RAPID RISK ASSESSMENT

Assessing the risk to public health of multiple detections of poliovirus in wastewater in the EU/EEA

Summary

Poliomyelitis (polio) is a highly infectious disease caused by polioviruses, which can be prevented by vaccination. Polioviruses can be transmitted easily and silently across wide geographic areas. Most infected people do not develop symptoms, but if the virus invades the nervous system it can cause acute flaccid paralysis (AFP) within hours. Fewer than 1% of infections lead to irreversible paralysis. As the last indigenous case caused by an infection with wild poliovirus in Europe was reported in 1998, it has become a forgotten disease for most people in the European Union/European Economic Area (EU/EEA). The World Health Organization European Region (WHO Europe) was declared polio-free in June 2002, because of successful immunisation programmes, surveillance and outbreak response.

Between September and December 2024, four countries in the EU/EEA (Finland, Germany, Poland, and Spain) and the United Kingdom (UK) reported detections of a genetic cluster of circulating vaccine-derived poliovirus type 2 (cVDPV2) in sewage samples. This is the first time cVDPV2 has been detected in EU/EEA countries from environmental surveillance. No human cases of polio related to these detections of cVDPV2 have been reported in EU/EEA or the UK to date.

These recent importations and potential circulation of the virus pose a possible threat to public health within the EU/EEA and should be closely monitored, as they can lead to outbreaks in unvaccinated individuals. This risk assessment is the basis for ECDC recommendations to maintain high vaccination coverage, strengthen environmental and clinical surveillance and be vigilant to potential outbreaks of polio. ECDC encourages EU/EEA public health authorities to focus on the following actions:

- **Achieve and sustain a very high uptake of three doses of IPV (inactivated poliovirus vaccine) (>90%)** across communities, at subnational and national level, through the implementation of effective and timely routine childhood vaccination programmes.
- **Design and rapidly deliver targeted catch-up programmes** to identify and vaccinate individuals with incomplete or unknown vaccination status, following them until completed series. This is particularly important and urgent in communities and local areas of known suboptimal coverage or geographical clustering of the non- or under-vaccinated individuals in proximity of positive findings detected through environmental sampling.
- **If polio cases occur, activate national poliomyelitis response plans (these plans should be updated, as needed, and field-tested) and alert clinicians**, particularly paediatricians and neurologists, about AFP symptoms and polio risk.
- **Review vaccination coverage data** for the full IPV series at the lowest possible administrative level.
- Factors that lead to sub-optimal coverage in specific areas and population groups need to be explored to **develop tailored, context-specific, culturally sensitive interventions** to increase vaccination uptake.
- **Conduct risk communication activities** to highlight the importance of ensuring timely routine vaccination.

Suggested citation: European Centre for Disease Prevention and Control. Assessing the risk to public health of multiple detections of circulating vaccine-derived poliovirus type 2 (cVDPV2) in wastewater in the EU/EEA. 30 January 2025. ECDC: Stockholm; 2025.

ISBN: 978-92-9498-773-0
doi: 10.2900/6615283
Catalogue number: TQ-01-25-004-EN-N

- **Prioritise the offer of IPV to migrant populations** in the EU/EEA with an unknown polio vaccination history.
- **Ensure adequate stocks** of IPV.
- **Implement environmental surveillance** for polioviruses according to WHO guidelines relevant also in polio-free countries with exclusive IPV use, **asses environmental surveillance site performance** and consider **enhancing geographical coverage** and **sampling frequency,** especially if detections have been made.
- **Enhance Acute Flaccid Paralysis (AFP) syndromic and clinical enterovirus surveillance**, where available, to ensure no infection in humans is missed.

Epidemiological situation

Between September and December 2024, four countries in the EU/EEA (Finland, Germany, Poland, and Spain) and the United Kingdom (UK) reported detections of circulating vaccine-derived poliovirus type 2 (cVDPV2)[1] in sewage samples [1]. This is the first time cVDPV2 has been detected in EU/EEA countries from environmental surveillance. No human cases of poliomyelitis[2] related to these detections of cVDPV2 have been reported in the EU/EEA or the UK to date.

In September 2024, Spain reported sewage samples in Barcelona that tested positive for cVDPV2 [2-4]. Samples collected in Poland in October and December from sites in Warsaw and Rzeszów, respectively, were also cVDPV2-positive [5]. In Germany, cVDPV2 was detected in nine cities i.e. Munich, Bonn, Cologne, Hamburg, Dresden, Dusseldorf, Mainz, Berlin and Stuttgart between weeks 44 (starting 28 October) and 51 (starting 16 December 2024) of 2024 [6-8]. Finland reported detection of cVDPV2 in December 2024 in samples collected in Tampere in November 2024 [1,9]. Besides the four EU/EEA countries that reported detections of cVDPV2 in 2024, the UK also reported positive wastewater samples from September to November 2024 in Leeds, London, and West Essex [10]. Genetic sequences of these viruses corresponding to the VP1 region were determined and analysed from Finland (7), Germany (21), Poland (2), and Spain (1) (Figure 1). Of note, often and not unexpectedly, more than one sequence originated from the same wastewater sample, e.g. seven sequences from Finland represent results of one single wastewater sample. The sequences belong to the NIE-ZAS-1 cVDPV2 emergence group first detected in Nigeria in 2020, which has predominantly been detected in northern and western African countries, up to and including in 2024 [11].

Phylogenetic analysis conducted using MAFFT and IQTREE, with the Sabin2 vaccine strain as outgroup, indicates that the sequences form a single distinct genetic cluster. This cluster exhibits a high degree of internal genetic variability, indicating that the variant is not newly emerged (Figure 1). Based on its genetic distance from other members of the NIE-ZAS-1 lineage this variant appears to have emerged approximately one year ago [12]. Furthermore, the observed intra-cluster diversity shows no strong correlation with either geographical location or sample collection date, reducing the likelihood that it represents ongoing virus transmission in the EU/EEA but clearly signalling the consistent presence of cVDPV in the environment.

The virus variant in the cluster carries a reversion mutation at vaccine strain attenuation site nt 2909 in the VP1 genomic region (VP1 protein residue aa143) and the 5' untranslated region where the other attenuation marker is located is replaced by recombination with another Enterovirus [12], potentially restoring its neurovirulence. With a total of around 40 nt changes compared to Sabin2 in the VP1 region, these viruses meet the WHO definition of a cVDPV2 (≥6 nt changes [13]). In addition, these viruses are close to the limit for the definition of an orphan virus (≥1.5% nucleotide divergence in the VP1-coding region compared to previous isolates [14]) which indicates that there are gaps in global poliovirus surveillance that prevents identification of the geographic region from which the virus has been introduced into Europe. Further information on these environmental detections and an in-depth genomic analysis that provides more details than the analysis presented here is available in Böttcher et al. 2025 [12].

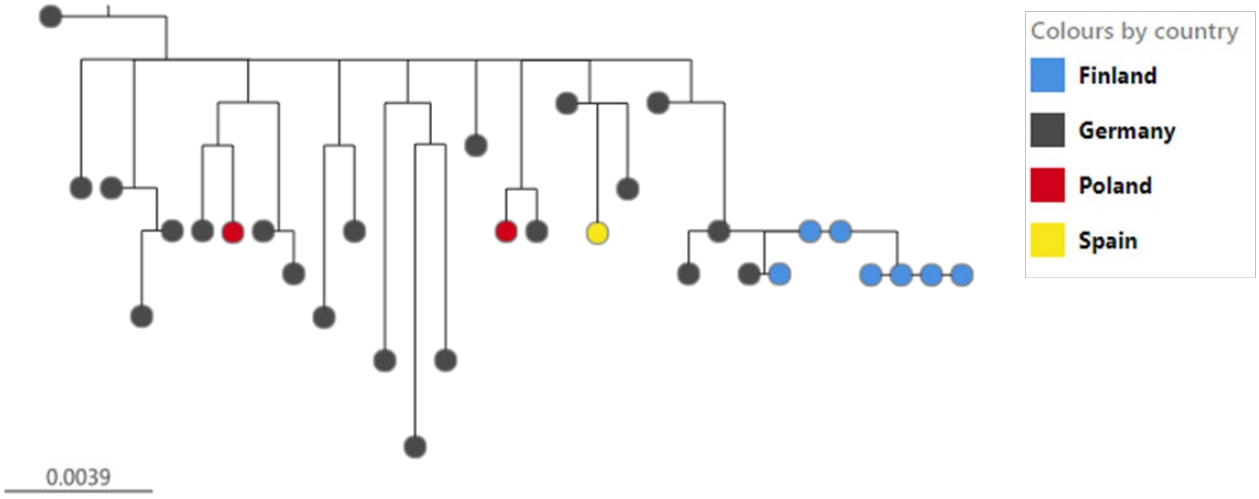
ECDC conducted a survey among EU/EEA Member States from 9–17 January 2025 to obtain latest information on the status of their wastewater-based surveillance (WBS) programmes for poliovirus. The majority of Member States

[1] cVDPV are defined as VDPV isolates for which there is evidence of person-to-person transmission in the community. These isolates must be genetically linked VDPVs, isolated from one the following: (i) at least two individuals (not necessarily AFP cases), who are not direct (household) contacts; (ii) one individual and one or more environmental surveillance (ES) samples; (iii) two or more ES samples if they were collected at more than one distinct ES collection site (no overlap of catchment areas), or from one site if collection was more than two months apart (https://www.who.int/publications/m/item/vaccine-preventable-diseasessurveillance-standards-polio)

[2] According to the EU case definition (https://ec.europa.eu/health/ph_threats/com/docs/1589_2008_en.pdf#page=48), a poliomyelitis confirmed case is any person <15 years of age with acute flaccid paralysis (AFP) from whom poliovirus (either WPV, VDPV or Sabin-like virus has been isolated or any person in whom polio is suspected by a physician and from whom poliovirus (either WPV, VDPV or Sabin-like) has been isolated. In this RRA, the term 'polio case' refers to any case of AFP (paralytic polio case) due to circulating vaccine-derived poliovirus type 2 (cVDPV2).

are performing WBS for poliovirus either as a routine national programme or in the context of research projects (18 of 29 responding countries), established since median 13 years (range 1–61 years). The lack of environmental surveillance in eleven EU/EEA countries, although the majority of these are planning to introduce it in the future, represents a significant gap for assessing the potential spread of cVDPV2 in the EU/EEA. More information on environmental surveillance and details of countries' WBS for poliovirus are included in Annex 1.

Figure 1. Phylogenetic tree of 31 VP1 sequences collected from EU/EEA Member States between September and December 2024



The sequences from Finland are replicate isolations from a single sample.

The most likely explanation for the observations in Figure 1 is repeated virus introductions from a region with ongoing circulation of this variant of cVDPV2. It is also possible, albeit less likely, that they reflect virus circulation in EU/EEA that went undetected by environmental surveillance until recently.

