Seventy Years of Immunization in Morocco (1956–2026): Impact and Challenges of the National Immunization Programme — A Narrative Review

Aida Soulaymani[1,2*], Fatima Aslaou[1,2], Soumaia Hmimou[2], Ayoub El Assali[2], Faiçal El Hattimy[3]

[1]Higher Institute of Nursing Professions and Health Techniques (ISPITS), Department of Public Health, Rabat, Morocco

[2]Ibn Tofail University, Kenitra, Morocco

[3]National School of Public Health, Rabat, Morocco

***Corresponding Author**

DOI: https://doi.org/10.51584/IJRIAS.2026.11090104

Received: 28 September 2026; Accepted: 03 October 2026; Published: 16 October 2026

ABSTRACT

Introduction. Since independence in 1956, Morocco has built a National Immunization Programme (NIP) integrated into primary health care. This review traces its evolution, appraises its performance in terms of coverage and data quality, and assesses its impact on the incidence, mortality and case fatality of vaccine-preventable diseases.

Methods. We conducted a structured narrative review (1956–September 2026), guided by the SANRA criteria, of open-access sources (PubMed/PubMed Central, WHO/EMRO, UNICEF) and documents of the Ministry of Health and Social Protection. Fifty-six sources were retained, 34 of which provided Moroccan or institutional data; Moroccan findings were compared with those of Tunisia, Algeria, Egypt and Jordan. Pre/post relative reductions were recalculated when indicators were comparable, and the strength of evidence was graded by indicator type.

Results. The Expanded Programme on Immunization (1981), restructured as the NIP in 1987, was followed by documented declines: under-five mortality from vaccine-preventable diseases −88% (1987–1996); minimum incidence of *Haemophilus influenzae* meningitis −93% after 2007; invasive pneumococcal disease in children aged ≤2 years −60.9% and under-five respiratory mortality −28% after pneumococcal vaccine introduction; rotavirus positivity among hospitalized gastroenteritis cases −41.5%. Neonatal tetanus was eliminated (2002) and wild poliovirus transmission has been interrupted since the late 1980s. However, estimated coverage (99%) has been extrapolated since 2020 without empirical data, measles re-emerged in late 2023 (>25,000 suspected cases, 184 deaths), measles catch-up rates ranged from 16% to 79% across regions, and diphtheria reappeared in 2026 among unvaccinated or incompletely vaccinated children. Half of measles cases were unvaccinated, parental hesitancy towards HPV vaccination reached 84.8% in a 2025 multiregional survey, and no Moroccan impact evaluation was found for hepatitis B, BCG, rubella or HPV vaccines.

Conclusion. The NIP had a major impact on incidence and mortality, but reductions in case fatality remain insufficiently documented and actual coverage should be revalidated by survey. An individual-level information system linking vaccination, cases and deaths, together with subnational monitoring of zero-dose children, is a priority. Regional experience, including verified measles elimination in Egypt and survey-based coverage validation in Jordan, provides useful benchmarks, and restoring vaccine confidence requires trained health professionals and community engagement.

Keywords: National Immunization Programme; vaccination coverage; vaccine impact; measles; Morocco.

INTRODUCTION

Vaccination is one of the public health interventions that has most profoundly changed child morbidity and mortality. In Morocco, its history predates independence, with the introduction of smallpox vaccination in 1929 and BCG in 1949. After 1956, vaccines against diphtheria, tetanus and pertussis were introduced in 1963; poliomyelitis campaigns were conducted between 1964 and 1967, followed by mass and fixed-site vaccination activities from 1967 onwards (Lamdouar Bouazzaoui, 2006).

The Expanded Programme on Immunization (EPI) was adopted in 1981 and restructured as the National Immunization Programme (NIP) in 1987. This reorganization combined routine vaccination, fixed and mobile strategies, National Immunization Days and the strengthening of tetanus vaccination for women of childbearing age (Lamdouar Bouazzaoui, 2006; Ministère de la Santé du Maroc, n.d.).

A historical assessment of the NIP should not, however, be limited to vaccination coverage. An effective programme must produce a measurable decline in the incidence of target diseases, in their mortality and, where demonstrable, in their case fatality. These three indicators are distinct: incidence measures the occurrence of cases in the population, mortality relates deaths to the population, and case fatality is the proportion of deaths among cases. This distinction is essential when vaccine impact is assessed from surveillance data or hospital-based studies.

The aim of this review is to analyse the evolution of the Moroccan immunization system from 1956 to 2026, to appraise its performance in terms of coverage and data quality, to document its epidemiological impact through pre/post comparisons where available, and to identify the current limits of evaluation, particularly regarding case fatality and the territorial heterogeneity of coverage.

METHODS

Type of review and period

A structured narrative review was conducted for the period from 1956 to 28 September 2026. The starting point corresponds to Morocco's independence, and the end point includes epidemiological events available up to the time of writing. Reporting followed the six criteria of the SANRA scale for narrative reviews (Baethge et al., 2019).

Information sources and selection

The literature search, closed on 28 September 2026, prioritized open-access full-text articles (PubMed/PubMed Central, BMC/Springer Nature, WHO/EMRO and open-access journals), supplemented by institutional documents from the Ministry of Health and Social Protection, WHO and UNICEF. Searches were conducted in French and English, combining the terms Morocco, vaccination, immunization, incidence, mortality, case fatality, measles, diphtheria, neonatal tetanus, poliomyelitis, Hib, pneumococcal disease, rotavirus, hepatitis B, HPV, vaccine coverage, catch-up and vaccine hesitancy. The search was updated on 3 October 2026 and extended to regional comparators (Tunisia, Algeria, Egypt and Jordan), to peer-reviewed and grey literature on hepatitis B, BCG, rubella and HPV, to the 2023–2025 measles outbreak, to vaccine confidence and to the methodological literature on vaccine impact assessment. The platforms queried, search strings, dates, inclusion and exclusion criteria and selection steps are documented in Supplementary File S2.

Documents providing Moroccan data on schedule changes, coverage, surveillance, incidence, mortality, case fatality, equity or acceptability were included. Documents without Moroccan data (used only for context or international comparison), duplicates and sources that did not allow the origin of the figures to be identified were excluded. Screening was performed on titles and abstracts, then on full texts. Because of the substantial overlap of results across queries and platforms, raw counts were not summed, to avoid PRISMA-type pseudo-precision in a narrative review. Instead, the identification and selection process is described narratively in Supplementary File S2, together with the composition of the final corpus by source type. The final corpus comprises 56 sources, including 34 providing Moroccan or institutional data and 22 methodological, regional or comparative

references; the 34 Moroccan or institutional sources are described in Supplementary Table S1 (source type, period, indicators and level of evidence). Given the heterogeneity of designs and indicators, no meta-analysis was performed.

Coverage data were taken from the WHO/UNICEF Estimates of National Immunization Coverage (WUENIC), which combine administrative data, official estimates and surveys, and assign each estimate a grade of confidence based on its empirical support (Burton et al., 2009; World Health Organization [WHO] & UNICEF, 2024).

Impact assessment framework

For each vaccine, results were classified into four levels: (i) change in the number of cases; (ii) change in incidence; (iii) change in mortality; (iv) change in case fatality. When values were comparable, the relative reduction was calculated as RR = (Pre − Post)/Pre × 100; all reported reductions were recalculated from the published values. For incidence, a post/pre incidence ratio was used when published. For mortality, adjusted rate ratios from interrupted time series were preferred.

The term “case fatality” was used only when both the numerator (deaths) and the denominator (cases) were documented in comparable populations before and after vaccination. A decrease in the number of deaths may indeed result from a decline in incidence even if the case fatality of residual cases remains high, and improvements in care may reduce case fatality independently of vaccination. Finally, a pre/post association does not by itself constitute causal evidence: changes in surveillance, access to care, case management, demography and other public health interventions may contribute to the observed trends.

RESULTS

Building the programme, 1956–1987

After independence, Morocco progressively expanded its schedule. DTP was introduced in 1963; the first poliomyelitis campaigns were organized between 1964 and 1967; the EPI was adopted in 1981. The insufficient results of the first half of the 1980s led to the restructuring of the programme as the NIP in 1987 and to the launch of National Immunization Days (Lamdouar Bouazzaoui, 2006; Ministère de la Santé du Maroc, n.d.). Vaccination coverage, low in 1982, reached about 50% in 1987 and 87% in 1997 (Garenne et al., 2007).

Expansion of the vaccination schedule

The schedule was enriched over time: hepatitis B in 1999; *Haemophilus influenzae* type b (Hib) in 2007; 13-valent pneumococcal conjugate vaccine (PCV13) in October 2010, replaced by PCV10 in July 2012; rotavirus vaccine in 2010 (October to December depending on the source); inactivated poliovirus vaccine (IPV) in June 2015; switch from trivalent to bivalent oral poliovirus vaccine under the 2013–2018 strategic plan; and HPV in 2022 (Lahlou, 2016; Lamdouar Bouazzaoui, 2006; WHO & UNICEF, 2024).

The history of measles vaccination deserves careful reading, as sources diverge. Historical sources place its start in the early 1980s, whereas the Ministry of Health and WHO date its integration into the national schedule to 1987 (measles vaccine at 9 months) (Lahlou, 2016; WHO, 2025). For the second dose, a “second opportunity” was introduced in 2003–2004 (WHO Regional Office for the Eastern Mediterranean, n.d.), and the second dose was then reintroduced into the routine schedule in April 2014, together with the rubella component combined with the first dose (WHO & UNICEF, 2024). The 2025 WHO Disease Outbreak News mentions only the 2014 addition (WHO, 2025). These discrepancies are explicitly reported rather than arbitrarily resolved.

Performance: vaccination coverage and data quality

According to WHO/UNICEF estimates, coverage in Morocco has been very high for more than a decade: 99% for the third dose of DTP and the first dose of measles-containing vaccine from 2012 to 2023; for the second measles dose, 54% in 2014 (year of reintroduction), 95% in 2015 and 99% from 2016; for PCV, an increase

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

from 72% in 2012 to 98–99% since 2016; for rotavirus, from 88% to 98–99% (Table 1) (WHO & UNICEF, 2024). In contrast, the hepatitis B birth dose given within 24 hours remains low (41% in 2019–2023).

These levels must be interpreted with caution. Since 2020, no official or administrative data have been accepted in the WUENIC profile: the 2020–2023 estimates are extrapolated from previous years, with the statement "no accepted empirical data", and WHO and UNICEF recommend a high-quality coverage survey, as no national survey has covered the five most recent birth cohorts (WHO & UNICEF, 2024). In the 2025 revision, released on 15 July 2026, Morocco submitted its reporting form without coverage data, and the 2025 estimates were carried forward unchanged from 2024 (WHO & UNICEF, 2026). The last national survey (ENPSF 2018) found coverage of 94.4% for DTP3 and 93.1% for the first measles dose (card or recall), lower than the published estimates. Moreover, WHO reports that the 95% threshold for the second measles dose had not been reached in the three years preceding the 2023–2025 outbreak (WHO, 2025), and a local study in Guelmim reported in 2025 that only 44.29% of the children studied had received measles vaccination (Asraoui & Soulaymani, 2026). The gap between national averages close to 99% and the occurrence of a nationwide epidemic is a finding in itself: it points either to an overestimation of coverage or to substantial territorial and generational heterogeneity.

