

Vaccine Economics and Policy in Morocco: Financing, Efficiency, Access, and the Transition Toward Health Sovereignty

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ABSTRACT

Introduction: Vaccination is a public health intervention, an economic investment, and a health-security instrument. In Morocco, the national immunization program (PNI) has progressively expanded to include newer vaccines, while the COVID-19 pandemic reinforced concerns over supply security, logistical resilience, and local production.

Objective: To analyze the evolution of vaccine economics and policy in Morocco, focusing on financing, the introduction of new vaccines, economic evaluation data, access, supply chains, and the transition toward greater industrial autonomy.

Methods: A scoping review mapped available evidence on vaccine economics and policy in Morocco, combining Scopus, PubMed/MEDLINE, Web of Science Core Collection, and ScienceDirect, supplemented by relevant institutional sources. Selection, extraction, and synthesis followed PRISMA-ScR principles, and studies were classified by relevance to Morocco and by the economic, programmatic, logistical, financial, and industrial dimensions examined.

Results: The Moroccan literature shows an economic evidence base that is still limited but now better structured, with the most robust data concerning rotavirus and HPV. PubMed confirmed the Moroccan rotavirus economic evaluation by Mohy et al. [2], while Web of Science and ScienceDirect broadened the analysis to vaccine financing, procurement, pricing, local production, and African industrial capacity. The systematic review by Bishop et al. [1], covering 26 economic evaluations (12 HPV, 9 rotavirus, 5 pneumococcal), concludes that PCV and rotavirus vaccination are generally economically favorable and that HPV vaccination is generally cost-effective in Morocco. The evidence converges on the importance of assessing total program cost, budget impact, financing sustainability, and the economic viability of local production, beyond acquisition price alone.

Conclusion: Morocco is moving from a model centered on vaccination coverage toward an integrated policy combining prevention, economic efficiency, budget sustainability, supply security, local production, and African cooperation. Developing cost-effectiveness, cost-utility, and budget-impact analyses based on national data appears essential to guide future vaccination decisions.

Keywords: vaccination; health economics; vaccine policy; cost-effectiveness; Morocco.

INTRODUCTION

Vaccination is one of the most important interventions for preventing communicable diseases. Its economic value, however, extends beyond the mere acquisition cost of doses. A vaccination policy mobilizes resources for procurement, transport, the cold chain, information systems, human resources, administration, surveillance,

and pharmacovigilance. In return, it can avert consultations, hospitalizations, treatments, disabilities, deaths, and productivity losses.

In middle-income countries, this trade-off is particularly complex. The introduction of newer vaccines often increases financial needs precisely when external support mechanisms are more limited. Onishchenko et al. [4] showed that vaccine investment in middle-income countries remains heterogeneous and depends on states' capacity to sustain durable financing. Recent work by Bishop et al. [1, 3] also highlights the difficulties of introducing new vaccines in middle-income MENA countries, including fiscal constraints, pricing, procurement mechanisms, the availability of local economic data, and vaccine hesitancy.

Morocco is a relevant case study. The country has a long-standing and structured national immunization program (PNI) and has progressively introduced new antigens. The rotavirus experience is particularly informative: before vaccine introduction, Benhafid et al. [5] had shown that rotavirus accounted for 44% of diarrhea hospitalizations among young children across four Moroccan sentinel sites. After vaccine introduction, Benhafid et al. [6] observed a substantial decrease in the proportion of hospitalizations associated with rotavirus. Health-economic planning in Morocco has, in fact, a long history: Barlow [7] applied an early health-planning model to the country decades before the current wave of vaccine-specific economic evaluations.

The national economic literature subsequently expanded. Messoudi et al. [8] developed a Markov model comparing HPV vaccination and cervical cancer screening in Morocco. Mohy et al. [2] conducted an economic evaluation comparing several rotavirus vaccination schedules in Moroccan children. This work shows that vaccine choices can and should be analyzed in terms of health outcomes, costs, savings, and cost-effectiveness ratios, not solely on the basis of a dose's face price.

Since the COVID-19 pandemic, the debate has broadened to encompass supply security and production capacity. The Benslimane industrial project and the development of Marbio place vaccination within a logic of health sovereignty and industrial policy. This evolution nonetheless needs to be assessed through a comprehensive economic approach integrating fixed investments, technology transfers, volumes, unit costs, supply security, and export potential.

The overall objective of this review is to analyze the evolution of vaccine economics and policy in Morocco. The specific objectives are to: (i) describe the place of economic evaluation in vaccination decisions; (ii) synthesize Moroccan data on rotavirus and HPV; (iii) examine financing and new-vaccine-introduction issues; (iv) analyze access, logistics, and resilience dimensions; and (v) discuss the transition toward local production and vaccine sovereignty.

METHODS

Review type and reporting framework

This is a scoping review aimed at mapping the extent, nature, and gaps in knowledge relating to vaccine economics and policy in Morocco. This design is suited to a broad question spanning economic evaluations, financing, access, procurement, pricing, logistics, governance, and local production, drawing on heterogeneous evidence sources. Reporting was harmonized with PRISMA-ScR. Because the search strategy was built exploratorily and then refined through thematic queries, the flow-diagram counts should be regarded as a consolidated count of the working corpus rather than the arithmetic sum of each query's raw results.

Databases and documentary sources

Four international bibliographic databases or platforms were searched: Scopus, PubMed/MEDLINE, Web of Science Core Collection, and ScienceDirect. Scopus served as the primary database for exploratory and thematic screening; PubMed was used as a biomedical and public-health complement; Web of Science was used to check interdisciplinary coverage and identify additional references or duplicates; ScienceDirect was mobilized in a targeted complementary phase, particularly for economic evaluations, financing, procurement mechanisms, pricing, local production, and vaccine industrial capacity. Official Moroccan and international

institutional sources were also consulted to document recent financing, supply, local-production, and vaccine-sovereignty policies when this information was not yet sufficiently described in indexed publications.

