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# Human papillomavirus vaccine acceptability in Cameroon: a systematic review and meta-analysis

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## Abstract

**Background:** Human papillomavirus (HPV) vaccination is a key strategy for cervical cancer elimination. In Cameroon, HPV vaccine was introduced into the expanded program on immunization in 2020. However, synthesized evidence on vaccine acceptability is needed to guide policy. This systematic review and meta-analysis aimed to estimate the pooled prevalence of HPV vaccine knowledge, willingness to vaccinate, recommendation practices, and actual uptake in Cameroon, and to identify determinants of vaccine hesitancy.

**Methods:** We searched PubMed, Scopus, Web of Science, Embase, Cochrane Library, and African Journals Online from studies to January 2025. Studies reporting willingness to vaccinate,

knowledge, recommendation, and uptake of HPV vaccine were included. Pooled prevalence estimates and odds ratios were calculated using random-effects models. Heterogeneity was assessed using the  $I^2$  statistic. The study was reported following PRISMA 2020 guidelines and registered in PROSPERO ID: CRD420261301213.

**Results:** Thirty-three studies were included. Among 4,993 participants, who were mainly healthcare workers ( $n = 1,739$ ) and parents ( $n = 2,419$ ), the pooled prevalence of willingness to vaccinate was 68.1% (95% confidence interval [CI]: 57.4–77.2; 12 studies;  $I^2 = 98\%$ ). The pooled prevalence of HPV vaccine knowledge was 41.3% (95% CI: 28.7–55.1; 33 studies;  $n = 8,175$  participants;  $I^2 = 98\%$ ). Approximately two-thirds of participants (67.7%; 95% CI: 50.7–81.0; 8 studies;  $n = 1,617$ ) reported recommending the vaccine, but actual uptake was 22.9% (95% CI: 6.9–54.5; 9 studies;  $n = 9,686$ ). The vaccine coverage ranged from 1.6% to 90.6%. Willingness significantly declined from 74.2% before 2014 to 57.5% after 2021. Healthcare workers had the highest knowledge (74.5%) and willingness (77.8%) among included participant groups. Lack of HPV knowledge was associated with nearly three-fold higher hesitancy (odds ratio [OR]: 2.58; 95% CI: 2.06–3.22). High heterogeneity was observed for all pooled estimates, suggesting that they should be interpreted as average estimates rather than precise values.

**Conclusions:** Despite moderate willingness, HPV vaccine knowledge and uptake remain low in Cameroon, with marked disparities across regions and populations. Addressing knowledge gaps and strengthening context-specific vaccination strategies are needed to improve coverage.

**Keywords:** *Human papillomavirus; vaccine hesitancy; willingness; awareness; cervical cancer; Cameroon; meta-analysis*

## 1. Background

Human papillomavirus (HPV) is the most common sexually transmitted infection worldwide, with a global pooled prevalence of 31% (95% CI: 27–35) for any HPV and 21% (95% CI: 18–24) for high-risk HPV. Almost all sexually active individuals are likely to contract it at some point in their lives [1, 2]. It is the main cause of cervical cancer globally [3]. Cervical cancer is still a major public health issue globally, with about 90% of deaths occurring in low- and middle-income countries [4]. Sub-Saharan Africa faces a higher burden of cervical cancer because of limited screening, late diagnoses, and poor access to preventive care [5].

HPV vaccination is a very effective way to prevent cervical cancer. In 2020, the World Health Organization (WHO) introduced the Global Strategy to Accelerate the Elimination of Cervical

Cancer, which set the “90-70-90” targets. One of these goals is to reach 90% HPV vaccination coverage among girls by age 15 by 2030 [6]. Meeting this goal needs more than just having the vaccine available; it also depends on public trust, acceptance, and good integration into national immunization programs. In this review, we distinguish between three key concepts. Awareness refers to having heard of the HPV vaccine or knowing of its existence. Willingness (or acceptability) reflects an individual's expressed intention to receive the HPV vaccine or to have their child vaccinated if the vaccine is offered freely. Uptake denotes the actual receipt of at least one dose of the HPV vaccine, representing real-world vaccination behavior [7, 8].

