



Epidemiological, Clinical and Health-Economic Burden of Neonatal and Perinatal Health in Morocco: Direct, Indirect and Intangible Costs, and Parental Psychological Impact a Structured Narrative Review

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ABSTRACT

Background: Neonatal and perinatal health in Morocco has, over the past decade, been addressed through several research efforts published separately, covering the epidemiology of neonatal infection, neonatal outcome, perinatal medicinal plant misuse, and the health-economic burden of maternal and child care. No synthesis had, until now, brought these findings into a single, cross-cutting perspective.

Objective: To provide a structured narrative synthesis of the epidemiological, clinical, toxicological and health-economic determinants of neonatal and perinatal health in Morocco, cross-referencing the research team's own publications with the international literature, without duplicating primary data already published or under separate review.

Methods: A structured narrative review was conducted around five predefined thematic axes, drawing on the team's publications (2020-2026) based on Moroccan cohorts (the national reference centre in Rabat, the regional unit of Dakhla, and oncology screening cohorts), complemented by a targeted PubMed search for each axis.

Results: The synthesis highlights the convergence of four categories of determinants — sociodemographic, biological/neonatal, behavioural (perinatal phytotherapy use) and organisational/economic — in the occurrence and severity of neonatal and perinatal conditions in Morocco. A detailed health-economic analysis, combining the team's own costed studies (cervical cancer screening and HPV vaccination, Prevenar13 pharmacoeconomics, childhood poisoning micro-costing, generic medicines) with independent Moroccan and international cost-effectiveness studies, consistently shows that primary prevention strategies outperform curative care on economic grounds. International meta-analyses further show that 41-51% of parents of hospitalised neonates experience clinically significant anxiety, a dimension of intangible cost that remains unmonitored and unaddressed in Moroccan neonatal units, including the one in Dakhla whose hospital performance indicators and cost of care are the subject of a separate, complementary manuscript currently under review.

Conclusion: An integrated approach, combining clinical quality improvement, community health education on perinatal phytotherapy risks, and a deliberate budgetary prioritisation of primary prevention — including parental psychological support — appears necessary to durably reduce the neonatal and perinatal morbidity and mortality burden in Morocco.

Keywords: neonatal infection, perinatal health, health economics, cost of illness, parental psychological distress, Morocco.

1. Introduction

Globally, the neonatal period concentrates nearly half of all deaths among children under five, despite the continuous decline in child mortality observed since 1990 [1]. In the Eastern Mediterranean region and across the African continent, this vulnerability is compounded by structural, socioeconomic and environmental factors, together with persistent barriers to quality care [2].

In Morocco, perinatal conditions — prematurity, intrauterine hypoxia, acute respiratory distress and early-onset bacterial neonatal infection — overwhelmingly dominate the causes of infant death [3]. Beyond these classical clinical determinants, perinatal health is embedded in a wider network of sociocultural determinants (parturients' use of traditional phytotherapy) and organisational determinants (unit performance, health-system budget constraints), whose interplay is rarely synthesised in the Moroccan literature.

Since 2020, our team has produced several original studies addressing, separately, the epidemiological profile of early-onset bacterial neonatal infection at the national reference centre in Rabat [4], the prevalence of neonatal near-misses [5], the impact of a short interpregnancy interval [6], perinatal medicinal plant misuse in a regional unit in southern Morocco [7], and several related health-economic strands: the cost of cervical cancer screening and HPV vaccination [8], the pharmacoeconomic evaluation of Prevenar13® vaccination [9], the direct cost of childhood poisoning [10], and the economics of generic medicines in Morocco [11]. These works, published separately, had not previously been placed in perspective relative to one another.

The objective of this structured narrative review is therefore to synthesise and cross-reference the epidemiological, clinical, toxicological and health-economic evidence generated by our team with the international scientific literature, in order to draw a cross-cutting reading of the determinants of neonatal and perinatal health in Morocco. This synthesis does not reproduce the primary results of the source studies: it offers a narrative perspective on them, with every figure attributed and referenced to its original publication. In particular, the detailed evaluation of hospital performance indicators and cost of care for early-onset neonatal infection at the Dakhla regional unit is the subject of a separate original article, currently under review [12], to which the reader is referred for these specific aspects.