Search strategy in Scopus

The initial exploratory search in Scopus used the combination «vaccine AND economics AND policy», targeted on Morocco/Moroccan. As of August 11, 2026, this search identified 829 documents. The 829 records were screened in successive batches to identify directly Moroccan studies and relevant comparative work. A second phase then used several more specific thematic queries covering: (i) vaccine policy and economic evaluation; (ii) cost-effectiveness, cost-benefit, and budget impact; (iii) financing and sustainability; (iv) access, equity, coverage, and affordability; (v) procurement, pricing, tenders, and procurement mechanisms; (vi) logistics chain, cold chain, distribution, and implementation costs; (vii) economic burden and disease costs; and (viii) local production, manufacturing, technology transfer, and supply security. The corpora obtained through these queries overlapped and were therefore not summed.

Search strategy in PubMed/MEDLINE

PubMed was searched using a query combining vaccination terms in the title/abstract (vaccin*, vaccination, immunization, immunisation), economic and public-policy terms (economics, economic*, cost*, financing, expenditure*, affordability, cost-effectiveness, cost benefit, budget impact, procurement, policy), and the geographic terms Morocco or Moroccan. This strategy identified 77 references. Screening distinguished relevant human studies from duplicates with Scopus and from out-of-scope results, notably veterinary, biological, or purely contextual studies.

Search strategy in Web of Science

Web of Science Core Collection was searched using a conceptually equivalent Topic (TS) query: TS=((vaccin* OR immunization OR immunisation) AND (economics OR economic* OR cost* OR financing OR expenditure* OR affordability OR “cost-effectiveness” OR “cost effectiveness” OR “cost-benefit” OR “cost benefit” OR “budget impact” OR procurement OR policy) AND (Morocco OR Moroccan)). This search identified 111 documents. References were screened to identify relevant human and economic studies, to identify duplicates with Scopus and PubMed, and to exclude veterinary or animal publications, or those with no direct link to human vaccine economics or policy.

Search strategy in ScienceDirect

ScienceDirect was searched using several targeted queries rather than a single very broad equation. Combinations paired Morocco/Moroccan and vaccine/vaccination with economic and industrial terms, including cost, cost-effectiveness, economic evaluation, financing, budget impact, procurement, pricing, and local manufacturing. The broadest searches generated several thousand results, while more specific queries reduced the document volume (for example, 458 results for Morocco AND vaccine AND “cost-effectiveness”, 80 for Morocco AND vaccination AND “economic evaluation”, and 43 for Morocco AND vaccine AND “local manufacturing”). Because of the platform’s full-text search behavior and the substantial overlap between queries, these counts were treated as screening volumes rather than as numbers of unique studies. Screening prioritized articles that were directly Moroccan or regional MENA/Africa analyses providing transferable insights on financing, procurement, pricing, logistics, and vaccine production.

Selection and relevance criteria

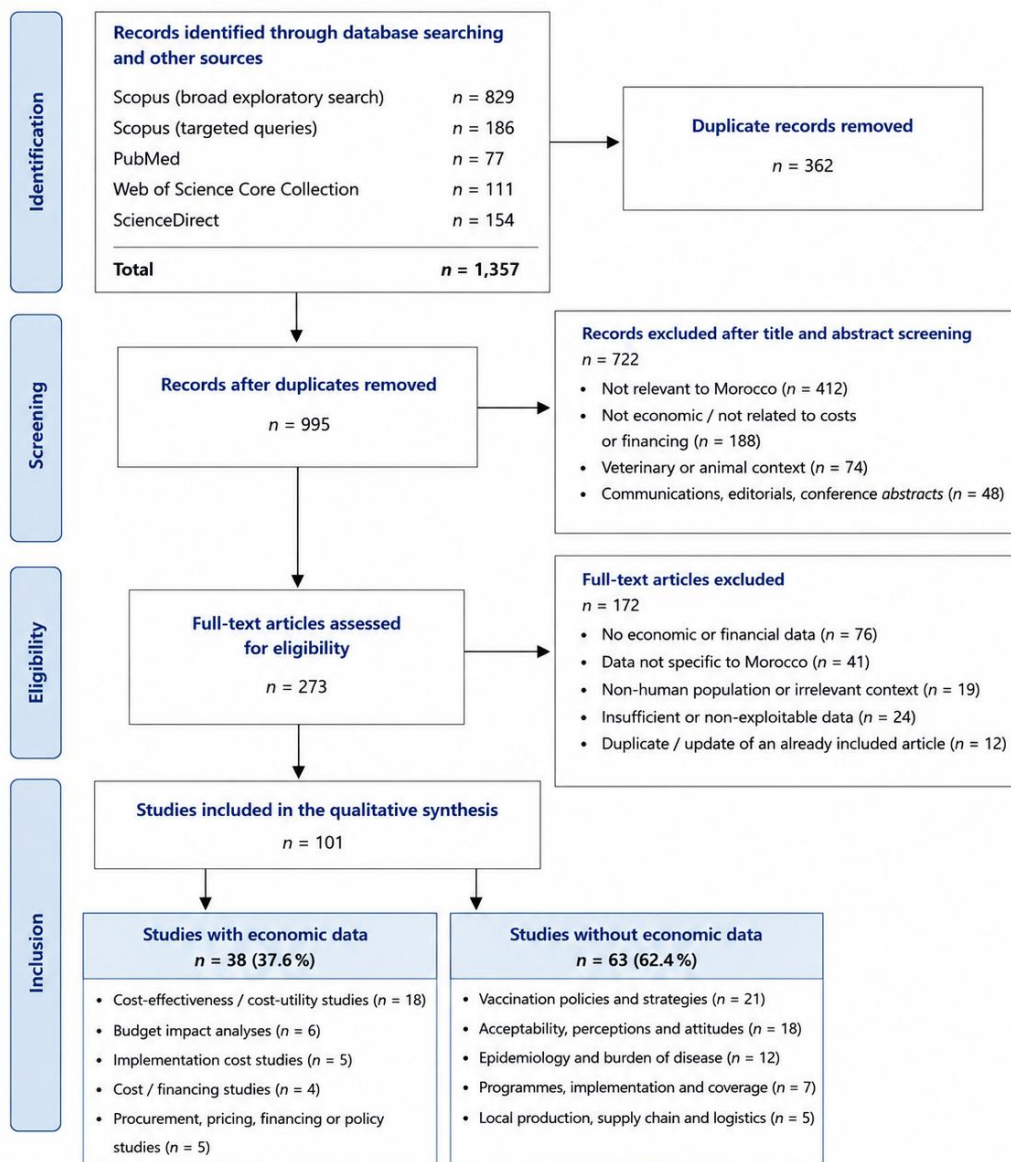
Priority was given to: (1) studies conducted in Morocco; (2) economic evaluations of vaccines or vaccine prevention strategies; (3) studies on financing, budget impact, resource allocation, or program sustainability; (4) work on access, equity, coverage, and acceptability when it included an economic or public-policy dimension; (5) studies on procurement, pricing, logistics, the cold chain, deployment costs, and supply security; (6) work on local production, manufacturing, and technology transfer; and (7) regional MENA or international analyses directly transferable to the Moroccan context. Excluded were purely biological,