In this regard, a meta-analysis in Ethiopia reported that the pooled estimate of HPV vaccination uptake of at least one dose among girls was 55% (95% CI: 53–57). The pooled estimates for mothers who were knowledgeable about HPV vaccination, had a positive attitude, and were willing to vaccinate their children were 38% (95% CI: 36–40), 58% (95% CI: 56–60), and 74% (95% CI: 72–75), respectively. Positive attitudes toward the vaccine, higher maternal education, and knowledge about HPV and its vaccine were reported as statistically significant predictors, whereas lack of adequate information and concerns about possible side effects were cited as reasons for vaccine rejection [9].

In Cameroon, cervical cancer is the second most common cancer among women and a leading cause of cancer-related deaths, causing an estimated 1,700 to 1,800 deaths annually despite being vaccine-preventable [10]. HPV vaccination began in Cameroon around 2014 with pilot and demonstration projects in selected regions [11]. These early projects, which often received additional support and resources not necessarily available during routine national rollout, showed relatively high awareness and acceptance, particularly among adolescents and parents who participated in organized information campaigns [12, 13].

Following pilot studies in various regions of Cameroon beginning in 2014, the vaccine was subsequently introduced into the national expanded program of immunization in 2020 [14]. While many studies report moderate to high willingness to vaccinate and recommend the vaccine, actual uptake is much lower in many communities [15, 16]. This gap between what people say and what happens in practice points to barriers, lack of information, and vaccine hesitancy.

Despite extensive research on HPV vaccine awareness, willingness, recommendation, and uptake in Cameroon, findings remain inconsistent and vary considerably by region, time period, and population group. Furthermore, few studies have examined trends across the key phases of vaccine implementation including the pre-vaccination period (<2014), the demonstration phase

(2014–2020), and the period following integration into the Expanded Program on Immunization (EPI) in 2020. Unlike meta-analyses conducted in other African countries that explore only acceptance or uptake of the HPV vaccine, our study simultaneously synthesizes existing literature on awareness, willingness, recommendation, and uptake across these distinct time periods in Cameroon. The primary aim of this systematic review and meta-analysis was to estimate the overall prevalence of willingness to vaccinate against HPV. The secondary aims were to determine the prevalence of vaccine knowledge, recommendation practices, and actual uptake, as well as to identify the main factors associated with HPV vaccine hesitancy in Cameroon. This thorough review will therefore help inform evidence-based strategies to achieve the WHO's 90% vaccination coverage target within the routine immunization system.

## 2. Methods

### 2.1. Study design and protocol registration

This systematic review and meta-analysis were reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020 guideline and was registered with the international prospective register of systematic reviews (PROSPERO) under registration ID CRD420261301213.

### 2.2. Eligibility Criteria

**Inclusion criteria:** This review focuses on quantitative, observational studies conducted before 2025. Interventional studies (randomized control trials, quasi-experimental) that measure at least our outcome of interest were also eligible. To be included, research must have reported on at least one of the following outcomes: HPV vaccine knowledge, willingness to vaccinate against HPV, HPV vaccine recommendation, or HPV vaccine uptake among individuals residing in Cameroon. Finally, the review was limited to literature written in either English or French.

**Exclusion criteria:** Studies conducted outside Cameroon, qualitative studies, review articles, editorials, commentaries, conference abstracts, and letter to editor were excluded. Studies lacking sufficient data (full-text) to estimate these specific prevalences were also disregarded.

### 2.3. Search strategy

**Databases:** A comprehensive literature search was conducted in PubMed, Scopus, Cochrane library, Web of Science, Embase, and African Journals Online (AJOL), Health Sciences and Diseases. To ensure completeness and saturation, grey literature was not systematically searched; however, the inclusion of Google Scholar and reference list screening helped capture

relevant studies not indexed in major databases. Screening was conducted using the Rayyan tool by two study investigators (FZLC and RT) [17]. An inter-rater agreement (kappa) of  $\geq 0.8$  was achieved on a pilot set of records; and disagreements were resolved through discussion. The last search was conducted on January 27, 2026.

