	-	0	-	0	-	0	-	0	-	4	-	137	-	141	141
2019	-	0	-	0	-	0	-	0	-	3	-	164	-	167	167
2020	-	0	-	0	-	0	-	0	-	3	-	147	-	150	150
2021	-	0	-	0	-	0	-	0	-	4	-	140	-	144	144
2022	-	0	-	0	-	0	-	0	-	5	-	139	-	144	144
2023	-	0	-	0	-	0	-	0	-	2	-	133	-	135	135
2024*	-	0	-	0	-	0	-	0	-	3	-	124	-	127	127
Registrations (vulva cancer; source NKR)^															
2015	-	0	-	0	-	0	-	0	-	43	-	336	-	379	379
2016	-	0	-	0	-	0	-	0	-	38	-	380	-	418	418
2017	-	0	-	0	-	0	-	0	-	38	-	372	-	410	410
2018	-	0	-	0	-	0	-	0	-	43	-	384	-	427	427
2019	-	0	-	0	-	0	-	0	-	51	-	409	-	460	460
2020	-	0	-	0	-	0	-	0	-	42	-	388	-	430	430
2021	-	0	-	0	-	0	-	1	-	35	-	413	-	449	449
2022	-	0	-	0	-	0	-	0	-	29	-	435	-	464	464
2023*	-	0	-	0	-	0	-	0	-	38	-	419	-	457	457
2024*	-	0	-	0	-	0	-	0	-	33	-	418	-	451	451

^While HPV can contribute to the formation of this type of cancer, it is not solely responsible for all registrations or deaths presented here.
*Preliminary figures.

Human papillomavirus ICD-10: C52															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (vagina cancer; source: CBS)^															
2015	-	0	-	0	-	0	-	0	-	0	-	21	-	21	21
2016	-	0	-	0	-	0	-	0	-	1	-	22	-	23	23
2017	-	0	-	0	-	0	-	0	-	0	-	18	-	18	18
2018	-	0	-	0	-	0	-	0	-	1	-	24	-	25	25
2019	-	0	-	0	-	0	-	0	-	2	-	23	-	25	25
2020	-	0	-	0	-	0	-	0	-	0	-	21	-	21	21
2021	-	0	-	0	-	0	-	0	-	1	-	26	-	27	27
2022	-	0	-	0	-	0	-	0	-	0	-	15	-	15	15
2023	-	0	-	0	-	0	-	0	-	1	-	14	-	15	15
2024*	-	0	-	0	-	0	-	0	-	1	-	21	-	22	22
Registrations (vagina cancer; source NKR)^															
2015	-	0	-	0	-	0	-	0	-	4	-	49	-	53	53
2016	-	0	-	0	-	0	-	1	-	7	-	33	-	41	41
2017	-	0	-	0	-	0	-	0	-	4	-	47	-	51	51
2018	-	0	-	0	-	0	-	0	-	1	-	55	-	56	56
2019	-	0	-	0	-	0	-	0	-	3	-	38	-	41	41
2020	-	0	-	0	-	0	-	0	-	3	-	53	-	56	56
2021	-	0	-	0	-	0	-	0	-	6	-	52	-	58	58
2022	-	0	-	0	-	0	-	0	-	5	-	47	-	52	52
2023*	-	0	-	0	-	0	-	0	-	8	-	47	-	55	55
2024*	-	0	-	0	-	0	-	0	-	8	-	52	-	60	60

^While HPV can contribute to the formation of this type of cancer, it is not solely responsible for all registrations or deaths presented here.
*Preliminary figures.

Human papillomavirus ICD-10: C60															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (penis cancer; source: CBS)^															
2015	0	-	0	-	0	-	0	-	2	-	33	-	35	-	35
2016	0	-	0	-	0	-	0	-	1	-	33	-	34	-	34
2017	0	-	0	-	0	-	0	-	4	-	30	-	34	-	34
2018	0	-	0	-	0	-	0	-	2	-	32	-	34	-	34
2019	0	-	0	-	0	-	0	-	1	-	45	-	46	-	46
2020	0	-	0	-	0	-	0	-	1	-	50	-	51	-	51
2021	0	-	0	-	0	-	0	-	0	-	37	-	37	-	37
2022	0	-	0	-	0	-	0	-	2	-	37	-	39	-	39
2023	0	-	0	-	0	-	0	-	1	-	33	-	34	-	34
2024*	0	-	0	-	0	-	0	-	1	-	47	-	48	-	48
Registrations (penis cancer; source NKR)^															
2015	0	-	0	-	0	-	0	-	11	-	141	-	152	-	152
2016	0	-	0	-	0	-	0	-	9	-	158	-	167	-	167
2017	0	-	0	-	0	-	0	-	13	-	152	-	165	-	165
2018	0	-	0	-	0	-	0	-	12	-	175	-	187	-	187
2019	0	-	0	-	0	-	0	-	11	-	192	-	203	-	203
2020	0	-	0	-	0	-	0	-	13	-	174	-	187	-	187
2021	0	-	0	-	0	-	0	-	5	-	176	-	181	-	181
2022	0	-	0	-	0	-	0	-	9	-	201	-	210	-	210
2023*	0	-	0	-	0	-	0	-	5	-	200	-	205	-	205
2024*	0	-	0	-	0	-	0	-	5	-	205	-	210	-	210

^While HPV can contribute to the formation of this type of cancer, it is not solely responsible for all registrations or deaths presented here.
*Preliminary figures.

Human papillomavirus ICD-10: C10															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (oropharynx cancer; source: CBS)^															
2015	0	0	0	0	0	0	0	0	2	0	61	32	63	32	95
2016	0	0	0	0	0	0	0	0	3	1	66	31	69	32	101
2017	0	0	0	0	0	0	0	0	4	0	64	32	68	32	100
2018	0	0	0	0	0	0	0	0	1	1	67	34	68	35	103
2019	0	0	0	0	0	0	0	0	2	1	74	40	76	41	117
2020	0	0	0	0	0	0	0	0	2	1	81	33	83	34	117
2021	0	0	0	0	0	0	0	0	1	0	75	47	76	47	123
2022	0	0	0	0	0	0	0	0	3	1	114	35	117	36	153
2023	0	0	0	0	0	0	0	0	1	1	79	42	80	43	123
2024*	0	0	0	0	0	0	0	0	2	2	92	42	94	44	138
Registrations (oropharynx cancer; source NKR)^**															
2015	0	0	0	0	0	0	2	0	55	14	607	237	664	251	915
2016	0	0	0	0	0	0	1	0	47	21	658	274	706	295	1001
2017	0	0	0	0	0	0	1	1	44	21	635	250	680	272	952
2018	0	0	0	0	0	0	1	3	40	20	660	275	701	298	999
2019	0	0	0	0	0	0	2	0	39	24	683	244	724	268	992
2020	0	0	0	0	0	0	1	1	25	24	674	278	700	303	1003
2021	0	0	0	0	0	0	2	0	43	17	694	273	739	290	1029
2022	0	0	0	0	0	0	3	0	50	17	705	279	758	296	1054
2023*	0	0	0	0	0	0	0	0	44	16	739	303	783	319	1102
2024*	0	0	0	0	0	0	0	0	35	21	654	266	689	287	976

^While HPV can contribute to the formation of this type of cancer, it is not solely responsible for all registrations or deaths presented here.
*Preliminary figures.
** ICD-10: C01, C05.1-2, C09, C10.0, C10.2-4, C10.8-9

Human papillomavirus ICD-10: C21															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (anus cancer; source: CBS)^															
2015	0	0	0	0	0	0	0	0	3	0	16	15	19	15	34
2016	0	0	0	0	0	0	0	0	3	1	30	19	33	20	53
2017	0	0	0	0	0	0	0	0	1	1	30	27	31	28	59
2018	0	0	0	0	0	0	0	0	4	0	34	20	38	20	58
2019	0	0	0	0	0	0	0	0	1	2	31	30	32	32	64
2020	0	0	0	0	0	0	0	0	1	2	20	33	21	35	56
2021	0	0	0	0	0	0	0	0	2	4	29	30	31	34	65
2022	0	0	0	0	0	0	0	0	3	4	27	36	30	40	70
2023	0	0	0	0	0	0	0	0	2	0	41	31	43	31	74
2024*	0	0	0	0	0	0	0	0	4	1	29	38	33	39	72
Registrations (anus cancer; source NKR)^															
2015	0	0	0	0	0	0	0	0	16	18	105	112	121	130	251
2016	0	0	0	0	0	0	0	0	18	15	105	121	123	136	259
2017	0	0	0	0	0	0	0	0	13	13	111	120	124	133	257
2018	0	0	0	0	0	0	0	0	14	16	132	150	146	166	312
2019	0	0	0	0	0	0	0	0	13	12	119	143	132	155	287
2020	0	0	0	0	0	0	0	0	11	16	110	159	121	175	296
2021	0	0	0	0	0	0	0	0	14	20	147	172	161	192	353
2022	0	0	0	0	0	0	0	0	13	17	120	181	133	198	331
2023*	0	0	0	0	0	0	0	0	15	17	154	162	169	179	348
2024*	0	0	0	0	0	0	0	0	11	19	130	181	141	200	341

^While HPV can contribute to the formation of this type of cancer, it is not solely responsible for all registrations or deaths presented here.
*Preliminary figures.