2. Methodology

2.1. Review Type

This is a structured (non-systematic) narrative review, organised around five predefined thematic axes, following a synthesis approach informed by the SANRA recommendations for narrative reviews [13]. This format was chosen because the source studies rely on heterogeneous methodologies (retrospective cohort studies, case-control studies, health-economic evaluations), making a quantitative meta-analysis inappropriate.

2.2. Sources

Two categories of sources were used: (i) the original publications of the Mother and Child Health and Nutrition Research Team (Faculty of Medicine and Pharmacy, Rabat) and its collaborators, published between 2020 and 2026, based on Moroccan cohorts (Table 1); and (ii) a targeted PubMed search for each of the five thematic axes, using MeSH keyword combinations ("neonatal sepsis", "neonatal near miss", "medicinal plant toxicity", "cost of illness", "hospital performance indicators", "NICU parental psychological distress"), limited to the last ten years and to articles in English or French.

2.3. Reading Framework

Data were read through a conceptual framework common to the source studies, distinguishing four categories of determinants: maternal sociodemographic characteristics, neonatal history, behavioural/toxicological risk factors (including perinatal phytotherapy use), and organisational and economic determinants of care facilities.

2.4. Overview of Synthesised Studies

Table 1 summarises the nine team studies mobilised in this synthesis, with their cohort, main theme and reference.

Table 1: Overview of the team studies synthesised in this review.

Study	Cohort / setting	Main theme	Ref.
Aslaou et al., 2023	N=856 (474 infected), Rabat, 2010-2020	Epidemiological profile and risk factors of early-onset neonatal infection	[4]
Chafik, Aslaou et al., 2023	N=2,676 live births, Rabat	Prevalence of neonatal near-misses	[5]
Chafik, Aslaou, Barkat, 2022	N=162 mothers, Rabat	Short interpregnancy interval: fetal/neonatal impact	[6]
Aslaou et al., 2024	N=243, Dakhla, 2022-2023	Perinatal medicinal plant misuse and neonatal survival	[7]
Aslaou et al., 2024	N=250 women, Rabat	Cervical cancer (HPV) screening profile and activity-based cost	[8]
Aslaou et al., 2024	Southern Morocco	Pharmacoeconomic study of Prevenar13® vaccination	[9]
Benabdellah, Soulaymani et al., 2020	Rabat-Salé-Kénitra	Direct cost of childhood poisoning (micro-costing)	[10]
Soulaymani, 2025	Literature review, Morocco	Economic issues of generic medicines	[11]
Aslaou et al., under review	N=243, Dakhla (same cohort as [7])	Hospital performance indicators and cost of neonatal infection care	[12] separate submission

Each study retains its own unit of results; this synthesis does not reproduce or recompute the figures from the original tables, but offers a narrative cross-reading in the sections that follow.

3. Thematic Synthesis

3.1. Epidemiological Profile and Risk Factors of Early-Onset Bacterial Neonatal Infection

At the national neonatology reference centre in Rabat, a study of 856 newborns (474 infected) over 2010-2020 identified prolonged rupture of membranes beyond 12 hours, vaginal group B streptococcus carriage and a gestational age below 37 weeks as the main risk factors for early-onset bacterial neonatal infection, with caesarean delivery as the only consistent protective factor [4]. These findings are consistent with a recent systematic review of 49 studies and nearly 88,000 newborns across Africa, which confirmed the predominant role of prolonged rupture of membranes, low birth weight, a low Apgar score and prematurity, with a pooled prevalence of neonatal infection close to 41% [14].

