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Transient recovery and renewed decline in HPV vaccination coverage in Cameroon after single-dose and gender-neutral vaccination: a secondary analysis of national immunisation coverage estimates, 2020–2025

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Abstract

Background

Cameroon adopted a single-dose gender-neutral human papillomavirus (HPV) vaccination schedule in January 2023. Girls' first-dose coverage rose sharply to 68% in 2023 before declining to 36% in 2024 and further to 30% in 2025, representing a net two-year decline of 38 percentage points from the 2023 peak. The central analytical question was what operational, policy, and system factors plausibly account for this trajectory.

Methods

We conducted a health policy analysis informed by Walt and Gilson's health policy triangle and a root-cause-to-intervention logic model to address this question and propose an evidence-informed girls-first recovery framework. Primary data were WHO and UNICEF Estimates of National Immunization Coverage (WUENIC) 2025 revision estimates for Cameroon, including HPV first dose and completed series among girls from 2020 to 2025, and coverage for 11 comparator antigens with stable indicator definitions across the 2024 and 2025 revisions. WUENIC Estimate Descriptions and WHO/UNICEF 2025 revision notes were reviewed for documented stockout events and reporting-method context.

Results

Under the former two-dose schedule, dose-completion attrition was marked: estimated dropout was 76% in 2021 and 70% in 2022. An apparent 2023 supply paradox suggests a plausible role for policy, delivery, and demand-side factors: despite a four-month national and subnational stockout affecting the first and third doses of diphtheria-tetanus-pertussis-containing vaccine, HPV coverage nearly tripled that year. By 2025, all 11 comparator antigens had improved from 2024 while remaining substantially higher than HPV coverage; the HPV-specific coverage gap widened for every comparator antigen assessed. This pattern is consistent with an HPV/adolescent-specific delivery and sustainability barrier rather than general immunisation-system weakness.

Conclusions

The analysis suggests that renewed recovery may depend on reliable supply, protected school-based delivery, strategic communication, outreach for underserved girls, multi-year faith-sector engagement, and time-limited girls-first prioritisation until enabling conditions for gender-neutral vaccination are restored.

BACKGROUND

Cervical cancer is the second most deadly cancer among women in Cameroon. In 2022, an estimated 2,525 new cervical cancer cases occurred (age-standardized incidence 33.1 per 100,000) in Cameroon and 1,837 women died [1]. Available human papillomavirus (HPV) prevalence evidence from Cameroon remains heterogeneous and geographically limited. A systematic review of five studies involving 1,856 Cameroonian women reported an overall HPV prevalence of 36.3%, with evidence concentrated in the Centre, Littoral, and South West regions [2]. A cross-sectional study among 364 non-vaccinated women attending routine consultations in reference hospitals in Yaoundé and Douala found high-risk HPV positivity of 21.4% and substantial genotype diversity [3]. Evidence from high-risk subgroups also shows substantial HPV transmission: a cross-sectional study among 599 female sex workers aged 30 years and older found that 62.1% were positive for one or more HPV types [4]. Persistent infection with oncogenic HPV is the necessary cause of most cervical cancers, and HPV vaccination of adolescent girls remains one of the most effective and cost-effective cancer prevention strategies available [1,5,6]. In 2022, WHO updated its HPV vaccination recommendations to include a one- or two-dose schedule for girls aged 9 to 14 years, while maintaining multi-dose recommendations for immunocompromised individuals [7]. This policy shift created an important delivery opportunity for constrained health systems by reducing the operational burden associated with multi-visit vaccination schedules. Cameroon introduced HPV vaccination nationally in October 2020 using a two-dose schedule [8]. Introduction occurred during the COVID-19 pandemic and immediately encountered documented Catholic institutional opposition. Catholic bishops publicly expressed concerns about HPV vaccination, and programme sources reported restrictions affecting HPV vaccination in Catholic health centres and schools, which were estimated to represent approximately 30% of national service delivery capacity [9,10]. District-level evidence from Saa Health District also reported restrictions on HPV awareness activities in Catholic churches and schools, while showing that engagement of teachers and Catholic priests could support successful school-based vaccination [11]. This 30% estimate is programme-reported and likely heterogeneous by region and school network; it should therefore be interpreted as an operational planning constraint rather than a precise national proportion. Programme sources also suggest that early contradictory public statements may have contributed to hardened opposition positions and continued hesitancy in subsequent years [10].

Under the initial two-dose schedule, HPV programme performance was constrained by both low first-dose uptake and substantial attrition between doses. WHO and UNICEF Estimates of National Immunization Coverage (WUENIC) 2025 revision estimates show very low first-dose coverage at introduction in 2020, followed by incomplete series completion in 2021 and 2022 despite modest gains in first-dose uptake [12]. This pattern suggests that the two-dose schedule created an important delivery bottleneck in a context already affected by pandemic disruption, documented Catholic institutional opposition, and limited school- and facility-based delivery capacity [8,10,12]. The subsequent transition to a single-dose schedule therefore warrants analysis not only as a policy change, but as a programme adaptation to a documented completion challenge.

Following National Immunization Technical Advisory Group review and programme adaptation in 2022, Cameroon intensified communication and community engagement, adopted a single-dose HPV

vaccination schedule with gender-neutral eligibility in January 2023, and implemented periodic intensification of routine immunization (PIRI) activities in households and schools from March 2023 [8,10]. These changes coincided with a marked rise in girls' HPV vaccination coverage in 2023, followed by decline in 2024 and renewed decline in 2025 [12]. A peer-reviewed interrupted time-series analysis reported that PIRI was associated with a statistically significant immediate increase in girls vaccinated nationally, while gender-neutral single-dose vaccination was also associated with an immediate national-level increase [8]. However, the post-2023 decline through 2025 raises concerns about sustainability, prioritization, vaccine supply, demand generation, and the operational trade-offs of expanded eligibility under resource constraints.

This study uses the WUENIC 2025 revision as the primary quantitative source, supplemented by WUENIC Estimate Descriptions, peer-reviewed programme evidence, WHO guidance, and contextual programme documents, to address the central analytical question: what operational, policy, and system factors plausibly account for Cameroon's 2023 HPV coverage recovery and its subsequent renewed decline through 2025? It analyses HPV vaccination performance before and after the single-dose transition, contextualizes HPV coverage against broader routine immunization system performance, examines the implications of gender-neutral eligibility under resource constraints, and proposes a girls-first recovery pathway aligned with the WHO cervical cancer elimination target of 90% HPV vaccination coverage among girls by age 15 [13].