Measles ICD-10: B05															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (source: CBS)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024*	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1
Notifications (source: Osiris)															
2015	0	0	0	0	0	0	0	0	5	1	1	0	6	1	7
2016	0	0	0	0	0	2	0	0	2	2	0	0	2	4	6
2017	0	0	1	0	0	1	1	1	5	7	1	0	8	9	17
2018	2	1	1	3	0	0	1	1	6	8	0	1	10	14	24
2019	3	0	6	8	11	8	4	6	22	13	0	1	46	36	82
2020	0	0	0	1	0	0	0	0	1	0	0	0	1	1	2
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	1	1	3	0	0	0	0	1	0	0	4	2	6
2023	0	0	1	1	0	0	0	0	2	3	0	0	3	4	7
2024	7	5	31	38	33	29	9	13	11	22	4	3	95	110	205
Hospitalisations^ (source: Prismant/DHD)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	5	0	0	0	5	0	5
2018	0	0	0	0	0	0	0	0	5	0	0	0	5	5	10
2019	0	0	0	0	0	0	0	0	5	0	0	0	10	5	10

Measles ICD-10: B05															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5

*Preliminary figures.
^Data corrected for non-participating hospitals and rounded off to closest five. Therefore, 0 cases can also be a few cases.

Meningococcal disease ICD-10: A39, M010															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (source: CBS)															
2015	0	0	0	1	0	0	0	0	1	0	0	2	1	3	4
2016	0	0	1	1	0	0	0	1	0	0	1	2	2	4	6
2017	1	0	1	1	0	0	1	0	1	1	0	2	4	4	8
2018	0	0	2	0	0	0	1	3	2	0	1	4	6	7	13
2019	0	1	0	1	0	0	0	1	1	0	0	4	1	7	8
2020	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	1	0	0	0	0	0	0	0	0	2	1	2	3
2023	0	0	0	1	0	0	0	0	0	0	1	1	1	2	3
2024*	1	0	1	0	0	0	0	0	1	0	4	0	7	0	7
Notifications (source: Osiris)															
2015	7	6	5	6	4	1	9	5	8	5	13	19	46	42	88
2016	4	8	8	8	3	4	11	15	16	13	14	42	56	90	146
2017	6	10	10	9	1	2	13	26	23	13	29	53	82	113	195
2018	9	6	15	11	1	2	16	19	13	12	34	61	89	111	199
2019	2	3	12	5	3	2	12	13	18	15	23	43	71	82	151
2020	6	0	5	5	2	2	5	3	10	2	10	14	38	26	64
2021	3	3	2	4	0	0	7	5	2	1	1	5	15	18	33
2022	4	1	7	2	0	2	20	14	14	5	5	7	50	32	81
2023	3	7	13	5	4	1	19	19	8	20	9	24	61	83	134
2024	9	8	11	8	5	3	16	8	11	18	22	17	77	64	137
Laboratory diagnoses (all serogroups; source: NRLBM)															
2015	7	6	5	6	4	1	9	5	9	5	13	21	47	44	92
2016	5	8	8	8	3	4	11	15	16	13	16	47	59	95	154
2017	7	10	10	9	1	2	13	26	23	14	30	54	84	115	199
2018	9	6	16	11	1	2	16	19	13	13	35	64	90	115	205
2019	3	3	12	5	3	2	12	13	18	15	23	45	71	83	154

Meningococcal disease ICD-10: A39, M010															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
2020	6	0	5	5	2	2	5	3	10	2	10	15	38	27	65
2021	3	3	2	4	0	0	7	5	3	1	1	6	16	19	35
2022	4	1	7	2	0	2	20	15	12	6	6	8	49	34	83
2023	3	7	14	5	4	1	20	19	6	20	10	25	57	77	134
2024	9	9	11	8	5	3	16	8	11	18	21	17	73	63	137
Laboratory diagnoses (serogroup C; source: NRLBM)															
2015	2	0	0	0	0	0	0	0	2	1	2	1	6	2	8
2016	0	0	0	0	0	0	0	1	2	0	0	3	2	4	6
2017	0	1	0	0	0	0	1	0	1	0	3	3	5	4	9
2018	0	0	0	0	0	0	0	0	0	1	0	2	0	3	3
2019	0	0	0	0	0	0	0	0	1	0	2	3	3	3	6
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	1	0	0	0	0	1	1	1	2	3
2023	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2
2024	0	0	0	0	0	0	1	0	0	0	2	1	3	1	4
Laboratory diagnoses (serogroup W; source: NRLBM)															
2015	0	1	0	0	0	0	0	0	1	0	0	5	1	6	8
2016	0	0	1	2	0	1	4	5	5	3	6	25	16	36	52
2017	1	3	3	1	0	0	5	10	13	6	12	29	34	49	83
2018	4	1	0	3	1	1	4	11	6	6	18	46	33	68	101
2019	1	0	1	1	1	0	4	2	7	6	8	27	22	36	58
2020	1	0	1	0	1	0	0	0	1	0	2	5	6	5	11
2021	0	0	0	0	0	0	0	0	1	1	0	2	1	3	4
2022	0	0	0	0	0	0	0	0	1	0	0	1	1	1	2
2023	0	0	0	0	0	0	0	1	0	0	2	3	2	4	6
2024	1	0	1	1	0	0	0	0	0	0	2	1	4	2	6

Meningococcal disease ICD-10: A39, M010															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Laboratory diagnoses (serogroup B; source: NRLBM)															
2015	5	5	5	6	4	1	9	5	4	4	8	10	35	31	66
2016	5	8	7	6	3	3	7	6	6	10	6	10	34	43	77
2017	6	6	7	8	1	2	6	15	9	7	5	8	34	46	80
2018	5	4	16	8	0	1	7	7	7	4	13	5	48	29	77
2019	2	3	11	4	2	1	6	11	7	6	8	9	36	34	70
2020	4	0	4	5	1	2	4	3	6	2	4	4	23	16	39
2021	3	3	2	4	0	0	7	4	2	0	1	3	15	14	29
2022	4	1	7	2	0	1	19	14	10	6	5	4	45	28	73
2023	3	7	14	5	4	1	16	17	6	18	4	15	47	63	110
2024	8	9	10	7	5	2	14	8	10	17	16	14	63	57	121
Hospitalisations^ (source: Prismant/DHD/CBS)															
2015	10	5	5	5	5	5	10	5	5	5	5	15	35	40	75
2016	5	10	5	10	5	5	10	10	15	15	10	25	45	70	115
2017	10	5	15	10	0	0	15	25	15	10	20	30	70	85	155
2018	10	5	15	10	0	0	15	15	10	5	20	40	75	80	155
2019	5	0	10	5	5	5	10	10	15	10	15	25	50	55	105
2020	5	0	5	5	5	0	5	5	10	5	5	5	30	20	50
2021	5	5	0	5	0	0	5	5	0	0	0	5	15	15	30
2022	5	0	5	0	0	0	20	15	15	5	5	5	45	30	80
2023	5	5	10	5	5	0	15	15	5	15	10	20	50	60	115

*Preliminary figures.
^Data corrected for non-participating hospitals and rounded off to closest five. Therefore, 0 cases can also be a few cases.

Mumps ICD-10: B26															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (source: CBS)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
2024*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notifications (source: Osiris)															
2015	0	0	0	0	0	2	14	9	32	26	0	4	46	41	87
2016	0	0	3	2	5	2	14	6	15	19	4	1	41	30	71
2017	0	0	3	1	0	0	6	2	23	9	1	1	33	13	46
2018	0	0	0	1	1	3	2	3	31	22	4	6	38	35	73
2019	0	0	3	1	1	2	17	5	60	35	4	3	85	46	131
2020	0	0	1	2	0	0	9	4	26	18	2	2	38	26	64
2021	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
2022	0	1	2	0	0	0	0	0	3	4	1	0	6	5	11
2023	0	1	6	12	18	12	7	5	11	18	1	2	43	50	93
2024	1	0	29	18	85	50	87	77	92	136	11	11	305	292	597
Hospitalisations^ (source: Prismant/DHD)															
2015	0	0	0	0	0	0	0	0	0	5	0	5	5	10	15
2016	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5
2017	0	0	0	0	0	0	0	0	5	0	0	5	5	5	10
2018	0	0	0	0	0	0	0	0	0	0	0	5	5	5	10
2019	0	0	0	0	0	0	0	0	5	0	0	0	5	5	10

Mumps ICD-10: B26															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
2020	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5

*Preliminary figures.
^Data corrected for non-participating hospitals and rounded off to closest five. Therefore, 0 cases can also be a few cases.