**Search terms:** The search strategy used Medical Subject Headings (MeSH) and free-text terms combined with Boolean operators: ("human papillomavirus" OR HPV OR "cervical cancer") AND (vaccine OR vaccination OR knowledge OR awareness OR attitude OR practice) AND (Cameroon OR Cameroonian OR Cameroun). The PubMed search strategy was as follows: (("human papillomavirus"[TIAB] OR "HPV"[TIAB], "cervical cancer"[TIAB])) AND ("vaccine"[TIAB] OR "vaccination"[TIAB] OR "vaccines"[TIAB] OR "knowledge"[TIAB] OR "awareness"[TIAB] OR "attitude"[TIAB] OR "practice"[TIAB]) AND ("Cameroon"[Mesh] OR "Cameroon"[TIAB] OR "Cameroonian"[TIAB] OR "Cameroun"[TIAB])) (**Supplementary Table 1**).

## 2.4. Data extraction

Data were extracted using a standardized data extraction form. Extracted variables included study characteristics (author, year of study completion, region, setting, and design), population characteristics, sampling methods, sample size, and reported outcomes of interest. Odds ratios (ORs) and corresponding confidence intervals (CI) of factors associated with willingness to vaccinate were also extracted. Outcomes of interest included willingness or trust to vaccinate against HPV, knowledge of the HPV vaccine, HPV vaccine recommendation, HPV vaccine uptake. To address potential overlapping datasets, we assessed duplicate populations by comparing author names, study sites, sample sizes, and study periods. When multiple publications reported on the same study population, only the most comprehensive or recent publication was included to avoid double-counting participants. Data were extracted by two study investigators (FZLC, RT). and any disagreements were resolved through discussions or by consulting a third reviewer (CA).

## 2.5. Outcome measurement and operational definition

Our primary outcome of interest included the prevalence of willingness or trust to vaccinate against HPV which refers to an individual's expressed intention to receive the HPV vaccine or to have their child vaccinated, regardless of the specific wording used (e.g., "would you accept", "are you willing to" ). Our secondary outcomes encompassed prevalence of knowledge of the HPV vaccine as a mean to prevent HPV infection and ultimately the cervical cancer. The prevalence of HPV vaccine recommendation which referred to the proportion of individuals who reported they

can recommend HPV vaccine to other members of the community. The prevalence of HPV vaccine uptake which represented the proportion of eligible individuals who reported ever having received the HPV vaccine.

## **2.6. Data quality assessment**

The risk of bias in the included articles was assessed using the Joana Briggs Institute critical appraisal checklist [18]. The JBI tool was selected because it is specifically validated for prevalence and analytical cross-sectional studies, provides a standardized and widely recognized approach for assessing methodological quality in systematic reviews of observational studies, and offers clear criteria for evaluating risk of bias in studies reporting outcome frequencies. The number of parameters used to assess the quality of the included manuscript depended on the study design. For studies reporting prevalence data the items included : (1) sample frame appropriate to address the target population, (2) study participants sampled in an appropriate way, (3) sample size adequate, (4) study subjects and the setting described in detail, (5) data analysis conducted with sufficient coverage of the identified sample, (6) valid methods used for the identification of the condition, (7) condition measured in a standard, reliable way for all participants, (8) appropriate statistical analysis, (9) response rate adequate, and or low response rate managed appropriately. Each parameter was scored as 1 (yes) or 0 (no or unclear). The risk of bias was categorized as low: 7-9, moderate: 6-4, or high: 3-0 [19, 20]. Two reviewers independently assessed the risk of bias. Disagreements between the reviewers were resolved by discussion to reach consensus (FZLC, ATT).

## **2.7. Statistical analysis and synthesis**

For each study outcome, prevalence estimates and corresponding 95% confidence intervals (CIs) were calculated. To explore the variability in results, subgroup analyses were performed based on study timeframe, population group, study setting, sampling method. The  $I^2$  statistic was used to assess heterogeneity between studies. A Der Simonian and Laird random-effects model was chosen to pool the estimates, anticipating significant heterogeneity. The generalized linear mixed model (GLMM), coupled with the probit-logit transformation (PLOGIT), was utilized for its effectiveness in handling meta-analyses of binary outcomes and proportions close to 0% or 100% without continuity correction [21]. Given the anticipated high heterogeneity, we present prediction intervals alongside confidence intervals to reflect the true variation in effect estimates across studies. Statistical significance was set at a  $p$ -value of  $<0.05$ . All analyses were conducted using the 'meta' package in R Statistics version 4.5.2 [22]. Correlates of willingness to vaccinate against HPV were also computed to generate pooled ORs and their corresponding 95% CIs. The

acceptance of the vaccine is guided by the health belief model, which posits that vaccine acceptance is shaped by perceived susceptibility to HPV, perceived severity of cervical cancer, perceived benefits of vaccination, perceived barriers (safety concerns, cost, access), cues to action (healthcare provider recommendations), and self-efficacy. We selected determinants based on these constructs. Vaccine hesitancy frameworks further informed our interpretation of contextual factors such as misinformation and sociocultural norms. This framework guided variable selection and the organization of our findings [23, 24].