METHODS

Patient and Public Involvement

Patients and members of the public were not directly involved in the design, conduct, analysis, or reporting of this study. The analysis used only publicly available, aggregate, de-identified national immunisation coverage estimates and published literature. No primary data were collected from human participants, and no individual-level or identifiable data were accessed. The findings are intended to inform immunisation programme planning and may be relevant to national programme implementers, education-sector partners, faith-sector stakeholders, and communities involved in adolescent vaccination.

Analytical framework

We conducted a health policy analysis informed by Walt and Gilson's health policy triangle [14], examining how the content, context, process, and actors of HPV vaccination policy shaped programme outcomes. Particular analytical attention was given to the actors dimension - specifically faith institutions as structural gatekeepers of delivery capacity - and to context, including supply chain fragility and fiscal constraints as systemic determinants. Recommendations were derived using a root-cause-to-intervention logic model, presented as Table 1, linking operational drivers of the 2024–2025 decline to

recovery activities, immediate outputs, and measurable outcomes. Each identified root cause was linked to intervention options from published evidence and WHO guidance. Options were assessed against three criteria: (i) equity impact, prioritizing interventions that reach girls bearing the predominant cervical cancer burden; (ii) operational feasibility within current resource and platform constraints; and (iii) transferability to comparable low-resource settings. This explicit framework makes the recommendation development process transparent and reproducible.

Data sources

Primary quantitative data came from the WUENIC 2025 revision for Cameroon [12]. All coverage values in this analysis use this revised dataset unless otherwise stated. Data extracted included HPV first dose among girls (prHPV1 F) and completed series (prHPVc F) for 2020–2025, and coverage for 11 comparator antigens with stable indicator definitions across the 2024 and 2025 revisions: BCG (Bacillus Calmette-Guérin), DTP1 and DTP3 (diphtheria-tetanus-pertussis-containing vaccine, first and third dose), HepB3 (hepatitis B, third dose), Hib3 (Haemophilus influenzae type b, third dose), IPV1 (inactivated poliovirus vaccine, first dose), MCV1 and MCV2 (measles-containing vaccine, first and second dose), RCV1 (rubella-containing vaccine, first dose), RotaC (rotavirus vaccine, completed series), and YFV (yellow fever vaccine). Because the WUENIC 2025 revision retired the third dose of polio-containing vaccine (Pol3) and replaced IPV2 and PCV3 with completed-series indicators (IPVC and PCVC respectively), these redefined indicators were excluded from the primary comparator set and examined in a sensitivity check. HepBB (hepatitis B birth dose) and MengA (meningococcal A conjugate vaccine) had no available WUENIC estimates for Cameroon and were excluded. WUENIC Estimate Descriptions available for the 2023 and 2024 comparison period were extracted and used as the source for stockout documentation.

Additional sources included WHO HPV vaccination guidance [7], UNICEF HPV market and supply data [15]; cancer burden data [1]; and a published interrupted time series analysis of Cameroon's HPV programme covering October 2020 to December 2023 [8], which provides PIRI dates, communication intensification onset, and intervention effect estimates. A peer-reviewed meeting summary provided programme-level context [16]. The conference presentation by Tchokfe Ndoula [10] is cited for programme narrative context across several sections of this analysis. Specifically, it is used as a source for: (i) the reported National Immunization Technical Advisory Group-recommended four-part response framework in 2022; (ii) programme-context evidence on Catholic institutional opposition and faith-linked access barriers affecting vaccination in some health facilities and schools, including an unverified programme-reported estimate of affected delivery capacity; (iii) programme-reported facility readiness estimates approximately two years after national introduction; and (iv) dose receipt and dose-utilisation context not fully reported in the peer-reviewed Njoh et al. analysis, including programme-reported received-versus-administered dose figures used only as contextual evidence [8]. This source is an unpublished conference presentation that has not undergone peer review, and all findings drawn from it are therefore interpreted cautiously. No primary epidemiological or coverage estimates, including HPV

coverage values, dropout rates, and coverage gaps, derive from this source. All primary coverage estimates derive from the WUENIC 2025 revision [12].

The conference presentation [10] also reports programme-level administrative HPV coverage estimates for 2020 to 2024 that differ from WUENIC estimates. WUENIC 2025 revision estimates were selected as the primary quantitative source because WUENIC is designed to describe routine immunisation programme performance and to enable standardised comparison of immunisation coverage across countries, years, and antigens [17]. The magnitude of the 2023 rise and post-2023 decline may therefore differ depending on which data source is used. However, both the programme-context source and WUENIC indicate the same qualitative trajectory through 2024: very low early uptake, marked improvement in 2023, and decline in 2024. This analysis does not use programme-reported administrative coverage values from the conference presentation for quantitative coverage conclusions.

Calculations

Dose-completion dropout rate was calculated as:

Dropout rate = 1 - (completed-series coverage / first-dose coverage)

Coverage gap for cross-antigen comparisons was calculated as:

Coverage gap = comparator antigen coverage - HPV first-dose coverage

All calculations were performed using Python (version 3.10). WUENIC estimates are standardised WHO/UNICEF national coverage estimates derived from administrative data, survey evidence, and country consultation processes [17]. They are interpreted here as the most appropriate source for national cross-year and cross-antigen comparison, but not as exact counts. Derived dropout rates and coverage gaps are therefore treated as approximate programme indicators; uncertainty was not formally propagated. Dropout calculations used same-year national coverage estimates and do not represent individual-level cohort follow-up between doses.

Reporting

Relevant STROBE reporting items were used to guide transparent reporting of this aggregate, publicly available, WUENIC-based health policy analysis. Items requiring individual-level participant recruitment, matching, follow-up, or loss-to-follow-up assessment were marked as not applicable. The adapted checklist is provided in Additional file 1.

RESULTS

Dose-completion attrition under the two-dose schedule, 2020 to 2022

The WUENIC 2025 revision allowed first-dose uptake and completed-series coverage to be analyzed separately during Cameroon's initial two-dose HPV vaccination period (Fig. 1B). Following national introduction in October 2020, girls' first-dose coverage increased from 5% in the partial introduction year to 21% in 2021 and 23% in 2022. However, completed-series coverage remained substantially lower, reaching only 5% in 2021 and 7% in 2022. This corresponded to estimated dropout rates of 76% in 2021 and 70% in 2022. Using same-year WUENIC first-dose and completed-series estimates, approximately 24 completed-series vaccinations were recorded per 100 first-dose-equivalent vaccinations in 2021. In 2022, approximately 30 completed-series vaccinations were recorded per 100 first-dose-equivalent vaccinations. These findings indicate marked attrition between dose 1 and dose 2 under the original schedule.