Table 1. Vaccination coverage estimated by WHO and UNICEF (WUENIC, 2023 revision) and coverage measured by the most recent national survey, Morocco (WHO & UNICEF, 2024)

Antigen	2012	2014	2016	2019	2020–2023[a]	ENPSF 2018 survey[b]
DTP3	99%	99%	99%	99%	99%	94.4%
Measles, 1st dose	99%	99%	99%	99%	99%	93.1%
Measles, 2nd dose	—	54%	99%	99%	99%	—
PCV3	72%	90%	98%	98%	98%	—
Rotavirus (last dose)	88%	90%	99%	98%	98%	—
Hepatitis B birth dose (<24 h)	9%	14%	22%	41%	41%	—

[a] Extrapolated estimates, with no accepted empirical data for 2020–2023; the 2025 revision (July 2026) also carries the estimates forward, as no data were submitted for 2025 (WHO & UNICEF, 2026). [b] Card or maternal recall, children aged 12–23 months; results assigned by WHO/UNICEF to the 2016 birth cohort. DTP3: third dose of diphtheria-tetanus-pertussis-containing vaccine; PCV3: third dose of pneumococcal conjugate vaccine.

Impact on incidence, mortality and case fatality

Aggregate impact on under-five mortality

Two national verbal autopsy surveys on the causes and circumstances of child deaths (ECCD-1, 1988–1989, and ECCD-2, 1997–1998) were linked to mortality rates for reference periods centred on 1987 and 1996. Under-five mortality fell from 104.1 to 59.4 per 1,000, and mortality attributable to vaccine-preventable diseases from 11.71 to 1.37 per 1,000 (relative risk 0.117), a decline of 88.3% — rounded by the authors to −87% — the largest of all cause categories (Garenne et al., 2007). Neonatal tetanus mortality decreased by 94.8% (9.97 to 0.51 per 1,000). Vaccine-preventable diseases accounted for 23% of the total decline in under-five mortality over the period. These estimates are based on limited samples of deaths and do not allow each averted death to be attributed precisely to a particular antigen.

Haemophilus influenzae type b

Hib vaccine was introduced in 2007. An evaluation covering 11 sentinel hospitals compared 2004–2006 with 2008–2009: the mean annual number of confirmed *H. influenzae* meningitis cases in children under 5 years fell from 24 to 6, a 75% decrease ($p<0.001$). In the Greater Casablanca prefecture, the estimated minimum incidence

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

fell from 15 to 1 case per 100,000 children under 5 years, a reduction of about 93% (Braikat et al., 2012). This study provides one of the most direct Moroccan demonstrations of vaccine impact on incidence.

Pneumococcus

In Casablanca, the incidence of invasive pneumococcal disease (IPD) in children aged ≤2 years decreased from 34.6 to 13.5 per 100,000 between 2007–2010 and 2011–2014, a relative reduction of 60.9% ($p<0.0001$), particularly marked for vaccine serotypes (Diawara et al., 2015). A national interrupted time-series analysis showed a 28% decrease in respiratory mortality among children under 5 years after PCV introduction (mortality rate ratio 0.72; 95% CI 0.58–0.83) and a 30% decrease among infants (Bennani Mechita et al., 2020). These results concern population mortality, not the case fatality of pneumococcal cases.

A later hospital series reported a case fatality of 26.47% (18 deaths among 68 patients with IPD), but without a comparable pre-vaccine group; this value therefore does not allow any conclusion about a change in case fatality (Chikhaoui et al., 2022).

Rotavirus

Before vaccine introduction, 766/1,861 (41%) children under 5 years hospitalized for acute gastroenteritis (AGE) in three sentinel hospitals tested positive for rotavirus; after introduction, 128/533 (24%) did so in 2011–2013, a 41.5% decrease in prevalence (Benhafid et al., 2015). A second evaluation covering 2006–2014 found a decrease in the proportion of rotavirus AGE from 37.0% to 31.1%, significant among infants aged 0–11 months (38.8% to 28.1%; $p=0.009$), with an estimated vaccine effectiveness of 57% (Ezzine et al., 2021). These indicators reflect a reduction in burden among hospitalizations rather than a national population incidence.

Diphtheria

After the NIP was implemented in 1987, diphtheria cases declined sharply: a historical review reports 14 cases in 1989 and a single case in 1991 (−92.9%), followed by the absence of notified cases in subsequent years according to the same source (Lamdouar Bouazzaoui, 2006). The notification, in September 2026, of two family clusters in the Souss-Massa region (one confirmed case, eight under investigation) shows that a prolonged absence of cases does not mean eradication (Ministry of Health and Social Protection, 2026). According to the Ministry, the children concerned had never been vaccinated against diphtheria or had not received all recommended doses; the two deaths recorded among cases under investigation were schoolchildren in Chtouka-Aït Baha province (Ministry of Health and Social Protection, 2026).

Neonatal tetanus

Historical data show 103 cases of neonatal tetanus in 1983 compared with 8 in 1994, a 92.2% reduction. Protection of newborns improved with tetanus vaccination of women of childbearing age, and elimination of neonatal tetanus was validated in 2002 (Lamdouar Bouazzaoui, 2006; WHO, 2002). The 94.8% decline in neonatal tetanus mortality between 1987 and 1996 confirms this trend (Garenne et al., 2007).

Poliomyelitis

Between 1980 and 1989, 289 poliomyelitis cases were reported (Institut National d'Hygiène, n.d.). The year of the last case differs across sources: 1987 according to the Ministry of Health (Lahlou, 2016), and 1989 for the last wild poliovirus case according to the National Institute of Hygiene (Institut National d'Hygiène, n.d.). Acute flaccid paralysis surveillance was generalized in 1994 and the certification dossier was submitted in November 2001 (Lamdouar Bouazzaoui, 2006); the final national documents were accepted by the Regional Certification Commission in 2007 (WHO Regional Committee for the Eastern Mediterranean, 2008). Interruption of transmission is the relevant indicator here; no numerical relative reduction was calculated.

Measles

Measles vaccination led to a substantial reduction in viral circulation, but Moroccan history is marked by recurrent outbreaks whenever pockets of susceptibility accumulate; studies from the 1990s already described epidemics in rural localities despite improved national coverage (Cherkaoui et al., 1997). From 1 October 2023 to 13 April 2025, more than 25,000 suspected cases, including 13,706 confirmed, and 184 deaths were reported across all 12 regions; 68% of cases occurred in people under 18 years and 49% in unvaccinated people; only genotype B3 was identified (WHO, 2025). By 25 April 2025, the national campaign had verified the vaccination status of 10.74 million children and adolescents under 18 years (verification rate 98.45%), with catch-up vaccination rates of 73.6% for measles–rubella vaccine, 61.8% for the DTP component and 57.7% for oral poliovirus vaccine (WHO, 2025); cases had fallen by 80% from the January 2025 peak ("Infectious Disease Surveillance Update," 2025). By mid-May 2025, the Ministry's weekly reports no longer recorded any deaths (746 cases and no deaths from 12 to 18 May 2025) ("L'épidémie poursuit sa régression," 2025); no consolidated final report of the outbreak had been identified by the search closing date.

Additional sources document the geographical, age and clinical profile of the outbreak. The first cases were reported in a few provinces of the Souss-Massa region before nationwide spread (WHO, 2025). A GIS-based analysis of 2023–2024 notifications identified marked spatial heterogeneity, with high-risk areas in Tanger-Tétouan-Al Hoceima, the Oriental, Souss-Massa and Béni Mellal-Khénifra, intermediate transmission in Casablanca-Settat, Marrakech-Safi and Rabat-Salé-Kénitra, and lower incidence in the southern regions, i.e., a north-centre versus south gradient (Haisoufi et al., 2026). At the Children's Hospital of Rabat, among 587 children hospitalized in 2024–2025, the median age was 15 months and 67% were infants; 61% were unvaccinated, 16% partially vaccinated and 23% fully vaccinated; complications, mainly respiratory, occurred in 56% and were more frequent among children who were not fully vaccinated (Mahraoui, 2026). Surveillance capacity was uneven: in Essaouira province, about one third of the health professionals surveyed in 2024 were unfamiliar with the measles case definition, only 34.1% considered that suspected (rather than only confirmed) cases should be notified, and 92.7% had received no additional training in measles surveillance (Mejdouli et al., 2025). Age-specific incidence, vaccination status by region and case fatality by age group had not been published at national level by the search closing date.

Table 2 brings together the pre/post comparisons with the most directly interpretable quantitative estimates, and Figure 1 summarizes them. As the indicators differ in nature, the magnitudes should not be compared as interchangeable estimates.

Table 2. Available quantitative assessment of vaccine impact in Morocco

Vaccine / disease	Introduction / strengthening	Indicator	Before	After	Reduction	Type	Source
Vaccine-preventable diseases	EPI 1981 / NIP 1987	Under-5 mortality	11.71‰ (1987–88)	1.37‰ (1994–98)	−88.3%	Mortality	(Garenne et al., 2007)
Hib	2007	Minimum incidence of Hi meningitis, <5 y	15/100,000	1/100,000	−93%	Incidence	(Braikat et al., 2012)
Hib	2007	Mean annual confirmed cases (11 sites)	24	6	−75%	Cases	(Braikat et al., 2012)
PCV	2010	IPD ≤2 y, Casablanca	34.6/100,000	13.5/100,000	−60.9%	Incidence	(Diawara et al., 2015)

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Vaccine / disease	Introduction / strengthening	Indicator	Before	After	Reduction	Type	Source
PCV	2010	Respiratory mortality <5 y	Reference	MRR 0.72	−28%	Mortality	(Bennani Mechita et al., 2020)
Rotavirus	2010	RV+ share of hospitalized AGE	41%	24%	−41.5%	Proportion	(Benhafid et al., 2015)
Neonatal tetanus	1987[a]	Annual cases	103 (1983)	8 (1994)	−92.2%	Cases	(Lamdouar Bouazzaoui, 2006)
Diphtheria	NIP 1987	Annual cases	14 (1989)	1 (1991)	−92.9%	Cases	(Lamdouar Bouazzaoui, 2006)

[a] Strengthening of the NIP and expansion of tetanus vaccination of women of childbearing age; tetanus activities existed earlier. MRR: mortality rate ratio; IPD: invasive pneumococcal disease; AGE: acute gastroenteritis; RV+: rotavirus-positive.