Pertussis ICD-10: A37															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (source: CBS)															
2015	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
2016	0	1	0	0	0	0	0	0	0	0	1	0	1	1	2
2017	1	0	0	0	0	0	0	0	0	0	0	1	1	1	2
2018	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
2019	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2
2020	1	0	0	0	0	0	0	0	0	0	1	0	2	0	2
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	1	0	0	0	0	0	0	0	0	0	1	0	2	2
2024*	2	2	0	0	0	0	0	0	0	0	4	2	6	4	10
Notifications (source: Osiris)															
2015	86	91	122	156	257	311	918	1036	744	1315	633	893	2760	3802	6566+
2016	121	97	194	211	217	274	652	771	674	1131	513	704	2371	3188	5562$
2017	82	99	104	119	173	248	620	679	567	1054	516	664	2062	2863	4926>
2018	97	93	174	167	179	254	559	685	558	967	461	669	2028	2835	4865<
2019	85	102	141	173	193	238	714	892	802	1352	721	971	2656	3728	6388+
2020	21	21	21	26	29	52	102	129	106	189	127	145	406	562	970<
2021	4	5	2	6	2	1	4	4	7	16	14	14	33	46	79
2022	9	10	13	22	10	4	9	7	11	21	12	14	64	78	142
2023	74	86	86	98	97	97	582	630	288	463	187	254	1314	1628	2944<
2024	426	412	420	483	445	492	1785	2182	2418	4033	2264	2820	7758	10422	18208#
Hospitalisations^ (source: Prismant/DHD)															
2015	55	70	0	5	0	0	5	5	0	0	0	10	65	90	160
2016	75	55	5	10	0	0	5	0	5	0	5	5	90	75	165
2017	60	70	5	10	0	0	5	5	0	0	0	10	65	95	160
2018	55	55	0	10	0	0	5	0	0	0	0	5	60	75	135
2019	45	55	0	10	0	0	0	0	0	0	10	10	55	80	135

Pertussis ICD-10: A37															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
2020	15	15	0	0	0	0	0	0	0	0	5	0	25	15	40
2021	10	5	0	0	0	0	0	0	0	0	0	0	10	5	15
2022	5	10	0	0	0	0	0	0	0	0	0	0	5	10	20
2023	25	35	0	5	0	0	0	0	0	0	5	5	35	45	85

* Preliminary figures.
+ For 4 notifications gender was unknown.
$ For 3 notifications gender was unknown.
> For 1 notification gender was unknown.
< For 2 notifications gender was unknown.
For 28 notifications gender was unknown.
^ Data corrected for non-participating hospitals and rounded off to closest five. Therefore, 0 cases can also be a few cases.

Pneumococcal disease ICD-10: J13															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Notifications IPD* (source: Osiris)															
2015	15	11	10	7	0	0	-	-	-	-	-	-	25	18	43
2016	12	12	10	9	0	1	-	-	-	-	-	-	22	22	44
2017	15	9	8	7	6	0	0	0	-	-	-	-	29	16	45
2018	21	14	11	9	5	6	2	0	-	-	-	-	39	29	68
2019	14	15	18	6	6	4	1	1	-	-	-	-	39	26	65
2020	6	8	9	6	7	7	1	0	-	-	-	-	23	21	44
2021	21	11	21	16	7	3	2	3	-	-	311	269	362	302	664
2022	14	16	28	20	12	6	7	8	-	-	710	648	771	698	1469
2023	33	18	14	11	18	8	7	5	-	-	775	687	847	729	1576
2024	19	15	19	18	11	3	8	8	-	-	751	719	808	763	1571
Laboratory diagnoses IPD (nationwide; source: NRLBM)															
2015	21	23	14	8									35	31	66
2016	17	13	13	7									30	20	50
2017	18	15	12	12	14	2	8	3					52	32	84
2018	25	17	16	11	11	7	4	6					56	41	97
2019	17	16	23	8	5	5	8	4					53	33	86
2020	7	8	9	7	7	7	3	0					26	22	48
2021	24	16	20	17	7	2	8	4	81	72	471	403	611	514	1130
2022	13	15	28	19	12	6	12	8	123	79	883	807	1071	934	2014
2023	34	18	14	8	18	6	12	6	153	104	948	827	1179	969	2151
2024	22	17	21	18	11	5	13	20	146	118	926	849	1139	1027	2168
Mortality pneumococcal pneumonia (source: CBS)															
2015	0	0	0	0	0	0	0	0	0	1	13	15	13	16	29
2016	0	0	0	0	0	0	0	0	0	0	15	12	15	12	27
2017	0	0	0	0	0	0	0	0	0	0	7	8	7	8	15
2018	0	0	0	0	0	0	0	0	1	0	13	12	14	12	26
2019	0	0	0	0	0	0	0	0	0	0	9	7	9	7	16

Pneumococcal disease ICD-10: J13															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
2020	0	0	0	0	0	0	0	0	1	1	9	12	10	13	23
2021	0	0	0	0	0	0	0	0	0	1	6	8	6	9	15
2022	0	0	0	0	0	0	0	0	0	0	14	11	14	11	25
2023	0	0	0	0	0	0	0	0	1	1	24	13	25	14	39
2024**	0	0	0	0	0	0	0	0	0	0	15	14	15	14	29
Hospitalisations^ pneumococcal pneumonia (source: Prismant/DHD)															
2015	0	0	10	5	5	5	15	5	140	140	1025	1015	1195	1175	2370
2016	0	0	5	0	0	5	10	10	160	190	1005	1000	1180	1205	2385
2017	0	5	5	0	5	0	10	5	150	95	1070	975	1240	1080	2320
2018	5	0	5	5	0	0	5	5	150	130	1225	1120	1395	1265	2665
2019	5	0	5	10	5	0	10	5	125	105	1075	985	1220	1105	2325
2020	5	0	0	0	0	0	0	0	80	65	605	550	690	615	1305
2021	0	0	5	0	0	0	5	0	85	75	590	500	685	580	1265
2022	0	0	10	10	5	0	5	10	135	105	860	810	1015	940	1955
2023	0	0	5	5	5	0	10	10	150	115	940	835	1115	965	2080

*Notifiable for children born from 2006 onwards, and from April 2021 also for people aged 60 and over.
**Preliminary figures.
^ Data corrected for non-participating hospitals and rounded off to closest five. Therefore, 0 cases can also be a few cases.

Poliomyelitis ICD-10: A80															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (acute; source: CBS)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notifications (source: Osiris)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	1**	0	0	0	1**	0	1**
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospitalisations^ (source: Prismant/DHD)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Poliomyelitis ICD-10: A80															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Preliminary figures.
** Asymptomatic polio-infection
^ Data corrected for non-participating hospitals and rounded off to closest five. Therefore, 0 cases can also be a few cases.

Rubella (acquired) ICD-10: B06															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (source: CBS)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notifications (source: Osiris)															
2015	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospitalisations^ (source: Prismant/DHD)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Rubella (acquired) ICD-10: B06															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Preliminary figures.
^ Data corrected for non-participating hospitals and rounded off to closest five. Therefore, 0 cases can also be a few cases.

Tetanus ICD-10: A33-35															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (source: CBS)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024*	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Notifications (source: Osiris)															
2015	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1
2016	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
2017	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
2018	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	1	0	0	0	0	1	1	1	2
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2
2023	0	0	0	0	0	0	0	0	1	1	0	3	1	4	5
2024	0	0	0	0	1	0	0	0	0	0	0	2	1	2	3

Rotavirus ICD-10: A0, A09, K52, K529							
	Age (years)						
Year	0	1-4	5-9	10-19	20-49	50+	Total
Hospitalisations* (source: Prismant/DHD)							
2015	1447	3273	225	48	135	1460	6589
2016	711	1739	115	25	8	666	3265
2017	1072	2557	161	21	14	921	4746
2018	1102	2560	172	26	0	811	4671
2019^	969	2285	171	37	20	883	4363
2020†	335	804	82	0	66	0	1288
2021†	836	2003	205	0	165	0	3208
2022†	1333	3195	328	0	263	0	5118
2023x	880	1972	118	18	65	778	3545
2024x	846	1894	113	17	63	748	3404

* Hospitalisations are based on data from 2 years before and 2 years after the concerning year (if available).
^ The estimates for 2019 were based on 2017-2019, to exclude the exceptional COVID-19 pandemic years.
† The estimates for 2020-2022 were based on data for 2020 only.
x The estimates for 2023 and 2024 were based on data for 2023 only

Potential NIP target diseases

Hepatitis A ICD-10: B15															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (acute; source: CBS)															
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Notifications (source: Osiris)															
2015	0	0	3	5	7	5	14	8	15	13	4	6	43	37	80
2016	1	0	3	2	3	9	9	9	22	11	7	5	45	36	81
2017	0	0	3	2	5	16	20	11	209	33	55	18	292	80	372
2018	0	0	4	5	2	6	10	17	60	30	37	17	113	75	188
2019	0	0	3	3	14	5	19	10	51	20	26	12	113	50	163
2020	0	0	2	0	4	5	7	1	13	7	5	6	31	19	50
2021	1	0	4	0	3	4	5	6	14	14	11	15	38	39	77
2022	0	0	3	0	7	4	11	7	25	18	7	11	53	40	93
2023	0	0	9	7	17	11	17	11	34	27	11	9	88	65	153
2024	0	0	10	10	16	9	20	18	70	39	18	28	134	104	238

* Preliminary figures.