Figure 1. HPV vaccination coverage trends in Cameroon before and after single-dose adoption, 2020–2025.

Panel A shows the WUENIC 2025 revision estimates of HPV first-dose coverage among girls. Policy milestones indicate the National Immunization Technical Advisory Group review in June 2022 and adoption of the single-dose schedule with gender-neutral eligibility in January 2023. The shaded band marks the PIRI period from March to June 2023. Panel B compares first-dose coverage and completed-series coverage during the two-dose schedule period, showing estimated dropout of 76% in 2021 and 70% in 2022. From 2023, first-dose and completed-series coverage were equivalent by definition under the single-dose schedule. Panel A additionally shows the 2025 estimate of 30%, and Panel B shows single bars for 2023, 2024, and 2025 reflecting this equivalence. PIRI = periodic intensification of routine immunization; WUENIC = WHO/UNICEF Estimates of National Immunization Coverage.

The programmatic significance of this attrition extends beyond documenting low coverage. If the same dropout pattern had persisted, even a hypothetical first-dose coverage level of 70% would have translated into completed-series coverage of only approximately 17% to 21%. The adoption of the single-dose schedule in January 2023 therefore removed a major completion barrier: under the revised schedule, first-dose and completed-series coverage became equivalent by definition, reaching 68% in 2023 before declining to 36% in 2024 and further to 30% in 2025. The net decline from the 2023 peak to 2025 was 38 percentage points over two consecutive years.

The 2023 recovery and the apparent supply paradox

Adoption of the single-dose schedule in January 2023, together with gender-neutral eligibility and PIRI activities from March to June 2023, was associated with a sharp increase in girls' HPV first-dose coverage from 23% in 2022 to 68% in 2023 (Fig. 1A, Fig. 2). A published interrupted time-series analysis of Cameroon's HPV programme reported that PIRI was associated with a statistically significant

immediate level increase of 35,716 girls vaccinated nationally ($p < 0.01$), while introduction of gender-neutral single-dose vaccination was associated with an immediate increase of 25,099 girls vaccinated nationally ($p = 0.02$) [8].

Figure 2. Programme interventions and documented vaccine stockout context, Cameroon, 2020–2025.

The timeline shows key HPV programme interventions and documented routine-antigen stockout events identified from WUENIC Estimate Descriptions and published programme evidence. HPV coverage values are shown as contextual markers through 2025; the full annual coverage trajectory is presented in Fig. 1A. Only documented programme and stockout events are displayed, and no additional 2025 programme event is inferred from the coverage estimate. The figure provides ecological programme context and should not be interpreted as evidence of causation.

Antigen-level supply information from WUENIC Estimate Descriptions provides important context for interpreting this recovery. In 2023, Cameroon reported a four-month national and subnational stockout affecting DTP1, DTP3, HepB3, and Hib3, and a one-month national stockout affecting MCV1, MCV2, and RCV1 [12]. Despite these documented disruptions, routine infant vaccine coverage remained relatively high in 2023, with DTP1 coverage at 81%, DTP3 at 75%, and MCV1 at 71%. During the same year, girls' HPV first-dose coverage increased almost threefold, from 23% to 68%. This pattern suggests an apparent supply paradox: HPV coverage increased sharply during a year in which several routine infant antigens experienced documented supply disruption. The finding is consistent with the interpretation that the 2023 HPV recovery was unlikely to be explained by broad health-system supply improvement alone, but by a combined programme effect involving single-dose adoption, delivery intensification through PIRI, expanded eligibility, and intensified communication. However, this remains indirect ecological evidence. Antigen-specific HPV stock availability, subnational implementation variation, school-based delivery intensity, and other unmeasured confounders cannot be excluded. The finding should therefore be interpreted as supportive of a plausible programme mechanism, not as definitive evidence of causation. The comparison does not assume that a DTP supply interruption should reduce annual coverage in direct proportion to stockout duration, because infant vaccines are delivered through multiple scheduled contacts and catch-up opportunities across the year. Rather, the comparison highlights a structural difference between the infant immunisation system, which can absorb short-term supply disruptions through schedule flexibility and catch-up, and HPV vaccination, which depends more heavily on school-based outreach platforms with fewer compensatory contacts if a session is missed.

Operational bottlenecks plausibly associated with the 2024–2025 decline

Four operational bottlenecks were plausibly associated with the 2024–2025 decline: supply and redistribution constraints, delivery-platform fragility, communication gaps, and premature expansion of eligibility before girls' coverage had stabilized.

Supply and redistribution constraints

Vaccine stockouts, delayed redistribution, and incomplete session implementation were repeatedly identified as constraints affecting HPV service delivery. Programme-reported records also suggest substantial under-utilization of supplied doses before the 2023 recovery: approximately 377,100 doses were reportedly received in 2021, while 90,584 were reported as administered; in 2022, approximately 185,570 doses were reportedly received, while 98,045 were administered [10]. These grey-literature figures should be interpreted cautiously, but they suggest that the programme faced not only supply availability challenges, but also operational absorption and delivery constraints. The same source reports 2023 and 2024 dose receipt and administration figures in which administered doses exceeded doses received, indicating that direct same-year interpretation is unreliable without additional information on stock carry-over, redistribution timing, reporting periods, and stock reconciliation. These dose receipt and administration figures are therefore used only as contextual programme evidence and not as formal supply-chain or utilisation estimates. Publicly available data do not separately report HPV-specific stockout duration in 2024. However, WUENIC Estimate Descriptions document wider routine immunization supply disruption that year, including a one-month national and subnational stockout affecting DTP1 and DTP3, and a two-month national and subnational stockout affecting RotaC [12]. Because DTP-containing vaccines are delivered through combination products in Cameroon, these disruptions are also relevant to interpreting HepB3 and Hib3 programme performance. These data provide evidence of broader supply-chain fragility in 2024, but they should not be interpreted as direct evidence of an HPV vaccine stockout. Rather, they support the conclusion that HPV delivery was operating within a wider context of supply and redistribution vulnerability.

Delivery-platform fragility

Programme-reported records suggest that approximately 84% of health facilities were not providing HPV vaccination approximately two years after national introduction [10]. This estimate is derived from grey literature and should be interpreted cautiously, but it points to limited institutionalization of HPV vaccination within routine service platforms. Access was further constrained by reported opposition from Catholic institutions, including restrictions affecting HPV vaccination activities in Catholic health facilities and schools, which programme sources estimated to represent a substantial share of national service delivery capacity [9,10]. District-level evidence from Saa Health District similarly identified restrictions on HPV awareness activities in Catholic churches and schools as contributors to hesitancy, while also showing that engagement of teachers and Catholic priests can support successful school-based vaccination [11]. This proportion is likely heterogeneous by region and school network, and should be interpreted as an operational planning constraint rather than a precise national estimate. Taken together, the programme-reported facility readiness gap and restricted access to faith-linked delivery platforms suggest limited institutionalization of HPV vaccination within routine service delivery and likely weakened continuity of planned sessions.