## **2.8. Publication bias, sensitivity analysis, GRADE assessment**

Publication bias was assessed using funnel plots and statistically through Egger's or Begg's test, provided at least 10 studies were included in the meta-analysis [25, 26]. A  $p$ -value  $> 0.05$  was considered indicative of no statistically significant evidence of publication bias. To evaluate the robustness of pooled estimates, a sensitivity analysis was performed using leave-one-out method (iteratively excluding one study at a time). The Duval and Tweedie trim-and-fill method was used to adjust for potential publication bias [27].

## **3. Results**

### **3.1. Studies selection**

A total of 443 articles were identified through searches of relevant databases. Of these, 25 duplicates were removed. After screening titles and abstracts, 346 reports were excluded. Among the remaining 77 full-text articles, 44 were excluded for specific reasons, including not reporting any of the outcomes of interest ( $n = 37$ ), being a review article ( $n = 4$ ), and lacking a reported sample size ( $n = 1$ ). Screening from other sources enabled the identification of 5 additional eligible study reports. Finally, 33 studies met the inclusion criteria and were included in the systematic review and meta-analysis (**Fig. 1**).

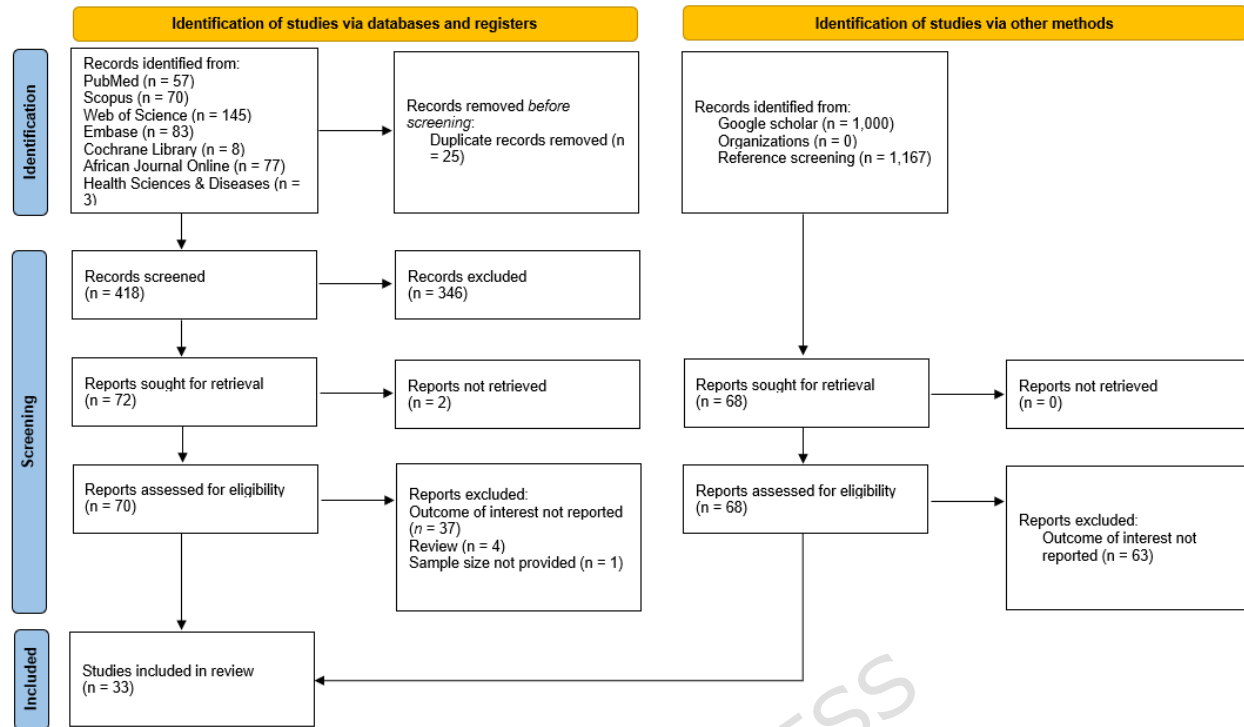


**Fig. 1** PRISMA diagram flow from study identification to inclusion in the systematic review and meta-analysis [28]

### 3.2. Study characteristics

A total of 33 study reports were included in this systematic review and meta-analysis. Most included studies were cross-sectional ( $n = 32$ ; 97%) and were conducted from 2014 to 2020, corresponding to the HPV vaccination demonstration period in Cameroon ( $n = 21$ ; 64%). The most frequently studied Cameroonian regions included the Centre ( $n = 16$ ; 48%), followed by the West ( $n = 8$ ; 24%), the South-West ( $n = 5$ ; 15%) regions. Included reports were primarily hospital-based ( $n = 25$ ; 76%) and used a non-probabilistic sampling method ( $n = 31$ ; 94%). Most study participants were women belonging to an unspecified risk group or the general population ( $n = 25$ ; 76%). Most studies presented low risk of bias ( $n = 26$ ; 79%) (**Table 1 and Supplementary Table 2-4**).

### 3.3. Willingness to vaccinate against human papillomavirus

The reported pooled prevalence of willingness to vaccinate targeted children (9-14 years) against HPV in Cameroon was 68.1% (95% CI: 57.4-77.2; 12 reports;  $n = 4,993$  participants), with high heterogeneity observed between studies ( $I^2 = 98.0$ ;  $p < 0.001$ ). The prediction interval ranged from 25.98% to 92.84% reflecting the true variation in the willingness to vaccinate. Due to