experimental, veterinary, or environmental studies, or those with no direct link to human vaccination, health economics, or public policy.

Duplicate management and selection of evidence sources

Results from Scopus, PubMed, Web of Science, and ScienceDirect were compared to identify publications found across multiple databases. Raw query counts were not summed, given the substantial overlap between databases and strategies. Selection distinguished: (i) studies directly usable for Morocco; (ii) MENA or African studies useful for interpretation and transferability; and (iii) out-of-scope references. The flow diagram (Figure 1) summarizes the consolidated count used in the working corpus. Before final submission, these figures will need to be reconciled with the deduplicated bibliographic file to ensure fully reproducible traceability.

In the consolidated count currently documented, 995 references were screened after deduplication, 273 full texts were assessed, and 101 studies were retained in the qualitative synthesis. Of these, 38 (37.6%) provided directly usable economic data, and 63 (62.4%) primarily documented vaccine policy, acceptability, epidemiology, implementation, logistics, or local production. This structure highlights a contrast between a relatively broad vaccination literature and a more limited number of formal economic evaluations. These figures are retained as a working count and must be validated against the final bibliographic file before submission.



Note: Numbers may not add up exactly due to rounding and because some references address more than one theme.

Figure 1. Flow diagram of bibliographic selection for the scoping review (working consolidated counts; final validation against the deduplicated reference file required before submission).

Data charting and synthesis

For each retained source, data were charted according to the following variables: vaccine or pathology, country and level of transferability to Morocco, study type, population, economic method, perspective, time horizon when available, health outcomes, costs and savings, cost-effectiveness ratios, budget impact or economic burden, access and equity, financing, procurement and pricing, logistics and implementation costs, governance, local production, and supply security. Results were synthesized descriptively and thematically. Directly Moroccan data were distinguished from regional MENA/African data and international comparators to avoid any implicit extrapolation.

Reporting: the manuscript was revised in line with PRISMA-ScR. The full electronic search strategy for at least one database, the search dates, and the detailed extraction table should be provided as supplementary material at submission.

RESULTS

A large corpus but still a limited body of Moroccan economic literature

Screening of the 829 records confirms that the raw size of the corpus substantially overstates the literature actually devoted to Moroccan vaccine economics: many results concern other sectors, non-vaccine models, or work in which Morocco is only a contextual element. Nonetheless, several structuring references were identified on vaccine investment in middle-income countries, coverage equity, HPV economic evaluation, and vaccine schedule choices. This contrast between bibliometric volume and the limited number of directly national studies is itself a finding: Moroccan vaccine economics remains a field to be consolidated.

This finding is consistent with Nagi et al. [9], who identified only 46 vaccine economic evaluations across 26 MENA countries through 2019, with studies concentrated in Iran, Israel, and Turkey. The authors noted the scarcity of local data and the need to improve methodological quality and reporting. The updated review by Bishop et al. [1] confirms that economic evaluations of new vaccine introduction remain unevenly distributed across middle-income MENA countries.

Rotavirus: from epidemiological burden to economic evaluation

Before vaccine introduction, Benhafid et al. [5] studied 345 children under five hospitalized for acute gastroenteritis across four Moroccan sentinel hospitals. Among the 314 children with complete data, 138 (44%) were rotavirus-positive. This surveillance helped document the disease burden and informed the vaccine introduction decision.

After Rotarix was introduced into the PNI in October 2010, Benhafid et al. [6] reported a marked reduction in the proportion of children hospitalized for gastroenteritis who were rotavirus-positive. The mean pre-vaccination proportion was 44% between 2006 and 2010; it fell to 29%, 15%, and 24% in 2011, 2012, and 2013. The reduction was particularly pronounced among infants.