On the biological side, several recent international studies emphasise the superior kinetics of procalcitonin over C-reactive protein (CRP) for guiding early, safe discontinuation of empirical antibiotic therapy: a scoping review of 4,755 newborns showed that a biomarker-guided discontinuation strategy reduced mean antibiotic duration by 38.6%, without excess relapse or mortality [15], a finding corroborated by a systematic review specifically addressing the biological diagnosis of early-onset neonatal sepsis [16].

3.2. Neonatal Outcome: Near-Misses, Mortality and Obstetric Factors

A study of the prevalence of neonatal near-misses among 2,676 live births at the Rabat university hospital found a high frequency of potentially fatal events among survivors, most cases concerning referred and multiparous mothers, with intravenous antibiotic use as the main pragmatic criterion [5]. Separately, a study of 162 pregnancies showed that an interpregnancy interval below 18 months was associated with a significantly higher rate of preterm birth and low birth weight compared with a longer interval [6], consistent with the international literature linking short interpregnancy intervals to adverse perinatal outcomes regardless of geographic context.

3.3. Perinatal Medicinal Plant Misuse: An Underestimated Toxicological Risk

At the Dakhla regional neonatal unit (southern Morocco), a study of 243 newborns hospitalised in 2022-2023 found persistent parturient use of traditional phytotherapy, with neonatal mortality significantly associated with the use of *Artemisia herba-alba* (wormwood), *Rosmarinus officinalis* (rosemary) and *Juniperus oxycedrus* (cade oil) [7]. These findings align with available toxicological evidence: alpha-thujone in wormwood is a GABAergic receptor inhibitor capable of triggering seizures and fetomaternal respiratory distress [17], while cade oil is associated with severe systemic intoxication in newborns [17]. A Chinese case-control study of herbal remedies used during pregnancy similarly highlights the heterogeneity of fetomaternal toxicity profiles across plant species [18].

This observation is directly corroborated by a Moroccan case report, published by a team from the Moroccan Poison Control and Pharmacovigilance Centre, describing a previously healthy newborn who developed seizures, collapse, acute pulmonary oedema, renal failure and hepatotoxicity after cutaneous application of cade oil for atopic dermatitis; the infant survived only after prolonged intensive care [19]. Experimentally, *Artemisia herba-alba* ingestion has been associated, in female rats, with a significant decrease in ovarian and embryonic weight, confirming a dose-dependent reproductive toxicity beyond clinical human observations [20]. A comparable clinical picture — repeated neonatal tonic-clonic seizures — has also been reported after accidental exposure to another thujone-rich Lamiaceae, common sage (*Salvia officinalis*), showing that the convulsant risk is shared across several traditional phytotherapeutic species rather than specific to wormwood alone [21].

At the African continental level, this phenomenon extends well beyond the Moroccan context. A cross-sectional study of 380 deliveries in Kumasi (Ghana) found that newborns of mothers using medicinal plants during pregnancy had twice the risk of neonatal hospitalisation (OR=2.05; 95%CI [1.17-3.60]) and four times the risk of a low Apgar score (OR=4.09; 95%CI [1.66-10.07]), after adjustment for maternal age, education, birth weight and socioeconomic status [22]. A Cameroonian prospective cohort of parturients exposed to traditional medicine within 72 hours of delivery similarly found associations with adverse maternal and fetal outcomes [23], while a South African systematic review restricted to randomised trials confirms that while some uses (ginger for nausea) appear safe, others (castor oil for labour induction) are associated with an increased risk of caesarean section and meconium-stained fluid [24]. In Tanzania, this phenomenon

has been described as a "forgotten exposure", in that it remains systematically under-asked during standard antenatal follow-up despite its potential to hinder progress towards Sustainable Development Goal 3 on maternal and neonatal health [25].

A complementary analysis, based on this same cohort of 243 newborns but focused on distinct outcomes — the neonatal unit's hospital performance indicators (average occupancy rate, average length of stay, rotation interval) and the cost of care from a societal perspective — is the subject of a separate original article, currently under review [12]. This synthesis does not reproduce those results and refers the reader to that publication for the details of these indicators.