the high heterogeneity observed, the estimate should be interpreted cautiously as an average summary rather than precise national estimate (**Fig. 2**).

Significant sources of heterogeneity were observed across study timeframes ( $p = 0.006$ ), settings ( $p < 0.001$ ), study regions ( $p < 0.001$ ), risk of bias (0.037), and participant type ( $p < 0.001$ ). The prevalence of willingness to vaccinate significantly declined ( $p = 0.006$ ) over time, from 74.2% (95% CI: 67.2-80.1; 3 studies;  $n = 1,291$ ) before 2014 to 57.5% (95% CI: 40.4-72.9; 6 studies;  $n = 3,421$ ) with a peak observed in 2014-2020, during the demonstration phase (81.14%; 76.14-85.30; 3 studies;  $n = 281$ ). Community-based studies reported significantly lower prevalence of willingness to vaccinate (55.7%; 95% CI: 40.6-69.9; 6 studies;  $n = 2,533$ ) compared to other settings (Hospital: 76.5%; 95% CI: 67.5-83.6; 4 studies;  $n = 682$ ). For studies targeting specific Cameroonian regions, the pooled prevalence of willingness was significantly higher in the North-West region (78.1%; 95% CI: 75.3-80.7; 2 studies;  $n = 890$ ) and lower in the South-West region (47.4%; 95% CI: 38.6-56.4; 2 studies;  $n = 1,438$ ). Regarding participant type, higher prevalences of willingness to vaccinate were observed in studies conducted among healthcare workers (77.8%; 95% CI: 68.6-84.9; 4 studies;  $n = 1,739$ ) and parents of eligible children (62.0%, 95%CI: 43.3-77.7; 5 studies;  $n = 2,419$ ). Studies with moderate risk of bias reported higher willingness to vaccinate (77.0; 95% CI: 70.2-82.6; 5 studies;  $n = 1,235$ ) compared to study with lower risk (60.7; 95% CI: 44.9-74.4; 7 studies;  $n = 3,758$ ) (**Table 2 and Supplementary Fig. 1-6**).

### 3.4. Knowledge of the preventive vaccine against cervical cancer

The pooled prevalence of HPV vaccine Knowledge as preventive method against cervical cancer in Cameroon was 41.3% (95% CI: 28.7-55.1; 33 studies;  $n = 8,175$  participants) with high heterogeneity across included studies ( $I^2 = 97.9$ ;  $p < 0.001$ ). The prediction interval ranged from 3.10% to 93.93% reflecting the true variation of the knowledge of the HPV vaccine. Given the observed high heterogeneity, the estimate should be interpreted cautiously as an average summary rather than a precise national estimate(**Fig. 3**).