Varicella (chickenpox) ICD-10: B01															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (source: CBS)															
2015	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2
2016	0	0	0	0	0	0	0	0	0	0	3	1	3	1	4
2017	0	1	0	1	0	0	0	0	0	0	0	1	0	3	3
2018	0	0	0	0	0	1	0	0	0	0	1	0	1	1	2
2019	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3
2020	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2
2021	0	0	0	0	0	0	0	0	0	0	1	3	1	3	4
2022	0	1	1	2	0	1	0	0	1	0	1	3	3	7	10
2023	0	0	0	0	0	0	0	0	0	0	1	4	1	4	5
2024*	0	0	1	0	0	0	0	0	0	0	3	1	4	1	5
Hospitalisations^ (source: Prismant/DHD)															
2015	25	20	55	50	5	10	5	5	25	15	40	30	160	120	280
2016	30	20	60	55	15	10	5	10	25	20	40	30	175	145	320
2017	40	30	70	40	10	15	5	5	30	20	30	25	190	135	325
2018	25	20	40	40	10	10	10	5	35	20	35	30	155	120	280
2019	30	25	55	45	10	5	5	5	35	15	35	50	170	150	320
2020	10	10	20	15	5	5	5	0	15	10	30	30	85	65	150
2021	10	5	20	20	5	10	5	5	15	15	40	40	95	90	185
2022	35	25	105	100	35	20	5	5	35	20	45	30	260	195	455
2023	15	10	25	25	5	5	10	5	20	20	45	40	120	105	225

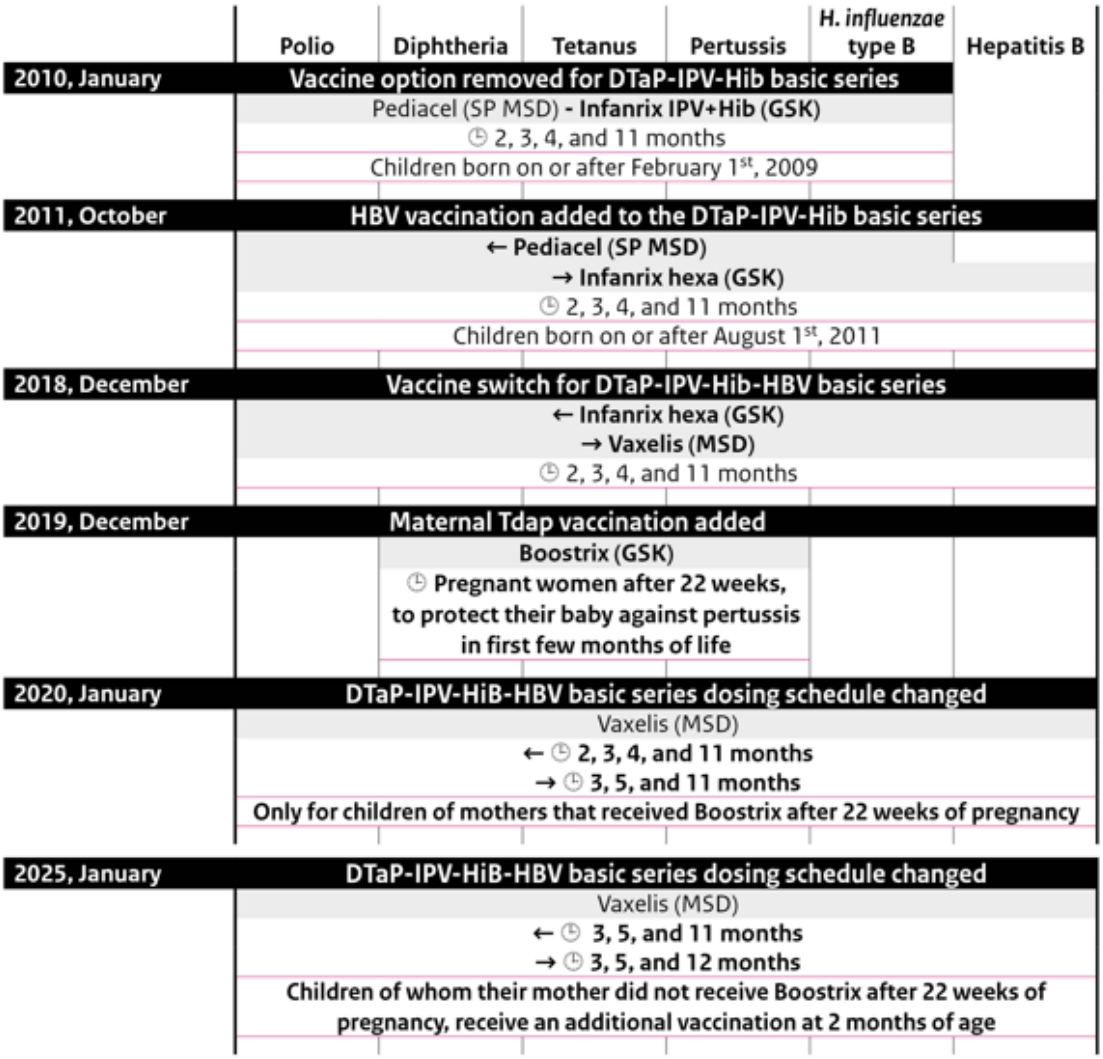
* Preliminary figures.
^ Data corrected for non-participating hospitals and rounded off to closest five. Therefore, 0 cases can also be a few cases.

Herpes zoster (shingles) ICD-10: B02															
	Age (years)														
	0		1-4		5-9		10-19		20-49		50+		Total		
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
Mortality (source: CBS)															
2015	0	0	0	0	0	0	0	0	0	0	10	23	10	23	33
2016	0	0	0	0	0	0	0	0	0	0	9	18	9	18	27
2017	0	0	1	0	0	0	0	0	0	0	6	26	7	26	33
2018	0	0	0	0	0	0	0	0	0	0	12	24	12	24	36
2019	0	0	0	0	0	0	0	0	0	0	11	21	11	21	32
2020	0	0	0	0	0	0	0	0	0	0	15	28	15	28	43
2021	0	0	0	0	0	0	0	0	0	0	11	26	11	26	37
2022	0	0	0	0	0	0	0	0	0	0	16	22	16	22	38
2023	0	0	0	0	0	0	0	0	0	0	9	32	9	32	41
2024*	0	0	0	0	0	0	0	0	0	0	10	34	10	34	44
Hospitalisations^ (source: Prismant/DHD)															
2015	0	0	5	5	10	0	5	5	20	35	165	225	210	270	480
2016	0	0	5	5	5	5	5	5	20	20	155	240	190	270	460
2017	0	0	5	5	5	0	5	10	20	20	155	220	195	260	455
2018	0	0	5	5	0	5	5	0	35	35	180	240	220	285	510
2019	0	0	5	5	5	0	5	5	30	35	195	250	235	290	525
2020	0	0	5	5	0	5	5	5	35	30	170	240	215	285	500
2021	0	0	0	0	0	0	10	5	25	30	190	255	225	290	510
2022	5	5	5	5	5	0	5	5	25	30	185	205	225	245	470
2023	0	0	10	5	5	0	10	10	45	30	245	240	310	290	600

* Preliminary figures.
^ Data corrected for non-participating hospitals and rounded off to closest five. Therefore, 0 cases can also be a few cases.