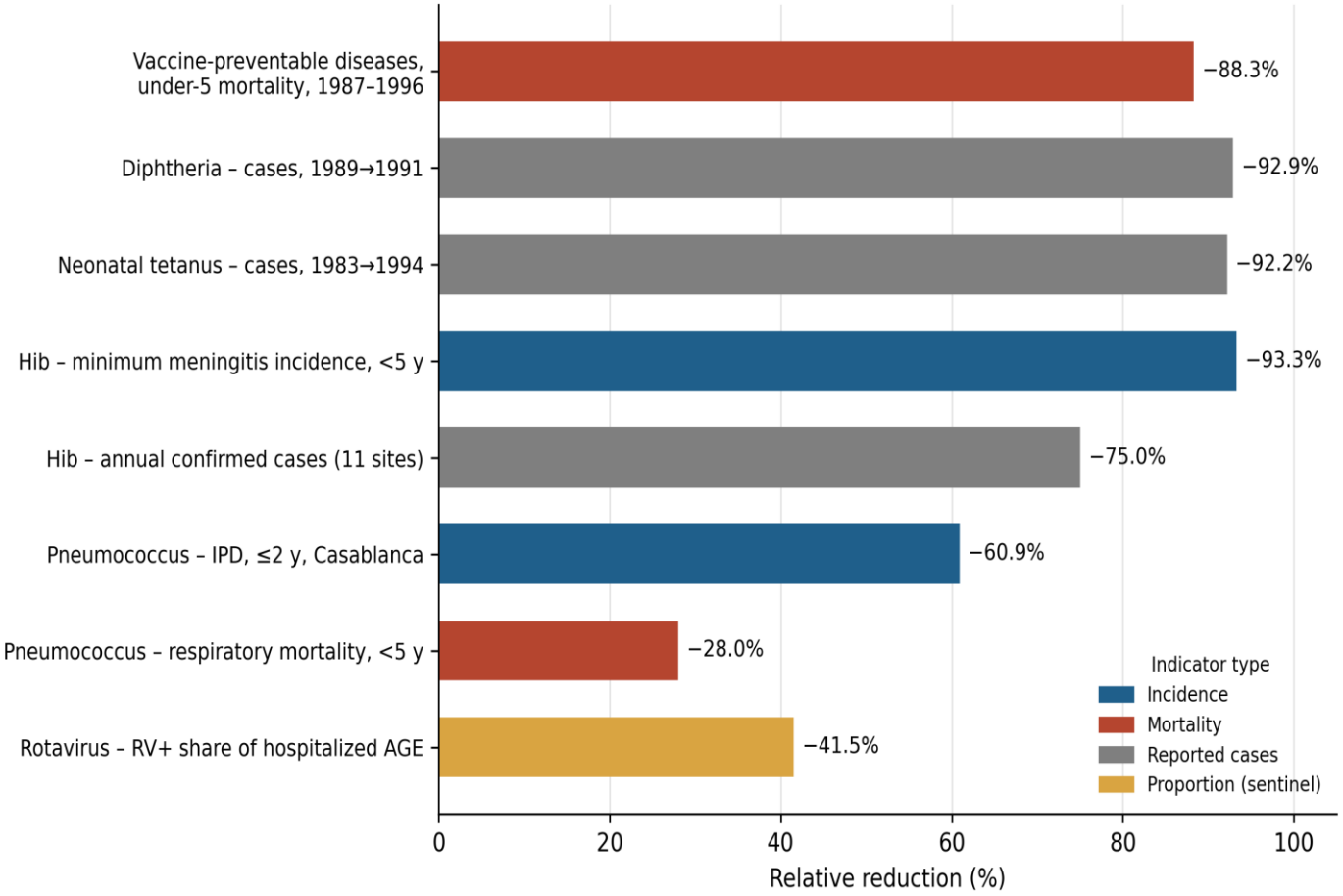


Figure 1. Relative reductions observed after vaccine introduction or programme strengthening in Morocco. Indicators are heterogeneous (incidence, mortality, reported cases, proportion in sentinel surveillance) and do

not measure the same event. Sources: (Benhafid et al., 2015; Bennani Mechita et al., 2020; Braikat et al., 2012; Diawara et al., 2015; Garenne et al., 2007; Lamdouar Bouazzaoui, 2006).

What can — and cannot — be concluded about case fatality

The available data support firm conclusions on a decline in incidence for Hib and IPD, a decline in respiratory mortality after PCV and in mortality from vaccine-preventable diseases, and a dramatic reduction in cases of neonatal tetanus, diphtheria and poliomyelitis. In contrast, a decline in case fatality is not directly demonstrated for any disease, because historical series do not simultaneously report, with stable definitions, the number of deaths and the number of cases before and after vaccination.

For the 2023–2025 measles outbreak, the crude ratio of deaths to suspected cases is at most 0.74% (184/>25,000) and the ratio of deaths to confirmed cases about 1.34% (184/13,706), the latter being an upper bound since not all deaths necessarily occurred among confirmed cases (WHO, 2025). These descriptive ratios are not comparable with earlier periods. For the September 2026 diphtheria events, no case fatality ratio should be calculated before epidemiological classification is completed (Ministry of Health and Social Protection, 2026).

Recent resurgence and heterogeneity of protection

Recent events show that the historical impact of the NIP is not irreversible. The measles outbreak that began in late 2023 in the Souss-Massa region spread to all 12 regions, with nearly half of cases occurring in unvaccinated people (WHO, 2025). In September 2026, family clusters of diphtheria were reported in the same region (Ministry of Health and Social Protection, 2026). These events underline the value of subnational indicators of coverage, zero-dose children and catch-up.

Pockets of susceptibility are not solely a matter of vaccine availability. In Guelmim, a cross-sectional study conducted in 2025 among 350 mothers attending three urban health centres associated lower measles vaccination with delays during the COVID-19 pandemic, missed doses, insufficient information, access difficulties and lower trust in vaccines offered by the public sector; catch-up was strongly associated with vaccination (Asraoui & Soulaymani, 2026). These local data cannot be generalized, but they document plausible mechanisms through which pockets of under-vaccination form. At the national level, the analysis of the verification and catch-up campaign among under-18s reported a mean vaccination-status verification rate of 96.64%, but a national incompleteness rate of 15.69%. The measles catch-up rate varied widely across regions, from 79.05% in Dakhla-Oued Eddahab to 16.12% in Guelmim-Oued Noun (El Fadeli et al., 2026) — the region where the above local study was conducted — underlining that high national performance can mask substantial territorial disparities.

The introduction of HPV vaccine in 2022 illustrates another challenge: the presence of a vaccine in the schedule does not guarantee its uptake. In northern Morocco, only 8.7% of parents were aware of the national HPV programme, whereas 60% said they were in favour of vaccination (Lemrabett et al., 2026). The programme, launched in October 2022 under the National Cancer Control Plan 2020–2029, targets 11-year-old girls, mainly through schools, with two doses of quadrivalent vaccine given at least six months apart (Zraidi & Ibriz, 2023). In a multicentre survey of 2,088 parents of girls aged 11–14 years in five regions (2025), 84.8% reported hesitancy towards vaccinating their daughters (Essayagh et al., 2026). No published estimate of national HPV vaccination coverage was identified by the search closing date. Recent Moroccan literature on vaccine hesitancy also highlights the role of perceived safety and information (Erefai et al., 2025).

Historical series and estimated reductions in incidence

Historical series complement pre/post comparisons with temporal landmarks (Table 3). Reported cases are surveillance data whose trends depend on vaccination, on the sensitivity of the notification system, on catch-up campaigns and on demographic change; they should not be interpreted as an isolated causal effect of vaccination (Lamdouar Bouazzaoui, 2006; WHO, 2003; WHO, n.d.).

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Table 3. Historical landmarks for reported incidence, mortality and case fatality of the main vaccine-preventable diseases in Morocco. Incidence for 1980, 1990 and 1995 was calculated from the cases and populations published in WHO profiles and rounded (WHO, 2003; WHO, n.d.).

Disease	Period / year	Reported cases	Population	Incidence or ratio	Estimated change	Deaths / case fatality	Interpretation
Measles	1980	86,919	19.382 M	≈448.5/100,000	Reference	Not available	Very high burden before programme scale-up
Measles	1990	1,577	24.564 M	≈6.4/100,000	−98.6% vs 1980	Not available	Major decline, not monotonic thereafter
Measles	1995	2,380	27.213 M	≈8.7/100,000	−98.1% vs 1980	Not available	Persistent susceptible pockets
Measles	Oct 2023–13 Apr 2025	>25,000 suspected; 13,706 confirmed	National	Not comparable with a single year	Resurgence	184 deaths; ≤0.74% (suspected); ≈1.34% (confirmed)	Descriptive, non-standardized ratios (WHO, 2025)
Diphtheria	1980	43	19.382 M	≈0.22/100,000	—	Not documented	Disease still circulating
Diphtheria	1989 → 1991	14 → 1	—	—	−92.9% of cases	Not available	No notified cases thereafter (Lamdouar Bouazzaoui, 2006)
Diphtheria	Sept 2026	1 confirmed + 8 under investigation	—	—	Focal re-emergence	2 deaths among cases under investigation	Case fatality not calculable (Ministry of Health and Social Protection, 2026)
Poliomyelitis	1980	52	19.382 M	≈0.27/100,000	—	Not available	Transmission present
Poliomyelitis	Since the late 1980s	0	—	0	Transmission interrupted	—	Last case: 1987 or 1989 depending on source (Institut National d'Hygiène, n.d.; Lahlou, 2016)
Neonatal tetanus	1983 → 1994	103 → 8	Live births	Not recalculated	−92.2% of cases	Neonatal mortality −94.8% (1987–1996)	Elimination validated in 2002 (Garenne et al., 2007; WHO, 2002)

M: million inhabitants.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Measles provides the most complete historical series. Between 1980 and 1990, reported incidence fell from about 448.5 to 6.4 cases per 100,000 inhabitants, a 98.6% reduction, coinciding with the introduction of the EPI and its acceleration through the NIP and National Immunization Days. This decline was not linear: the data show resurgences in 1992–1993, 1998–2000 and 2003, followed by the major resurgence of 2023–2025 (Figure 2) (Lamdouar Bouazzaoui, 2006; WHO, 2003; WHO, n.d.).