Communication gaps

The transition to a single-dose schedule required clear communication to parents, teachers, health workers, and community influencers. Where such communication was incomplete, uncertainty about

whether one dose provided adequate protection may have contributed to hesitancy or delayed acceptance [8,10]. District-level evidence from Saa Health District identified safety and fertility-related rumours as barriers to HPV vaccination, while also showing that engagement of teachers and Catholic priests could support successful school-based vaccination [11]. More recent parental evidence from Buea Health District similarly found that HPV vaccine hesitancy was associated with safety concerns, fear of side effects, distrust in the Ministry of Health or pharmaceutical companies, and lack of support from religious leaders [18]. Programme experience further indicated the need for stronger communication with fathers, religious leaders, teachers, and other decision-makers who influence adolescent vaccination uptake [10,16].

Premature eligibility expansion

Gender-neutral eligibility was extended to boys in January 2023 alongside single-dose adoption, PIRI, and intensified communication - enabling conditions that collectively supported the coverage recovery observed that year. However, the same expansion increased the target population, vaccine requirements, cold-chain needs, transport, supervision, session planning, data-reporting workload, and operational financing demands. When those enabling conditions were not sustained after the 2023 recovery, expanded eligibility may have become an operational constraint rather than an asset. Njoh and colleagues reported that 112,610 boys were vaccinated in 2023; based on UNICEF HPV vaccine pricing, the estimated vaccine cost was approximately US$506,745, reportedly borne by the national government because Gavi support was directed primarily towards girls [8,12,15]. In a context where girls' coverage had fallen to 30% by 2025, continued routine vaccination of boys may have increased operational complexity before the girls-first programme objective had stabilized. This finding supports a recovery strategy that prioritizes restoring high coverage among girls while reassessing the timing, financing, and delivery model for gender-neutral vaccination.

Renewed decline through 2025

The WUENIC 2025 revision shows that girls' HPV first-dose coverage declined further, from 36% in 2024 to 30% in 2025, indicating that the 2024 fall was not a single-year fluctuation but the second year of a sustained post-peak decline [12]. The available public evidence does not support attribution of the 2025 estimate to a specific stockout or discrete programme event. Two independent sources nevertheless provide plausible, though non-causal, context for this continued decline. A qualitative study of stakeholder perceptions of Cameroon's gender-neutral HPV programme, conducted in 2024, reported persistent concerns about limited resources, misinformation, hesitancy, and logistics, and called for securing long-term funding to sustain the programme [19]. Separately, a mixed-methods analysis of Cameroon's vaccine procurement and financing system documented procurement complexity, funding deficits, delayed dose acquisition, and stockouts affecting at least one antigen, supporting financing and supply-chain vulnerability as relevant programme context [20]. Neither source documents a specific cause of the 2025 HPV decline, but both are consistent with an unresolved sustainability problem rather than a one-off disruption.

Contextualizing HPV within the routine immunization system, 2025

WUENIC 2025 revision estimates show that Cameroon's HPV coverage shortfall was substantially larger than gaps observed for selected routine immunisation indicators (Fig. 3), and that this gap widened further between 2024 and 2025. In 2025, coverage was 93% for BCG, 86% for DTP1, 83% for DTP3, 81% for IPV1, and 75% for MCV1, compared with 30% for girls' HPV first-dose coverage. These 11 comparator antigens all use indicator definitions that are stable across the 2024 and 2025 WUENIC revisions; Pol3, IPV2, and PCV3 were retired or redefined as completed-series indicators (IPVC, PCVC) in the 2025 revision for all countries, and are therefore not used in the primary comparator set (see Methods). The full 2025 WUENIC comparator table, including the 11-antigen primary comparator set, 2024 values for comparison, coverage gaps, and the IPVC/PCVC sensitivity check, is provided in Additional file 2.

The selected routine immunisation indicator estimates were 45 to 63 percentage points higher than HPV coverage in 2025, compared with a 35 to 57 percentage-point range on the same indicators in 2024. Notably, MCV2, administered after the first year of life, reached 66% coverage in 2025, up from 49% in 2024, yet still exceeded HPV first-dose coverage among girls by 36 percentage points (Fig. 3), compared with a 13 percentage-point gap in 2024. HPV underperformance relative to MCV2 is particularly notable because MCV2 is itself a challenging indicator, requiring a second contact after the first year of life; that HPV coverage remained below this benchmark by a widening margin points to the severity and specificity of the adolescent delivery gap. All 11 comparator antigens improved or held steady from 2024 to 2025 while HPV coverage declined further, so the HPV gap widened on every comparator antigen assessed. This pattern is not readily explained by general routine immunization weakness or a shared supply-chain constraint, since the routine antigens moved in the opposite direction to HPV during the same period. The residual gap points to adolescent- and HPV-specific barriers, including school-platform fragility, restricted faith-linked delivery channels, persistent safety and fertility-related hesitancy, inconsistent communication around single-dose protection, and the operational burden of widened eligibility. The 45 percentage-point gap between MCV1 and HPV in 2025 provides an illustrative benchmark of the widening HPV programme shortfall. However, the comparison is not causal: MCV1 is delivered through the infant immunization platform, whereas HPV vaccination depends on adolescent outreach, school engagement, parental consent, teacher support, and community trust.

Figure 3. HPV vaccination shortfall relative to selected routine immunisation indicators in Cameroon, 2025.

Bars show WUENIC 2025 revision estimated national coverage for selected routine immunisation indicators and HPV first-dose coverage among girls, using the 11-antigen stable-definition comparator set described in the Methods. Selected indicators are BCG, DTP1, DTP3, IPV1, MCV1, MCV2, and HPV1 girls. MCV2 is included to show that HPV coverage in 2025 remained lower than the second dose of measles-containing vaccine, and that this gap widened relative to 2024. The dotted vertical line indicates the WHO cervical cancer elimination target of 90% HPV vaccination coverage among girls by age 15. The

45 percentage-point gap between MCV1 and HPV1 in 2025 is presented as an illustrative benchmark of the HPV/adolescent delivery gap and should not be interpreted causally, because MCV1 and HPV vaccination differ by target age group, delivery platform, and demand context. Abbreviations: BCG = Bacillus Calmette-Guérin; DTP1/DTP3 = diphtheria-tetanus-pertussis-containing vaccine, first/third dose; IPV1 = inactivated poliovirus vaccine, first dose; MCV1 = measles-containing vaccine, first dose; MCV2 = measles-containing vaccine, second dose; HPV1 = HPV vaccine first dose among girls (prHPV1 F); pp = percentage points. Additional file 2 presents 2025 WUENIC revision coverage for the 11 stable-definition comparator antigens, together with the HPV first-dose girls reference estimate and the IPVC/PCVC sensitivity check described in the Methods and Limitations.