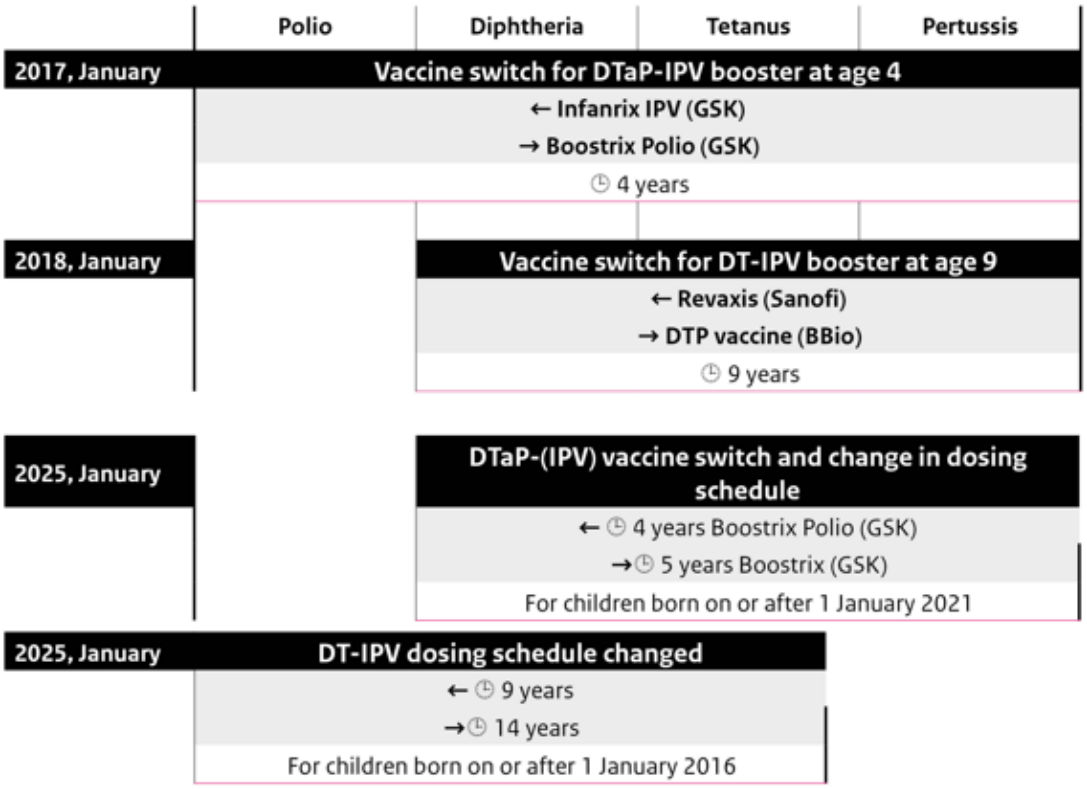
Appendix 3 Overview of vaccine changes in the NIP from 2010

DTaP-IPV-Hib-HBV basic series

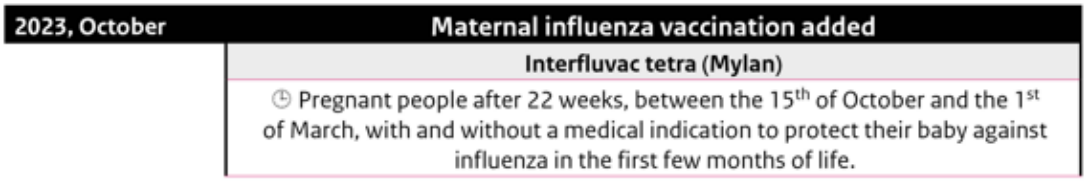


Source: https://rijksvaccinatieprogramma.nl/wat-is-het-rijksvaccinatieprogramma and the NIP report of last year: https://www.rivm.nl/publicaties/national-immunisation-programme-in-netherlands-surveillance-and-developments-in-2023

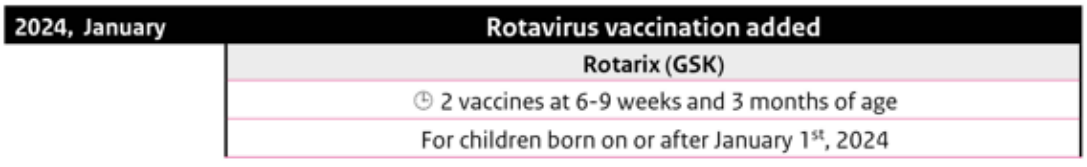
Tdap-IPV booster vaccinations



Influenza vaccination



Rotavirus vaccination



Source: https://rijksvaccinatieprogramma.nl/wat-is-het-rijksvaccinatieprogramma and the NIP report of last year: https://www.rivm.nl/publicaties/national-immunisation-programme-in-netherlands-surveillance-and-developments-in-2023

Pneumococcal vaccination

2011, May	**Vaccine switch**
	← Prevnar (Wyeth)
	→ Synflorix (GSK)
	🕒 2, 3, 4, and 11 months
	Children born on or after March 1st, 2011
2013, December	**Vaccine switch + change in dosing schedule**
	Synflorix (GSK)
	← 🕒 2, 3, 4, 11 months
	→ 🕒 2, 4, 11 months
	Children born on or after October 2013
2020, January	**Change in dosing schedule**
	Synflorix (GSK)
	← 🕒 2, 4, 11 months
	→ 🕒 3, 5, 11 months
2024, September	**Vaccine switch**
	← Synflorix (GSK)
	→ Vaxneuvance (MSD)
	From 1 september 2024 onwards, children received their third vaccination with Vaxneuvance. After that, the other vaccination moments gradually switched to Vaxneuvance as well. From 1 May 2025, children received this vaccine for all their pneumococcal vaccinations.

MMR vaccination

2025, January	**Change in dosing schedule**
	MMR-VaxPro (SP MSD)
	← 🕒 14 months, 9 years
	→ 🕒 14 months, 3 years
	Children born on or after 1 January 2016. Children born between 1 January 2016 to 2021 will receive the second MMR vaccination between the ages of 5 and 9 years. Children born in or after 2022 receive the second MMR vaccination at the age of 3 years.

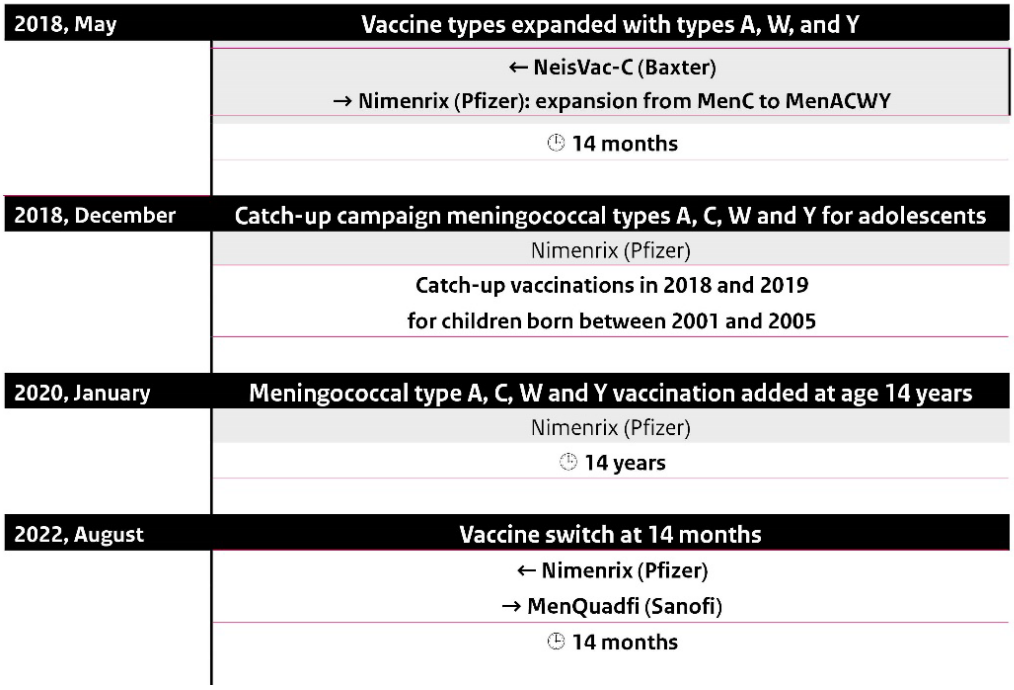
Source: https://rijksvaccinatieprogramma.nl/wat-is-het-rijksvaccinatieprogramma and the NIP report of last year: https://www.rivm.nl/publicaties/national-immunisation-programme-in-netherlands-surveillance-and-developments-in-2023

HPV vaccination

2010, January	**HPV vaccination added at age 13**
	Cervarix (GSK)
	13 years, girls only
	Children born on or after January 1st, 1997, 3 doses at 0, 1, and 6 months Catch-up campaign for children born between January 1st, 1993, to December 31st, 1996
2014, January	**Change in dosing schedule**
	Cervarix (GSK)
	13 years, girls only
	← 3 doses, intervals of 1 and 5 months **→ 2 doses, interval 6 months**
	Children born on or after January 1st, 2001
2022, January	**Boys are also offered HPV vaccination + age of vaccination lowered to age 10**
	Cervarix (GSK)
	Boys *and* girls, at age 10
	Children born on or after January 1st, 2012 Catch-up campaign in 2022 and 2023 for children born between January 1st, 2004, to December 31st, 2011
2022, September	**Change in dosing schedule**
	Cervarix (GSK)
	Boys *and* girls, aged 15 and over
	← 3 doses, intervals of 1 and 5 months **→ 2 doses, interval 6 months**
2023, February	**Catch up campaign HPV 18+**
	Cervarix (GSK)
	Boys and girls born between January 1st 1996 to December 31st 2003 2 doses, interval 6 months