3.4. The Broader Health-Economic Dimension: Beyond Neonatology

Beyond the strictly neonatal domain, several team studies have explored the broader health-economic dimension of maternal and child health, using comparable costing methodologies (activity-based costing, micro-costing) applied to distinct conditions and populations. This subsection is deliberately more detailed than the preceding ones, as it gathers all available quantified data to objectify the economic weight of maternal and child health in Morocco.

3.4.1. Cervical Cancer: Vaccination versus Curative Care

A case-control study of 250 women followed over five years in the Rabat region compared risk and protective factors for cervical cancer, then applied activity-based costing to quantify the direct and indirect expenses of care [8]. Clinically, the study identified a diet rich in vitamins A and C (RR=2.9; 95%CI [1.69-4.18]) and progestin-only injectable contraceptive use (RR=0.5; 95%CI [0.36-0.75]) as protective factors, and smoking (RR=9.8), menopause (RR=1.3), post-coital metrorrhagia (RR=4.83), a history of chlamydia (RR=3.9), haemoglobin $\leq 10\text{g/dl}$ (RR=6.8), 10 years or more of oestrogen-progestin use (RR=5.9), and multiple partners (RR=5.6) as risk factors. Economically, the study estimated the unit cost of HPV vaccination at €44.9 per dose and the total cost of covering all Moroccan girls aged 10-14 (about 1,526,000 girls) at approximately €67.3 million, a figure the authors conclude is far lower than the cumulative national cost of curative care for invasive forms, supporting a cost-minimisation strategy through generalised screening and vaccination [8].

These findings are corroborated by two independent Moroccan studies. A Markov model calibrated on Moroccan cervical cancer incidence showed that, at 70% coverage, HPV vaccination of pre-adolescent girls reduced the cumulative

risk of cervical cancer by 62% at a cost of US\$1,150 per year of life saved (YLS), against US\$551/YLS for screening alone (14% reduction) and US\$2,843/YLS for combined vaccination-screening (69% reduction), concluding that HPV vaccination would be highly cost-effective in the Moroccan context [26]. Separately, a micro-costing study at the National Institute of Oncology in Rabat, covering 550 patients, estimated the total annual cost of curative cervical cancer care at approximately US\$1,429,673, or a mean of US\$2,599±839 per patient, with radiotherapy alone accounting for 53-55% of the total cost, followed by brachytherapy (27%) and surgery (7-14%) [27]. This mean curative cost per patient (≈US\$2,599) is thus far higher than the unit cost of preventive vaccination (€44.9, about US\$49 per dose), independently corroborating our team's conclusion in favour of a primary prevention strategy [8,26,27].

3.4.2. Prevenar13® Pneumococcal Vaccination in Southern Morocco

In Morocco, pneumonia remains the leading cause of death among children under five, with about 4,000 deaths per year, 15% linked to meningeal complications, and one in three cases of acute otitis media attributable to pneumococcus [9]. In the study cohort, among infants under six months hospitalised for bronchiolitis, 73% were positive for respiratory syncytial virus, against 26.1% for adenovirus among those over six months, and 10.5% of those under six months hospitalised for bronchitis; 7.03% of patients hospitalised for bronchitis had been exposed to influenza A and 6.03% to influenza B. The pharmaco-economic study, based on Monte Carlo simulation (100 simulations), a societal perspective and a 1.5% discount rate, compared the direct and indirect cost of generalised Prevenar13® vaccination against averted hospital costs (pneumonia, meningitis and otitis admissions), concluding a favourable cost-benefit ratio for vaccination, consistent with WHO estimates that low-income countries can save 12-24% of their annual health expenditure by improving hospital efficiency [9].

At the Maghreb level, a decision model comparing PCV13 or PCV10 vaccination with no vaccination estimated that a national programme in Algeria would avert 2,177 deaths and nearly 349,000 cases of pneumonia, otitis and invasive pneumococcal disease, at a highly cost-effective US\$308 per QALY gained (US\$731/QALY for PCV10); in Tunisia, the expected impact was 308 deaths averted at a ratio of US\$848/QALY (US\$1,366/QALY for PCV10) [28]. The authors note that both PCV10 and PCV13 are also available on the Moroccan private market, making these regional results directly transferable to the expanded vaccination coverage context evaluated by our team in southern Morocco [9,28].