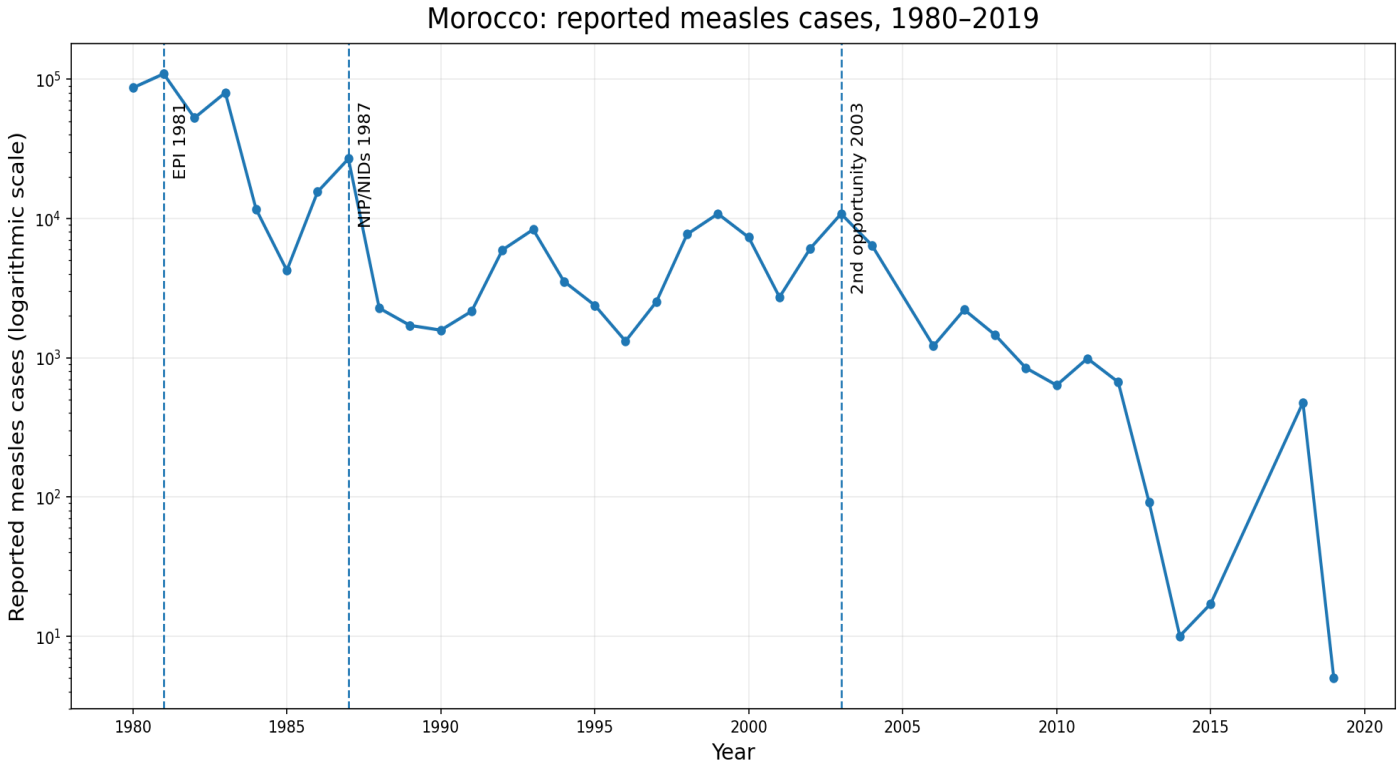


Figure 2. Reported measles cases in Morocco, 1980–2019 (logarithmic scale). Vertical lines indicate programme milestones; years without published data (2005, 2016–2017) are not shown as points, and segments joining non-consecutive years do not represent observed values. Source: WHO/JRF historical data (WHO, 2003; WHO, n.d.).

Antigens without published Moroccan impact evaluation

For four antigens of the schedule, no Moroccan study with a pre/post or comparative design was identified, despite a targeted search of the peer-reviewed literature and of grey literature (Ministry of Health and Social Protection, National Institute of Hygiene, WHO-EMRO and WHO/UNICEF documents). This should be read as an evidence gap rather than as an absence of effect.

Hepatitis B. Twenty-five years after its introduction in 1999, no published Moroccan evaluation has compared the prevalence of hepatitis B surface antigen (HBsAg) between birth cohorts born before and after vaccine introduction. A systematic review of 30 Moroccan studies (2000–2024; 750,784 participants) estimated a pooled HBsAg prevalence of 1.33% (95% CI 1.07–1.61%), consistent with a transition towards low endemicity; the lowest prevalence (0.36%) was observed among military personnel, a predominantly young population, but no stratification by birth cohort was performed (Feindiri et al., 2025). The low coverage of the birth dose within 24 hours (41%) further limits protection against perinatal transmission (WHO & UNICEF, 2024). An HBsAg serosurvey of children born after 1999 would be the most direct way to document impact.

BCG. BCG has been used in Morocco since 1949. Its protection is greatest against severe childhood forms of tuberculosis, such as tuberculous meningitis and miliary tuberculosis, and highly variable against pulmonary disease (Mangtani et al., 2014). Its effect on tuberculosis incidence in Morocco cannot be separated from that of case detection and treatment, and no Moroccan time series of childhood tuberculous meningitis was identified.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Rubella. The rubella component was added to the schedule in 2014 (WHO & UNICEF, 2024), but no published Moroccan data on congenital rubella syndrome, or on rubella incidence before and after its introduction, were identified.

HPV. An effect on cervical cancer incidence cannot be expected before several decades. Dose-specific coverage by cohort and region and the prevalence of vaccine-type HPV infection in vaccinated cohorts are the relevant short-term indicators (WHO, 2022); none had been published for Morocco by the search closing date.

Analytical synthesis of vaccine impact

The strength of evidence varies by disease and indicator. The best-demonstrated effects are based on pre/post population incidence or interrupted time series; declines in historical case counts support the programme's impact but are more sensitive to changes in surveillance. Table 4 ranks the strength of evidence so that these different types of data are not given the same weight.

Table 4. Summary of observed effects and level of evidence for the impact of the NIP in Morocco

Disease / domain	Indicator	Observed effect	Level of evidence	Interpretation
Vaccine-preventable diseases	Under-5 mortality 1987→1996	−88.3%	Moderate	Repeated national verbal autopsy; small numbers per cause (Garenne et al., 2007)
Hib	Meningitis incidence <5 y	≈ −93%	Strong	Pre/post comparison with population denominator (Braikat et al., 2012)
Pneumococcus	IPD ≤2 y	−60.9%	Strong	Pre/post population incidence (Diawara et al., 2015)
Pneumococcus	Respiratory mortality <5 y	−28%	Strong	Interrupted time series (Bennani Mechita et al., 2020)
Rotavirus	Share of hospitalized AGE testing positive	≈ −41.5%	Moderate	Sentinel surveillance; proportional indicator (Benhafid et al., 2015; Ezzine et al., 2021)
Measles	Reported incidence 1980→1990	≈ −98.6%	Moderate	Large historical decline; surveillance and campaigns changed (WHO, 2003)
Neonatal tetanus	Reported cases 1983→1994	−92.2%	Moderate	Historical decline and elimination validated in 2002 (Lamdouar Bouazzaoui, 2006; WHO, 2002)
Diphtheria	Reported cases 1989→1991	−92.9%	Moderate	Historical decline; focal re-emergence in 2026 (Lamdouar Bouazzaoui, 2006; Ministry of Health and Social Protection, 2026)
Poliomyelitis	Indigenous transmission	Interrupted since the late 1980s	Strong	Elimination indicator more relevant than a percentage (Lamdouar Bouazzaoui, 2006; WHO Regional Committee for the Eastern Mediterranean, 2008)

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Disease / domain	Indicator	Observed effect	Level of evidence	Interpretation
Case fatality	Pre/post comparisons	Not estimable consistently	Insufficient	Cases and deaths not comparable over time
Hepatitis B, BCG, rubella, HPV	Pre/post or birth-cohort comparisons	Not assessed	Insufficient	No published Moroccan impact evaluation (Section 3.8)

DISCUSSION

This review shows a major effect of the Moroccan NIP on several dimensions of disease burden, with a clear hierarchy of evidence. The strongest data come from studies with a temporal comparator and a population denominator: the reduction of about 93% in the minimum incidence of Hib meningitis and of 60.9% in IPD among children aged ≤2 years (Braikat et al., 2012; Diawara et al., 2015). Mortality data strengthen this conclusion: after PCV introduction, respiratory mortality among children under 5 years fell by 28%, whereas congenital and chromosomal causes used as a comparison did not show the same decline (Bennani Mechita et al., 2020); overall, mortality attributed to vaccine-preventable diseases decreased by 88% between 1987 and 1996 (Garenne et al., 2007).

These results are consistent with international experience. Reviews of Hib vaccine impact show a near-disappearance of invasive Hib infections in countries that achieved high coverage (Morris et al., 2008); in the United States, PCV introduction was followed by a rapid and marked decline in IPD among young children, with an indirect effect in adults (Whitney et al., 2003); and global analyses of rotavirus vaccination report substantial reductions in rotavirus hospitalizations and diarrhoeal deaths among children under 5 years (Burnett et al., 2020). The magnitude of the effects observed in Morocco therefore lies within the expected range, which strengthens the plausibility of a vaccine effect.

The effect observed for rotavirus should, however, be interpreted with greater nuance, as the available indicators are proportions among hospitalized gastroenteritis cases rather than population incidence (Benhafid et al., 2015; Ezzine et al., 2021). For diphtheria, neonatal tetanus and poliomyelitis, the historical impact is dramatic, extending to a prolonged absence of indigenous cases; elimination and interruption of transmission are more appropriate indicators than a comparison of two years.

The main programmatic lesson concerns the measurement of coverage. Published estimates remain at 99% for most antigens, but they have been extrapolated since 2020 without accepted empirical data (WHO & UNICEF, 2024), even though a nationwide measles epidemic occurred with nearly half of cases among unvaccinated people (WHO, 2025). This mismatch, also observed in other countries after COVID-19-related disruptions (Minta et al., 2023), is a reminder that national administrative coverage can mask denominator errors, delayed administration and geographical or generational pockets of under-vaccination. A high-quality national coverage survey, as recommended by WHO and UNICEF, is therefore a priority (Burton et al., 2009; WHO & UNICEF, 2024).

The analysis of case fatality is the main documentary gap. Post-vaccine publications may still report high case fatality among selected hospital cases, such as the pneumococcal series reporting 26.47%, without contradicting vaccine effectiveness: vaccination first reduces the number of people who develop disease, while the remaining hospitalized cases may be the most severe (Chikhaoui et al., 2022). A national database linking individual vaccination status, case notification, laboratory confirmation, hospitalization and vital outcome would make it possible to calculate, by antigen and cohort, incidence rates and mortality and case fatality ratios with confidence intervals, ideally using interrupted time series or segmented models.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Methodological challenges in attributing impact to vaccination

Most of the Moroccan evidence summarized here relies on before–after comparisons. Such designs are exposed to several biases: secular declines in child mortality driven by improved living conditions, nutrition, hygiene and access to care (Garenne et al., 2007); changes in case definitions, laboratory confirmation and surveillance sensitivity; regression to the mean when a vaccine is introduced after an epidemic year; and, for proportional indicators such as the share of rotavirus-positive gastroenteritis, changes in the denominator. Post-licensure studies must also distinguish the direct, indirect, total and overall effects of vaccination, each of which requires a different design (Hanquet et al., 2013).