Source: https://rijksvaccinatieprogramma.nl/wat-is-het-rijksvaccinatieprogramma and the NIP report of last year: https://www.rivm.nl/publicaties/national-immunisation-programme-in-netherlands-surveillance-and-developments-in-2023

Meningococcal vaccination



Source: https://rijksvaccinatieprogramma.nl/wat-is-het-rijksvaccinatieprogramma and the NIP report of last year: https://www.rivm.nl/publicaties/national-immunisation-programme-in-netherlands-surveillance-and-developments-in-2023

Appendix 4 Composition of vaccines used in the NIP

Vaccine	Composition
M-M-R VaxPro / MSD EU/1/06/337 Mumps, measles and rubella vaccine 0.5 ml	Measles virus[1] (Enders' Edmonston)[3], ≥1000 $TCID_{50}$ [4] Mumps virus[1] (Jeryl Lynn, Level B)[3], ≥12,500 $TCID_{50}$ [4] Rubella virus[2] (Wistar RA 27/3)[3], ≥1000 $TCID_{50}$ [4] [1] produced in chick embryo cells [2] produced in WI-38 human diploïd lung fibroblasts [3] live attenuated [4] 50% tissue culture of infectious doses
Boostrix Polio / GSK RVG 35123 Diphtheria, tetanus, pertussis (acellular component), inactivated poliomyelitis vaccine (adsorbed, reduced antigen) 0.5 ml	Diphtheria toxoid[1], ≥2 IU Tetanus toxoid[1], ≥20 IU *Bordetella pertussis* antigens Pertussis toxoid (PT)[1], 8 µg Filamentous haemagglutinin (FHA)[1], 8 µg Pertactin (PRN)[1], 2.5 µg Inativated poliovirus type 1 poliovirus (Mahoney)[2], 40 DU type 2 poliovirus (MEF-1)[2], 8 DU type 3 poliovirus (Saukett)[2], 32 DU [1] adsorbed to aluminiumhydroxide ($Al(OH)_3$), hydrated, 0.3 mg Al^{3+} and aluminiumphosphate ($AlPO_4$), 0.2 mg Al^{3+} [2] produced in Vero cells
Boostrix / GSK RVG 35121 Diphtheria, tetanus and pertussis (acellular component) vaccine (adsorbed, reduced antigen) 0.5 ml	Diphtheria toxoid[1], ≥2 IU Tetanus toxoid[1], ≥20 IU *Bordetella pertussis* antigens Pertussis toxoid (PT)[1], 8 µg Filamentous haemagglutinin (FHA)[1], 8 µg Pertactin (PRN)[1], 2.5 µg [1] adsorbed to aluminiumhydroxide ($Al(OH)_3$), hydrated, 0.3 mg Al^{3+} and aluminiumphosphate ($AlPO_4$), 0.2 mg Al^{3+}

Vaccine	Composition
Vaxelis / MCM Vaccine B.V. EU/1/15/1079 Diphtheria, tetanus, pertussis (acellular component), hepatitis B (rDNA), inactivated poliomyelitis and *Haemophilus influenzae* type b vaccine (adsorbed) 0.5 ml	Diphtheria toxoid[1], ≥20 IU[6] Tetanus toxoid[1], ≥40 IU[6] *Bordetella pertussis* antigens[1]: Pertussis toxoid, 20 µg Filamentous haemagglutinin, 20 µg Fimbriae type 2 and 3, 5 µg Pertactin, 3 µg Hepatitis B surface antigen[2,3], 10 µg Inactivated poliovirus[4]: Inactivated type 1 poliovirus, 40 DE Inactivated type 2 poliovirus, 8 DE Inactivated type 3 poliovirus, 32 DE *Haemophilus influenzae* type b polysaccharide (Polyribosylribitol Phosphate), 3 µg Conjugated to meningococcal protein[2], 50 µg [1] adsorbed on aluminiumphosphate, 0.17 mg Al^{3+} [2] adsorbed on amorphous aluminium hydroxyphosphate sulfate, 0.15 mg Al^{3+} [3] produced in yeast (Saccharomyces cerevisiae) cells by recombinant DNA technology [4] produced in Vero cells [5] or equivalent antigenic quantity determined by a suitable immunochemical method [6] or equivalent activity determined by an immunogenicity evaluation
REVAXIS / SP RVG24534 Diphtheria, tetanus and inactivated poliomyelitis vaccine (absorbed; limited quantity of antigen(s)) 0.5 ml	Purified diphtheria toxoid[1], ≥2 IU Purified tetanus toxoid[1], ≥20 IU Inactivated poliovirus type 1[2], 29 DU Inactivated poliovirus type 2[2], 7 DU Inactivated poliovirus type 3[2], 26 DU [1] adsorbed to aluminium hydroxide, 0.35 mg (as aluminium) [2] produced in Vero cells

Vaccine	Composition
Engerix-B Junior / GSK RVG24290 Hepatitis B vaccine (recombinant) 0.5 ml	Hepatitis B-virus surface antigen recombinant (S protein)[1,2], 10 µg [1] adsorbed to aluminium hydroxide, hydrated, 0,25 mg Al3+ [2] produced on genetically engineered yeast cells (Saccharomyces cerevisiae)
Engerix-B / GSK RVG17316 Hepatitis B (rDNA) vaccine (adsorbed) 1 ml	Hepatitis B-virus surface antigen[1,2], 20 µg [1] adsorbed on aluminium hydroxide, hydrated, 0.5 mg Al3+ [2] produced on yeast cells (Saccharomyces cerevisiae) with recombinant DNA technology
Cervarix / GSK EU/1/07/419	Human papillomavirus type 16 L1 protein[1,2,3], 20 µg Human papillomavirus type 18 L1 protein[1,2,3], 20 µg [1] adjuvanted by AS04 containing 3-O-desacyl-4'-monophosphoryl lipid A (MPL)[3], 50 µg [2] absorbed on aluminium hydroxide, hydrated (Al(OH)3), 0.5 mg Al^{3+} in total [3] L1 protein in the form of non-infectious virus-like particles (VLPs) produced by recombinant DNA technology using a Baculovirus expression system, which uses Hi-5 Rix4446 cells derived from *Trichoplusia ni*
Nimenrix / Pfizer EU/1/12/767 Conjugated meningococcal group A, C, W-135 and Y vaccine 0.5 ml	*Neisseria meningitidis*-group A polysaccharide[1], 5 µg *Neisseria meningitidis*-group C polysaccharide[1], 5 µg *Neisseria meningitidis*-group W-135 polysaccharide[1], 5 µg *Neisseria meningitidis*-group Y polysaccharide[1], 5 µg [1] conjugated to tetanus toxoid carrier protein, 44 µg

Vaccine	Composition
MenQuadfi / SP EU/1/20/1483 Conjugated meningococcal group A, C, W and Y vaccine 0.5 ml	*Neisseria meningitidis*-group A polysaccharide1, 10 µg *Neisseria meningitidis*-group C polysaccharide1, 10 µg *Neisseria meningitidis*-group Y polysaccharide1, 10 µg *Neisseria meningitidis*-group W polysaccharide1, 10 µg [1] conjugated to tetanus toxoid carrier protein, 55 µg
Synflorix / GSK EU/1/09/508 Pneumococcal polysaccharide conjugate vaccine (adsorbed) 0.5 ml	Pneumococcal polysaccharide serotype $1^{1,2}$, 1 µg Pneumococcal polysaccharide serotype $4^{1,2}$, 3 µg Pneumococcal polysaccharide serotype $5^{1,2}$, 1 µg Pneumococcal polysaccharide serotype $6B^{1,2}$, 1 µg Pneumococcal polysaccharide serotype $7F^{1,2}$, 1 µg Pneumococcal polysaccharide serotype $9V^{1,2}$, 1 µg Pneumococcal polysaccharide serotype $14^{1,2}$, 1 µg Pneumococcal polysaccharide serotype $18C^{1,3}$, 3 µg Pneumococcal polysaccharide serotype $19F^{1,4}$, 3 µg Pneumococcal polysaccharide serotype $23F^{1,2}$, 1 µg [1] adsorbed on aluminium phosphate, 0.5 mg Al^{3+} in total [2] conjugated to protein D (derived from non-typeable Haemophilus influenzae) carrier protein, 9–16 µg [3] conjugated to tetanus toxoid, 5–10 µg [4] conjugated to diphtheria toxoid, 3–6 µg
Rotarix /GSK EU/1/05/330 Rotavirus vaccine 1.5 ml	Human rotavirus RIX4414 strain (live, attenuated)[1] $\geq 10^{6.0}$ Cell Culture Infective Dose $(CCID)_{50}$ [1] Produced in Vero cells