Mohy et al. [2] subsequently provided an explicitly economic analysis, found and verified in PubMed (PMID 38757507). Their static deterministic model, from national payer and societal perspectives, compares three strategies in Moroccan children under five. The two-dose human rotavirus vaccine (HRV) was associated, relative to three-dose options, with 194 fewer home-care episodes, 57 fewer medical consultations, and 8 fewer hospitalizations, as well as 7 discounted QALYs gained. Relative to HBRV, HRV reduced costs by approximately USD 1.8 million for the payer and USD 4.1 million for society. Against single-dose BRV-PV, HRV remained less costly from a societal perspective (approximately USD 187,000 in savings), whereas from the payer perspective BRV-PV was less costly, yielding an ICER of approximately USD 328,376/QALY for HRV, far above the USD 3,500 threshold adopted by the authors. These results illustrate the importance of the analytic perspective in vaccine decision-making.

HPV and cervical cancer prevention: a Moroccan demonstration of cost-effectiveness

Messoudi et al. [8] developed a Markov model adapted to the Moroccan context to compare visual inspection with acetic acid (VIA) screening, HPV vaccination, and combined strategies. According to their model, vaccinating adolescent girls at 70% coverage would reduce lifetime cervical cancer risk by 62% relative to no intervention, at an estimated cost of USD 1,150 per life-year saved. The authors conclude that HPV vaccination could be highly effective and cost-effective in Morocco.

This analysis should be viewed alongside the work of Aslaou et al. [10], who studied the epidemiological profile of cervical cancer in two Moroccan screening cohorts and discussed activity-based costs in a comparison of vaccine prevention versus therapeutic care. Together, these studies reinforce the case for viewing the HPV vaccine as a long-term prevention investment rather than an isolated expenditure of the immunization program. Arechkik et al. [11] similarly conducted a systematic review of cervical cancer in Morocco, reinforcing the disease-burden case for HPV prevention.

Introduction of new vaccines: lessons from middle-income MENA countries

Bishop et al. [3] analyzed the progress and difficulties of new vaccine introduction across several middle-income MENA countries, particularly for HPV, pneumococcal, and rotavirus vaccines. Obstacles include fiscal constraints, uncertainty over financial sustainability, pricing, the availability of local data, procurement mechanisms, and vaccine hesitancy. For Morocco, these findings argue for a more systematic formalization of economic evaluation ahead of introduction or strategy-change decisions.

Bishop et al. [1] specifically examined economic evaluations of new vaccine introduction in the region. This literature confirms that decision quality depends not only on clinical efficacy but also on the availability of local data on incidence, disease costs, negotiated prices, program costs, and budget impact.

Coverage, equity, and program performance

Vaccine coverage should be interpreted both as a performance indicator and as a determinant of a program's economic value. Recent global analyses by Haeuser et al. [12] note that coverage gains are heterogeneous and that delays, service disruptions, and under-vaccinated populations can reduce expected benefits. For Morocco, economic evaluation should therefore incorporate not only cost per dose but also cost per fully vaccinated child, drop-out rates, and the costs of catch-up strategies.

The Scopus screening reinforces this point through Hajizadeh's [13] study of socioeconomic inequalities in childhood vaccination in low- and middle-income countries. This literature cautions against limiting PNI evaluation to a national average coverage figure: a program's economic value also depends on its ability to reach under-vaccinated groups, for whom the marginal cost of access may be higher but the equity and public-health gains substantial.

Supply chain, resilience, and local production

The COVID-19 pandemic exposed the vulnerability of systems heavily dependent on international markets. Recent literature on vaccine access underscores that local production can improve supply security, but that it is sustainable only when accompanied by sufficient volumes, regulatory harmonization, predictable procurement mechanisms, technology transfers, and access to critical inputs (Tsega [14]).

In Morocco, the Benslimane project was designed as a vaccine manufacturing and fill-and-finish infrastructure intended to strengthen national and African vaccine sovereignty [15]. The Marbio–Sanofi industrial partnership, ratified in 2026, provides for the local manufacturing and supply of vaccines, including a pediatric hexavalent vaccine [16]. This development brings industrial policy closer to the needs of the PNI and opens the possibility of a comparative analysis of importation, local fill-and-finish, technology transfer, and integrated manufacturing.

African cooperation and vaccine diplomacy

In May 2026, Morocco signed an agreement providing a USD 5 million donation to Gavi, the Vaccine Alliance [17]. This contribution marks a political repositioning of the country: beyond its role as a buyer and potential producer, Morocco is also seeking to position itself as a contributor to vaccine equity and health-system strengthening. This African and international dimension gives Moroccan vaccine economics a scope that extends beyond the PNI's national budget alone.