Several quasi-experimental approaches can strengthen causal inference. Interrupted time series with segmented regression model the pre-existing level and trend and adjust for seasonality, and their validity improves when a control series not expected to respond to the vaccine is included (Bernal et al., 2017); the Moroccan PCV analysis, which used congenital and chromosomal causes as a comparison, illustrates this approach (Bennani Mechita et al., 2020). Synthetic control methods build the counterfactual from a weighted combination of control causes of hospitalization or death and are suited to routine hospital discharge or death-registration data (Bruhn et al., 2017). Case-control designs, including the test-negative design applied to surveillance data, estimate vaccine effectiveness directly; during the 2019 Tunisian measles outbreak, this design estimated an effectiveness of 86.4% for one dose and 91.8% for two doses (Bennasrallah et al., 2026). Finally, ecological comparisons across regions with contrasting coverage, such as those revealed by the 2023–2025 catch-up campaign (El Fadeli et al., 2026), can generate hypotheses but are exposed to ecological bias. In Morocco, the use of these designs depends above all on the availability of long, consistent and disaggregated series.

Regional comparison

Comparison with neighbouring countries helps situate Morocco's achievements and challenges (Table 5). Morocco is the most advanced in new vaccine introduction: among seven middle-income countries of the Middle East and North Africa, it was the only one to have introduced PCV, rotavirus and HPV vaccines (Bishop et al., 2025). In contrast, Egypt is the only comparator whose measles elimination has been verified (2021), whereas Morocco, Tunisia and Jordan have not reached this stage (Musa et al., 2024). Across the Eastern Mediterranean Region, only 9 of 22 countries reached at least 95% coverage with both measles doses in 2024, and the region remains off track for measles and rubella elimination by 2030 (Farid et al., 2026).

Three lessons appear transferable. First, Tunisia experienced a nationwide measles outbreak in 2019 (3,141 suspected cases and 30 deaths by April), in which 84% of affected children aged 1–5 years were unvaccinated and 28% of cases were infants aged 6–12 months, after the first dose had been moved from 9 to 12 months of age in 2013 (WHO, 2019); the response relied on outbreak response immunization, whose effectiveness was later documented with a test-negative design (Bennasrallah et al., 2026). The Moroccan outbreak shares the same signature of accumulated unvaccinated cohorts and a heavy burden among infants. Second, Jordan conducted a population-based survey in 2023, which measured full basic vaccination at 79% and first-dose measles coverage at 91.4% among children aged 12–23 months, with lower coverage in rural areas and among children of less educated mothers (Motawi et al., 2025); the gap with the WUENIC first-dose estimate of 76% for 2022 (Musa et al., 2024) shows that administrative and survey sources can diverge in either direction, which is why Morocco, without a national survey since 2018, cannot currently assess its true coverage. Third, Algeria reported a diphtheria outbreak in its southern wilayas in 2024–2025 (915 suspected cases and 119 deaths), mainly among displaced populations, and a further cluster in Skikda in October 2025 in which none of the confirmed cases had been vaccinated, despite a national DTP3 coverage of 92% (WHO Regional Office for Africa, 2025). Together with the Moroccan diphtheria clusters of 2026, these events show that high national coverage does not protect unvaccinated subgroups, including mobile and displaced populations, and argue for subnational monitoring and regional coordination of surveillance.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Table 5. Regional comparison of selected immunization indicators: Morocco, Tunisia, Algeria, Egypt and Jordan

Country	Measles elimination status; MCV1/MCV2 coverage (2022)	Recent outbreaks of vaccine-preventable disease	PCV, rotavirus and HPV vaccine introduction	Survey-based validation of coverage
Morocco	Not verified; 99%/99%	Measles 2023–2025: >25,000 suspected, 13,706 confirmed, 184 deaths; diphtheria clusters, 2026	PCV 2010; rotavirus 2010; HPV 2022	Last national survey 2018 (ENPSF); estimates extrapolated since 2020
Tunisia	Not verified; 95%/98%	Measles 2019: 3,141 suspected cases, 30 deaths (January–April)	PCV 2019; HPV planned	Not identified in this review
Algeria (WHO African Region)	Not covered by Eastern Mediterranean reports; DTP3 92% (2024)	Diphtheria 2024–2025: 915 suspected cases, 119 deaths (south); Skikda, October 2025: 13 suspected cases, 2 deaths	PCV 2016; rotavirus and HPV not introduced	Not identified in this review
Egypt	Verified in 2021; 96%/96%	Measles incidence 0 per million in 2019 and 2022	PCV, rotavirus and HPV not introduced	Not identified in this review
Jordan	Not verified; 76%/90%	Measles incidence 4.5 (2019) and 1.9 (2022) per million	Rotavirus 2015; PCV and HPV not introduced	JPFHS 2023: full basic vaccination 79%; MCV1 91.4%

MCV1/MCV2: WHO/UNICEF estimates of coverage with the first/second dose of measles-containing vaccine; DTP3: third dose of diphtheria-tetanus-pertussis-containing vaccine; JPFHS: Jordan Population and Family Health Survey. Sources: Musa et al. (2024) for elimination status, coverage and incidence; Bishop et al. (2025) for vaccine introduction; WHO (2019) for Tunisia; WHO Regional Office for Africa (2025) for Algeria; Motawi et al. (2025) for Jordan; WHO (2025) and WHO & UNICEF (2024) for Morocco. Introduction status refers to the date of the source and may have changed since.

The 2023–2025 measles outbreak in historical perspective

Compared with the earlier resurgences of 1992–1993, 1998–2000 and 2003, the 2023–2025 outbreak differs in scale, vaccination context and age structure. Earlier peaks reached roughly 8,000 to 11,000 reported cases per year and recurred every five to six years (Figure 2), whereas the recent outbreak produced more than 25,000 suspected cases in 18 months after almost a decade in which annual notifications remained below about 500 (WHO, 2025; WHO, n.d.). The earlier resurgences occurred when a single dose was given at 9 months, the second opportunity having been introduced only in 2003–2004 and the routine second dose in 2014, so that primary vaccine failure in a fraction of vaccinated children could sustain transmission despite high coverage (WHO Regional Office for the Eastern Mediterranean, n.d.; WHO & UNICEF, 2024). In 2023–2025, under a two-dose schedule, half of all cases were unvaccinated (WHO, 2025) and, in a paediatric referral hospital, 61% of hospitalized children were unvaccinated and only 23% fully vaccinated (Mahraoui, 2026): the outbreak therefore reflects mainly a failure to vaccinate rather than vaccine failure. Finally, nearly one third of cases occurred in people aged 18 years or more (WHO, 2025), indicating that susceptible individuals had accumulated over many birth cohorts during the long low-incidence period, while infants too young for the first dose depended entirely on population immunity.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Four factors probably contributed, although their respective weight cannot be quantified from published data. (i) Accumulation of susceptible individuals: second-dose coverage had remained below the 95% threshold in the three years preceding the outbreak (WHO, 2025), and survey-measured first-dose coverage was already lower than the official estimate in 2018 (WHO & UNICEF, 2024). (ii) COVID-19-related disruptions: the national catch-up analysis attributes pre-campaign declines to pandemic-related service interruptions, and the Guelmim study documents delayed and missed doses (Asraoui & Soulaymani, 2026; El Fadeli et al., 2026); the extrapolation of national estimates since 2020 prevents this effect from being quantified. (iii) Vaccine hesitancy, reported as a challenge during the campaign (WHO, 2025) and discussed in Section 4.4. (iv) Surveillance gaps, suggested by the limited knowledge of case definitions and notification rules among front-line professionals (Mejdouli et al., 2025), which may have delayed detection while the outbreak was still confined to Souss-Massa. The north-centre versus south gradient of incidence (Haisoufi et al., 2026) contrasts with the regional ranking of catch-up performance, in which Guelmim-Oued Noun, a southern region, had the lowest rate (El Fadeli et al., 2026); the geography of transmission and that of vaccination gaps therefore do not overlap entirely, possibly because of differences in population density and mobility.

The catch-up campaign illustrates what worked and what could be improved. Its strengths were scale and speed: fixed and mobile teams operating in schools and health centres verified the status of 10.74 million children and adolescents by April 2025 (WHO, 2025), and cases fell by 80% from the January 2025 peak ("Infectious Disease Surveillance Update," 2025). Its limits concern the conversion of verification into vaccination: catch-up rates were 73.6% for measles–rubella, 61.8% for DTP and 57.7% for oral poliovirus vaccine (WHO, 2025), the measles catch-up rate ranged from 16.12% to 79.05% across regions, and a verification rate above 100% in one region pointed to denominator problems (El Fadeli et al., 2026). The low DTP catch-up rate is particularly relevant in light of the 2026 diphtheria clusters. School-based vaccination, digital reminder systems and community engagement have been proposed to consolidate these gains (El Fadeli et al., 2026); a consolidated final outbreak report, including age-specific attack rates and vaccination status by region, remains necessary to draw definitive lessons.

Vaccine confidence and hesitancy

Vaccine hesitancy, defined as delay in acceptance or refusal of vaccines despite the availability of vaccination services, is context-specific, varies across vaccines, time and place, and is shaped by confidence, complacency and convenience (MacDonald & SAGE Working Group on Vaccine Hesitancy, 2015). Moroccan evidence, although fragmented, points to three recurring determinants. The first is trust: among 1,272 health science students surveyed in 2021, only 26.9% were willing to receive a COVID-19 vaccine, safety concerns dominated, and a physician's recommendation was considered persuasive by 48% of respondents compared with 22.6% for a Ministry of Health recommendation (Khalis et al., 2021); in Guelmim, lower trust in vaccines offered by the public sector was associated with lower measles vaccination (Asraoui & Soulaymani, 2026); and lack of trust in the health system was the strongest determinant of parental HPV hesitancy (adjusted odds ratio [AOR] 17.23) (Essayagh et al., 2026). The second is perceived safety, a determinant of COVID-19 vaccine hesitancy among young people (Erefai et al., 2025) and of HPV hesitancy among parents (Essayagh et al., 2026). The third is information: never having heard of cervical cancer (AOR 2.94) and negative media influence (AOR 2.68) were associated with HPV hesitancy (Essayagh et al., 2026), consistent with the role of social media in spreading vaccine misinformation documented internationally (Wilson & Wiysonge, 2020).

The contrast observed in northern Morocco between low awareness of the HPV programme (8.7%) and a majority of favourable parents (60%) (Lemrabett et al., 2026) suggests that a large part of the problem lies in communication and delivery rather than in opposition: favourable intentions are not converted into vaccination when parents are not informed of the programme, of consent procedures or of school vaccination dates. The much higher hesitancy measured in the multiregional survey (84.8%) (Essayagh et al., 2026) relies on a broader definition that includes delay and uncertainty, and confirms that hesitancy is a continuum rather than a binary refusal. For adolescent vaccination delivered mainly in schools (Zraidi & Ibriz, 2023), success depends on parental engagement, coordination between the health and education sectors, and the training of school health and primary care staff; the WHO position that a single-dose schedule may be used in girls aged 9–14 years could also simplify school-based delivery (WHO, 2022).