Vaccine	Composition
Vaxneuvance / MSD EU/1/21/1591 Pneumococcal polysaccharide conjugate vaccine (15-valent, absorbed)	Pneumococcal polysaccharide serotype 1[1,2], 2 µg Pneumococcal polysaccharide serotype 3[1,2], 2 µg Pneumococcal polysaccharide serotype 4[1,2], 2 µg Pneumococcal polysaccharide serotype 5[1,2], 2 µg Pneumococcal polysaccharide serotype 6A[1,2], 2 µg Pneumococcal polysaccharide serotype 7F[1,2], 2 µg Pneumococcal polysaccharide serotype 9V[1,2], 2 µg Pneumococcal polysaccharide serotype 14[1,2], 2 µg Pneumococcal polysaccharide serotype 18C[1,2], 2 µg Pneumococcal polysaccharide serotype 19A[1,2], 2 µg Pneumococcal polysaccharide serotype 19F[1,2], 2 µg Pneumococcal polysaccharide serotype 22F[1,2], 2 µg Pneumococcal polysaccharide serotype 23F[1,2], 2 µg Pneumococcal polysaccharide serotype 33F[1,2], 2 µg Pneumococcal polysaccharide serotype 6B[1,2], 4 µg [1,2] [1] adsorbed on aluminum phosphate [2] conjugated to Cross-Reacting Material (CRM) 197

More extensive product information can be found at: www.cbg-meb.nl and https://www.ema.europa.eu/en/medicines.

Appendix 5 Overview of recent RIVM publications (01/07/2024 to 30/06/2025)

Vaccination coverage

Van Lier E.A., Hament J-M, Holwerda, M.R., Westra M, Giesbers H, van der Maas N.A.T., et al. Vaccination coverage National Immunisation Programme in the Netherlands. Reporting year 2025 (Vaccinatiegraad Rijksvaccinatieprogramma Nederland. Verslagjaar 2025). RIVM report, number 2025-0019

Pluijmaekers, A. J. M., Steens, A., Houweling, H., Rots, N. Y., Benschop, K. S. M., van Binnendijk, R. S., ... & de Melker, H. E. (2024). A literature review and evidence-based evaluation of the Dutch national immunisation schedule yield possibilities for improvements. *Vaccine: X*, *20*, 100556.

Vink, K., Kusters, J., & Wallinga, J. (2025). Chrono-optimizing vaccine administration: a systematic review and meta-analysis. *Frontiers in Public Health*, *13*, 1516523.

Acceptance of vaccination

Hamdiui, N., Boer, M., van Steenbergen, J., van den Muijsenbergh, M., Timen, A., & Stein, M. (2024). Exploring Different Sampling Strategies: A Description of Our Success in Reaching Hard-to-Reach Turkish and Moroccan Immigrant Women in The Netherlands. *Health Expectations*, *27*(6), e70105.

Kroese, F., van Dijk, M., Boer, M., Stok M. (2025) Resultaten van de SocioVax monitor 2024: sociaal wetenschappelijk inzicht in vaccinatiebereidheid voor het RVP. RIVM kennisnotitie KN-2025-0025.

Kroese, F., van den Boom, W., Buskens, V., van Empelen, P., Hulscher, M., Ruiter, R. A., ... & Lambooij, M. (2024). When and why do people change their minds in favor of vaccination? Longitudinal analyses of switching COVID-19 vaccination preferences. *BMC Public Health*, *24*(1), 1-12.

Current NIP

Diphtheria

Hoefer A, Seth-Smith H, Palma F, Schindler S, Freschi L, Dangel A, Berger A, D'Aeth J, Cordery R, Delgado-Rodriguez E, Gruner E, Flury D, Hinic V, Kofler J, Lienhard R, Mariman R, Nolte O, Schibli A, Toubiana J, Traugott M, Jacquinet S, Indra A, Fry NK, Palm D, Sing A, Brisse S, Egli A; 2022 European Diphtheria Consortium. Corynebacterium diphtheriae Outbreak in Migrant Populations in Europe. N Engl J Med. 2025 Jun 19;392(23):2334-2345.

Haemophilus influenzae

Koenen MH, de Steenhuijsen Piters WAA, de Jonge MI, Langereis JD, Nierkens S, Chu MLJN, van der Woude R, de Vries RP, Sanders EAM, Bogaert D, van der Vries E, Boes M, Verhagen LM. Salivary polyreactive antibodies and Haemophilus influenzae are associated with respiratory infection severity in young children with recurrent respiratory infections. Eur Respir J. 2024;64(4):2400317. doi: 10.1183/13993003.00317-2024.

Hepatitis B

Swets MC, Kerr SR, MacKenna B, Fisher L, van Wijnen M, Brandwagt D, Schenk PW, Fraaij P, Visser LG, Bacon S, Mehrkar A, Nichol A, Twomey P, Matthews PC, ISARIC4C Hepatitis Study Group, Semple MG, Groeneveld GH, Goldacre B, Jones I, Baillie JK. Using Laboratory Test Results for Surveillance During a New Outbreak of Acute Hepatitis in 3-Week- to 5-Year-Old Children in the United Kingdom, the Netherlands, Ireland, and Curaçao: Observational Cohort Study JMIR Public Health Surveill 2024;10:e55376

Human papillomavirus (HPV) infection

van Eer, K., Dzebisasjvili, T., Steenbergen, R. D., & King, A. J. (2024). Comparative Analysis of HPV16 Variants in the Untranslated Regulatory Region, L1, and E6 Genes among Vaccinated and Unvaccinated Young Women: Assessing Vaccine Efficacy and Viral Diversity. *Viruses*, *16*(9), 1381.

van Eer, K. (2025). *The human papillomavirus: Dynamics between vaccination, viral properties and surveillance.* [PhD-Thesis - Research and graduation internal, Vrije Universiteit Amsterdam]. https://doi.org/10.5463/thesis.988.

Kusters, J. M., Schim van der Loeff, M. F., Heijne, J. C., King, A. J., de Melker, H. E., Heijman, T., ... & van Benthem, B. H. (2025). Changes in Genital Human Papillomavirus (HPV) Prevalence During 12 Years of Girls-Only Bivalent HPV Vaccination: Results From a Biennial Repeated Cross-sectional Study. *The Journal of Infectious Diseases*, *231*(1), e165-e176.

Kusters, J. M., van der Loeff, M. F. S., van Benthem, B. H., King, A. J., PASSYON study group van der Meijden Helmie Kampman Karlijn Hoornenborg Elske Bak Annet Smit Marga van Buel Harriette Neienhuijsen Ferna Ippel Marlot Schriemer Dianne Swart Inez Twisk Denise, de Melker, H. E., ... & Heijne, J. C. (2024). Effectiveness of bivalent HPV vaccination against genital HPV DNA-positivity of a catch-up campaign at age 13–16 years compared to routine vaccination at age 12 years: a biennial repeated cross-sectional study. *BMC medicine*, *22*(1), 469.

Kusters, J. M. A. (2024). *Epidemiology of human papillomavirus: Beyond cervical infection*. [Phd-Thesis - Research and graduation internal, University of Amsterdam].

Middeldorp, M., Brouwer, J.G.M., Duijster, J.W., Knol, M.J., van Kemenade, F.J., Siebers, A.G., Berkhof, J., de Melker, H.E. (2025) The effect of bivalent HPV vaccination against invasive cervical cancer and cervical intraepithelial neoplasia grade 3 (CIN3+) in the Netherlands: a population-based linkage study. Lancet Reg Health-Eu 2025; 54:101327.

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Measles

Jollivet O, Urchueguía-Fornes A, Chung-Delgado K, Klint Johannesen C, Lehtonen T, Gideonse D, Cohen RA, Kramer R, Orrico-Sánchez A, Fischer TK, Heikkinen T, Van Boven M, Nair H, Campbell H, Osei-Yeboah R. Respiratory syncytial virus hospitalisation burden in children below 18 years in six European countries (2016-2023) pre- and post-COVID-19 pandemic. Int J Infect Dis. 2025 Jun;155:107903.

Munday, J. D., Atkins, K. E., Klinkenberg, D., Meurs, M., Fleur, E., Hahné, S. J., ... & Jan van Hoek, A. (2024). Estimating the risk and spatial spread of measles in populations with high MMR uptake: Using school-household networks to understand the 2013 to 2014 outbreak in the Netherlands. *PLoS medicine*, *21*(10), e1004466.