DISCUSSION

Health policy triangle analysis

Applying the health policy triangle framework [14] shows that Cameroon's HPV trajectory was shaped by the interaction of policy content, implementation context, policy process, and actor dynamics. In terms of policy content, the 2023 package was evidence-informed: single-dose adoption directly addressed dose-completion attrition, while gender-neutral eligibility reflected an equity ambition. However, the two components had different operational implications. Single-dose conversion reduced a documented delivery bottleneck, whereas extending routine eligibility to boys increased target population size, vaccine requirements, supervision needs, and data workload before girls' coverage had stabilized. The implementation context included enabling factors, such as NITAG legitimacy, prior HPV pilot experience, and the 2022 triangulation of programme data, but also persistent supply and redistribution constraints, fragile adolescent delivery platforms, fiscal pressure, and Catholic or faith-linked access barriers. The policy process generated actionable NITAG-led recommendations and was followed by measurable gains in 2023, but the 2024–2025 decline suggests that policy adoption was stronger than policy institutionalization. The actor dimension, particularly the roles of faith institutions, schools, parents, teachers, health workers, and programme decision-makers, remained central to whether policy changes translated into sustained delivery. Sustained recovery is therefore likely to require converting episodic consultation into standing governance, financing, microplanning, communication, and accountability mechanisms.

The structural access constraint and faith-sector engagement

The reported exclusion of a substantial share of faith-linked health and school infrastructure represents a major structural constraint on HPV vaccine access and trust. Although the approximately 30% estimate is programme-reported, heterogeneous by region, and should not be interpreted as a precise national coverage ceiling, it has important planning implications. Without a dedicated faith-sector engagement strategy or credible alternative delivery channels, improvements in vaccine supply, session calendars, and routine communication may still be insufficient to achieve the 90% global strategy target.

Transparent target-setting should therefore distinguish between programme underperformance that can be corrected through operational improvements and coverage limitations created by unresolved institutional access barriers.

Experience from Rwanda and Nigeria suggests that high HPV vaccination uptake is more feasible when adolescent vaccination is embedded in structured school-based delivery, early social mobilization, and sustained engagement with trusted community actors. Rwanda's national programme achieved high coverage through school-based vaccination, nationwide sensitization before vaccine delivery, and community involvement in identifying girls who were absent from school or not enrolled [21]. Nigeria's HPV vaccine introduction experience similarly highlighted the importance of early social mobilization, local-language communication, expanded technical working groups that included religious and community leaders, and the use of traditional leaders, religious leaders, town criers, teachers, and community-based mobilisers to build trust and counter misinformation [22]. This is consistent with a sub-Saharan Africa systematic review identifying stakeholder engagement, community engagement, information, and target-oriented vaccination campaigns as facilitators of HPV vaccination [23]. For Cameroon, the NITAG-recommended approach of iterative stakeholder engagement[8,16] correctly identifies this pathway. However, the 2024–2025 decline, together with persistent communication gaps and unresolved faith-sector access barriers, suggests that stakeholder engagement should not remain an ad hoc activity. It should be resourced as a standing programme function, with dedicated staff, budget, monitoring indicators, and accountability mechanisms.

The girls-first case: sequencing, not permanent exclusion of boys

A time-limited re-prioritization of girls for HPV vaccination should be considered as an operational sequencing strategy, not as a permanent exclusion of boys from HPV prevention. The 2023 evidence suggests that gender-neutral vaccination can be compatible with programme recovery when implemented alongside single-dose adoption, PIRI, and intensified community engagement [8]. However, the 2024–2025 decline suggests that these enabling conditions were not sustained strongly enough after the 2023 recovery. When these conditions are weak, expanding vaccination to boys adds operational pressure. It increases the number of people to vaccinate, the vaccine doses required, cold-chain needs, transport, supervision, session planning, and data workload. This added complexity may reduce the programme's ability to first achieve high and sustained HPV coverage among girls, which remains the primary cervical cancer prevention objective.

Three arguments support temporary girls-first prioritization. Epidemiologically, girls and women bear the overwhelming burden of cervical cancer, which remains the primary public health rationale for HPV vaccination in Cameroon [1]. Operationally, focusing routine delivery on girls would approximately halve the target population, reducing cold-chain, transport, session-planning, and supervisory demands during the recovery phase. From a resource-allocation perspective, when girls' HPV coverage had fallen to 30% by 2025, each additional dose delivered to an eligible girl would more directly support immediate cervical

cancer prevention objectives than routine expansion to boys, while acknowledging that boys also benefit directly from HPV vaccination and that gender-neutral vaccination remains a valid longer-term equity objective [6,24].

Any time-limited girls-first sequence should include transparent criteria for reviewing or resuming routine gender-neutral delivery, such as recovery of girls' coverage, reliable vaccine supply, and stable session implementation.

Table 1
Logic model for HPV vaccination recovery in Cameroon.