Study timeframe ( $p = 0.002$ ), study regions ( $p < 0.001$ ), sampling method ( $p < 0.001$ ), and participants type ( $p < 0.001$ ) were significant sources of heterogeneity in HPV vaccine Knowledge estimates. Knowledge declined over time with a significant drop observed during the 2014-2020 period (95% CI: 13.3-45.6; 14 studies;  $n = 3,229$ ) compared with the higher estimates that were recorded before 2014 (68.5%; 95% CI: 55.1-79.4; 5 studies;  $n = 1,668$ ). The study revealed significant regional disparities across regions; the lowest knowledge was observed in the West region (4.7%; 95% CI: 2.2-9.7; 2 studies;  $n = 464$ ) while higher rates were found in the Centre

region (48.0%; 95% CI: 26.4-70.4; 9 studies; n = 1,403); South-West (50.0%; 95% CI: 38.9-61.0; 8 studies; n = 2,489) and Far North (76.1%; 95% CI: 70.3-81.2; 1 study; n = 251). Regarding the type of participants, the highest knowledge rate was significantly observed among healthcare workers (74.5%; 95% CI: 49.5-89.7; 5 studies; n = 618) and students (51.1%; 95% CI: 36.3-65.7; 6 studies; n = 3,266), while the lowest rates were identified among women from the general population (27.0%; 95% CI: 13.9-45.9; 13 studies; n = 3,370) and community health workers (15.6%; 95% CI: 5.3-32.8; 1 study; n = 32) (**Table 3 and Supplementary Fig. 7-11**).

### 3.5. Human papillomavirus vaccine recommendation and uptake

This study showed that in Cameroon, 67.7% (95% CI: 50.7-81.0; 8 studies; n = 1,617) of individuals recommended vaccination against HPV to other community members; with high heterogeneity across studies ( $I^2 = 97.3\%$ ;  $p < 0.001$ ). This estimate should be interpreted cautiously as it is based on only eight studies. The prediction interval ranged from 14.63% to 96.24%, reflecting the true variation in HPV vaccine recommendation within the studied population. However, a much lower proportion of the population reported having ever actually received the HPV vaccine (22.9%; 95% CI: 6.9-54.5; 9 studies; n = 9,686) with similar high heterogeneity between studies ( $I^2 = 99.7\%$ ;  $p < 0.001$ ). The prediction interval ranged from 0.18% to 98.04% reflecting the true variation in the pooled estimate. The wide confidence interval and the high heterogeneity suggest that this pooled estimate should be interpreted with caution. The lowest prevalences were observed in studies conducted in 2021 and 2018, which revealed prevalences of 1.6% and 1.7%, respectively, among women from the general population [16, 29]. Conversely, the highest prevalence was recorded in a study carried out in 2011 (90.6%) among target children [30] (**Fig 4 and 5**).

**Table 1** Synthesis of included study characteristics

| Author             | Year <sup>1</sup> | Design | Region              | Setting             | Sampling method   | Type of participant         | Risk of bias | Sample size | Prevalence of knowledge of vaccine <sup>2</sup> |
|--------------------|-------------------|--------|---------------------|---------------------|-------------------|-----------------------------|--------------|-------------|-------------------------------------------------|
| McCarey,2009 [31]  | 2009              | CS     | Centre              | Hospital            | Non-probabilistic | Healthcare worker           | Moderate     | 401         | 44.14                                           |
| Ayissi,2011 [12]   | 2011              | CS     | North-West          | School              | Non-probabilistic | Adolescent girl             | Moderate     | 553         | 75.95                                           |
| Ladner,2011 [30]   | 2011              | CS     | NR                  | School and hospital | Non-probabilistic | Adolescent girl             | Low          | 6400        | NR                                              |
| Wamai,2011_1 [32]  | 2011              | CS     | Centre & North-West | Hospital            | Non-probabilistic | Healthcare worker           | Moderate     | 76          | 78.95                                           |
| Wamai,2011_2 [13]  | 2011              | CS     | North-West          | Community           | Non-probabilistic | Parent of eligible children | Low          | 337         | 80.12                                           |
| Sossauer,2012 [33] | 2012              | RCT    | Centre              | Community           | Probabilistic     | Women                       | Moderate     | 301         | 57.81                                           |