Nielsen, S., Fisker, A. B., Sie, A., Müller, O., Nebie, E., Becher, H., ... & Benn, C. S. (2024). Contradictory mortality results in early 2-dose measles vaccine trials: interactions with oral polio vaccine may explain differences. *International Journal of Infectious Diseases*, *148*, 107224.

Saha, S., Millier, M., Samaranayaka, A., Edmonds, L., Best, E., Ussher, J., ... & McIntyre, P. (2025). Immunogenicity and safety of measles-mumps-rubella vaccine delivered by the aerosol, intradermal and intramuscular routes in previously vaccinated young adults: a randomized controlled trial protocol. *PloS one*, *20*(3), e0318893.

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Meningococcal disease

Arends DW, van Rooijen D, van Woudenbergh E, Wolf J, Ohm M, de Jonge MI, et al. Impact of host factors and invasive meningococci on bacterial adhesion, proliferation, primary nasal epithelial barrier function, and immune response. Microbiol Spectr. 2025:e0014125

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Mumps

Gouma, S., Durand, M. L., & van Binnendijk, R. S. (2024). Mumps and other types of viral parotitis. *Infections of the Ears, Nose, Throat, and Sinuses*, 359-370.

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Pneumococcal disease

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Rubella

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Covid-19

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Potential NIP target diseases

Hepatitis A

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Appendix 6 Overview of relevant websites

General information for NIP professionals

NIP website for professionals:
http://www.rivm.nl/Onderwerpen/R/Rijksvaccinatieprogramma/Professionals

Dienst Vaccinvoorziening en Preventieprogramma's
(DVP, Department for Vaccine Supply and Prevention Programmes):
https://www.rivm.nl/rivm/organisatie/dienst-vaccinvoorziening-en-preventieprogramma-s-0

Meldingsplicht infectieziekten
(Mandatory notification of infectious diseases in the Netherlands):
http://www.rivm.nl/Onderwerpen/M/Meldingsplicht_infectieziekten

Cervical cancer screening programme:
https://www.rivm.nl/Onderwerpen/B/Bevolkingsonderzoek_baarmoederhalskanker_voor_professionals

European Surveillance Atlas of Infectious Diseases:
https://www.ecdc.europa.eu/en/surveillance-atlas-infectious-diseases

Sociaalwetenschappelijk onderzoek naar vaccineren (SocioVax):
SocioVax: sociaalwetenschappelijk onderzoek naar vaccineren | RIVM

General information for the public

National Immunization Program:
https://rijksvaccinatieprogramma.nl/

Available vaccines that are not (yet) part of a public vaccination programme:
www.rivm.nl/vaccinaties

Volksgezondheidenzorg.info:
https://www.volksgezondheidenzorg.info/

Cervical cancer screening programme:
https://www.rivm.nl/Onderwerpen/B/Bevolkingsonderzoek_baarmoederhalskanker

Vaccines Today:
https://www.vaccinestoday.eu/about-us/who-we-are/

Other NIP-related RIVM reports

Vaccination coverage National Immunisation Programme in the Netherlands. Reporting year 2025:
Vaccinatiegraad Rijksvaccinatieprogramma Nederland. Verslagjaar 2025 | RIVM

Adverse events in the Netherlands Vaccination Programme, reports in 2010 and review 1994–2010:
http://www.rivm.nl/bibliotheek/rapporten/205051004.pdf
Adverse events in the Netherlands Vaccination Programme. Report 2024:
https://www.lareb.nl/news/meldingen-van-bijwerkingen-rijksvaccinatieprogramma-2024/

Product information

NIP vaccine product information and package leaflets:
https://rijksvaccinatieprogramma.nl/professionals/productinformatie-vaccinaties

National organisations

General
Ministry of Health, Welfare and Sport:
http://www.rijksoverheid.nl/onderwerpen/vaccinaties

Gezondheidsraad (Health Council of the Netherlands):
http://www.gezondheidsraad.nl/

GGD GHOR
https://ggdghor.nl/
Vaccine safety
Netherlands Pharmacovigilance Centre Lareb:
http://www.lareb.nl/

College ter Beoordeling van Geneesmiddelen (CBG, Netherlands Medicines Evaluation Board):
https://www.cbg-meb.nl/
Data sources
Statistics Netherlands (CBS):
http://www.cbs.nl/

Dutch Hospital Data (DHD):
https://www.dhd.nl/

Nederlands instituut voor onderzoek van de gezondheidszorg (NIVEL, Netherlands Institute for Health Services Research):
http://www.nivel.nl/

Nederlands Referentielaboratorium voor Bacteriële Meningitis (NRLBM, Netherlands Reference Laboratory for Bacterial Meningitis):
https://www.amc.nl/web/specialismen/medische-microbiologie-infectiepreventie-1/medische-microbiologie-infectiepreventie-1/nederlands-referentie-laboratorium-voor-bacteriele-meningitis-nrlbm.htm

Integrated Primary Care Information (IPCI):
http://www.ipci.nl/

The Netherlands Cancer Registry (NKR):
http://www.cijfersoverkanker.nl/

Nederlandse Werkgroep Klinische Virologie
(NWKV, Netherlands Working Group Clinical Virology):
http://www.nvmm.nl/vereniging/commissies-en-werkgroepen/nederlandse-werkgroep-klinische-virologie/

International organisations

World Health Organization (WHO):
http://www.who.int/en/

World Health Organization (WHO) Europe:
https://www.who.int/europe/home?v=welcome

European Centre for Disease Prevention and Control (ECDC):
http://ecdc.europa.eu/en/

Centers for Disease Control and Prevention (CDC):
http://www.cdc.gov/
https://www.cdc.gov/vaccines/

ClinicalTrials.gov:
https://clinicaltrials.gov/
Advisory Committees
Joint Committee on Vaccination and Immunisation (JCVI):
https://www.gov.uk/government/groups/joint-committee-on-vaccination-and-immunisation

Advisory Committee on Immunization Practices (ACIP):
https://www.cdc.gov/acip/?CDC_AAref_Val=https://www.cdc.gov/vaccines/acip/

National Immunization Technical Advisory Groups (NITAGs):
http://www.nitag-resource.org/
Safety of vaccines
European Medicines Agency (EMA):
https://www.ema.europa.eu/en/homepage

U.S. Food and Drug Administration (FDA):
http://www.fda.gov/
International vaccine schedules
European Centre for Disease Prevention and Control (ECDC):
https://www.ecdc.europa.eu/en/publications-data/ecdc-vaccine-scheduler

World Health Organization (WHO):
https://immunizationdata.who.int/
International networks
EUVAC-Net:
https://www.ecdc.europa.eu/en/vaccine-preventable-diseases

HAVNET:
http://www.rivm.nl/en/Topics/H/HAVNET

National Respiratory and Enteric Virus Surveillance System (NREVSS):
https://www.cdc.gov/surveillance/nrevss/

WHO Global Polio Laboratory Network (GPLN):
https://www.who.int/europe/initiatives/polio-laboratory-network

European Respiratory Virus Surveillance Summary (ERVISS)
erviss.org

Invasive Respiratory Infections Surveillance (IRIS):
Invasive Respiratory Infections Surveillance (IRIS) | PubMLST

VITAL:
VITAL | IHI Innovative Health Initiative (europa.eu)

Communication platforms

Epidemic Intelligence Information System (EPIS):
https://ecdc.europa.eu/en/publications-data/epidemic-intelligence-information-system-epis

Vaccination of risk groups

Covid-19 vaccination
RIVM website on Covid-19 vaccination:
https://www.rivm.nl/corona/coronaprik

Influenza vaccination
RIVM website on Influenza vaccination:
http://www.rivm.nl/Onderwerpen/G/Griep/Griepprik

Stichting Nationaal Programma Grieppreventie
(SNPG, Foundation for the National Influenza Prevention Programme):
http://www.snpg.nl/

Scientific Institute for Quality of Healthcare:
http://www.iqhealthcare.nl/nl/

Annual Report on Surveillance of Influenza and Other Respiratory Infections in the Netherlands:
https://www.rivm.nl/luchtweginfecties/samenvatting-seizoen-2024-2025

Tuberculosis
KNCV Tuberculosis foundation:
https://www.kncvtbc.org/

Annual Report on Surveillance of Influenza and Other Respiratory Infections in the Netherlands:
https://www.rivm.nl/luchtweginfecties/samenvatting-seizoen-2024-2025

National Tuberculosis Control Plan 2021-2025:
https://www.rivm.nl/bibliotheek/rapporten/2021-0215.pdf

Traveller vaccinations
Landelijk Coördinatiecentrum Reizigersadvisering
(National Coordination Centre for Information for Travellers):
https://www.lcr.nl/Index.htm

A.M. van Roon | S.J. Lanooij | H.E. de Melker

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