3.4.3. Childhood Poisoning: Structure of the Direct Cost

A Moroccan micro-costing study in the Rabat-Salé-Kénitra region quantified the mean direct cost of hospital care for childhood poisoning, distinguishing medical items (consultations, laboratory tests, antidotes, hospitalisation), which accounted for 80% of the total cost, from non-medical items (transport, meals for accompanying family), for the remaining 20%; the mean total cost per case was estimated at the equivalent of about 60% of the Moroccan monthly minimum wage (SMIG), illustrating the burden an acute child-health episode places on a low-income household [10].

Figure 1 compares the direct cost structure of this study with the more finely itemised structure of the cervical cancer study [27] presented above.

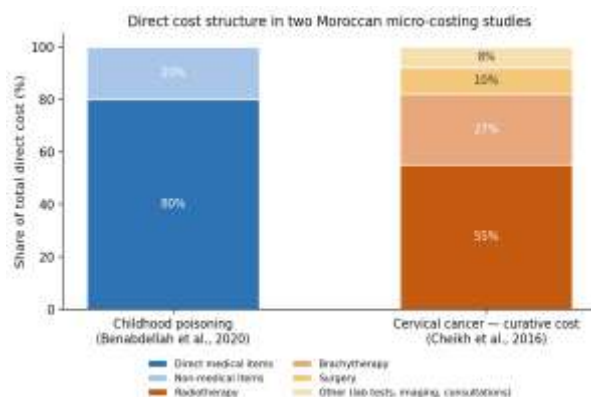


Figure 1: Structure of the direct cost in two Moroccan micro-costing studies (childhood poisoning [10]; cervical cancer [27]).

In both cases, direct medical items (hospitalisation, technical procedures, radiotherapy) dominate the cost structure by a wide margin, while non-strictly-medical items (transport, meals, consultations and ancillary tests) represent only a minority share — which, as discussed below, tends to underestimate the real burden borne by families when indirect costs (lost income, caregiving time) are not systematically included in the analysis.

3.4.4. Generic Medicines: An Underused Lever for Access to Care

A recent literature review on the economic issues of generic medicines in Morocco notes that the price gap between originator and generic products remains insufficiently exploited as a lever for containing household and Compulsory Health Insurance (AMO) expenditure, particularly for chronic treatments and prolonged antibiotic courses; the review calls

for a more proactive generic-substitution policy, notably in under-covered regions such as southern Morocco [11].

3.4.5. International Perspective

These Moroccan data sit within an international context where the cost of maternal and child health is highly heterogeneous depending on health-system resource levels. At the sub-Saharan African level, the annual economic burden of neonatal sepsis alone has been estimated, using the value-of-statistical-life method, at between US\$10 and 469 billion, for 5.29 to 8.73 million disability-adjusted life years (DALYs) lost each year [29]. The direct hospital cost of a neonatal sepsis or bacterial meningitis episode has been estimated at 300-700 international dollars in Mozambique and South Africa [30], against approximately US\$3,346 on average per hospitalisation in the Brazilian public health system [31] — a five- to ten-fold difference between African and South American contexts, more indicative of differing hospital cost structures than of intrinsic clinical severity.

3.5. Intangible Costs and Parental Psychological Impact

None of the Moroccan health-economic studies synthesised above monetised intangible costs, even though the international literature documents a major and quantifiable parental psychological toll associated with neonatal hospitalisation. A meta-analysis of 56 studies and 6,036 parents estimated the pooled prevalence of anxiety at 41.9% (95%CI [30.9-53.0]) and of post-traumatic stress at 39.9% (95%CI [30.8-48.9]) in the month following birth, rates that decline but remain substantial between one month and one year (26.3% and 24.5% respectively), with post-traumatic stress still present in 27.1% of parents more than one year after birth [32]. A second meta-analysis, focused specifically on parents of newborns admitted to neonatal intensive care, estimated the pooled prevalence of anxiety, depression and stress at 51%, 31% and 41% respectively among mothers, against 26%, 12% and 22% among fathers (Figure 2), confirming a significantly heavier psychological burden among mothers but one far from negligible among fathers [33].