Disease characteristics

Poliomyelitis (polio) is a highly infectious disease caused by polioviruses, which can be prevented by vaccination. Humans are the only reservoir of the infection, thus poliovirus is targeted for eradication [15]. The last indigenous case caused by an infection with wild poliovirus in Europe was reported in 1998 and the WHO European Region was declared polio-free (free of wild poliovirus) in June 2002.

Poliovirus can be excreted by nasopharyngeal secretions for about one week and in stool for three to six weeks after infection, even from people who do not develop symptoms [16]. Maximum excretion of the virus is seen in two to three days prior and one week after appearance of symptoms [17]. Poliovirus transmission occurs from person-to-person by oral contact with secretions (oro-oral) or faecal material (faecal-oral) from an infected person. Faecal-oral transmission is more common in areas with poor access to water and sanitation [18]. Worldwide polio mainly affects children under five years of age. Most infected people do not develop symptoms, but if the virus invades the nervous system it can cause acute flaccid paralysis (AFP) within hours [19]. Fewer than 1% of infections lead to irreversible paralysis (one case in 200 infections with poliovirus type 1 and one case in more than 1 000 infections with poliovirus type 2 or 3, respectively) [16]. cVDPV acts with the same characteristics of WPV, including the proportion of infections leading to paralysis. No specific therapy is available against the virus. Immunisation is the only effective method of providing protection against severe disease caused by polio.

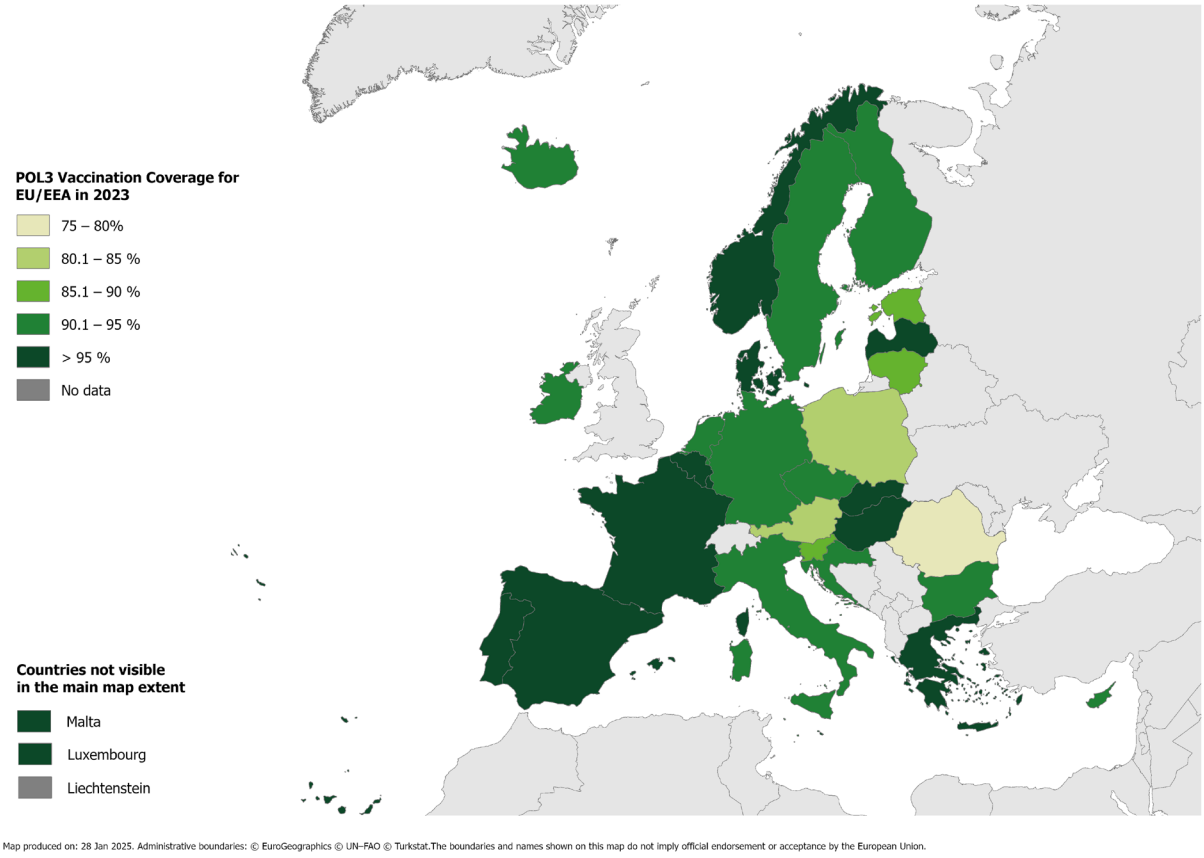
Polio vaccination coverage at national and subnational level

Vaccination coverage data for polio antigen-containing vaccine are collected every year as part of the WHO/UNICEF reporting mechanism [20]. In addition, as part of this risk assessment, ECDC performed an additional data call aimed at collecting subnational estimates to complement the information available for EU/EEA countries and to further understand and describe sub-national variation. Collected data were then validated directly via either the country or, when already available but unpublished, received from the WHO Regional Office for Europe.

As part of the data collection, the vaccination coverage for the third dose of polio vaccine for 2023 at both national and subnational level was defined as the percentage of surviving infants who received a third dose of polio containing vaccine. The vaccine coverage is estimated as the percentage of children ages 12–23 months who received three doses of the polio vaccine before the time of assessment [21].

Data related to the year 2023 on the national level (WHO/UNICEF WUENIC estimates), available for 29 out of 30 EU/EEA countries, indicate that the average vaccination coverage (VC) in EU/EEA countries for the third dose of polio vaccine was 94%, ranging between 78–99%. Twenty-four EU/EEA countries (80%) had VC of ≥90% in 2023, out of which 14 countries had VC of ≥95%. In addition, five countries had VC of less than 90% (RO, AT, PO, EE, SL). Data for Lichtenstein are not available.

Figure 2. Vaccination coverage for third dose of polio containing vaccine (POL3), EU/EEA, 2023*



***Source**: WUENIC POL3 estimates in WHO Immunization Data portal [21]*
** Data for Germany refer to children in school entrance examinations, 4–7 years old, collected in 2020.*
Data for Spain for 2023 are extracted from Interactive NHS Consultation [22].

The additional data collection related to the subnational estimates were asked to be reported at the Nomenclature of Territorial Units for Statistics 3 level (NUTS3), or the next higher level of granularity possible if NUTS3 was not available. For most countries data reported referred to the year 2023, with the exception of France (data referred to 2022).

Of the 1 176 units at the level of NUTS3 and Country and Subnational Regions level (CSR - Norway only) in the EU/EEA Member States in 2023, ECDC received data referring to 794 NUT3/CSR units (68%). Among these, 199 NUTS3/CSR units (25% of the overall units with data available) had estimated POL3 vaccination coverage ≥95%, 112 NUTS3/CSR units (14% of the overall units with data available) between 90–95%, 217 NUTS3/CSR units (27% of the overall units with data available) between 80-90%, 192 NUTS3/CSR units (24% of the overall units with data available) between 70-80%, 58 NUTS3/CSR units (7% of the overall units with data available) between 60–70, 14 NUTS3/CSR units (2% of the overall units with data available) between 50–60 and two NUTS3/CSR units (0.3% of the overall units with data available) ≤50%. Additionally, Ireland and Slovenia provided data at subnational level in a health district format (data not displayed in Figure 2). Among these 40 additional districts from Ireland and Slovenia, most districts (n=31) reported POL3 vaccination coverages ≥90% (range: 80%–98%).

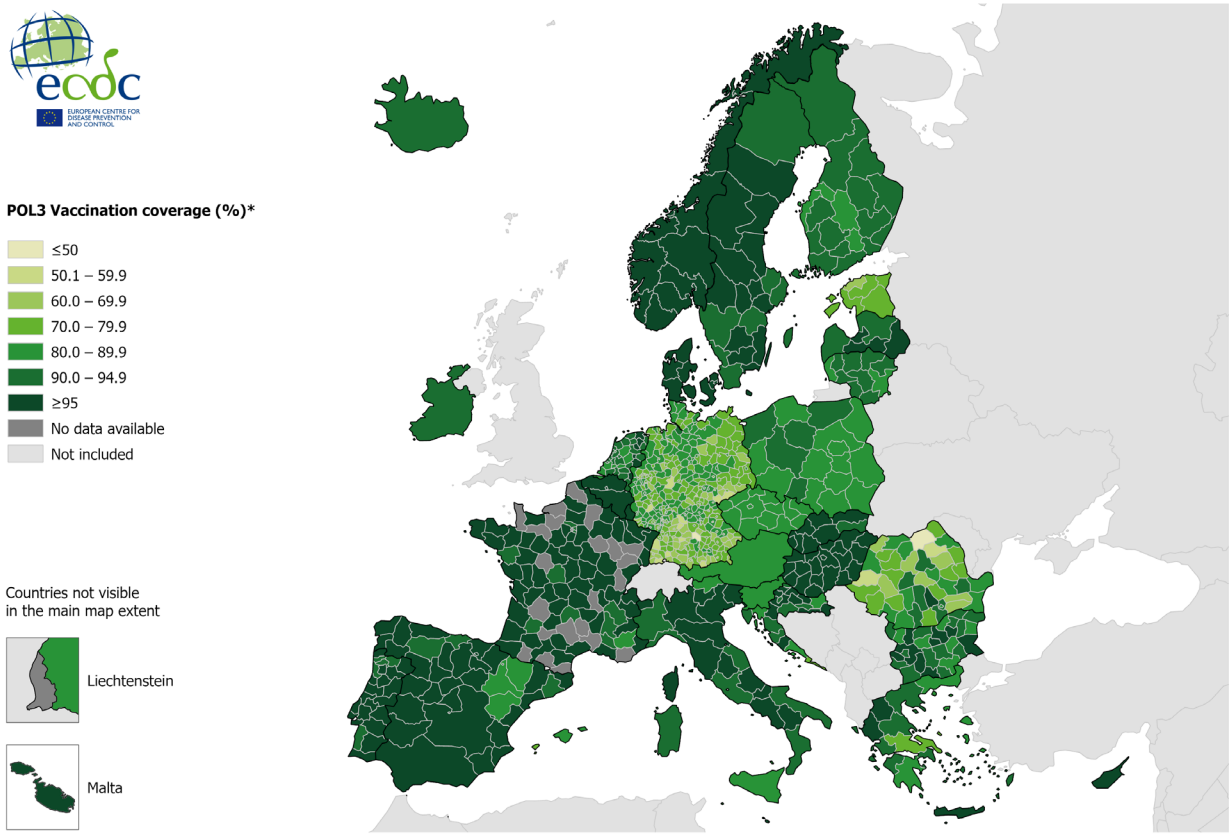
Entities with a vaccination coverage below 60% were reported in Germany and Romania (2023 data), which complements the information of the national coverage of the two EU/EEA countries with lowest national coverage (Romania (78%) and Austria (84%)) estimated for 2023. Germany reported the vaccination coverage for 24 month-old children as 94% for two doses of polio-containing vaccine and as 66% for three doses, respectively (data reported to ECDC and personal communication from Robert Koch Institute). Since June 2020, Germany recommends a 2+1 schedule (three doses) of the hexavalent vaccine including IPV (inactivated poliovirus vaccine) replacing the previously used 3+1 schedule (four doses) as the primary immunisation series. However, there have been reports of delays in the administration of the third dose of the 2+1 schedule – at the time this is offered – following this change. To accommodate the schedule change, Germany reports subnational coverage not as third

dose (POL3) but as last dose of polio-containing vaccine (that is, either four doses, or three doses with correct interval between doses). At the age of 12 months, only 21% of the children born in Germany in 2021 had received the last dose of polio-containing vaccine [23].