| Author                 | Year <sup>1</sup> | Design | Region              | Setting    | Sampling method   | Type of participant         | Risk of bias | Sample size | Prevalence of |
|------------------------|-------------------|--------|---------------------|------------|-------------------|-----------------------------|--------------|-------------|---------------|
| Hallen-Ekane,2017 [34] | 2017              | CS     | South-West          | Hospital   | Probabilistic     | Student (male and female)   | Low          | 416         | 24.28         |
| Mforteh,2017 [35]      | 2017              | CS     | North-West          | Community  | Non-probabilistic | Women                       | Low          | 476         | 7.14          |
| Simo,2017 [36]         | 2017              | CS     | West                | Hospital   | Probabilistic     | Women                       | Moderate     | 228         | 2.63          |
| Kindong,2018 [37]      | 2018              | CS     | Littoral            | Community  | Probabilistic     | Women                       | Low          | 226         | 4.42          |
| Layu,2018 [38]         | 2018              | CS     | North-West          | Community  | Probabilistic     | Women                       | Low          | 253         | 15.81         |
| Nkfusai,2018 [39]      | 2018              | CS     | South-West          | Community  | Non-probabilistic | Women                       | Low          | 434         | 53.92         |
| Dekenyo,2018 [40]      | 2018              | CS     | West                | Community  | Probabilistic     | Women at reproductive age   | Low          | 236         | 7.63          |
| Eakin,2018 [29]        | 2018              | CS     | South-West          | University | Non-probabilistic | Student female              | Low          | 120         | 66.67         |
| Fru,2019 [41]          | 2019              | CS     | South-West          | Community  | Non-probabilistic | Women                       | Low          | 117         | 75.21         |
| Guenou,2019 [15]       | 2019              | CS     | Centre              | Hospital   | Non-probabilistic | Parent of eligible children | Moderate     | 168         | 14.88         |
| Maïdadi,2019 [42]      | 2019              | CS     | Centre              | Community  | Non-probabilistic | Women at reproductive age   | Low          | 204         | 19.12         |
| Guenou,2019 [15]       | 2020              | CS     | Centre              | Hospital   | Non-probabilistic | Healthcare worker           | Moderate     | 89          | 44.94         |
| Haddison,2020 [43]     | 2020              | CS     | Centre              | Hospital   | Non-probabilistic | Healthcare worker           | Moderate     | 24          | 91.67         |
| Ambori,2020 [44]       | 2020              | CS     | South-West          | Hospital   | Non-probabilistic | Women                       | Low          | 238         | 39.92         |
| Sobe,2022 [45]         | 2021              | CS     | South-West          | University | Non-probabilistic | Student (male and female)   | Low          | 414         | 56.28         |
| Tassang,2021_1 [46]    | 2021              | CS     | Far North           | Community  | Non-probabilistic | Women                       | Low          | 251         | 76.10         |
| Tassang,2021_2 [47]    | 2021              | CS     | South-West          | Community  | Non-probabilistic | Women                       | Low          | 250         | 40.40         |
| Fru,2021 [16]          | 2021              | CS     | South-West          | Community  | Probabilistic     | General population          | Low          | 250         | NR            |
| Eta,2021 [48]          | 2021              | CS     | Littoral            | Community  | Non-probabilistic | Female sex worker           | Low          | 384         | 38.02         |
| Tchouaket,2021 [49]    | 2021              | CS     | Centre and Littoral | Hospital   | Non-probabilistic | Non-pregnant women          | Low          | 63          | NR            |
| Afegenwi,2022 [50]     | 2022              | CS     | Multi-region        | University | Probabilistic     | Student (male and female)   | Low          | 1263        | 38.16         |
| Batoum,2023 [51]       | 2023              | CS     | Centre              | Hospital   | Non-probabilistic | Healthcare worker           | Low          | 28          | 92.86         |
| Zeuko'o,2023 [52]      | 2023              | CS     | South-West          | University | Probabilistic     | Female student              | Low          | 500         | 45.40         |
| Nechi,2023 [53]        | 2023              | CS     | Centre              | Community  | Probabilistic     | Parent of eligible children | Low          | 330         | NR            |
| Nechi,2023 [53]        | 2023              | CS     | Centre              | Community  | Probabilistic     | Community health worker     | Low          | 32          | 15.62         |
| Tchamani,2023 [54]     | 2023              | CS     | Centre              | Community  | Non-probabilistic | Women                       | Low          | 156<br>239  | 48.08<br>NR   |
| Njoh,2024 [55]         | 2024              | CS     | Multi-region        | Online     | Non-probabilistic | Healthcare worker           | Low          | 1225        | NR            |
| Ntonifor,2024 [56]     | 2024              | CS     | South-West          | Community  | Non-probabilistic | Parent of eligible children | Low          | 1187        | NR            |
| Kehbila,2025 [57]      | 2025              | CS     | Centre              | Community  | Probabilistic     | Parent of eligible children | Low          | 397         | NR            |