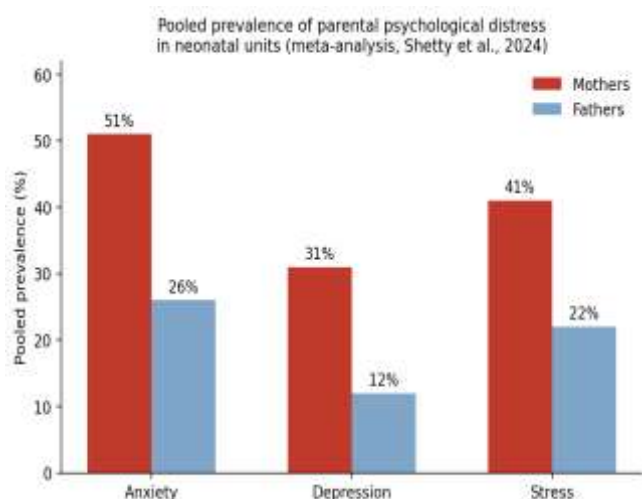


Figure 2: Pooled prevalence of parental psychological distress (anxiety, depression, stress) in neonatal units, international meta-analysis [33].

Although not converted into monetary units in the source studies, these prevalence rates help qualify the scale of the intangible cost associated with neonatal and perinatal hospitalisation: as an illustration, applying a 51% anxiety prevalence to all mothers whose newborn is hospitalised annually in Morocco would concern tens of thousands of women each year, with no systematic psychological screening or support currently integrated into the Moroccan neonatal units documented in this review, including the Dakhla unit [7,12]. Table 2 summarises, for comparison, the main quantified economic findings of the studies mobilised in this review.

Table 2: Comparative summary of quantified economic indicators from the studies mobilised in this review (Morocco and international literature).

Study	Condition / intervention	Key economic indicator	Ref.
Aslaou et al., 2024	Cervical cancer — HPV vaccination	€44.9/dose; ~€67.3M for the target cohort (10-14 y)	[8]
Messoudi et al., 2019	Cervical cancer — Markov model, Morocco	US\$1,150/YLS (vaccination); US\$551/YLS (screening); US\$2,843/YLS (combined)	[26]

Cheikh et al., 2016	Cervical cancer — curative cost, INO Rabat (n=550)	US\$2,599±839/patient ; radiotherapy = 53-55% of cost	[27]
Aslaou et al., 2024	Prevenar13® vaccination	Favourable cost-benefit ratio (Monte Carlo simulation, societal perspective)	[9]
Pugh et al., 2019	PCV13/PCV10 — Tunisia/Algeria	US\$308/QALY (Algeria, PCV13); US\$848/QALY (Tunisia, PCV13)	[28]
Benabdellah, Soulaymani et al., 2020	Childhood poisoning	Direct cost ≈60% of Moroccan monthly minimum wage (80% medical / 20% non-medical)	[10]
Soulaymani, 2025	Generic medicines	Originator/generic price gap underused as access lever	[11]
Ranjeva et al., 2018	Neonatal sepsis, sub-Saharan Africa	US\$10-469 billion/year; 5.29-8.73 million DALYs/year	[29]
Aerts et al., 2021	Neonatal sepsis/meningitis, Mozambique/South Africa	300-700 international dollars per hospital episode	[30]
de Abreu et al., 2023	Neonatal sepsis, Brazil (SUS)	≈US\$3,346 per hospitalisation	[31]
Malouf et al., 2021 / Shetty et al., 2024	Parental psychological distress, NICU (meta-analyses)	Anxiety up to 51% (mothers), 26% (fathers); intangible, unmonetised	[32,33]
Aslaou et al., under review	Neonatal infection, Dakhla (same cohort as [7])	Direct/indirect/intangible cost per newborn (societal perspective)	[12] — separate submission