Data related to 2023 on the subnational level show an heterogenous picture; 39% of the NUTS3/CSR entities for which data were available reported a POL3 VC of ≥90.0%, however 34% of the NUTS3/CSR entities for which data was available reported a concerning POL3 VC of ≤80%. In addition, there is variation when compared to the national level estimates, underlining the importance of understanding, describing and assessing the local situation.

The POL3 VC in the geographical NUTS areas that tested positive for cVDPV2 was reported as follows: Barcelona (94.6%) in Spain; Warsaw (82%) and Rzeszów (83%) in Poland; Munich (81%), Berlin (77%), Bonn (80.8%), Cologne (75.0%), Hamburg (80.5%), Dresden (79.3%), Stuttgart (68%), Dusseldorf (80.5%) and Mainz (80.4%) in Germany and Tampere (93.8%) in Finland. These data need to be interpreted with caution, as the area of influence of the catchment areas where the environmental samples were detected may include neighbouring NUTS geographical areas.

Figure 3. Vaccination coverage for third dose of polio containing vaccine (POL3) at subnational level, EU/EEA, 2023; France 2022



Source: Data submitted to WHO through eJRF and/or to ECDC.
** Data presented are for 2023 at the smallest subnational level where data were available by the time of assessment except for the following countries: France (data represented: 2022).*
*** Vaccination coverage presented should be interpreted considering the different schedules in place in each EU/EEA country. Subnational data for Germany refer to last dose of polio-containing vaccine (either four doses, or three doses with correct interval between doses) instead of POL3.*
**** Data displayed for Greece (GR) is based on a new methodology (e-prescription data analysis), and thus should be interpreted with caution. Taking a longer period in analysis, the areas with lower POL3 vaccination coverage were found with POL3 vaccination coverage >90%. Final validation of the method is currently pending.*
***** Data displayed for AT, CY, IE, IS, LU, MT and SI correspond to the national POL3 vaccination coverage.*

POL3 vaccination gap estimates for the 2014–2023 period

ECDC has updated a previous analysis that estimated the number of children who may not have received the POL3 by the time of assessment, for the 10-year period of 2012–2021, which indicated that approximately 2.4 million children of the same age group may not have received three doses of the polio-containing vaccine [24] by the time of assessment. The updated detailed calculations are provided in Annex 3. Within the EU/EAA and between 2014–2023 approximately 2.7 million children aged between 12 to 23 months may not have received POL3 by the time of assessment. Specifically for 2022 and 2023, the estimated amount indicates approximately 600 000 children aged 12 to 23 months (Table 3, Annex 3). The estimation is based on calculating the number of children 12–23 months old who were not fully vaccinated divided by the total number of children in the cohort of 12–23 months-old children in the same period.

The estimation of individuals not having received three doses of polio containing vaccine by the time of the assessment should be interpreted cautiously, as some have partial protection provided by the first two doses, and some might have received the third or other doses of vaccination after the time of formal assessment. In addition, countries have different methods of implementation of immunisation systems, with some countries using coverage surveys at a frequency that is less than annual; for other countries with electronic immunisation registries, lack of registration for some parts of the health sector or delays in registration might affect these data.

ECDC risk assessment for the EU/EEA

This risk assessment has been developed based on the currently available data at the time of publication and follows the ECDC rapid risk assessment methodology, where the overall risk is determined by a combination of the probability of developing polio and its impact on public health [25].

What is the current public health risk of polio in the EU/EEA?

Since 2016, epidemiologic data have shown that the detection of any cVDPV, even single detections in new areas, is evidence of potential previously undetected ongoing poliovirus transmission, leading to a potentially higher risk of transmission in the immediate future [26]. Europe experiences constant importation of Sabin-like[3] polioviruses and VDPV[4] through international travel and migration from OPV-using countries. The current detections of cVDPV2 in EU/EEA countries is a signal of cVDPV2 importation into the EU/EEA, which indicates some degree of silent transmission and a potential for polio cases among unvaccinated or under-vaccinated individuals. Furthermore, in countries using IPV only some self-limiting local circulation is expected due to weak mucosal immunity among vaccinees. Although not all environmental signals warrant an emergency response, all are a reminder of the constant pressure of poliovirus importation, the importance of filling known immunity gaps and of the need to strengthen surveillance systems for early detection.

Different people in EU/EEA countries have different susceptibilities to infection with cVDPV2 and different probabilities of developing polio depending on the type of vaccine administered and on the vaccine coverage in the different regions/countries (Annex 2). The size of susceptible populations varies across EU/EEA countries depending on the year of initiation of the polio immunisation programme, history of OPV and IPV, history of vaccination coverage by birth cohort, and current vaccine coverage at national and sub-national level (Annex 2), and these parameters need to be taken into account to assess the situation at national and subnational level. Immunocompetent people vaccinated with OPV doses as per national schedule have a minimal risk of infection. Cohorts of the EU/EEA population only vaccinated with IPV-containing vaccines could be infected and shed the poliovirus (thereby potentially contributing to circulation), but similarly to OPV vaccinees they are protected against disease.

The probability of infection with poliovirus for unvaccinated or under-vaccinated individuals living in areas with low vaccination coverage is likely higher than that of those living in areas with high vaccination coverage. However, even in areas with high vaccination coverage, there is moderate probability of disease for under- and unvaccinated individuals, because poliovirus circulation remains possible in populations with high IPV-only vaccine coverage.

Table 1 presents an overview of the probability of disease (i.e. of polio cases following infection with cVDPV2) and the potential impact on public health systems (i.e. at the population level, rather than at the individual level), assessed for vaccinated and under-/unvaccinated populations across all EU/EEA countries. While a probability of disease is very low for vaccinated individuals, it is assessed as moderate for un- or under-vaccinated individuals. An

[3] Sabin-like: Any poliovirus isolate from human or environmental sample with any nucleotide difference from Sabin less than the number that meets the definition of a VDPV (https://www.who.int/publications/m/item/vaccine-preventable-diseases-surveillancestandards-polio)

[4] Vaccine-derived poliovirus (VDPV): OPV-derived virus strains that have diverged from their parent type-specific Sabin strain by > 1%, (≥ 10 nucleotide changes) for types 1 and 3, or by > 0.6% (≥ 6 nucleotide changes) for type 2 in the complete VP1 genomic region (https://www.who.int/publications/m/item/vaccine-preventable-diseases-surveillancestandards-polio)

important assumption is made that while the impact of developing polio at the individual level can be permanent and considerable, at the population level there would be relatively few polio cases requiring hospitalisation and intensive management; so the impact on public health services would be correspondingly low in areas of low vaccination coverage, and very low in areas of high vaccination coverage where herd immunity further reduces the probability of virus circulation and infections.

Based on these considerations, the overall risk among vaccinated populations is assessed to be very low in both areas of high vaccination coverage and in areas of low vaccination coverage in EU/EEA countries. The overall risk among under- and unvaccinated populations is assessed to be low in areas with high vaccination coverage and moderate in areas with low vaccination coverage.

Table 1. Assessment of the current risk of polio in the EU/EEA, by population group and vaccination coverage

	Areas of high vaccination coverage		Areas of low vaccination coverage	
	Vaccinated	Under-/un-vaccinated	Vaccinated	Under-/un-vaccinated
Probability of disease	Very low	Moderate	Very low	Moderate
Impact*	Very low	Very low	Very low	Low
Risk	**Very low**	**Low**	**Very low**	**Moderate**

** Impact at population level and on health services*

Impact on public health in the event of sustained community transmission of cVDPV2 in the EU/EEA

If polio cases are detected or clear evidence of sustained community transmission emerges, the impact on public health services across EU/EEA countries will be significant. Mobilisation of public health resources would be required to control the outbreak including for example strengthening of vaccination campaigns and surveillance programs, management of polio cases in hospitals and in the community, increase in vaccine stockpiles, revision of national poliomyelitis plans, and continuous assessments until the event would be considered concluded.

ECDC recommendations

Recommendations for environmental surveillance

- EU/EEA countries should implement environmental surveillance for polioviruses according to WHO guidelines [27]. Such surveillance systems can increase the overall surveillance sensitivity even in polio-free countries, especially where AFP surveillance is non-existent or suboptimal and/or IPV is used exclusively to enable the detection of re-introduction of WPV or emergence of a cVDPV and aid in the assessment of the geographic extent, duration of circulation and extent of community transmission.
- EU/EEA countries that conduct environmental surveillance for polioviruses, should assess the performance and sensitivity of the sites in their programmes to meet the quality criteria [27] and consider adapting their national programmes as required to ensure they are able to detect cryptic circulation of VDPVs by reviewing the sampling frequency and geographical coverage. Countries with recent detections of cVDPV2 should and have followed the WHO outbreak response recommendations including increasing the sampling frequency to twice per month and considering increasing geographical coverage for a minimum of six month and until the event has been brought under control [26,28].
- EU/EEA countries could consider methods to mitigate the sensitivity issues of some current detection methods as described in the 2022-2023 polio investigation in the US [29], because such issues have also been described in the current event.
- EU/EEA countries should report any new detections of VDPV2, including sequence data, to ECDC or to global sequence databases where ECDC can access the data.

Recommendations for clinical surveillance

- Enhance AFP syndromic and clinical enterovirus surveillance, where available, to ensure no infection in humans is missed.
- Clinicians, in particular paediatricians and neurologists, should be alerted and constantly updated on AFP syndromes and about AFP cases potentially caused by poliovirus. They should also be reminded that AFP surveillance is based on polio virus identification in faecal samples and that negative test results of samples from other bodily substances do not exclude polio virus infection.
- Maintain sensitive and efficient surveillance systems (include AFP and environmental surveillance) (countries with clusters of unvaccinated individuals should consider strengthening or establishing environmental and enterovirus surveillance in these areas, as a complement to AFP surveillance).

Recommendations for immunisation/vaccination

With regards to the **implementation of polio vaccination programmes in the EU/EEA**, ECDC recommends that EU/EEA countries and immunisation stakeholders prioritise actions to address these key objectives:

Objective 1: Avoid at all costs the re-occurrence of paralytic polio in the EU/EEA;
Objective 2: Prevent the consistent establishment of local transmission of cVDPV in the EU/EEA;
Objective 3: Foster vaccine equity through an accessible immunisation offer regardless of geographic location, socioeconomic status, ethnicity or religious beliefs;
Objective 4: Sustain Europe's polio-free status.