Operational drivers of 2024–2025 decline	Recovery activities	Immediate outputs	Outcomes
1. Supply and redistribution constraints Stockouts; delayed redistribution; weak buffer-stock visibility; delayed operational funding	**1a. Supply reliability** Maintain 3–6 month HPV vaccine buffer; weekly stock visibility; 72-hour redistribution trigger; quarterly quantification updates	Routine HPV stockout monitoring established; once established, stockout days target ≤ 5 per quarter; 3-month buffer confirmed at national, regional, and district stores	**Near-term, 1–2 years**: Girls' HPV first-dose coverage returns to ≥ 60% from the 2025 baseline of 30%; HPV stockout days ≤ 5 per quarter; ≥80% planned sessions completed
2. Adolescent delivery-platform fragility Limited routine facility delivery; no protected school calendar; restricted access to some faith-linked schools/facilities*	**2a. Protected school-based calendar** Health-Education co-signed calendar; fixed school-term windows; ring-fenced session resources; catch-up days	≥ 80% planned school or community sessions conducted; catch-up sessions documented	
3. Communication and trust gaps Single-dose uncertainty; safety and fertility rumours; inconsistent messaging; limited engagement with fathers and faith leaders	**3a. Strategic communication** Funded communication plan; standard single-dose and safety messages; district rumour tracking; quarterly faith-sector dialogue	Caregivers, teachers, and health workers receive consistent single-dose messages; rumours logged and addressed; quarterly dialogues documented	**Medium-term, 2–4 years**: Girls' WUENIC coverage sustained ≥ 80% and progressing toward the 90% target; district and schooling-status gaps narrowed; gender-neutral routine delivery reviewed or resumed if criteria are met
4. Expanded eligibility before systems stabilized Adding boys to routine eligibility increased target population, vaccine needs, supervision, and data workload	**4a. Equity outreach** Map out-of-school girls; conflict-sensitive microplans; community sessions; disability and adolescent-friendly service audits	Out-of-school girls included in microplans; conflict-affected districts have adapted session plans; disability access gaps documented	
	5a. Girls-first prioritization Time-limited girls-first focus; public criteria for reviewing or resuming	Vaccine and operational resources focused on girls during recovery; resumption	**Longer-term, 5 + years**: High girls' coverage sustained; gender-neutral vaccination implemented when resources allow; Cameroon recovery

Operational drivers of 2024–2025 decline	Recovery activities	Immediate outputs	Outcomes
	routine gender-neutral delivery	criteria monitored transparently	model documented for comparable settings; cervical precancer/cancer surveillance strengthened
	6a. Monitoring and accountability Track stockouts, session completion, communication reach, and equity-disaggregated coverage; quarterly performance reviews; review annual WUENIC revisions alongside subnational programme indicators to confirm whether national-level trends are sustained	Monthly district reports submitted; data triangulation and quality audits completed quarterly	

Overarching context

Faith-sector dynamics remain a cross-cutting access and trust constraint. Programme-reported estimates suggest restricted access to a substantial share of faith-linked delivery infrastructure; this estimate is heterogeneous and should be used for planning, not as a precise national statistic. The model assumes multi-year institutional engagement with faith leaders and credible alternative delivery channels where access remains restricted.

* Programme-reported estimates from grey literature; see Methods for source caveats. Indicators are proposed monitoring targets and theory-of-change milestones, not observed effects. Some indicators, including HPV-specific stockout tracking, are not yet routinely available publicly; establishing these data systems is treated as an early implementation priority within the recovery pathway, not a precondition for starting recovery activities. The column order indicates the logic model direction: operational drivers -> recovery activities -> immediate outputs -> outcomes.

Sequenced recovery priorities

Table 1 summarizes the theory of change underpinning the proposed recovery pathway. Six interdependent priorities are proposed. First, HPV vaccine supply reliability should be restored through a three-to-six-month buffer stock, routine stock visibility, and rapid redistribution triggers. Second, HPV vaccination should be protected within a school-term delivery calendar co-owned by the health and education sectors, with catch-up options for out-of-school girls. Third, strategic communication should be funded as a core intervention, with standard messages on HPV, single-dose protection, safety, and

fertility concerns, supported by district-level rumour tracking and structured faith-sector dialogue. Fourth, equity should be operationalized through mapping and outreach for out-of-school girls, conflict-affected areas, peri-urban informal settlements, and girls with disabilities. Fifth, gender-neutral delivery should be sequenced through time-limited girls-first prioritization until supply security, delivery-calendar stability, and sustained girls' coverage are restored. Sixth, monitoring should move beyond annual national estimates to track stockouts, session completion, communication reach, rumour response, and coverage gaps by district and schooling status.

STRENGTHS AND LIMITATIONS

This analysis has several strengths. It uses the WUENIC 2025 revision as the primary quantitative source, allowing standardized comparison of Cameroon's HPV vaccination trajectory across 2020–2025 and against routine immunization indicators. The 2025 revision left all 2020–2024 values used in this analysis unchanged, supporting the stability of the historical series. The analysis also combines coverage data, WUENIC Estimate Descriptions, peer-reviewed programme evidence, WHO guidance, and contextual programme sources to interpret the 2023 recovery and renewed decline through 2025.

Several limitations should be considered. First, the analysis relies on aggregated national estimates and publicly available sources; subnational variation in dose completion, school-platform performance, faith-linked access constraints, and implementation intensity could not be assessed. Second, WUENIC estimates are standardized national estimates rather than exact counts, and uncertainty was not formally propagated into derived dropout rates or coverage-gap estimates. Third, the analysis is ecological and cannot isolate the independent effects of single-dose adoption, gender-neutral eligibility, PIRI, communication intensification, supply constraints, or broader programme recovery activities.

Fourth, HPV-specific stockout data were not publicly available for 2024 or 2025. Publicly available WUENIC and country-level sources reviewed for the 2025 period did not identify a specific HPV stockout or discrete implementation event explaining the further decline to 30%; the 2025 estimate is therefore interpreted as part of a continuing sustainability signal rather than attributed to a specific documented cause. Fifth, some programme-context evidence was drawn from a conference presentation that has not undergone peer review and includes administrative coverage values that differ from WUENIC estimates. These findings are used only as contextual programme evidence. Sixth, the MCV1-HPV and MCV2-HPV comparisons are illustrative rather than causal because the vaccines differ by target age group, delivery platform, demand context, and community engagement requirements. The WUENIC 2025 revision also retired Pol3 and replaced IPV2 and PCV3 with completed-series indicators, so the primary cross-antigen comparison used an 11-antigen stable-definition comparator set. A sensitivity check including IPVC and PCVC did not change the direction or substance of the findings.

Finally, the proposed recovery pathway has not yet been formally reviewed or validated by national programme implementers, district health teams, education-sector partners, or faith-sector stakeholders.

It should therefore be interpreted as an evidence-informed framework requiring stakeholder review, contextual adaptation, and feasibility assessment before adoption.

CONCLUSION

Cameroon's HPV vaccination programme suggests that rapid recovery can occur in constrained settings, but may be difficult to sustain without institutionalized delivery systems. The high dropout under the two-dose schedule, estimated at 76% in 2021 and 70% in 2022, indicates that single-dose conversion was a critical operational adaptation. The 2023 rise in coverage was plausibly supported by the combined effects of single-dose adoption, PIRI, expanded eligibility, and intensified communication. The subsequent decline to 36% in 2024 and further to 30% in 2025 suggests that these enabling conditions were not sustained, and that the shortfall represents a renewed two-year decline rather than a single-year fluctuation. Sustained recovery may be feasible if supply reliability, protected school-based delivery, strategic communication, targeted outreach, careful sequencing of gender-neutral vaccination, and stronger monitoring are implemented as an integrated package. The unresolved faith-sector delivery constraint should be treated as an operational planning issue rather than a fixed coverage ceiling, but overcoming it is likely to require sustained institutional engagement, trust-building, and credible alternative delivery pathways where access remains restricted.