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Interventions to improve confidence should be multicomponent and tailored to the identified causes of hesitancy, as single-message approaches have limited effect (Jarrett et al., 2015). In Morocco, the evidence points to four priorities: training nurses and physicians in vaccine communication, since the absence of a professional recommendation was the second strongest determinant of HPV hesitancy (AOR 6.8) (Essayagh et al., 2026); community engagement with local leaders and parents; active monitoring of, and response to, misinformation on social media (Wilson & Wiysonge, 2020); and regular measurement of confidence by region, so that communication can be targeted at the areas with the largest immunity gaps.

Programmatic challenges

Beyond data quality, four challenges emerge. The first is equity: the global Immunization Agenda 2030 makes the reduction in the number of zero-dose and under-vaccinated children the central indicator of the decade (WHO, 2020), which in Morocco requires monitoring at provincial and municipal levels. The second is vaccine confidence, weakened after the pandemic and decisive for adolescent vaccines such as HPV (Section 4.4). The third is schedule completeness, in particular the hepatitis B birth dose, whose coverage within 24 hours is still estimated at 41% (WHO & UNICEF, 2024), while the impact of hepatitis B vaccination has never been evaluated serologically in Morocco (Section 3.8). The fourth is sustainability: the successive introduction of more expensive vaccines (PCV, rotavirus, HPV) and future introductions increase needs for financing, cold chain and logistics management, which would merit a dedicated health-economic evaluation.

Proposed indicators for a standardized national evaluation

- Disease- and age-specific incidence: confirmed cases / population at risk × 100,000.
- Specific mortality: disease-related deaths / population at risk × 100,000.
- Case fatality ratio: deaths among confirmed cases / number of confirmed cases × 100.
- Post/pre incidence ratio and relative reduction with 95% CI.
- Post/pre case fatality ratio, only when diagnostic definitions and completeness of follow-up are comparable.
- Interrupted time series adjusted for seasonality, demography, changes in surveillance and other health interventions.
- Survey-validated coverage and territorial analysis (region, province, municipality) to identify zero-dose or under-vaccinated children.

Strengths and limitations

The main strength of this review is the integration of national data and Moroccan studies covering several decades and several levels of impact, with systematic recalculation of the reported reductions. Its limitations are important. It is a narrative, not a systematic, review; the search was restricted to open-access sources and official documents, although its strategy is now documented in Supplementary File S2; sources and indicators are heterogeneous; some early periods rely on surveillance data or institutional documents; diagnostic definitions, completeness of notification and denominators have changed; and some dates (introduction of measles vaccination, last poliomyelitis case) differ across sources. The impact of several antigens in the schedule (hepatitis B, BCG, rubella, HPV) could not be assessed for lack of published Moroccan pre/post data (Section 3.8); for these antigens, the absence of identified studies may reflect unpublished programme data rather than an absence of data. In addition, the decline in child mortality occurred in a context of improving living conditions, hygiene, nutrition and management of diarrhoea and infections, which contributed to the observed trends (Garenne et al., 2007); the specific effect of vaccination can therefore be isolated only in studies with a temporal

comparator or a control group. Pre/post comparisons are thus interpreted as temporal associations, unless the study design provides a higher level of inference.

Implications for evaluation, 2026–2030

The results converge on six needs for the current phase of the NIP: (1) to conduct a national coverage survey and systematically measure coverage at subprovincial level; (2) to identify zero-dose or delayed children; (3) to link vaccination registries with notifications, laboratory confirmation, hospitalizations and deaths; (4) to institutionalize catch-up after any service interruption; (5) to strengthen communication and trust, particularly for adolescent vaccines, through trained health professionals and community engagement; and (6) to evaluate the impact of hepatitis B vaccination through an HBsAg serosurvey of birth cohorts born after 1999 (Asraoui & Soulaymani, 2026; Erefai et al., 2025; Lemrabett et al., 2026; WHO & UNICEF, 2024; WHO, 2020). These priorities would make it possible to move from an interpretation based on the national average to an assessment of the programme's equity, timeliness and resilience.

CONCLUSION

From 1956 to 2026, Morocco's National Immunization Programme profoundly reduced the burden of several vaccine-preventable diseases. The most quantifiable evidence shows an 88% decline in under-five mortality from vaccine-preventable diseases between 1987 and 1996, a reduction of about 93% in the minimum incidence of Hib meningitis, of 60.9% in the incidence of IPD among young children and of 28% in under-five respiratory mortality after PCV, as well as a decline of more than 90% in historical cases of neonatal tetanus and diphtheria.

In contrast, the decline in case fatality remains insufficiently documented by homogeneous Moroccan pre/post series; this absence of evidence does not mean absence of effect, but reflects a limitation of the data. Vaccination coverage, estimated at 99% without empirical validation since 2020, should be revalidated by survey. The resurgence of measles in 2023–2025 and the diphtheria clusters of 2026 are reminders that the gains achieved depend on high and homogeneous coverage, catch-up of under-vaccinated children and sufficiently sensitive surveillance. The experience of neighbouring countries and the evidence on vaccine hesitancy indicate that these gains also depend on survey-validated coverage data and on sustained public trust.

Declarations

Author contributions (CRediT). Aida Soulaymani: conceptualization, methodology, investigation, data curation, formal analysis, visualization, writing – original draft, writing – review and editing. Fatima Aslaou: investigation, literature search, data curation, validation, writing – review and editing. Soumaia Hmimou: methodology, validation, supervision, writing – review and editing. Ayoub El Assali: investigation, validation, writing – review and editing. Faiçal El Hattimy: methodology, validation, writing – review and editing. All authors read and approved the final manuscript.

Funding. This review received no specific funding.

Competing interests. The authors declare no competing interests.

Data availability. All data analysed come from published sources cited in the reference list; no new data were generated.

Ethics approval. Not applicable (review of aggregated published data).

Use of artificial intelligence. A generative AI tool was used to assist with the literature search, consistency checks of references and figures, language editing and translation. The authors verified the sources, analyses and final version and take full responsibility for the content.

REFERENCES

1. Asraoui, A., & Soulaymani, A. (2026). COVID-19-related disruptions and measles vaccination uptake among children attending urban health centers in Guelmim, Morocco: A cross-sectional study. BMC Public Health. Advance online publication, 25 June 2026. https://doi.org/10.1186/s12889-026-28209-z
2. Baethge, C., Goldbeck-Wood, S., & Mertens, S. (2019). SANRA—a scale for the quality assessment of narrative review articles. Research Integrity and Peer Review, 4, 5. https://doi.org/10.1186/s41073-019-0064-8
3. Benhafid, M., Elomari, N., Azzouzi Idrissi, M., Rguig, A., Gentsch, J. R., Parashar, U., & Elaouad, R. (2015). Effect of monovalent rotavirus vaccine on rotavirus disease burden and circulating rotavirus strains among children in Morocco. Journal of Medical Virology, 87(6), 944–953. https://doi.org/10.1002/jmv.24122
4. Bennani Mechita, N., Obtel, M., Elmarnissi, A., Lahlou, L., Lyaghfouri, A., Cherkaoui, I., Mrabet, M., Razine, R., & Abouqal, R. (2020). Decline in childhood respiratory-related mortality after the introduction of the pneumococcal conjugate vaccine in Morocco. Journal of Infection and Public Health, 13(3), 402–406. https://doi.org/10.1016/j.jiph.2019.06.021
5. Bennasrallah, C., Maatouk, A., Kacem, M., et al. (2026). The measles vaccine's effectiveness during an epidemic: A test negative case control study (Tunisia, 2019). BMC Infectious Diseases, 26, 414. https://doi.org/10.1186/s12879-025-12460-7
6. Bernal, J. L., Cummins, S., & Gasparrini, A. (2017). Interrupted time series regression for the evaluation of public health interventions: A tutorial. International Journal of Epidemiology, 46(1), 348–355. https://doi.org/10.1093/ije/dyw098
7. Bishop, C., Parashar, D., Kizza, D., et al. (2025). New vaccine introduction in middle-income countries across the Middle East and North Africa—Progress and challenges. Vaccines, 13(8), 860. https://doi.org/10.3390/vaccines13080860
8. Braikat, M., Barkia, A., El Mdaghri, N., Rainey, J. J., Cohen, A. L., & Teleb, N. (2012). Vaccination with Haemophilus influenzae type b conjugate vaccine reduces bacterial meningitis in Morocco. Vaccine, 30(15), 2594–2599. https://doi.org/10.1016/j.vaccine.2012.01.041
9. Bruhn, C. A. W., Hetterich, S., Schuck-Paim, C., Kürüm, E., Taylor, R. J., Lustig, R., et al. (2017). Estimating the population-level impact of vaccines using synthetic controls. Proceedings of the National Academy of Sciences of the United States of America, 114(7), 1524–1529. https://doi.org/10.1073/pnas.1612833114
10. Burnett, E., Parashar, U. D., & Tate, J. E. (2020). Global impact of rotavirus vaccination on diarrhea hospitalizations and deaths among children <5 years old: 2006–2019. The Journal of Infectious Diseases, 222(10), 1731–1739. https://doi.org/10.1093/infdis/jiaa081
11. Burton, A., Monasch, R., Lautenbach, B., Gacic-Dobo, M., Neill, M., Karimov, R., et al. (2009). WHO and UNICEF estimates of national infant immunization coverage: Methods and processes. Bulletin of the World Health Organization, 87(7), 535–541. https://doi.org/10.2471/BLT.08.053819
12. Cherkaoui, I., Fakhreddine, A., El Massaoudi, K., & Zidouh, A. (1997). Investigation d'une épidémie de rougeole dans la localité de Kouf, province de Tétouan, Maroc [Investigation of a measles epidemic in Kouf, Tetouan Province, Morocco]. Eastern Mediterranean Health Journal, 3(3), 493–500. https://www.emro.who.int/emhj-volume-3-1997/volume-3-issue-3/article12.html
13. Chikhaoui, A., Nzoyikorera, N., Diawara, I., Jouhadi, Z., & Zerouali, K. (2022). Burden of invasive pneumococcal disease in children in Casablanca, Morocco four years after the introduction of pneumococcal vaccination. Pan African Medical Journal, 41, 2. https://doi.org/10.11604/pamj.2022.41.2.29449
14. Diawara, I., Zerouali, K., Katfy, K., Zaki, B., Belabbes, H., Najib, J., & Elmdaghri, N. (2015). Invasive pneumococcal disease among children younger than 5 years of age before and after introduction of pneumococcal conjugate vaccine in Casablanca, Morocco. International Journal of Infectious Diseases, 40, 95–101. https://doi.org/10.1016/j.ijid.2015.09.019
15. El Fadeli, S., Abouraicha, E. F., Mejdouli, H., Kaddouri, M., Al-Zharani, M., Nasr, F. A., Qurtam, A. A., Chamhari, A., Ait Melloul, A., Ait Lahcen, Z., & Barkouch, Y. (2026). National campaign for measles vaccination, verification, catch-up, and response among children and adolescents under 18 years. BMC