Actions:

- Urgently **review vaccine coverage data for the full IPV vaccination immunisation series at the lowest possible level** (i.e. province, district or equivalent within the relevant subnational context in the EU), to enable an effective diagnosis of the local situation and the identification of areas for tailored interventions through immunisation.
- **Achieve and sustain a very high uptake of three doses of IPV vaccination (>90%) across communities**, at subnational and national level, through the implementation of **effective and timely routine childhood vaccination programmes**; both timeliness and completion of the entire primary immunisation series (minimum of three doses of IPV-containing vaccines) are paramount to avoid a susceptibility gap (and keeping in mind that effective routine programme implementation is more cost-effective than catch-up programmes or supplementary immunisation activities).
- Design and rapidly deliver **tailored catch-up programmes to identify individuals previously unvaccinated or with an incomplete or unknown immunisation** status and offer IPV vaccination; this is particularly important and urgent in communities and local areas of known suboptimal coverage or geographical clustering of the non- or under-vaccinated individuals in proximity of positive findings detected through environmental sampling. Catch-up vaccination efforts must first prioritise children (especially, but not only, those < 5 years of age) to ensure completion of the primary immunisation series with three IPV-containing vaccine doses; in addition, there should be a concerted focus on children and adolescents who have not completed the vaccination series (i.e. including booster doses) according to the national immunisation programme. The exact age cut-offs for catch-up vaccination efforts should be defined nationally based on their documented vaccine coverage and immunity gaps identified in the areas of intervention
- **Prioritise the offer of IPV vaccination to migrant populations** in the EU/EEA with an unknown polio vaccination history according to the following: for children, offering IPV vaccination in line with the nationally age-based recommended IPV-containing vaccine schedule; for adults, offering two doses of IPV vaccination at least one month apart. Follow-up documentation of such vaccination is critical for both migrants in-transit or at destination countries to ensure an effective continuation of immunisation services.

With regards to the **monitoring and overall performance management of polio vaccination programmes** in the EU/EEA, ECDC recommends EU/EEA countries and immunisation stakeholders to prioritise the following key actions:

- Significantly improve and address long-standing issues of data availability and data quality for an effective measurement of vaccine coverage at both national and subnational levels, as the basis for an effective estimation of existing levels of risk of polio disease and/or infection/transmission at community levels;
- Upgrade Immunisation Information Systems to effectively monitor vaccination programmes, and identify the unvaccinated; such systems should enable identification and monitoring of vaccination status beyond the primary immunisation series since little is known about the level of uptake of boosters and the complete IPV vaccination course;
- Systematically integrate evaluation programmes against set targets and indicators as part of programmatic interventions intended to increase uptake in the general population or specific target groups/communities to enable, inter alia, measuring return on investment and lessons learning;
- Ensure adequate stocks of IPV in line with effective vaccine stock management guidelines.

Risk communication and community engagement

With regards to risk communication and strategies to increase vaccine acceptance and uptake, ECDC recommends EU/EEA countries and immunisation stakeholders to prioritise the following key actions:

- Risk communication activities around detection of poliovirus in wastewater should provide information for the public on why such findings are relevant, actions implemented by the authorities and vaccination recommendations.
  - Key messages should highlight the importance of ensuring timely vaccination with all recommended doses as per national schedule, given the potential risks for those unvaccinated or not fully vaccinated. Information on vaccination opportunities, e.g. how and where to catch up with missed vaccinations, should be provided.
  - Frequently asked questions (FAQs) can help to clarify topics that may be difficult for lay audiences to grasp (e.g. why is there a 'vaccine-derived' virus, how does the virus circulate, who is at risk, two types of vaccines, etc.). Any circulating mis- and disinformation around the findings and on polio vaccination should be monitored and addressed. In Annex 2, examples of communication activities from countries where poliovirus has been detected in wastewater are provided.
  - In the context of global polio eradication efforts, remind travellers to endemic countries or those affected by outbreaks of cVDPV to complete immunisation, as well as comply with additional travel-related vaccine recommendations in line with existing WHO guidelines [18,30] and country-based assessments.
- Develop tailored initiatives for increasing vaccine acceptance and uptake.
  - Explore the factors that lead to sub-optimal vaccination coverage in specific areas and population groups, to gain a better understanding of drivers and barriers to vaccine acceptance and uptake (e.g. via surveys), and to inform the development of tailored interventions.
  - Map and design context-specific and culturally sensitive interventions in geographically clustered communities with close social contacts among members whose low vaccination coverage is often reported across several EU countries, e.g. faith-based groups, anthroposophical communities, etc.
  - Outreach activities should include engaging with community organisations and take into account cultural and social characteristics, trusted sources of information and messaging that can resonate with the specific audiences. Findings from studies on drivers and facilitators of polio vaccination uptake, as well as examples of outreach initiatives are provided in Annex 2.
  - All contacts with healthcare services can be an opportunity to check vaccination status and remind parents of the importance of following the vaccination schedule.

Recommendations if polio cases occur in the EU/EEA

- EU/EEA countries should activate their national poliomyelitis response plans. All EU/EEA countries should produce, annually revise and field test a national polio preparedness and response plans as recommended by the Regional Polio Eradication Certification Commission for Europe (RCC).
- The RCC regularly assesses the quality of national polio surveillance based on country reports, and the RCC's findings and recommendations should form the basis for action.
- Assess which populations are affected and decide on suitable control measures.

Limitations and research gaps

- As local transmission cannot be definitively confirmed or excluded at this stage, continued surveillance to determine whether the event is transient or persists and spreads to new regions is required. In addition, there is limited experience on the interpretation of cVDPV in wastewater in Europe and high-income countries in general.
- A lack of wastewater-based surveillance of poliovirus in several EU/EEA Member States may lead to underestimation of the number of affected countries in this outbreak as cryptic circulation can go undetected.
- Direct methods of detection for poliovirus using genomic extracts of wastewater samples are being used in some countries; these can have lower sensitivity, leading to false-negative results, particularly when a large catchment area is being sampled. This issue was detected and mitigated in the 2022–2023 polio investigation in the United States [29].
- The laboratory workflow following standard procedures i.e. using culture-base viral isolation followed by intratypic differentiation is laborious and time consuming [31] with results being available only several weeks after sampling. In turn, this affects the time required to confidently assess discontinued circulation after several negative testing samples.
- Limited literature is available on the response actions in IPV only settings, following identifications of cVDPV.

ECDC contributors (in alphabetic order)

Karam Adel Ali; Bahaa Alhaffar; Leonidas Alexakis; Erik Alm; Soraya Alvarez-Codesal; Xanthi Andrianou; Sabrina Bacci; Agoritsa Baka; Jordi Borrell Pique; Daniel Cauchi; Bruno Ciancio; Luca Freschi; Silvia Funke; Emma Lof; Phyo Myint; Isabel Olea Vivas; Maximilian Riess; Andrea Wuerz.

External reviewers

Donato Greco (European Regional Commission for the Certification of Poliomyelitis Eradication); Josefa Masa Calles and Noemí López Perea (National Centre for Epidemiology, CIBERESP Instituto de Salud Carlos III, Spain); Steen Ethelberg (Dept. of Infectious Disease Epidemiology and Prevention, Statens Serum Institut, Denmark; Co-leader of the European Joint Action on wastewater based surveillance: EU-WISH); José Hagan, Shahin Huseynov and Eugene Saxentoff (Vaccine-Preventable Diseases and Immunization, World Health Organization Regional Office for Europe); Silviu Ciobanu and Kareena Hundal (WHO Health Emergencies Programme, WHO Regional Office for Europe); Hanna Nohynek (Prevention of Health Threats Unit, Public Health Department, Finnish Institute for Health and Welfare, Finland), Ole Wichmann (Department for Infectious Disease Epidemiology, Robert Koch Institute, Germany)

Disclaimer

All experts submitted declarations of interest and a review of these declarations did not reveal any conflict of interest.

References

1. World Health Organization (WHO). Global Polio Eradication Initiative. Global circulating vaccine-derived (cVDPV) AFP cases and environmental samples 2021-2025. Geneva: WHO; 2025. Available at: https://polioeradication.org/circulating-vaccine-derived-poliovirus-count/
2. Agència de Salut Pública de Catalunya (ASPCAT). En estudi la presència de poliovirus en aigües residuals a l'Àrea Metropolitana de Barcelona. Barcelona: Generalitat de Catalunya; 2024. Available at: https://salutpublica.gencat.cat/ca/detalls/Article/poliovirus-circulant-aigues
3. Agència de Salut Pública de Catalunya (ASPCAT). Actualització 8/10/2024 sobre la presència de poliovirus en aigües residuals a l'àrea metropolitana de Barcelona. Barcelona: Generalitat de Catalunya; 2024. Available at: https://salutpublica.gencat.cat/ca/detalls/Article/actualitzacio-polio
4. Agència de Salut Pública de Catalunya (ASPCAT). Actualització final 25/10/2024 sobre la presència de poliovirus en aigües residuals a l'àrea metropolitana de Barcelona. Barcelona: Generalitat de Catalunya; 2024. Available at: https://salutpublica.gencat.cat/ca/detalls/Article/final-presencia-poliovirus-aiguees-residuals
5. Wieczorek M, Gad B, Krzysztoszek A, Kłosiewicz P, Oleksiak K, Zaborski B, et al. Detection of vaccine-derived poliovirus type 2 from sewage samples and public health response, Poland, November to December 2024. Euro Surv. 2025;30(1) Available at: https://dx.doi.org/10.2807/1560-7917.ES.2025.30.1.2400805
6. Robert Koch-Institut. Epidemiologisches Bulletin 48 | 2024. Berlin: Robert Koch Institut, 2024 28.11.2024. Report No.: 48.
7. Robert Koch-Institut. Epidemiologisches Bulletin 49 | 2024. Berlin: Robert Koch Institut, 2024 05.12.2024. Report No.: 49.
8. Robert Koch-Institut. Update zu cVDPV2-Nachweisen im Abwasser. Epidemiologisches Bulletin. 2025 (5):3--4.
9. Finnish Institute for Health and Welfare. Poliovirus detected in wastewater in the Tampere region – no cases have been diagnosed, polio vaccination coverage is very good in Finland. Helsinki: THL; 2024. Available at: https://thl.fi/en/-/poliovirus-detected-in-wastewater-in-the-tampere-region-no-cases-have-been-diagnosed-polio-vaccination-coverage-is-very-good-in-finland
10. UK Health Security Agency. Health Protection Report volume 18 issue 11. 2024
11. Namageyo-Funa A, Greene SA, Henderson E, Traore MA, Shaukat S, Bigouette JP, et al. Update on Vaccine-Derived Poliovirus Outbreaks - Worldwide, January 2023-June 2024. MMWR Morb Mortal Wkly Rep. 2024 Oct 17;73(41):909-16. Available at: https://www.ncbi.nlm.nih.gov/pubmed/39418214
12. Böttcher S, Kreibich J, Wilton T, Saliba V, Blomqvist S, Al-Hello H, et al. Detection of circulating vaccine-derived poliovirus type 2 (cVDPV2) in wastewater samples: a wake-up call, Finland, Germany, Poland, Spain, the United Kingdom, 2024. Eurosurveillance. 2025;30(3):2500037. Available at: https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2025.30.3.2500037
13. World Health Organization (WHO). Global Polio Eradication Initiative. Reporting and classification of vaccine-derived polioviruses. Geneva: WHO; 2015.
14. World Health Organization (WHO) Polio: Vaccine-Preventable Diseases Surveillance Standards. Geneva: WHO; 2018.
15. World Health Organization (WHO). Global Polio Eradication Initiative. Polio eradication strategy 2022-2026: delivering on a promise, extension to 2029. Geneva: WHO; 2024. 13.11.2024. Report No.:
16. Jafari HS. Poliomyelitis. In: Heymann DL, editor. Control of Communicable Diseases Manual (21st edition). DC: American Public Health Association; 2024.
17. Mehndiratta MM, Mehndiratta P, Pande R. Poliomyelitis: historical facts, epidemiology, and current challenges in eradication. Neurohospitalist. 2014 Oct;4(4):223-9. Available at: https://www.ncbi.nlm.nih.gov/pubmed/25360208
18. World Health Organization (WHO). Polio vaccines: WHO position paper – June 2022. Weekly Epidemiological Record. 2022 24.06.2022;97(25):277-300. Available at: https://iris.who.int/bitstream/handle/10665/357167/WER9725-eng-fre.pdf?sequence=1
19. European Centre for Disease Prevention and Control (ECDC). Disease factsheet about poliomyelitis. Stockholm: ECDC; 2023. Available at: https://www.ecdc.europa.eu/en/poliomyelitis/facts
20. World Health Organization (WHO) Immunization dashboard - Global Reported cases of vaccine-preventable diseases. Geneva: WHO; 2025. Available at: https://immunizationdata.who.int/
21. World Health Organization (WHO). Poliomyelitis vaccination coverage. Geneva: WHO; 2025.
22. Ministerio de Sanidad. Statistical Portal - Sistema de Información de Vacunaciones del Ministerio de Sanidad. Madrid: Ministerio de Sanidad (Spain); 2025. Available at: https://pestadistico.inteligenciadegestion.sanidad.gob.es/publicoSNS/S/sivamin