For comparable settings, Cameroon's experience highlights four lessons: single-dose schedules are especially important where multi-dose completion is weak; PIRI can contribute to rapid coverage improvement but must be routinely resourced; communication and sustained financing should accompany service expansion; and equity for out-of-school, conflict-affected, and marginalized girls should be planned from the outset.

Abbreviations

BCG
Bacillus Calmette-Guérin
DTP
diphtheria-tetanus-pertussis-containing vaccine
HPV
human papillomavirus
IPVC
inactivated poliovirus vaccine completed series
MCV
measles-containing vaccine
NITAG
National Immunization Technical Advisory Group
PCVC
pneumococcal conjugate vaccine completed series

PIRI
periodic intensification of routine immunization
WUENIC
WHO/UNICEF Estimates of National Immunization Coverage.

Declarations

Ethics approval and consent to participate

Not applicable. This study used only publicly available aggregate national immunisation coverage estimates and published literature. No individual-level or identifiable human participant data were collected, accessed, or analysed.

Consent for publication

Not applicable.

Availability of data and materials

The WUENIC 2025 revision data used in this study are publicly available from the WHO Immunization Data Portal and UNICEF immunization dataset portal at https://immunizationdata.who.int. All other supporting documents are referenced in the main text. No individual-level or identifiable participant data were used.

Competing interests

N.I.M. works for Cameroon's Ministry of Health, the government body responsible for the national immunisation programme evaluated in this study. The authors declare that this affiliation did not influence the analysis, interpretation, or conclusions. The authors declare that they have no competing interests.

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Authors' contributions

T.E.A conceptualized the study, extracted, analyzed, and validated the data, drafted the article, and approved the final version.

N.I.M contributed to data validation, interpretation of programme-context findings, critically reviewed the article for technical accuracy and policy relevance, and approved the final version.

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Use of AI-assisted technology

The authors used ChatGPT (OpenAI, GPT-5.5 Thinking) during article preparation for language refinement, structural editing, and consistency checks. The authors reviewed and edited all outputs, verified all factual claims and references, and take full responsibility for the content, analysis, interpretation, and conclusions. AI was not used to generate original data, conduct independent analysis, or make scientific conclusions.

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Figures

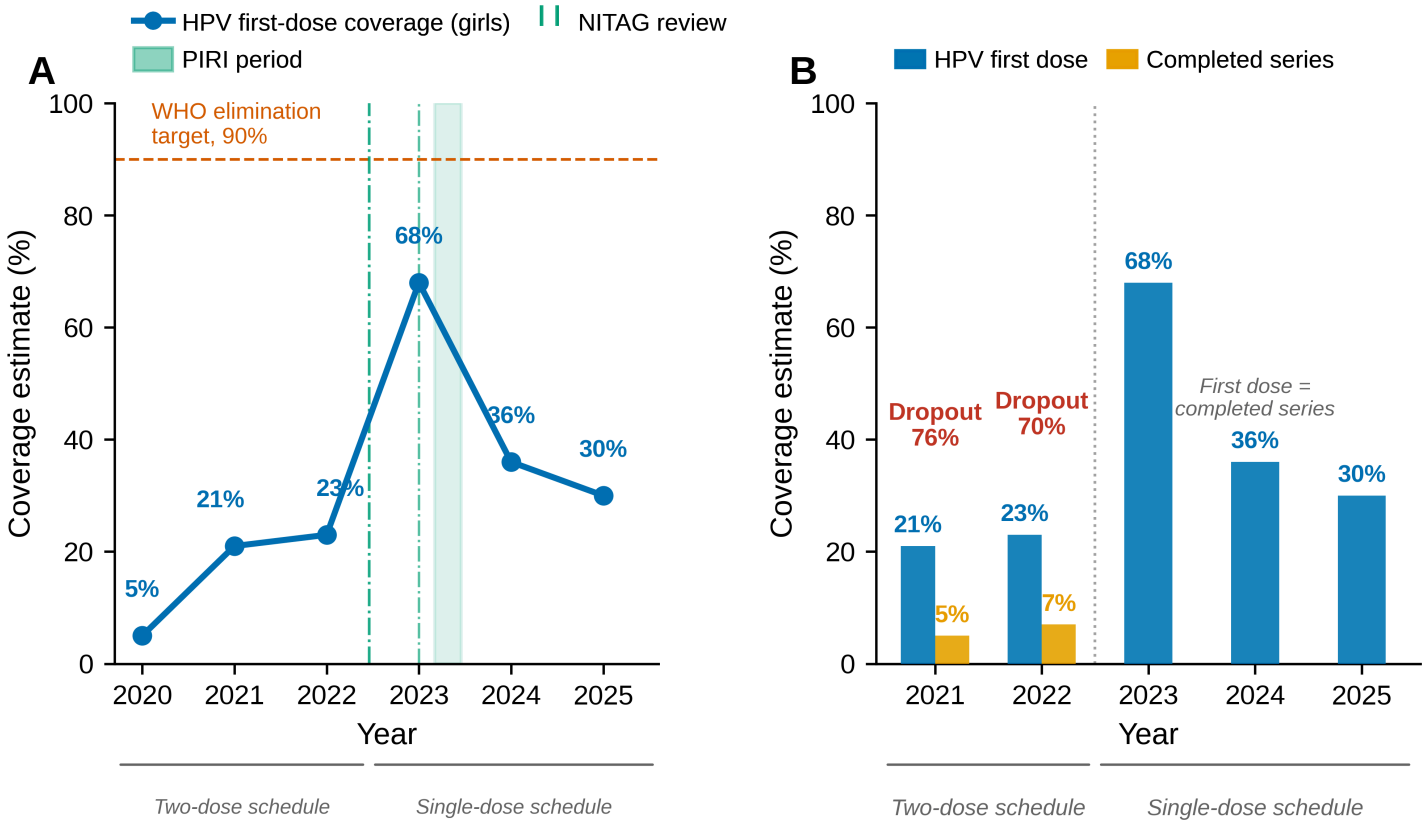

Figure 1

HPV vaccination coverage trends in Cameroon before and after single-dose adoption, 2020–2025.