Reference	Focus area	Type	Main contribution
Benhafid et al. [5]	Rotavirus	Sentinel surveillance, Morocco	44% of diarrhea hospitalizations were rotavirus-positive; data used to inform vaccine introduction.
Benhafid et al. [6]	Rotavirus	Post-introduction evaluation	Marked decline in the proportion of rotavirus-positive hospitalizations after vaccine introduction.
Messoudi et al. [8]	HPV / cervical cancer	Markov model, cost-effectiveness	Vaccination at 70% coverage: substantial reduction in cervical cancer risk and favorable cost-effectiveness ratio.
Mohy et al. [2]	Rotavirus	Economic evaluation, payer and societal perspectives	The 2-dose HRV schedule is associated with savings relative to certain 3-dose options and with health gains.
Aslaou et al. [10]	HPV / cervical cancer	Screening cohorts and activity-based cost analysis	Puts the cost of vaccine prevention in perspective against the burden of therapeutic care.
Nagi et al. [9]	Vaccines, MENA	Systematic review of economic evaluations	Shows the scarcity and heterogeneity of economic evaluations in the MENA region.
Bishop et al. [3]	New vaccines, MENA MICs	Policy analysis	Describes the financial, programmatic, and behavioral obstacles to new vaccine introduction.
Bishop et al. [1]	New vaccines, MENA MICs	Systematic economic review	Updates the economic data relevant to vaccine introduction decisions.
Tsega [14]	Local production	Policy and legal analysis	Highlights the conditions for sustainable local production: harmonization, procurement, diversification, and intellectual property.
Onishchenko et al. [4]	Financing / middle-income countries	Analysis of vaccine investment	Situates financing sustainability and the heterogeneity of vaccine investment in middle-income countries.
Abidi et al. [40]	HPV / Global South	Systematic economic review	Provides a comparative framework for interpreting the economic value of HPV vaccination in Morocco.
Hajizadeh [13]	Vaccine equity	Multi-country analysis, low/middle-income	Shows the importance of socioeconomic inequalities in vaccination and justifies integrating equity into PNI evaluation.
Bencheikroun et al. [19]	Public procurement / COVID-19	Procurement strategy study, Morocco	Analyzes Morocco's public procurement strategy; highlights supplier diversification, production internalization, and sustainability.
Mzili et al. [18]	Logistics / rural areas	Optimization modeling, Morocco	Shows the value of optimizing vaccine and medication distribution routes in rural areas.
Ussai et al. [20]	Pharmaceutical production / Africa	Pharmaceutical system analysis	Places Morocco among Africa's leading pharmaceutical hubs and highlights the continent's import dependence.

Berrada et al. [21]	HPV / anogenital warts	Resource use and costs, Morocco	Documents care resource use and costs for an HPV-related condition; useful for estimating avoidable costs.
Bennani Mechita et al. [22]	Pneumococcus	Before/after introduction analysis, Morocco	Reports a decline in infant respiratory mortality after introduction of the pneumococcal conjugate vaccine.
Chikhaoui et al. [23]	Pneumococcus	Burden study, Casablanca	Documents the residual burden of invasive pneumococcal disease four years after vaccination introduction.
Regragui et al. [24]	Influenza / children	Surveillance of severe acute respiratory infections, Morocco	Quantifies a hospital burden relevant to avoidable-cost models.
Ezzine et al. [25]	Seasonal influenza	Study of hospitalization factors, Morocco	Identifies hospitalizations as a resource-consuming outcome to incorporate into economic evaluation.
Bouazzaoui [28]	History / national immunization program	Historical review, Morocco	Traces the evolution of the vaccination schedule and the long-standing nature of national vaccination policy.
Jroundi et al. [29]	Governance / NITAG	Institutional assessment, Morocco	Documents the role of Morocco's NITAG in evidence-based vaccination recommendations.
Mouallif et al. [30]	HPV / acceptability	Parental survey, Morocco	Shows that HPV vaccine acceptability depends on knowledge factors and that cost can play a role in the decision.
Abouqal et al. [32]	Adult vaccination	Morocco–Tunisia review	Highlights the need to strengthen vaccination strategies for adults and older people.
Mohammed et al. [33]	Local production / Africa	Health policy perspective	Positions Morocco among the African countries engaged in local production of vaccines and medical products.

Table 1. Key references directly relevant to vaccine economics and policy in Morocco

Public procurement, logistics, and territorial distribution

The logistical dimension emerges as an economic determinant in its own right. Mzili et al. [18] studied the optimization of vaccine and COVID-19 medication distribution routes in rural Morocco using metaheuristic approaches. This work shows that the efficiency of a vaccination program does not depend on dose price alone: route organization, distances, territorial constraints, and the ability to serve rural areas directly influence the resources mobilized and effective access.

Bencheckroun et al. [19], for their part, analyzed Morocco's public procurement strategy for COVID-19 vaccines. Their framework links procurement strategy and sustainability and concludes that the Moroccan approach relied on supplier diversification and a shift toward internalizing production. This publication provides a direct link between procurement policy, supply security, resilience, and industrial strategy.

Local production and vaccine sovereignty

Targeted searching on local production identified only 15 documents, confirming the scarcity of scientific literature specifically devoted to Moroccan vaccine sovereignty. Bishop et al. [3] nonetheless note that, among the middle-income MENA countries studied, Morocco stands out for its introduction of HPV, pneumococcal, and rotavirus vaccines, while recalling that local production capacity and regional cooperation remain major determinants of resilience. Ussai et al. [20] situate this dynamic within the African context, characterized by heavy import dependence and a concentration of pharmaceutical capacity in a limited number of countries, including Morocco.

These findings call for distinguishing several levels of sovereignty: contractual security of procurement, supplier diversification, fill-and-finish, technology transfer, local manufacturing of finished products, and, ultimately, mastery of more complex steps of the value chain. The economic evaluation of this transition should incorporate fixed investments, unit costs by volume, national and regional demand, the risks of underutilized capacity, health-security externalities, and export potential toward Africa.

Economic burden and avoidable costs of vaccine-preventable diseases

Targeted searching on economic burden identified 84 references. It provides Moroccan data that complement cost-effectiveness analyses with a measure of resources consumed and potentially avoidable severe events. Berrada et al. [21] studied care resource use and costs associated with anogenital warts in Morocco, providing an additional economic argument for the HPV-related disease prevention continuum. For pneumococcus, Bennani Mechita et al. [22] reported a decline in infant respiratory mortality after introduction of the conjugate vaccine, while Chikhaoui et al. [23] documented the residual burden of invasive pneumococcal disease in children in Casablanca four years after vaccination introduction.