23. Robert Koch-Institut. Epidemiologisches Bulletin 50 | 2024. Berlin: Robert Koch Institut, 2024 17.12.2024. Report No.: 50
24. European Centre for Disease Prevention (ECDC). Poliomyelitis situation update. Stockholm: ECDC 2023
25. European Centre for Disease Prevention and Control (ECDC). Operational guidance on rapid risk assessment methodology. Stockholm: ECDC 2019
26. Polio Global Eradication Initiative Standard operating procedures: responding to a poliovirus event or outbreak, version 4.1. Geneva: 2022
27. Global Polio Eradication Initiative. Field guidance for the implementation of environmental surveillance for poliovirus. Geneva:World Health Organization 2023
28. Global Polio Eradication Initiative. Standard Operating Procedures for Polio Environmental Surveillance Enhancement Following Investigation of a Poliovirus Event or Outbreak. Geneva: World Health Organization, 2020.
29. Whitehouse ER, Gerloff N, English R, Reckling SK, Alazawi MA, Fuschino M, et al. Wastewater Surveillance for Poliovirus in Selected Jurisdictions, United States, 2022-2023. Emerg Infect Dis. 2024 Nov;30(11):2279-87. Available at: https://www.ncbi.nlm.nih.gov/pubmed/39447148
30. Polio IHR Emergency Committee. Statement of the fortieth meeting of the Polio IHR Emergency Committee. Geneva: World Health Organization; 2024.
31. Global Polio Eradication Initiative. Guidelines on environmental surveillance for detection of polioviruses - Working Draft. Geneva: World Health Organization2015
32. European Commission COMMISSION DECISION of 28/IV/2008 amending Decision 2002/253/EC laying down case definitions for reporting communicable diseases to the Community network under Decision No 2119/98/EC of the European Parliament and of the Council.
33. Global Polio Eradication Initiative. Surveillance Indicators. Geneva: World Health Organization; 2025. Available at: https://polioeradication.org/polio-today/surveillance-indicators/
34. Global Polio Eradication Initiative. Acute Flaccid Paralysis (AFP) Dashboard. Geneva: World Health Organization; 2025. Available at: https://app.powerbi.com/view?r=eyJrIjoiY2U3ODg2NjItMTlhNi00OGYzLTg1MjMtM2Y0YTAyZDBkNjc1IiwidCI6ImY2MTBjMGI3LWJkMjQtNGIzOS04MTBiLTNkYzI4MGFmYjU5MCIsImMiOjh9
35. Fischer TK, Johannesen CK, Benschop KSM, Berginc N, Saxentoff EV, Huseynov S, et al. Poliovirus circulation in the WHO European region, 2015-2022: a review of data from WHO's three core poliovirus surveillance systems. Lancet Reg Health Eur. 2024 Dec;47:101104. Available at: https://www.ncbi.nlm.nih.gov/pubmed/39498118
36. World Health Organization Regional Office for Europe (WHO Europe). Report of the thirty-eighth meeting of the European Regional Commission for Certification of Poliomyelitis Eradication: 5–6 September 2024. Copenhagen: WHO Europe; 2024.
37. World Health Organization (WHO). Polio laboratory manual. 4th ed. Geneva: WHO; 2004.
38. EU-WISH. EU-Wastewater Integrated Surveillance for Public Health (Joint Action EU-WISH). Luxembourg: EU-WISH; 2024. Available at: https://www.eu-wish.eu
39. Marine WM, Chin TD, Gravelle CR, Soergel ME. Effectiveness of Salk vaccine in reducing nonparalytic poliomyelitis in a large urban epidemic. N Engl J Med. 1961 May 4;264:903-7. Available at: https://www.ncbi.nlm.nih.gov/pubmed/13766783
40. World Health Organization (WHO). Meeting of the Strategic Advisory Group of Experts on Immunization, October 2022: conclusions and recommendations. Weekly Epidemiological Record. 2023;98(1) Available at: https://iris.who.int/bitstream/handle/10665/365498/WER9801-eng-fre.pdf?sequence=1
41. Vidor EJ, Modlin JF. Chapter 49 - Poliovirus Vaccine - Inactivated. In: Orenstein WA, Offit PA, Edwards KM, Plotkin SA, editors. Plotkin's Vaccines (Eighth Edition). Philadelphia, PA: Elsevier; 2023. p. Pages 890-913.e14.
42. Vaccine schedules in all countries in the EU/EEA. ECDC. 2025. Available at: https://vaccine-schedule.ecdc.europa.eu/
43. European Vaccination Information Portal. Polio. Stockholm: ECDC; 2022. Available at: https://vaccination-info.europa.eu/en/polio
44. UK Health Security Agency. Poliovirus detected in sewage from North and East London. London: Department of Health and Social Care (UK); 2022.
45. UK Health Security Agency. All children aged 1 to 9 in London to be offered a dose of polio vaccine. London: Department of Health and Social Care (UK); 2022. Available at: https://www.gov.uk/government/news/all-children-aged-1-to-9-in-london-to-be-offered-a-dose-of-polio-vaccine
46. NHS England. Children aged 5–9 in London able to get polio booster jab at dozens of sites across the capital. London: Department of Health and Social Care (UK); 2022. Available at:

https://www.england.nhs.uk/london/2022/09/22/children-aged-5-9-in-london-able-to-get-polio-booster-jab-at-dozens-of-sites-across-the-capital/

47. European Centre for Disease Prevention and Control (ECDC). Fighting polio | European Vaccination Information Portal. YouTube 2020.
48. Robert Koch Institut (RKI). Antworten auf häufig gestellte Fragen (FAQ) zu Poliomyelitis mit Schwerpunkt Abwasseruntersuchung. Berlin: RKI; 2024. Available at: https://www.rki.de/SharedDocs/FAQ/Polio/Polio-gesamt.html
49. Robert Koch Institut (RKI). Schutzimpfung gegen Poliomyelitis: Häufig gestellte Fragen und Antworten. Berlin: RKI; 2025. Available at: https://www.rki.de/SharedDocs/FAQ/Impfen/Poliomyelitis/FAQ-Liste_Poliomyelitis_Impfen.html
50. New York State Department of Health. New York State Department of Health and Rockland County Department of Health Alert the Public to A Case of Polio In the County. Albany, N.Y.: New York State; 2022. Available at: https://www.who.int/publications/m/item/vaccine-preventable-diseases-surveillance-standards-polio
51. European Centre for Disease Prevention and Control (ECDC). Facilitating COVID-19 vaccination acceptance and uptake in the EU/EEA. Stockholm: ECDC; 2021.
52. Ezezika O, Mengistu M, Opoku E, Farheen A, Chauhan A, Barrett K. What are the barriers and facilitators to polio vaccination and eradication programs? A systematic review. PLOS Glob Public Health. 2022;2(11):e0001283. Available at: https://www.ncbi.nlm.nih.gov/pubmed/36962654
53. The Vaccine Confidence Project. State of Vaccine Confidence in the European Union, 2022. Luxembourg: Publications Office of the European Union, 2022
54. UK Health Security Agency. Polio immunisation response in London 2022 to 2023: information for healthcare practitioners. London: Department of Health and Social Care (UK), 2023
55. Kasstan B, Mounier-Jack S, Zuriaga-Alvaro A, Weil LG, Chantler T. "We're potentially worsening health inequalities": Evaluating how delivery of the 2022 London polio booster campaign was tailored to Orthodox Jewish families to reduce transmission vulnerability. SSM Qual Res Health. 2023 Dec;4:100365. Available at: https://www.ncbi.nlm.nih.gov/pubmed/38169919
56. UK Health Security Agency. Information leaflet to support the polio booster campaign. In: UKHSA, editor. London: Department of Health and Social Care (UK); 2022.
57. NHS England. Paralympian Ade Adepitan throws support behind Polio Booster Campaign. London: Department for Health and Social Care (UK); 2022. Available at: https://www.england.nhs.uk/london/2022/11/24/paralympian-ade-adepitan-throws-support-behind-polio-booster-campaign/
58. Kasstan-Dabush B, Flores SA, Easton D, Bhatt A, Saliba V, Chantler T. Polio, public health memories and temporal dissonance of re-emerging infectious diseases in the global north. Soc Sci Med. 2024 Sep;357:117196. Available at: https://www.ncbi.nlm.nih.gov/pubmed/39180777
59. Impfen-Info. Polio-Impfung. Köln: Bundeszentrale für gesundheitliche Aufklärung (BZgA); 2024. Available at: https://www.impfen-info.de/polio/
60. Segalà AD. Salut busca 25.000 infants sense la vacuna de reforç contra la pòlio. Ara. 27 September 2024. Available at: https://www.ara.cat/societat/salut/polio-poliovirus-poliomielitis-salut-vacuna-vacunacio_1_5153616.html
61. AcToVax4NAM. Access to Vaccination for Newly Arrived Migrants (AcToVax4NAM) project page. 2024. Available at: https://www.accesstovaccination4nam.eu/
62. Population and Demography database. 2024. Available at: https://ec.europa.eu/eurostat/web/population-demography/demography-population-stock-balance/database

Annex 1. Surveillance

AFP surveillance, clinical enterovirus surveillance and environmental surveillance

According to the EU case definition a polio confirmed case is any person <15 years of age with AFP from whom poliovirus (either WPV, VDPV or Sabin-like) has been isolated or any person in whom polio is suspected by a physician and from whom poliovirus (either WPV, VDPV or Sabin-like) has been isolated [32].