Panel A shows the WUENIC 2025 revision estimates of HPV first-dose coverage among girls. Policy milestones indicate the National Immunization Technical Advisory Group review in June 2022 and adoption of the single-dose schedule with gender-neutral eligibility in January 2023. The shaded band marks the PIRI period from March to June 2023. Panel B compares first-dose coverage and completed-series coverage during the two-dose schedule period, showing estimated dropout of 76% in 2021 and 70% in 2022. From 2023, first-dose and completed-series coverage were equivalent by definition under the single-dose schedule. Panel A additionally shows the 2025 estimate of 30%, and Panel B shows single bars for 2023, 2024, and 2025 reflecting this equivalence. PIRI = periodic intensification of routine immunization; WUENIC = WHO/UNICEF Estimates of National Immunization Coverage.

Figure 2

Programme interventions and documented vaccine stockout context, Cameroon, 2020–2025.

The timeline shows key HPV programme interventions and documented routine-antigen stockout events identified from WUENIC Estimate Descriptions and published programme evidence. HPV coverage values are shown as contextual markers through 2025; the full annual coverage trajectory is presented in Fig 1A. Only documented programme and stockout events are displayed, and no additional 2025

programme event is inferred from the coverage estimate. The figure provides ecological programme context and should not be interpreted as evidence of causation.

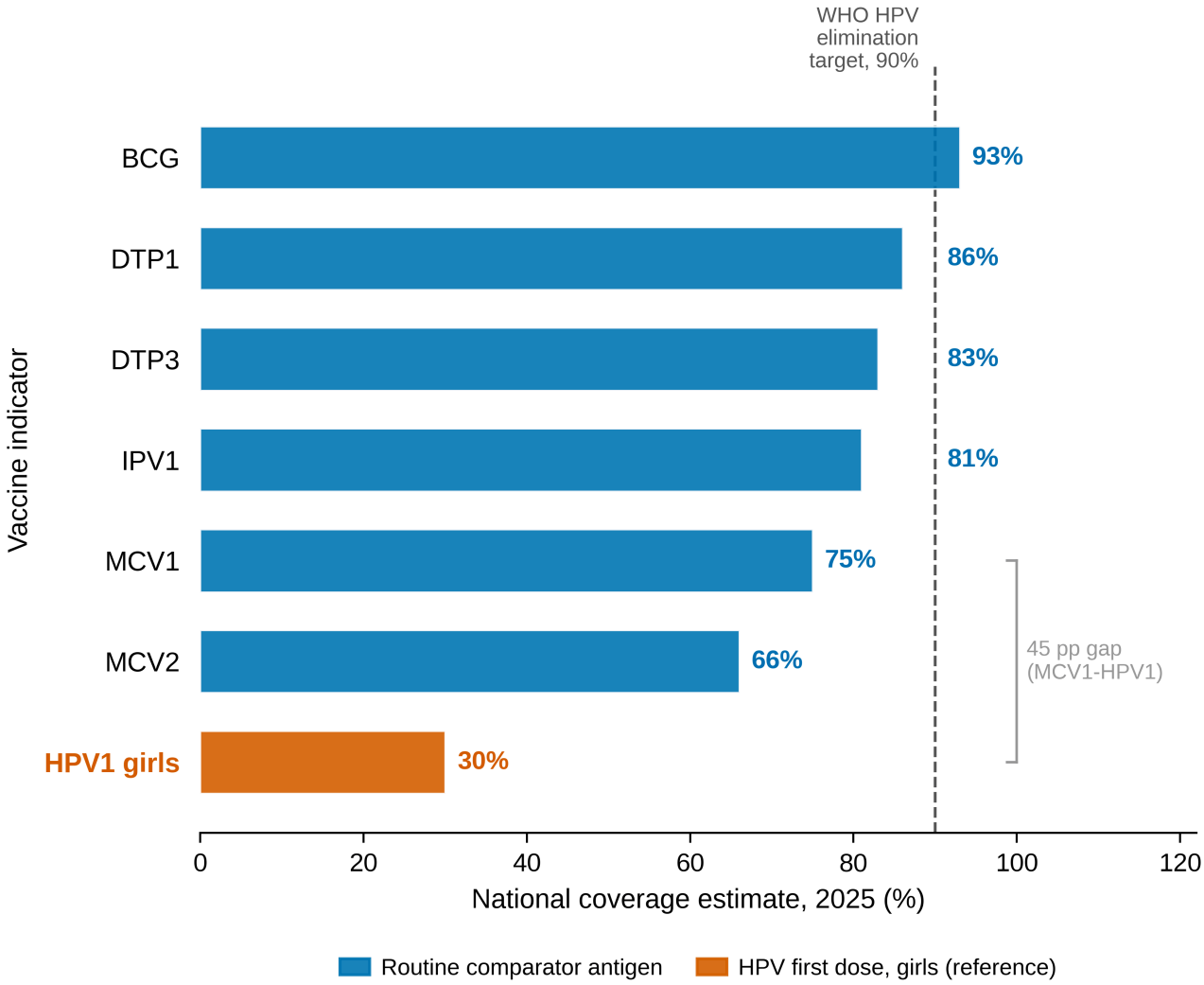

Figure 3

HPV vaccination shortfall relative to selected routine immunisation indicators in Cameroon, 2025.

Bars show WUENIC 2025 revision estimated national coverage for selected routine immunisation indicators and HPV first-dose coverage among girls, using the 11-antigen stable-definition comparator set described in the Methods. Selected indicators are BCG, DTP1, DTP3, IPV1, MCV1, MCV2, and HPV1 girls. MCV2 is included to show that HPV coverage in 2025 remained lower than the second dose of measles-containing vaccine, and that this gap widened relative to 2024. The dotted vertical line indicates the WHO cervical cancer elimination target of 90% HPV vaccination coverage among girls by age 15. The 45 percentage-point gap between MCV1 and HPV1 in 2025 is presented as an illustrative benchmark of the HPV/adolescent delivery gap and should not be interpreted causally, because MCV1 and HPV vaccination differ by target age group, delivery platform, and demand context. Abbreviations: BCG = Bacillus Calmette-Guérin; DTP1/DTP3 = diphtheria-tetanus-pertussis-containing vaccine, first/third dose;

IPV1 = inactivated poliovirus vaccine, first dose; MCV1 = measles-containing vaccine, first dose; MCV2 = measles-containing vaccine, second dose; HPV1 = HPV vaccine first dose among girls (prHPV1 F); pp = percentage points. Additional file 2 presents 2025 WUENIC revision coverage for the 11 stable-definition comparator antigens, together with the HPV first-dose girls reference estimate and the IPVC/PCVC sensitivity check described in the Methods and Limitations.

Supplementary Files

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- Additionalfile1STROBEBMCGPH.pdf
- Additionalfile2.pdf