Infectious Diseases. Advance online publication, 3 August 2026. https://doi.org/10.1186/s12879-026-13900-8

16. Erefai, O., Boumaaize, Z., Sennani, S., Soulaymani, A., Mokhtari, A., Hami, H., et al. (2025). Determinants of COVID-19 vaccine hesitancy and prevalence of booster dose uptake among youth in Morocco. Discover Public Health, 22, 695. https://doi.org/10.1186/s12982-025-01115-2
17. Essayagh, T., Essayagh, M., Lemriss, H., et al. (2026). Prevalence and determinants of human papillomavirus vaccine hesitancy among parents of young girls in Morocco. Scientific Reports, 16, 21387. https://doi.org/10.1038/s41598-026-52998-3
18. Ezzine, H., Rguig, A., Naciri, M., & Jroundi, I. (2021). Trends for rotavirus acute gastroenteritis in children under 5 years old before and after vaccine introduction, Morocco, 2006–2014. Eastern Mediterranean Health Journal, 27(6), 553–562. https://doi.org/10.26719/2021.27.6.553
19. Farid, M., Sahak, M. N., Baffoe-Nyarko, I., Ghoniem, A., et al. (2026). Measles and rubella elimination trends in the WHO Eastern Mediterranean Region, 2023–2024: Progress and recent epidemiological shifts. Vaccines, 14(8), 659. https://doi.org/10.3390/vaccines14080659
20. Feindiri, M., Kabbaj, H., Salihoun, M., Errabih, I., Melloul, M., Elfahime, E., & Seffar, M. (2025). Hepatitis B surface antigen seroprevalence in Morocco (2000–2024): A systematic review and meta-analysis. BMC Infectious Diseases, 25, 1607. https://doi.org/10.1186/s12879-025-12002-1
21. Garenne, M., Darkaoui, N., Braikat, M., & Azelmat, M. (2007). Changing cause of death profile in Morocco: The impact of child-survival programmes. Journal of Health, Population, and Nutrition, 25(2), 212–220. https://pmc.ncbi.nlm.nih.gov/articles/PMC2753997/
22. Haisoufi, D., Elkhalloufi, F., Rouani, A., Boukrim, M., Bouaiti, E. A., Erefai, O., Haisoufi, N., & Fares, R. (2026). Spatio-temporal analysis of measles in Morocco (2023–2024): GIS-based hotspot detection and evidence-driven priorities for elimination. Multidisciplinary Science Journal, 9(2), 2027057. https://doi.org/10.31893/multiscience.2027057
23. Hanquet, G., Valenciano, M., Simondon, F., & Moren, A. (2013). Vaccine effects and impact of vaccination programmes in post-licensure studies. Vaccine, 31(48), 5634–5642. https://doi.org/10.1016/j.vaccine.2013.07.006
24. Infectious disease surveillance update. (2025). The Lancet Infectious Diseases. https://doi.org/10.1016/S1473-3099(25)00377-9
25. Institut National d'Hygiène. (n.d.). Bulletin de l'INH n° 4 : Poliomyélite et surveillance des paralysies flasques aiguës au Maroc [INH Bulletin No. 4: Poliomyelitis and acute flaccid paralysis surveillance in Morocco]. http://inh.ma/wp-content/themes/twentythirteen-child/Documents_PDF/Bulletin_INH_N4.pdf
26. Jarrett, C., Wilson, R., O'Leary, M., Eckersberger, E., Larson, H. J., & SAGE Working Group on Vaccine Hesitancy. (2015). Strategies for addressing vaccine hesitancy – A systematic review. Vaccine, 33(34), 4180–4190. https://doi.org/10.1016/j.vaccine.2015.04.040
27. Khalis, M., Boucham, M., Luo, A., Marfak, A., Saad, S., Aboubacar, C. M., et al. (2021). COVID-19 vaccination acceptance among health science students in Morocco: A cross-sectional study. Vaccines, 9(12), 1451. https://doi.org/10.3390/vaccines9121451
28. Lahlou, K. (2016, January). Programme national d'immunisation : Évolution et perspectives [National Immunization Programme: Evolution and perspectives] [Presentation]. Directorate of Population, Ministry of Health, Casablanca, Morocco. https://www.capm-sante.ma/uploads/documents/Ebook_PRT_CALENDRIER_PNI_2016.pdf
29. Lamdouar Bouazzaoui, N. (2006). Évolution du calendrier vaccinal au Maroc [Evolution of the vaccination schedule in Morocco]. Bulletin de l'Académie Nationale de Médecine, 190(4–5), 1017–1033. https://www.academie-medecine.fr/evolution-du-calendrier-vaccinal-au-maroc/
30. Lemrabett, S., Elhailouch, F. Z., Gourinda, A., Mezzoug, N., et al. (2026). Awareness and acceptability of HPV vaccination among parents of young girls in northern Morocco: A mixed-methods study. BMC Cancer, 26, 854. https://doi.org/10.1186/s12885-026-16111-1
31. L'épidémie poursuit sa régression / Rougeole : 746 cas et 0 décès du 12 au 18 mai 2025 [The epidemic continues to decline / Measles: 746 cases and 0 deaths from 12 to 18 May 2025]. (2025, May). Aujourd'hui le Maroc. https://aujourdhui.ma/societe/lepidemie-poursuit-sa-regression-rougeole-746-cas-et-0-deces-du-12-au-18-mai-2025

32. MacDonald, N. E., & SAGE Working Group on Vaccine Hesitancy. (2015). Vaccine hesitancy: Definition, scope and determinants. Vaccine, 33(34), 4161–4164. https://doi.org/10.1016/j.vaccine.2015.04.036
33. Mahraoui, C. (2026). Measles outbreak in children: Experience of the Children's Hospital of Rabat (2024–2025). Cureus, 18(2), e102886. https://doi.org/10.7759/cureus.102886
34. Mangtani, P., Abubakar, I., Ariti, C., Beynon, R., Pimpin, L., Fine, P. E. M., et al. (2014). Protection by BCG vaccine against tuberculosis: A systematic review of randomized controlled trials. Clinical Infectious Diseases, 58(4), 470–480. https://doi.org/10.1093/cid/cit790
35. Mejdouli, H., El Fadeli, S., & Barkouch, Y. (2025). Epidemiological surveillance of measles in Morocco, 2024: Knowledge, attitudes and practices of health professionals in the province of Essaouira. Christian Journal for Global Health, 12(2), 13–22. https://doi.org/10.15566/cjgh.v12i2.421
36. Ministère de la Santé du Maroc. (n.d.). Programme national d'immunisation : Contexte, objectifs et structures concernées [National Immunization Programme: Context, objectives and structures involved]. https://www.sante.gov.ma/revuepresse/dossiersante/Documents/Programme%20National%20d'Immunisation.pdf
37. Ministry of Health and Social Protection. (2026, September 28). Press release on two family clusters of diphtheria in the Souss-Massa region [in French]. Reported by SNRT News (https://snrtnews.com/fr/article/159387) and Le Matin (https://lematin.ma/nation/diphterie-deux-foyers-detectes-huit-cas-sous-investigation/367496)
38. Minta, A. A., Ferrari, M., Antoni, S., Portnoy, A., Sbarra, A., Lambert, B., et al. (2023). Progress toward measles elimination — worldwide, 2000–2022. Morbidity and Mortality Weekly Report, 72(46), 1262–1268. https://doi.org/10.15585/mmwr.mm7246a3
39. Morris, S. K., Moss, W. J., & Halsey, N. (2008). Haemophilus influenzae type b conjugate vaccine use and effectiveness. The Lancet Infectious Diseases, 8(7), 435–443. https://doi.org/10.1016/S1473-3099(08)70152-X
40. Motawi, B., Ribaira, E., & El-Kamary, S. S. (2025). Childhood vaccination coverage and determinants in Jordan: A population-based study. BMC Public Health, 25, 4349. https://doi.org/10.1186/s12889-025-25549-0
41. Musa, N., Ghoniem, A., Hsu, C. H., et al. (2024). Progress toward measles elimination — World Health Organization Eastern Mediterranean Region, 2019–2022. Morbidity and Mortality Weekly Report, 73(7), 139–144. https://doi.org/10.15585/mmwr.mm7307a1
42. Whitney, C. G., Farley, M. M., Hadler, J., Harrison, L. H., Bennett, N. M., Lynfield, R., et al. (2003). Decline in invasive pneumococcal disease after the introduction of protein-polysaccharide conjugate vaccine. The New England Journal of Medicine, 348(18), 1737–1746. https://doi.org/10.1056/NEJMoa022823
43. Wilson, S. L., & Wiysonge, C. (2020). Social media and vaccine hesitancy. BMJ Global Health, 5(10), e004206. https://doi.org/10.1136/bmjgh-2020-004206
44. World Health Organization. (n.d.). Immunization Data Portal – Morocco: Vaccination coverage and reported cases of vaccine-preventable diseases (Joint Reporting Form). https://immunizationdata.who.int/dashboard/regions/eastern-mediterranean-region/MAR
45. World Health Organization. (2002). Validation of neonatal tetanus elimination, Morocco, 2002. Weekly Epidemiological Record, 77(39), 325–328.
46. World Health Organization. (2003). Immunization profile – Morocco (WHO/V&B/03.20). https://iris.who.int/bitstream/handle/10665/68469/WHO_VB_03.20-eng.pdf
47. World Health Organization. (2019, May 9). Measles – Tunisia: Disease outbreak news (update). https://reliefweb.int/report/tunisia/measles-tunisia-disease-outbreak-news-update-9-may-2019
48. World Health Organization. (2020). Immunization Agenda 2030: A global strategy to leave no one behind. https://www.who.int/publications/m/item/immunization-agenda-2030-a-global-strategy-to-leave-no-one-behind
49. World Health Organization. (2022). Human papillomavirus vaccines: WHO position paper, December 2022. Weekly Epidemiological Record, 97(50), 645–672. https://www.who.int/publications/i/item/who-wer9750-645-672

50. World Health Organization. (2025, May 13). Disease Outbreak News: Measles – Morocco (DON568). https://www.who.int/emergencies/disease-outbreak-news/item/2025-DON568
51. World Health Organization, & UNICEF. (2024). Morocco: WHO and UNICEF estimates of immunization coverage: 2023 revision. https://cdn.who.int/media/docs/default-source/country-profiles/immunization/2024-country-profiles/immunization-2024-mar.pdf
52. World Health Organization, & UNICEF. (2026). WHO/UNICEF estimates of national immunization coverage (WUENIC), 2025 revision: Technical notes. https://cdn.who.int/media/docs/default-source/immunization/immunization-coverage/wuenic_notes.pdf
53. World Health Organization Regional Committee for the Eastern Mediterranean. (2008). Progress report: Poliomyelitis eradication (EM/RC55/INF.DOC.2).
54. World Health Organization Regional Office for Africa. (2025, October 28). Rapid risk assessment: Diphtheria, African Region (Version 1). https://cdn.who.int/media/docs/default-source/documents/emergencies/20251103_web_diphtheria_regional-afro_rra-v.1.pdf
55. World Health Organization Regional Office for the Eastern Mediterranean. (n.d.). Measles elimination: Country profile – Morocco (WHO-EM/EPI/273).
56. Zraidi, M., & Ibriz, M. (2023). Human papillomavirus vaccination in view of the National Cancer Control Plan 2020–2029 in Morocco. Pan African Medical Journal, 45, 115. https://doi.org/10.11604/pamj.2023.45.115.40004

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Supplementary material

Supplementary Table S1. Characteristics of the 34 Moroccan or institutional sources included (in order of first citation).