AFP surveillance is considered the gold standard for detecting polio cases and essential for global polio eradication. It can work well in areas with limited resources and a high level of polio; however, since the poliovirus only causes clinical illness in approximately 1/100–1/1 000 people infected, AFP surveillance is a blunt surveillance tool because the virus may have been transmitting quite widely in a community before clinical cases are detected. AFP surveillance includes case finding, sample collection, laboratory analysis and mapping of the virus to determine the origin of the virus strain. To ensure sensitivity of surveillance, at least one case of non-polio AFP should be detected annually per 100 000 population aged below 15 years. In endemic regions, to ensure even higher sensitivity, this rate should be two per 100 000 [33]. AFP surveillance data are reported to the WHO on a weekly basis [34].

Polioviruses are part of the Enterovirus genus. Enteroviruses cause a wide range of illnesses, including respiratory and gastrointestinal symptoms and aseptic meningitis. Many clinical laboratories may only have the ability to identify enteroviruses as a 'generic' group and lack the ability to differentiate between types of enterovirus (polioviruses, echoviruses, Coxsackie viruses, etc.). The goal of enterovirus surveillance is to determine if any of the circulating enteroviruses are actually polioviruses. Clinical enterovirus surveillance can complement or replace AFP surveillance in polio-free countries, especially when the AFP surveillance cannot meet the criteria for minimum detection of AFP cases [35].

Environmental surveillance (detecting poliovirus in sewage water) may be a more sensitive tool to detect the transmission of poliovirus before clinical cases occur and when there may still be time to intervene to prevent disease. Environmental surveillance plays an increasingly important role for the Global Polio Eradication Initiative (GPEI) in its efforts to achieve and maintain a polio-free world. Through the examination of composite human faecal samples from untreated wastewater collection systems typically located downstream from high-risk populations, environmental surveillance provides valuable information on the presence or absence of poliovirus circulation in defined geographical areas. Though it cannot link poliovirus directly with infected individuals, it enhances the sensitivity of surveillance for AFP and can provide an early warning indicator on potentially multiple silent polio infections during an outbreak or in an endemic area. Therefore, to maintain poliovirus surveillance at the high sensitivity and specificity levels required to achieve and certify eradication, countries can rely on a combination of environmental and AFP surveillance.

The RCC advised countries on strengthening all types of surveillance including AFP surveillance, environmental surveillance and enterovirus surveillance [36].

Status of wastewater-based surveillance for poliovirus in the EU/EEA

ECDC conducted a survey among EU/EEA countries by email from 9–17 January 2025 to obtain the latest information on the status of their wastewater-based surveillance (WBS) programmes for poliovirus. The implementation landscape includes centralized national WBS programmes for poliovirus, long-term research projects, research projects in preparation of (renewed) implementation of national programmes or decisions not to engage in such a surveillance programme. Most countries (29/30; 97%) provided details and 16 (55%) replied they operate a WBS for poliovirus, established since median 13 years (range 1-61 years). Two of the 13 of countries not doing so indicated they are carrying out such surveillance in the form of research projects and seven countries are considering or planning implementation of a national programme or are performing research projects in preparation of (renewed) implementation of such a surveillance programme. The sampling frequency in implemented programmes ranged from weekly to 6-monthly sampling. A median of 8 sampling sites (range: 1-47) covering a median of 28% of the respective countries' population (range: 0.3 – 64%) are included (Table 2). Methods for detection and typing often follow the WHO guidance [31,37] but some countries perform direct detection before, or instead of, culture-based isolation in their laboratory algorithm. No data were provided for Hungary, but Hungary indicated to EU-WISH [38] that wastewater and environmental surveillance for poliovirus is being performed. EU-WISH is an ongoing project (Joint Action, funded by HERA) involving 26 European countries, aiming to facilitate and harmonise the use of WBS for a range of pathogen targets across Europe.

EU/EEA countries are encouraged to adapt their national programmes as required to ensure they are sensitive and robust systems, able to detect cryptic circulation of VDPVs in the EU/EEA. As part of country public health responses, several countries increased sampling frequencies, and one country added a new sampling site at the

border to an affected country of this outbreak. Gaps in WBS for poliovirus in countries, especially in those neighbouring countries reporting cVDPV2 detections in this outbreak, should be taken into consideration when assessing the potential spread in the EU/EEA.

Table 2. Details of the environmental surveillance programmes for poliovirus in EU/EEA countries as obtained through a survey conducted by ECDC, 9–17 January 2025

Country	Operating wastewater-based surveillance for poliovirus	Planned changes	Operated since	Routine sampling frequency	# sampling sites	Approx. population coverage
Austria	No	NA	NA	NA	NA	NA
Belgium	Yes	NA	2024	Monthly	6	17%
Bulgaria	No	NA	NA	NA	NA	NA
Croatia	Yes	NA	1995	Monthly	1	10%
Republic of Cyprus	No	Implementation is being considered	NA	NA	NA	NA
Czechia	Yes	Increase # sampling sites	1962	Monthly	20	50%
Denmark	No	Pilot study for implementation considered	NA	NA	NA	NA
Estonia	Yes		1963	Monthly	5	49%
Finland	Yes	NA	1960s	Fortnightly (capital) and monthly (elsewhere)	5	30%
France	No	Research project ongoing to consider renewed implementation	1973 - 2018	NA	NA	NA
Germany	No, only research project	NA	Current research project started in 2023 (10/2023-9/2026)	Weekly and monthly	10	7%
Greece	Yes	NA	2012, inclusion of urban sites since 2024	Variable	18 (5 urban sites, 13 refugee camps)	41%
Hungary	NA	NA	NA	NA	NA	NA
Ireland	Yes, for PV2	NA	2023	Fortnightly (2 pooled weekly samples)	1	25%
Italy	Yes	NA	2005	Biweekly	31	10%
Latvia	Yes	NA	ca 1995	Monthly	8	37%
Lithuania	Yes	NA	2024	Weekly	4	46%
Luxembourg	No	Renewed implementation planned in short-term	Earlier during 2017	NA	NA	NA
Malta	Yes	Implementation planned in short-term	2022	6-monthly	1	NA
Netherlands	Yes	NA	2021	6-weekly	15 community	ca 0.3%

Country	Operating wastewater-based surveillance for poliovirus	Planned changes	Operated since	Routine sampling frequency	# sampling sites	Approx. population coverage
					and 5 PEF sites	
Poland	Yes	NA	2021	Fortnightly	8	12%
Portugal	No	Research project ongoing to consider implementation	NA	NA	NA	NA
Romania	Yes	NA	2013	Weekly (capital), fortnightly (elsewhere)	13	20%
Slovakia	Yes	NA	1970	Bimonthly	47	64%
Slovenia	Yes	NA	2024	Quarterly	16	32%
Spain	No, only research project	NA	1981 (Barcelona) and 1999 (Madrid)	Bimonthly (Barcelona), ad hoc (Madrid)	16-60 (Madrid) and 2 (Barcelona)	ca 13%
Sweden	No	Implementation is being considered	NA	NA	NA	NA
Iceland	No	NA	NA	NA	NA	NA
Liechtenstein	No	Possibility to include in multi-pathogen WBS approach on short-term.	NA	NA	NA	NA
Norway	No	NA	NA	NA	NA	NA

NA: not applicable; #: number of; Approx.; approximately.

Annex 2. Vaccination

Poliovirus vaccination

There are two types of polio vaccine: oral live attenuated vaccines (oral polio vaccine; OPV) and inactivated vaccine (IPV), which are usually administered alongside other antigens as part of combined vaccines. Since the global 'switch' in 2016 to replace the trivalent OPV (tOPV) with bivalent OPV (bOPV) containing only poliovirus types 1 and 3, vaccination with bOPV does not protect against paralytic disease caused by poliovirus type 2. While OPV is more effective in inducing intestinal antibody production and hence more effective in interrupting virus transmission, IPV has the advantage of having no risk of causing vaccine associated paralytic poliomyelitis (VAPP) or the development of virulent vaccine-derived polio viruses (VDPV). IPV induces limited intestinal mucosal immunity in previously unvaccinated individuals, however, IPV can reduce the quantity and duration of virus shedding in faeces when provided to individuals already exposed to WPV or OPV, which may contribute to a reduction in transmission [18]. It has been suggested that IPV may have a greater impact on oropharyngeal shedding [18] and that IPV has a bigger impact on stopping transmission in areas with better sanitation [39] although there is limited evidence to support this [40].

VDPV are genetically mutated OPV strains that have lost key attenuating mutations. On rare occasions, and only in under-immunised populations, VDPV develop through a series of mutations and acquisition of genetic materials from other enteroviruses, a process that is estimated to take on average at least one year. The critical risk factor for VDPV development is the duration for which the vaccine virus circulates in a population. Average circulation time for OPV virus increases with lower vaccination coverage in the population, hence increasing the risk that VDPV strains will emerge. Circulating VDPV (cVDPV) are strains that have taken on the neurovirulence and transmissibility of WPV and are associated with person-to-person transmission. Polio disease caused by cVDPV presents with the same symptoms as polio caused by WPV and the same rate of infections leading to paralytic polio. A fully immunised population is protected against both vaccine-derived and wild polioviruses. cVDPV outbreaks have the ability to cause endemic polio disease, can be spread in any under-vaccinated community, and can be imported to other countries. Some of the factors favouring cVDPV emergence and spread are the same as for WPV circulation: low polio vaccine coverage rates or poorly conducted supplementary immunisation activities in areas where OPV use continues. Outbreaks occur when the density of non-immune people rises to the point where the chains of cVDPV transmission can propagate. The size of a cVDPV outbreak is a function of the size of the non-immune population and the potential for the outbreak virus to transport to susceptible communities elsewhere. Countries that were (or are) major reservoirs for WPV circulation, and where the potential for person-to-person poliovirus transmission is greatest, are at particularly high risk of cVDPV emergence, and maintenance of high rates of polio vaccine coverage in these settings is essential.