Taken together, these studies converge on a consistent message: regardless of the condition considered — neonatal infection, cervical cancer, pneumococcal pneumonia or childhood poisoning — primary prevention strategies and hospital cost-accounting tools objectively demonstrate the economic superiority of prevention over curative care, while the relative weight of non-medical, indirect and intangible

costs remains systematically underestimated in the available studies. Juxtaposing the quantified total cost (direct medical, non-medical and indirect items) with the documented prevalence of parental psychological distress (Figure 2) suggests that the true burden of neonatal and perinatal health in Morocco substantially exceeds the monetary amounts reported in the current literature.

4. Cross-Cutting Discussion

4.1. An Interplay of Biological, Behavioural and Organisational Determinants

Placing these studies in perspective confirms that neonatal and perinatal morbidity and mortality in Morocco results from the interplay of determinants of different natures: the newborn's intrinsic biological vulnerability (immune incompetence, immature cutaneomucosal barriers), deeply rooted sociocultural practices (perinatal phytotherapy use) insufficiently addressed in standard antenatal care, and organisational and budgetary constraints weighing on care facilities, particularly in the Kingdom's more remote regions.

4.2. Medicinal Plant Misuse: A Blind Spot in Antenatal Care

One cross-cutting contribution of this synthesis is to highlight a determinant rarely documented in Moroccan neonatal mortality studies: perinatal exposure to medicinal plants. Health professionals rarely systematically ask patients about these practices, described as a "forgotten exposure" [25], even though their potential toxicity is well documented, both through Moroccan clinical cases [19] and converging African epidemiological data [17,18,20-24]. Integrating targeted health-education modules into antenatal follow-up, combining awareness-raising among parturients and traditional midwife networks, appears to be a low-cost, high-prevention-potential course of action.

4.3. Economic Trade-Offs and the Prioritisation of Prevention

On the health-economic front, all the synthesised studies converge on the same message: in a resource-constrained context, primary prevention strategies (vaccination, screening, securing perinatal practices) consistently offer a better cost-benefit ratio than curative management of severe complications, whether for neonatal infection, cervical cancer or pneumococcal pneumonia. This cross-cutting reading argues for a deliberate budgetary prioritisation of primary prevention in Moroccan health planning, particularly in the southern regions where access to specialised care remains limited.

4.4. Limitations of the Synthesis

- Narrative, non-systematic review: the absence of a registered protocol and independent double screening carries a risk of source selection bias, although this is mitigated by the predefined thematic structure.
- Methodological heterogeneity of the source studies (retrospective cohorts, case-control studies, health-economic evaluations), precluding quantitative pooling of results.
- Largely descriptive scope of several source studies, limiting causal conclusions.
- Partial cohort overlap between the phytotherapy axis and the complementary analysis under separate review [12], managed through explicit cross-referencing rather than duplication of results.

5. Conclusion

This structured narrative review highlights the multifactorial nature of the determinants of neonatal and perinatal morbidity and mortality in Morocco, at the intersection of the newborn's biological vulnerability, perinatal sociocultural practices, and the organisational and economic constraints of care facilities. Three priority courses of action emerge: strengthening the quality of the perinatal care pyramid (continuing education, protocols for prolonged rupture of membranes and antibiotic prophylaxis); integrating community health education targeted at the toxicological risks of perinatal phytotherapy; and a deliberate budgetary prioritisation of primary prevention, including expanded vaccination and parental psychological support. The quantified data on hospital performance indicators and the cost of neonatal infection care in southern Morocco, deliberately not repeated here to avoid duplication, are the subject of a separate original article [12], whose reading complements this synthesis.

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[To be completed by the author, if applicable.]

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