Influenza provides another example of avoidable health costs: Regragui et al. [24] described severe acute respiratory infections associated with influenza in children under five, and Ezzine et al. [25] studied factors associated with hospitalization for seasonal influenza in Morocco. These studies are not all formal economic evaluations, but they document resource-consuming events – hospitalizations, severe forms, and mortality – needed for future disease-cost and budget-impact modeling.

Budget impact, HTA, and resource allocation

The query dedicated to budget impact, HTA, resource allocation, and economic evaluation identified 27 documents. Bishop et al. [1] synthesize 26 economic evaluations covering PCV, HPV, and rotavirus vaccines in middle-income MENA countries. The review concludes that PCV and rotavirus are generally cost-effective or cost-saving, and that HPV vaccination is generally cost-effective in Morocco, while highlighting insufficient data on delivery costs, programmatic constraints, and affordability. Mohy et al. [2] provides one of the few directly Moroccan economic evaluations, while Mzili et al. [18] extends the notion of efficiency to rural-distribution optimization.

These findings point to a central gap: the literature identified contains few budget-impact analyses explicitly designed for Moroccan decision-makers and little work simultaneously linking clinical efficacy, total program cost, budget capacity, equity, and implementation constraints. Institutionalizing a vaccine HTA framework would help transform one-off evaluations into a reproducible decision-support process.

Sustainable financing, pricing, and procurement mechanisms

Targeted searching on sustainable financing identified only seven documents, while the search on pricing, procurement mechanisms, and vaccine markets identified only four. This low bibliographic density contrasts with the strategic importance of these dimensions. Onishchenko et al. [4] show that, in middle-income countries, sustained vaccine financing is associated with improved access, coverage, and certain health indicators, even though vaccine spending represents a small share of total health expenditure. A historical study by Levin et al. [26] on Morocco further suggests that financial efforts devoted to polio eradication did not crowd out routine immunization financing.

On the procurement side, Benchekroun et al. [19] analyze Morocco's COVID-19 vaccine procurement strategy and highlight supplier diversification and a shift toward internalizing production. At the regional level, Jumaan et al. [27] proposed, to facilitate HPV vaccine introduction in the MENA region, the use of a regional pooled-procurement mechanism. For Morocco, these findings support a joint assessment of acquisition price, negotiating power, volumes, logistics costs, supply security, and the potential benefits of coordinated or pooled procurement.

Additional contributions from PubMed, Web of Science, and ScienceDirect

Beyond the thematic axes already presented, complementary screening of PubMed (77 references), Web of Science Core Collection (111 documents), and ScienceDirect enriched the institutional and logistical reading of Moroccan vaccine policy, without altering the economic findings of Bishop et al. [1] already detailed in section 3.11 (26 economic evaluations in middle-income MENA countries: 12 HPV, 9 rotavirus, 5 PCV). A substantial share of the raw results from these three databases remained out of direct scope (veterinary or animal studies, or purely contextual occurrences of “Morocco”), which confirms the need for manual screening and cross-database triangulation rather than an arithmetic sum of raw volumes.

On the institutional side, Bouazzaoui [28] traces the evolution of the Moroccan vaccination schedule, and Jroundi et al. [29] document the role of Morocco’s NITAG as an independent expert body supporting evidence-based recommendations — two references that reaffirm that economic evaluation carries decision-making weight only when linked to governance capable of prioritizing and translating data into recommendations. For HPV, Mouallif et al. [30] and Baddouh et al. [31] show that parental acceptability also depends on economic factors, while Abouqal et al. [32] broaden the perspective to adult and older-adult vaccination in Morocco and Tunisia. Mohammed et al. [33] finally situate Moroccan local production within the African context, confirming that Moroccan concerns now combine vaccination schedule, scientific governance, acceptability, and industrial policy.

On financing, procurement, and manufacturing, ScienceDirect identified work on vaccine financing in the Middle East and Africa (de Beer et al. [34], procurement mechanisms and fiscal space in the MENA region (Kaddar et al. [35], the costs of immunization programs in low- and middle-income countries (Sim et al. [36], pricing and pooled-procurement issues in Africa (Osei et al. [37], and African manufacturing capacity and technology transfer (Doua et al. [38]. Web of Science further confirms the relevance of work on adult and influenza vaccination practices and on the determinants of acceptability among health professionals, including the regional VACCIMENA-HCP project (Tanriover et al. [39]. Together, these references complement the Morocco-specific data by showing that the cost of a vaccination policy depends simultaneously on dose price, negotiating power, volumes, delivery costs, logistical capacity, and market structure — and that a Moroccan vaccine-sovereignty strategy must be assessed at both the national and regional scale.

DISCUSSION

From vaccine coverage to economic value: the main lesson of the mapping exercise

This scoping review highlights a conceptual shift: assessing a vaccination policy can no longer rest on coverage alone but must incorporate the health, economic, budgetary, and strategic value produced by the resources mobilized. For Morocco, this approach implies assessing the total cost of the program — acquisition, distribution, cold chain, human resources, wastage, information systems, and surveillance — alongside cases, hospitalizations, deaths, and costs averted.

The most robust directly Moroccan data mainly concern rotavirus and HPV. Regional MENA and African studies usefully complement this base for financing, procurement mechanisms, pricing, and local manufacturing, but they constitute elements of contextualization and transferability rather than national estimates. This distinction is essential for interpreting the results and defining future Moroccan data needs.

What economic indicators for Morocco’s national immunization program?