Source (author or organization, year)	Source type / design	Period covered	Indicators used	Level of evidence for impact
Lamdouar Bouazzaoui, 2006	Historical review	1929–2006	Schedule; diphtheria, neonatal tetanus and poliomyelitis cases	Moderate (surveillance)
Ministry of Health, n.d.	Institutional document	Since 1987	NIP organization and objectives	Context
WHO/UNICEF, 2024	WUENIC estimates (2023 revision)	2012–2023	Coverage by antigen; ENPSF 2018 survey	Moderate up to 2019; low 2020–2023 (extrapolated)
Garenne et al., 2007	Two national verbal autopsy surveys	1987–1996	Cause-specific under-5 mortality	Moderate
Lahlou, 2016	Institutional presentation	1982–2016	Schedule; poliomyelitis; neonatal tetanus	Context
WHO, 2025 (DON568)	Outbreak report	Oct 2023–Apr 2025	Cases, deaths, vaccination status, genotype	Descriptive
WHO-EMRO	Country profile	1980s–2000s	Measles vaccination schedule	Context
WHO/UNICEF, 2026	WUENIC technical notes (2025 revision)	2025	Submission of coverage data	Context (data quality)
Asraoui and Soulaymani, 2026	Cross-sectional study (350 mothers, Guelmim)	2025	Measles vaccination and determinants	Local, not generalizable
Braikat et al., 2012	Pre/post sentinel surveillance (11 hospitals)	2004–2009	Hi meningitis cases and incidence	Strong
Diawara et al., 2015	Pre/post population-based surveillance (Casablanca)	2007–2014	IPD incidence	Strong
Bennani Mechita et al., 2020	National interrupted time series	Before/after PCV (2010)	Under-5 respiratory mortality	Strong
Chikhaoui et al., 2022	Hospital case series	2015–2018	IPD case fatality	Low (no comparator)
Benhafid et al., 2015	Pre/post sentinel surveillance (3 hospitals)	Before 2010; 2011–2013	Proportion of rotavirus AGE	Moderate

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Source (author or organization, year)	Source type / design	Period covered	Indicators used	Level of evidence for impact
Ezzine et al., 2021	Sentinel surveillance and vaccine effectiveness	2006–2014	Proportion of rotavirus AGE; effectiveness	Moderate
Ministry of Health, 2026	Official press release	Sept 2026	Diphtheria cases and deaths	Preliminary, descriptive
WHO, 2002	Elimination validation	2002	Neonatal tetanus elimination	Strong (elimination criterion)
INH, n.d.	Surveillance bulletin	1980–2010s	Poliomyelitis cases; AFP surveillance	Moderate
WHO-EMRO, 2008	Regional report	2007	Poliomyelitis eradication certification	Strong (criterion)
Cherkaoui et al., 1997	Outbreak investigation	1990s	Measles cases and local coverage	Descriptive
Lancet Infect Dis, 2025	Epidemiological surveillance update	2023–May 2025	Catch-up coverage; case trends	Descriptive
Aujourd'hui le Maroc, 2025	Press (weekly Ministry report)	May 2025	Weekly measles cases and deaths	Descriptive
El Fadeli et al., 2026	National analysis of a verification and catch-up campaign (<18 y)	2024–2025	Vaccination-status verification; incompleteness; catch-up by region	Moderate (national programme data)
Lemrabett et al., 2026	Mixed-methods study (northern Morocco)	After 2022	HPV vaccine awareness and acceptability	Local
Erefai et al., 2025	Cross-sectional study (young people)	Post-pandemic	Vaccine hesitancy	Local
WHO, JRF portal	Official database	1980–2025	Reported cases; coverage	Moderate
WHO, 2003	Country profile	1980–2002	Cases, populations, coverage	Moderate
Haisoufi et al., 2026	Retrospective GIS-based spatial analysis	2023–2024	Regional measles incidence; hotspots	Descriptive
Mahraoui, 2026	Hospital case series (587 children, Rabat)	2024–2025	Age, vaccination status, complications of measles	Descriptive (hospital-based)
Mejdouli et al., 2025	Cross-sectional survey of health professionals (n = 41, Essaouira)	2024	Knowledge of case definition and notification rules	Context (surveillance quality)
Zraidi and Ibriz, 2023	Programme description	2022	HPV schedule, target group and delivery strategy	Context

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Source (author or organization, year)	Source type / design	Period covered	Indicators used	Level of evidence for impact
Essayagh et al., 2026	Multicentre cross-sectional survey (2,088 parents, five regions)	2025	HPV vaccine hesitancy and determinants	Multiregional, not representative
Feindiri et al., 2025	Systematic review and meta-analysis (30 studies)	2000–2024	HBsAg seroprevalence	Indirect (no birth-cohort comparison)
Khalis et al., 2021	Cross-sectional survey (1,272 health science students)	2021	COVID-19 vaccine acceptance and determinants	Local

AFP: acute flaccid paralysis; AGE: acute gastroenteritis; Hi: Haemophilus influenzae; IPD: invasive pneumococcal disease. The level of evidence describes the capacity of the source to document vaccine impact, not its intrinsic quality.

Supplementary File S2. Search strategy, selection process and composition of the final corpus

S2.1. Platforms and period. The search covered 1956 to September 2026. Peer-reviewed sources were searched in PubMed/PubMed Central, BMC/Springer Nature and other open-access journals (including WHO-EMRO journals). Institutional and grey literature was searched in WHO IRIS, WHO Disease Outbreak News, the WHO Immunization Data Portal and WUENIC country profiles, UNICEF data, the website and press releases of the Ministry of Health and Social Protection, National Institute of Hygiene bulletins, regional WHO risk assessments and the national press reporting official weekly epidemiological data. A general web search engine was used to locate grey literature during the update. The main search was closed on 28 September 2026 and updated on 3 October 2026 (blocks C to F in Table S2).

Table S2. Search blocks, platforms and search strings (English terms shown; French equivalents were used in parallel)

Search block	Platforms	Search string / terms	Date
A. Programme history, coverage and impact	PubMed/PubMed Central; BMC/Springer Nature; WHO-EMRO and other open-access journals	(Morocco OR Moroccan OR Maroc) AND (vaccin* OR immuniz* OR immunis*) AND (incidence OR mortality OR “case fatality” OR coverage OR measles OR diphtheria OR “neonatal tetanus” OR poliomyelitis OR “Haemophilus influenzae” OR pneumococc* OR rotavirus OR “hepatitis B” OR HPV OR papillomavirus OR “catch-up” OR hesitan*)	Closed 28 September 2026
B. Institutional and grey literature	WHO IRIS, Disease Outbreak News, Immunization Data Portal, WUENIC profiles; UNICEF; Ministry of Health and Social Protection; National Institute of Hygiene; national press	Morocco/Maroc combined with: Programme national d’immunisation; PEV; calendrier vaccinal; couverture vaccinale; rougeole; diphtérie; poliomyélite; tétanos néonatal; rattrapage	Closed 28 September 2026

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IX September 2026

Search block	Platforms	Search string / terms	Date
C. Regional comparators (update)	PubMed/PubMed Central; MMWR; WHO Disease Outbreak News; WHO regional risk assessments; open-access journals	(Tunisia OR Algeria OR Egypt OR Jordan OR "Eastern Mediterranean") AND (measles OR diphtheria OR "vaccination coverage" OR "vaccine introduction" OR "coverage survey")	3 October 2026
D. Antigens without impact data (update)	PubMed/PubMed Central; BMC/Springer Nature; institutional documents; general web search	Morocco AND ("hepatitis B" AND (HBsAg OR seroprevalence)); Morocco AND (BCG OR "tuberculous meningitis"); Morocco AND (rubella OR "congenital rubella"); Morocco AND (HPV OR papillomavirus) AND (vaccin* OR coverage OR programme)	3 October 2026
E. 2023–2025 measles outbreak and vaccine confidence (update)	PubMed/PubMed Central; open-access journals; WHO Disease Outbreak News	Morocco AND measles AND (outbreak OR epidemic OR catch-up OR surveillance OR hospital); Morocco AND vaccin* AND (hesitancy OR confidence OR acceptance OR refusal OR trust)	3 October 2026
F. Methods of vaccine impact assessment (update)	PubMed; reference lists of included methodological papers	("interrupted time series" OR "synthetic control" OR "test-negative" OR "post-licensure") AND vaccin* AND (impact OR effectiveness)	3 October 2026

S2.2. Selection. Records were screened on titles and abstracts, then on full texts. Inclusion criteria were: (i) Moroccan data on the vaccination schedule, coverage, surveillance, incidence, mortality, case fatality, equity, acceptability or vaccine confidence; (ii) open-access full text or official document; and (iii) identifiable origin of the figures reported. Exclusion criteria were: duplicates; documents without Moroccan data, except regional, international or methodological references retained for comparison or interpretation; and secondary documents reproducing figures without identifiable primary source. When several documents reported the same indicator, the primary or most recent official source was retained, and discrepancies between sources (for example, dates of introduction of measles vaccination or of the last poliomyelitis case) were reported rather than resolved arbitrarily. Because of the substantial overlap of results across queries and platforms, raw record counts were not summed.

S2.3. Composition of the final corpus (n = 56). Moroccan or institutional sources (n = 34): 20 peer-reviewed Moroccan studies or reviews; 12 institutional or WHO/UNICEF documents on Morocco; and 2 surveillance updates or press reports of official weekly data (Supplementary Table S1). Methodological, regional or comparative sources (n = 22): 7 regional comparative sources (Tunisia, Algeria, Egypt, Jordan and the Eastern Mediterranean Region); 5 international studies of vaccine impact or protection; 3 references on vaccine confidence; 2 global policy documents; and 5 methodological references.