Polio routine vaccination program

All countries in the EU/EEA have a childhood vaccination programme with a primary series of polio IPV vaccination aimed to be completed within the first year of life and at least one booster dose given most often around school entry age. The polio primary series in EU/EEA countries consists of three or four doses (the fourth dose may be part of the primary series if the first dose is administered around 6 weeks of age). Other vaccine antigens are included in the vaccines used for the primary series in EU, and the timing of the doses relates also to aspects such as immunity response related to them (diphtheria, tetanus, acellular pertussis, hepatitis B, *haemophilus influenzae* type b). At completion of a two-dose immunization series, seroprotection rates have been reported to range from 89% to 100% for poliovirus type 1, from 92% to 100% for poliovirus type 2, and from 70% to 100% for poliovirus type 3 [41]. The administration of the booster dose has been shown to provide an important boost to antibody titers.

A few EU/EEA countries recommend polio booster vaccination with an IPV containing vaccine at adolescence and adulthood. The frequency of booster dose administration varies across EU/EEA countries and some countries recommend regular boosting with IPV containing vaccines every 10 years in adulthood. Information from high-income countries on the duration of IPV-induced protection indicates that circulating antibody persists for decades and possibly for life[18].

Recommendations of individual countries can be reviewed in the ECDC Vaccine Scheduler [42].

Travel vaccination

Specific temporary recommendations that apply for travellers to and from endemic areas are detailed and regularly reviewed by WHO's Polio IHR Emergency Committee and are endorsed by ECDC. These recommendations vary according to the state of infection, the evidence of local transmission and the potential for international spread and are regularly revised. Review of the vaccination status of the traveller, including polio, before international travel and completion of missing doses as needed is important.

Risk communication activities

Depending on the national situation and outcomes of poliovirus wastewater surveillance, communication activities from the health authorities should provide information about the relevance of detecting poliovirus in wastewater, actions implemented and vaccine recommendations.

Key messages for the public should highlight the importance of ensuring timely vaccination with all recommended doses as per national schedule, given the potential risks for those unvaccinated or not fully vaccinated. Calls to action should include information on vaccination opportunities, e.g. how and where to catch up with missed vaccinations. It is also important to remind the public that high vaccination coverage is needed to avoid reintroduction of polio and to advance towards global polio eradication efforts. Further, communication activities can raise awareness about a disease that may not be in people's mind anymore.

- The European Vaccination Information Portal (EVIP) provides a factsheet on polio in all EU/EEA languages [43].
- Examples of communication activities implemented in countries where poliovirus was detected in wastewater, informing about the findings and vaccine recommendations include: A press release from the Finnish public health authorities [9]; information from London's public health authorities in 2022 [44-46].

Reassurances around the safety and effectiveness of polio vaccination, in place for many decades across the world, should be provided. The achievement through vaccination programmes of almost eradicating a debilitating and potentially deadly disease can be highlighted.

- A video is available in the EVIP highlighting the success of polio vaccination [47]

FAQs can address questions and concerns the public may have in relation to the findings, given the complexities of the topic, e.g. why OPV vaccine-derived polioviruses can occur, how the disease spreads, and around the vaccines (two types of vaccines, which type is used in the EU/EEA countries (IPV) and why the OPV vaccine is still being used in other regions).

- The German federal public health institute (RKI) published FAQs that help to explain what the findings mean [48] and on polio vaccination [49].

As the potential detection of sporadic cases of polio in the future cannot be ruled out, communication activities in relation to such event could be foreseen.

- An example of a press release on such situation comes from New York State's (U.S.) health authorities, when the first case of paralytic polio since many years was identified in July 2022, in an unvaccinated adult [50].

Strategies to increase vaccine acceptance and uptake

To achieve high coverage for poliovirus vaccination, strategies to promote acceptance and uptake should consider the following activities:

Explore the factors that lead to sub-optimal coverage: In particular, gain insights into why children in some areas/regions are not being vaccinated or have delays in the completion of the national schedule, including polio vaccination. Underlying factors can vary across place, time and population groups (e.g. underserved communities, faith-based communities, migrants and refugees, etc.).

- Factors could include, as per the 5Cs model [51] specific or a combination of issues related to **confidence** in childhood vaccines and in the recommendations from public health authorities, **constraints** in accessing vaccination services, **complacency** (e.g. in relation to the risk of contracting polio and low risk perception around a disease considered very rare and that does not occur anymore in most countries), **calculation** in relation to the benefit/risk balance of vaccination, and **collective responsibility**, e.g. in relation to prevent disease spread by getting vaccinated.
- A systematic review of international studies (most done in Asian and African countries) on potential barriers and facilitators to polio vaccination identified a wide range of factors among different groups of people or countries. This highlights the relevance of contexts in the efforts to increase vaccine coverage [52]. Seven recurrent themes were identified: fear (e.g. of the vaccine, as barrier, and of the disease as facilitator), levels of community trust in government/health authorities, infrastructure to support immunisation, beliefs about the intervention (related to cultural and religious conceptions as well as knowledge of the vaccine and its effectiveness), influential opinions (from health professionals or religious leaders), intervention design, and geo-politics (issues related to governance, security).

Monitoring levels of vaccine confidence can help to detect changes and trends that can impact uptake of vaccines in the childhood vaccination programmes. Biennial surveys done since 2018 to monitor vaccine confidence in the EU signalled that confidence in vaccines remains high overall, but with variations between countries and with steep decline in some. Confidence levels in younger generations in the EU (people 18-34 years old) are lower when compared to the older generations, and the gap appears to be widening in most countries [53]. This is concerning,

as the younger generations will be, or are already, parents that will take decisions around their children's vaccination.

Community engagement: Implement outreach activities and engage with community organisations for initiatives to promote uptake in under-vaccinated groups, taking into account cultural and social characteristics, and via trusted sources of information.

- In the context of the detection of polio in wastewater in London in 2022, health authorities implemented a polio booster campaign, with tailored interventions in traditionally under-vaccinated population groups, including faith-based communities [54,55]. Activities included notifications to eligible parents, culturally adapted messages and materials developed with stakeholders from already established health partnerships, providing vaccination in sites the community is familiar with, such as child centres, and more time flexibility. Disease and vaccine literacy materials were provided in various languages[56]. Celebrity endorsement was done with a Paralympian athlete who experienced first-hand the consequences of polio, speaking about the disease and importance of vaccination [57].

Assess what **type of messages will resonate with population groups in the public health advice promoting vaccine uptake:** A recent study cautions on the dissonance that focusing on narratives with memories of past polio outbreaks for encouraging vaccine uptake can cause in populations now vulnerable for disease transmission [58]. Based on ethnographic research following the public health response in London and New York, researchers found that other concerns of the communities and recent experiences with vaccination and public health advice, notably during the COVID-19 pandemic, influenced their trust in and engagement with recommendations. Hence the importance of working with communities to develop effective messages.

Facilitate access to services and vaccination opportunities: All contact with healthcare services can be an opportunity to check vaccination status and remind parents on the importance of following the vaccination schedule. Support to healthcare providers, recognised as trusted sources of information for parents and caregivers, can include awareness raising initiatives, information materials and trainings to address information needs and potential concerns during vaccination conversations. Examples of such activities include: Comprehensive information for healthcare practitioners on polio immunisation activities by London's health authorities [54] ; FAQs from Germany's Federal Centre for Health Education for various audiences that multiplicators can embed in their websites [59]; a text message campaign in Barcelona to reach families whose children had missed the polio booster [60].

In the efforts to address any immunisation gaps in children and individuals of all ages that enter the EU/EEA (refugees, migrants) and who may not have a complete immunisation, **potential barriers to uptake need to be assessed**. The EU-funded AcToVax4NAM project focuses on increasing access to vaccinations (in general) in newly arrived migrants (NAMs) in the EU/EEA. It provides a conceptual framework to characterise and analyse system barriers that can hinder NAMs' immunisation and identifies possible solutions, with information sheets on specific factors for eight EU/EEA countries participating in the project [61].

Annex 3. POL3 vaccination gap estimates for the 2014–2023 period

Table 3. Cumulated 12-23 months old cohort and corresponding cumulated number of individuals not having received three doses of poliovirus containing vaccines in the EU/EEA, period 2014-2023

Country	Cumulated 12-23 months old cohort in the 2014 to 2023 period	Estimation of the 12- 23 months old cohort in the 2014- 2023 period not having received three doses of poliovirus containing vaccine by date of ascertainment	Percentage of individuals calculated as not having received three doses among the specific birth cohorts in the 2014 - 2023 period
Austria	853,444	106,865	12.52%
Belgium	1,240,480	22,213	1.79%
Bulgaria	610,968	54,531	8.93%
Croatia	372,917	24,886	6.67%
Cyprus	94,868	3,894	4.11%
Czechia	1,116,498	48,101	4.31%
Denmark	605,570	22,854	3.77%
Estonia	141,549	12,320	8.70%
Finland	541,869	42,947	7.93%
France	7,537,701	277,459	3.68%
Germany	7,599,535	663,567	8.73%
Greece	932,016	9,320	1.00%
Hungary	921,083	9,210	1.00%
Iceland	43,851	3,731	8.51%
Ireland	637,754	36,015	5.65%
Italy	4,773,499	263,835	5.53%
Latvia	202,923	7,341	3.62%
Lithuania	282,708	22,688	8.03%
Luxembourg	65,662	656	1.00%
Malta	44,509	931	2.09%
Netherlands	1,738,087	102,360	5.89%
Norway	590,477	23,806	4.03%
Poland	3,796,289	447,280	11.78%
Portugal	871,479	12,227	1.40%
Romania	1,951,065	266,607	13.66%
Slovakia	582,847	20,323	3.49%
Slovenia	206,662	15,272	7.39%
Spain	4,106,954	178,975	4.36%
Sweden	1,185,240	37,801	3.19%

N.B: *Liechtenstein was not included in this analysis as no national data for the POL3 WUENIC vaccine estimates were available.*
Source: *WUENIC POL3 estimates in WHO Immunization Data portal and EUROSTAT population data [21,62]. Data for Germany refer to children in school entrance examinations, 4–7 years old, collected in 2020. Data for Spain for the years 2021/22/23 was extracted from Interactive NHS Consultation [22].*

In Table 4, an expanded table with the 2014-2023 series for the 12–23 months old cohort vaccination gap estimate for the EU/EEA is available. Variable definitions and data sources are:

- **Country cohort population:** Total number of two-year-old infants (12–23 months) per corresponding country and year. Source: Eurostat, Population on 1 January by age and sex [DEMO_PJAN] last update: 04/11/2024) 23:00[62]
- **POL3 coverage:** Vaccine coverage of three doses of poliovirus containing vaccine in specific country and year. **Source:** WUENIC POL3 estimates in WHO Immunization Data portal [21].
- **Individuals as not having received three doses among the specific birth cohorts in the 2014 to 2023 period:** Estimated susceptible population to poliovirus defined as not having received a completed course of three doses of poliovirus containing vaccine by the time of assessment among the two-year-old birth cohort (12-23 months) applying the methodological calculations detailed above.