A more structured economic evaluation of the PNI could rest on a dashboard including: acquisition cost per dose; full cost per dose administered; cost per fully vaccinated child; logistics cost and cold-chain cost; cost per case, hospitalization, and death averted; cost per DALY averted or QALY gained; 3–5-year budget impact; the cost of catch-up campaigns; and indirect costs averted for households and the economy.

The availability of these indicators would allow consistent comparison of new vaccines, schedule changes, and procurement or production strategies. It would also facilitate the integration of health technology assessment into vaccine governance.

Dose price versus total program cost

Mohy et al. [2] clearly illustrate the importance of this distinction. A schedule requiring fewer doses can lower product, transport, storage, and administration costs and reduce the risk of drop-out between doses. Conversely, a vaccine that is cheaper per dose is not necessarily the least costly option at the program level if the number of doses, wastage, logistics, or required visits are higher.

Additional evidence from the economic studies reviewed reinforces this distinction. A vaccine's face price represents only a fraction of the real implementation cost: storage, cold chain, transport, administration, training, information systems, supervision, communication, pharmacovigilance, and wastage management must all be factored into the calculation. A comparison between products or strategies should therefore rest on total program cost and, where relevant, on total cost of ownership and delivery rather than on unit price alone.

This approach is particularly important for comparing importation and local production. A locally produced option may present a higher industrial cost or purchase price in the short term while offering additional benefits in terms of reduced stock-out risk, shorter lead times, better stock control, and greater crisis-response capacity. Conversely, local production is economically justified only if these benefits offset fixed investments, learning costs, and the risks of underutilized capacity.

HPV: balancing vaccination and screening

The study by Messoudi et al. [8] is particularly important for prevention policy in Morocco, as it shows that vaccination and screening should not be evaluated independently. The cost-effectiveness ratio depends on coverage, the schedule, the cost of procedures, and the screening level already achieved. An optimal policy should therefore seek the best combination of adolescent vaccination and adult-women screening.

Socioeconomic equity: integrating the distribution of benefits

Vaccine economic analyses should not aim solely to maximize the total number of cases or DALYs averted. Hajizadeh [13] shows that socioeconomic gaps in vaccination remain a major issue in low- and middle-income countries. For Morocco, an "equity-informed" approach should document the additional cost needed to reach under-vaccinated populations and weigh this cost against the health and social benefits obtained. This perspective complements classic cost-effectiveness analyses and brings economic evaluation closer to universal-coverage objectives.

Local production: health security and economic rationale

Vaccine sovereignty should not be reduced to the existence of a factory. It constitutes a continuum running from full importation to fill-and-finish, then formulation, technology transfer, integrated production, and, ultimately, local research and development. Each level has a different cost structure and strategic value.

For Morocco, the key economic challenge will be to measure the total cost of local production relative to importation, while valuing benefits that are not strictly financial: reduced stock-out risk, crisis-response capacity, skills development, industrial spillovers, exports, and regional positioning. Tsega [14] notes, however, that local production becomes sustainable only if procurement mechanisms, regulation, volumes, and access to technology are aligned.

Recent work on African vaccine production [37, 38] suggests supplementing this analysis with a value-chain perspective. Industrial sustainability depends on access to inputs, technology transfers, specialized skills, regulatory quality, long-term financing, and, above all, demand predictability. Industrial policy and procurement policy therefore cannot be designed separately: multi-year contracts, purchase commitments, or

regional mechanisms can help secure the volumes needed for economies of scale while maintaining quality, performance, and competitiveness requirements.

This perspective also favors regional sovereignty over the full duplication of production chains in each country. The high fixed costs of vaccine manufacturing make market scale decisive. For Morocco, the economic viability of national capacity is thus strengthened if it is embedded in broader African markets, coordinated procurement mechanisms, and a regional specialization of capacities. Health sovereignty can then be understood as the ability to durably secure access, rather than as productive self-sufficiency.

From industrial capacity to economic sustainability

The complementary economic analyses reviewed show that a health-sovereignty policy must be evaluated by its effects on the health system as a whole. Lessons from pharmaceutical markets highlight that an increase in supply or a fall in industrial price does not automatically translate into an equivalent reduction in final spending: competition, market concentration, reimbursement rules, prescribing behavior, and supply security all condition the transmission of economic gains. By analogy, local vaccine production must be accompanied by governance of prices, procurement, and markets so that industrial capacity effectively translates into accessibility and budget sustainability.

A second lesson concerns the need for real-world economic data. Cost-effectiveness models are indispensable for anticipating choices, but they must be complemented after deployment by data on distribution costs, actual coverage achieved, wastage, human resources, pharmacovigilance, stock-outs, and costs borne by households. For Morocco, evaluating local production would thus benefit from combining manufacturing cost, budget impact, cost per fully vaccinated person, supply reliability, health gains, employment effects, and technological spillovers.

Toward a Moroccan vaccine diplomacy

The USD 5 million contribution to Gavi in 2026, together with the development of industrial capacity intended to also serve the African continent, suggests the emergence of a health-diplomacy dimension. This orientation could strengthen Morocco's role in African value chains, but its success will depend on competitiveness, regulatory quality, international recognition, and the ability to secure long-term markets.

Toward vaccine HTA adapted to Morocco

The findings converge on the need for a national health-technology-assessment framework applied to vaccines. A decision to introduce or modify the schedule should not rest on the cost-effectiveness ratio alone. It should combine: national epidemiological burden, efficacy and duration of protection, acquisition cost, delivery and cold-chain costs, multi-year budget impact, opportunity cost, distributive effects, acceptability, operational feasibility, supply security, and local-production potential. For Morocco, this framework would be particularly relevant when weighing competing products, choosing dosing schedules, and introducing new vaccines.

Vaccine governance and the role of the NITAG

The contribution of Jroundi et al. [29] is particularly important for translating economic findings into public policy. Morocco's NITAG constitutes a natural interface between epidemiological data, efficacy evidence, programmatic constraints, and economic considerations. A move toward more formalized vaccine HTA could build on this architecture rather than creating a parallel decision-making process.

This linkage would allow, for each new introduction or schedule change, the assembly of a standardized dossier covering disease burden, efficacy, safety, cost-effectiveness, budget impact, equity, logistical feasibility, acceptability, and supply security. It would strengthen the transparency of trade-offs and the comparability of decisions over time.

Strengths and limitations

This review has several strengths: a multi-database search, the integration of economic and public-policy dimensions rarely combined within a single synthesis, and an explicit distinction between Moroccan evidence and regional or international data. It nonetheless has important limitations. The initial strategies were exploratory and iterative, the queries overlap substantially, and ScienceDirect produces high documentary noise through full-text searching. The PRISMA-ScR count was reconstructed from the consolidated working corpus and must be checked one final time against the deduplicated bibliographic file before submission. Heterogeneity in methods, perspectives, time horizons, and economic indicators precludes a meaningful meta-analysis. Finally, some recent dimensions of financing and industrial policy are documented more through institutional sources than through peer-reviewed economic evaluations.

Research priorities

1. Establish the full annual cost of the PNI and the cost per fully vaccinated child.
2. Conduct budget-impact analyses when introducing or changing vaccines.
3. Develop cost-effectiveness evaluations based on Moroccan epidemiological and cost data.
4. Measure the costs of vaccination delays, stock-outs, and catch-up campaigns.
5. Economically compare importation, fill-and-finish, technology transfer, and integrated production.
6. Integrate territorial and social equity into economic evaluations.
7. Develop African scenario analyses to assess the viability of Moroccan vaccine exports.
8. Formalize the NITAG's role in integrating economic evaluation and budget impact into vaccination recommendations.
9. Study the economic value of extending vaccination to adults, older people, and at-risk professional groups.
10. Develop real-world cost studies incorporating distribution, human resources, pharmacovigilance, wastage, and stock-outs.
11. Assess multi-year procurement mechanisms, African pooled procurement, and market guarantees needed for the viability of local production capacity.

CONCLUSION

This mapping of the literature shows that Morocco has a growing knowledge base on vaccination, but that published national economic evaluations remain concentrated on a limited number of vaccines. The available evidence supports moving from a logic centered on price per dose toward an approach based on total program cost, budget impact, equity, supply resilience, and long-term value. Regional work on financing, procurement, pricing, and local manufacturing provides important lessons without substituting for Moroccan estimates. Developing cost-effectiveness, cost-utility, budget-impact, and real-world cost analyses based on national data should accompany future PNI decisions and the economic evaluation of the local-production strategy.

The work of Messoudi et al. [8] and Mohy et al. [2] demonstrates the value of further institutionalizing economic evaluation in vaccination decisions. A vaccine's value should be assessed based on total program cost, health outcomes, care savings, QALYs/DALYs, budget impact, and effects on households and society.

The current phase adds an industrial and logistical dimension. The work of Bencheckroun et al. [19] on public procurement, of Mzili et al. [18] on rural distribution, and of Bishop et al. [1, 3] on new vaccine introduction shows that vaccine economics must be approached as a continuum: vaccine selection, financing, procurement, delivery, territorial access, acceptability, health outcomes, and supply security. Local production therefore cannot be evaluated in isolation; its value depends on its alignment with PNI needs, market volumes, regulatory capacity, and regional partnerships.

An integrated Moroccan model could thus rest on nine pillars: data-driven prevention, coverage, equity, sustainable financing, economic evaluation, pricing and procurement policy, efficient logistics, industrial capacity, and African cooperation. Institutionalizing budget-impact and cost-effectiveness analyses,

complemented by indicators of equity, affordability, resilience, and procurement performance, would help more explicitly link vaccine policy to budgetary and industrial choices.

The complementary analysis of the literature on financing, pricing, procurement, and African production reinforces an essential conclusion: vaccine sovereignty cannot be measured by manufacturing capacity alone. It must be assessed by the system's ability to guarantee continuous, affordable, and equitable access while maintaining economically viable production. The linkage between industrial policy, procurement policy, HTA, real-world economic data, and regional cooperation thus constitutes a central axis for the next phase of Moroccan vaccine policy.

Dimension	Proposed indicators	Purpose
Acquisition	Price per dose, price per full schedule, contractual terms	Optimize procurement
Program	Cold chain, transport, staff, wastage, information systems	Calculate full cost
Health outcomes	Cases, consultations, hospitalizations, sequelae, deaths averted	Measure real-world effectiveness
Economics	Cost/case averted, cost/DALY, cost/QALY, net savings	Compare strategies
Budget	Annual and multi-year impact, sustainability	Plan introduction
Equity	Cost to reach under-vaccinated populations	Reduce disparities
Industry	Production cost, volumes, investment, inputs, technology transfer	Compare imports and local production
Resilience	Stock-out risk, strategic stockpiles, lead times	Value health security
African cooperation	Markets, exports, pooled procurement, partnerships	Assess regional scale

Table 2. Proposed framework for the economic evaluation of Moroccan vaccine policy

Ethical Approval

This is a scoping review of previously published literature and publicly available institutional documents. It did not involve human participants, human data, or animal subjects, and therefore did not require ethical approval or informed consent.

Conflict Of Interest

The authors declare no conflict of interest.

Data Availability Statement

No new data were generated for this study. All data supporting the findings are derived from the published sources cited in the reference list and from the publicly available institutional documents referenced therein.

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