Methodology:
For the purpose of estimating the number of individuals susceptible to poliovirus, defined as not having received a complete course of 3 doses of IPV containing vaccine by the time of assessment, the following equation has been used: Immunity gap among cohort population = country cohort population (month 12 – month 23) under analysis in specific year "Y" x POL3 coverage in specific year "Y"/100 - country cohort population under analysis in specific year "Y".

Table 4. Vaccination coverage and population used for the calculation of POL3 gaps among 12–23 months old children for the period between 2014–2023

Country	Variable	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Austria	Population	80,215	81,485	82,654	85,379	86,505	89,401	88,978	87,087	85,852	85,888	853,444
	POL3 (%)	98	93	87	90	85	85	85	85	84	84	
	Gap	1604.3	5703.95	10745.02	8537.9	12975.75	13410.15	13346.7	13063.05	13736.32	13742.08	106,865
Belgium	Population	130,248	129,363	127,278	127,120	124,212	123,554	121,595	120,271	119,365	117,474	1,240,480
	POL3 (%)	99	99	98	98	98	98	98	98	98	98	
	Gap	1302.48	1293.63	2545.56	2542.4	2484.24	2471.08	2431.9	2405.42	2387.3	2349.48	22,213
Bulgaria	Population	67,428	63,861	61,477	63,274	61,455	60,591	60,019	58,405	57,145	57,313	610,968
	POL3 (%)	88	91	92	92	92	93	91	89	91	92	
	Gap	8091.36	5747.49	4918.16	5061.92	4916.4	4241.37	5401.71	6424.55	5143.05	4585.04	54,531
Croatia	Population	40,685	41,235	39,106	38,390	36,401	36,302	35,395	35,615	34,953	34,835	372,917
	POL3 (%)	95	94	93	92	94	94	94	92	92	93	
	Gap	2034.25	2474.1	2737.42	3071.2	2184.06	2178.12	2123.7	2849.2	2796.24	2438.45	24,887
Cyprus	Population	9,576	9,985	9,280	9,257	9,168	9,452	9,379	9,329	9,522	9,920	94,868
	POL3 (%)	98	96	96	97	97	95	95	95	95	95	
	Gap	191.52	399.4	371.2	277.71	275.04	472.6	468.95	466.45	476.1	496	3,895
Czechia	Population	109,287	109,591	108,700	111,538	112,137	113,801	115,264	113,057	110,900	112,223	1,116,498
	POL3 (%)	99	97	96	94	96	97	96	94	94	94	
	Gap	1092.87	3287.73	4348	6692.28	4485.48	3414.03	4610.56	6783.42	6654	6733.38	48,102
Denmark	Population	60,046	59,134	57,484	58,520	59,523	62,675	62,148	61,967	61,864	62,209	605,570
	POL3 (%)	94	93	94	98	97	97	97	97	98	97	
	Gap	3602.76	4139.38	3449.04	1170.4	1785.69	1880.25	1864.44	1859.01	1237.28	1866.27	22,855
Estonia	Population	14,657	14,149	13,879	13,833	14,202	14,241	13,903	14,545	14,255	13,885	141,549
	POL3 (%)	93	93	93	93	92	91	91	89	89	89	
	Gap	1025.99	990.43	971.53	968.31	1136.16	1281.69	1251.27	1599.95	1568.05	1527.35	12,321

Country	Variable	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Finland	Population	60,741	60,419	59,050	58,331	56,167	53,817	51,271	48,387	46,400	47,286	541,869
	POL3 (%)	98	97	92	89	91	91	90	89	91	91	
	Gap	1214.82	1812.57	4724	6416.41	5055.03	4843.53	5127.1	5322.57	4176	4255.74	42,948
France	Population	803,353	798,153	784,803	781,440	763,306	746,095	729,698	719,454	714,438	696,961	7,537,701
	POL3 (%)	98	97	96	96	96	96	96	96	96	96	
	Gap	16067.06	23944.59	31392.12	31257.6	30532.24	29843.8	29187.92	28778.16	28577.52	27878.44	277,459
Germany	Population	672,324	694,369	715,608	753,217	770,628	802,651	802,415	798,366	789,145	800,812	7,599,535
	POL3 (%)	93	92	91	91	91	91	91	91	91	91	
	Gap	47062.68	55549.52	64404.72	67789.53	69356.52	72238.59	72217.35	71852.94	71023.05	72073.08	663,568
Greece	Population	105,719	99,577	93,427	93,147	94,663	96,953	92,782	90,101	83,768	81,879	932,016
	POL3 (%)	99	99	99	99	99	99	99	99	99	99	
	Gap	1057.19	995.77	934.27	931.47	946.63	969.53	927.82	901.01	837.68	818.79	9,320
Hungary	Population	87,556	90,491	89,503	92,867	91,764	94,929	94,001	92,708	92,603	94,661	921,083
	POL3 (%)	99	99	99	99	99	99	99	99	99	99	
	Gap	875.56	904.91	895.03	928.67	917.64	949.29	940.01	927.08	926.03	946.61	9,211
Iceland	Population	4,509	4,574	4,349	4,373	4,218	4,157	4,156	4,327	4,560	4,628	43,851
	POL3 (%)	90	92	91	89	91	93	93	92	92	92	
	Gap	450.9	365.92	391.41	481.03	379.62	290.99	290.92	346.16	364.8	370.24	3,732
Ireland	Population	71,127	67,994	66,327	64,664	63,438	64,642	62,709	60,591	58,626	57,636	637,754
	POL3 (%)	96	95	95	95	94	94	94	94	93	93	
	Gap	2845.08	3399.7	3316.35	3233.2	3806.28	3878.52	3762.54	3635.46	4103.82	4034.52	36,015
Italy	Population	540,449	532,895	510,117	499,100	482,810	470,813	457,314	443,571	425,183	411,247	4,773,499
	POL3 (%)	95	93	93	95	95	96	94	94	95	95	
	Gap	27022.45	37302.65	35708.19	24955	24140.5	18832.52	27438.84	26614.26	21259.15	20562.35	263,836
Latvia	Population	18,819	20,066	20,888	22,035	22,161	22,083	20,876	19,353	18,782	17,860	202,923

Country	Variable	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
	POL3 (%)	92	94	98	98	96	99	99	94	95	98	
	Gap	1505.52	1203.96	417.76	440.7	886.44	220.83	208.76	1161.18	939.1	357.2	7,341
Lithuania	Population	30,105	29,915	28,686	29,153	29,834	29,530	28,041	26,826	25,447	25,171	282,708
	POL3 (%)	93	93	94	94	92	92	91	90	90	90	
	Gap	2107.35	2094.05	1721.16	1749.18	2386.72	2362.4	2523.69	2682.6	2544.7	2517.1	22,689
Luxembourg	Population	6,296	6,347	6,558	6,574	6,495	6,489	6,645	6,705	6,724	6,829	65,662
	POL3 (%)	99	99	99	99	99	99	99	99	99	99	
	Gap	62.96	63.47	65.58	65.74	64.95	64.89	66.45	67.05	67.24	68.29	657
Malta	Population	4,320	4,322	4,243	4,346	4,570	4,676	4,555	4,672	4,288	4,517	44,509
	POL3 (%)	99	97	97	98	97	98	98	99	98	98	
	Gap	43.2	129.66	127.29	86.92	137.1	93.52	91.1	46.72	85.76	90.34	932
Netherlands	Population	180,172	176,388	172,395	176,866	172,815	174,256	171,951	170,474	171,226	171,544	1,738,087
	POL3 (%)	96	95	95	94	93	94	94	95	93	92	
	Gap	7206.88	8819.4	8619.75	10611.96	12097.05	10455.36	10317.06	8523.7	11985.82	13723.52	102,361
Norway	Population	62,184	62,083	60,458	60,572	60,482	60,347	57,881	56,142	55,550	54,778	590,477
	POL3 (%)	93	95	96	96	96	97	97	97	97	96	
	Gap	4352.88	3104.15	2418.32	2422.88	2419.28	1810.41	1736.43	1684.26	1666.5	2191.12	23,806
Poland	Population	388,716	388,715	369,496	375,502	372,037	385,622	405,022	387,491	372,308	351,380	3,796,289
	POL3 (%)	94	92	92	90	87	87	86	84	85	85	
	Gap	23322.96	31097.2	29559.68	37550.2	48364.81	50130.86	56703.08	61998.56	55846.2	52707	447,281
Portugal	Population	96,676	89,634	82,751	82,256	85,488	87,186	86,502	87,411	87,399	86,176	871,479
	POL3 (%)	98	98	98	98	99	99	99	99	99	99	
	Gap	1933.52	1792.68	1655.02	1645.12	854.88	871.86	865.02	874.11	873.99	861.76	12,228
Romania	Population	184,057	180,820	187,544	198,295	199,918	201,740	202,185	206,869	197,312	192,325	1,951,065
	POL3 (%)	94	89	89	82	86	88	87	86	85	78	

Country	Variable	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
	Gap	11043.42	19890.2	20629.84	35693.1	27988.52	24208.8	26284.05	28961.66	29596.8	42311.5	266,608
Slovakia	Population	61,242	56,576	55,942	56,394	57,279	59,358	59,802	59,523	59,066	57,665	582,847
	POL3 (%)	97	96	96	96	96	97	97	97	97	96	
	Gap	1837.26	2263.04	2237.68	2255.76	2291.16	1780.74	1794.06	1785.69	1771.98	2306.6	20,324
Slovenia	Population	22,178	22,109	21,222	21,209	20,614	20,461	20,410	19,847	19,582	19,030	206,662
	POL3 (%)	95	95	94	94	93	95	95	86	89	89	
	Gap	1108.9	1105.45	1273.32	1272.54	1442.98	1023.05	1020.5	2778.58	2154.02	2093.3	15,273
Spain	Population	471,029	451,086	425,175	429,017	425,295	418,510	402,245	376,033	360,498	348,066	4,106,954
	POL3 (%)	97	97	97	95	96	95	94	93.39	95.24	96.26	
	Gap	14130.87	13532.58	12755.25	21450.85	17011.8	20925.5	24134.7	24855.781	17159.705	13017.668	178,975
Sweden	Population	114,560	116,389	117,126	120,165	120,381	123,525	120,030	119,425	117,612	116,027	1,185,240
	POL3 (%)	97	98	98	97	97	98	97	98	94	94	
	Gap	3436.8	2327.78	2342.52	3604.95	3611.43	2470.5	3600.9	2388.5	7056.72	6961.62	37,802
Total gap per year		187633.8	235735.4	255675.2	283164.9	284934.4	277614.78	300737.53	311637.1	297014.9	303884.8	2738032.8

Source: EUROSTAT and WHO-WUENIC.
N.B: Liechtenstein was not included in this analysis as no national data for the third dose of polio containing vaccine WUENIC vaccine estimates were available. Data for Germany refer to children in school entrance examinations, 4-7 years old, collected in 2020. Data for Spain for the years 2021/22/23 were extracted from Interactive NHS Consultation [22].