1: Year of study completion; 2: Prevalence of individuals who are aware of the HPV vaccine that reduce the risk of uterine cervical cancers occurrence; 3: Prevalence of individuals who get their relative vaccinated if an HPV vaccine were freely made available for them ; 4: Prevalence of individuals who can recommend other people to get vaccinated; Randomized control trial;

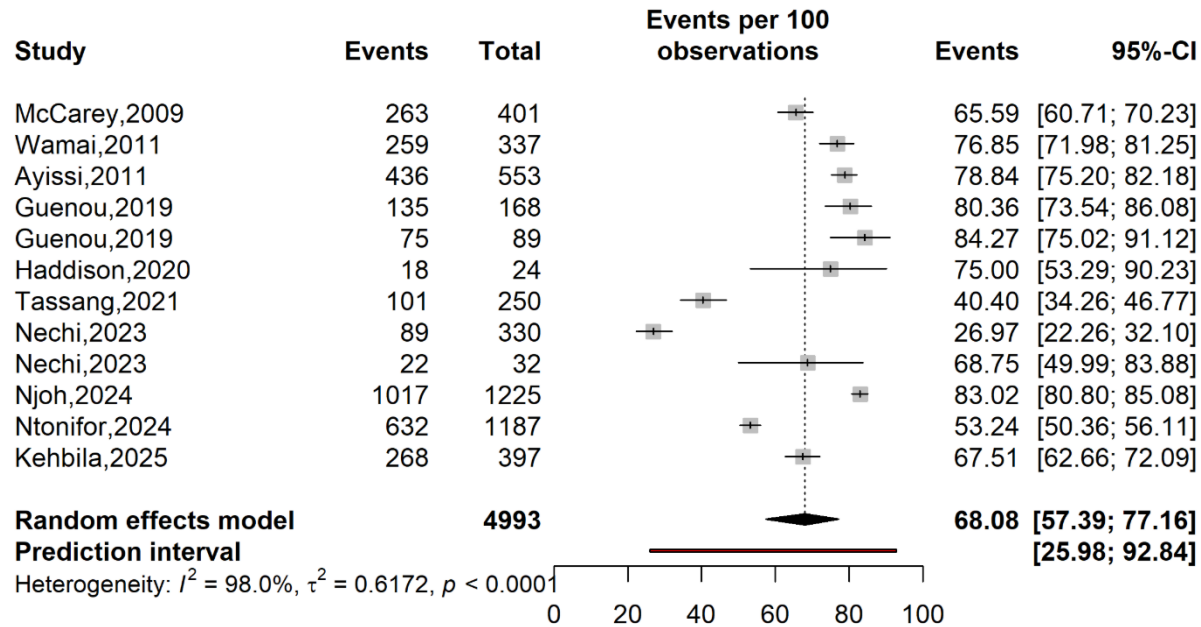


**Fig. 2** Forest plot displaying the pooled prevalence of willingness to vaccinate against the human papillomavirus in Cameroon

**Table 2** Subgroup meta-analysis of the pooled prevalence of willingness to vaccinate against the human papillomavirus in Cameroon

| Subgroup                               | Sample size | Prevalence (%) | 95% CI limits <sup>1</sup> |       | Number of studies | Heterogeneity statistic <sup>1</sup> |         | Subgroup difference p-value |
|----------------------------------------|-------------|----------------|----------------------------|-------|-------------------|--------------------------------------|---------|-----------------------------|
|                                        |             |                | Lower                      | Upper |                   | I <sup>2</sup> (%)                   | p-value |                             |
| <b>Study period (year)<sup>2</sup></b> |             |                |                            |       |                   |                                      |         | 0.006                       |
| <2014                                  | 1,291       | 74.15          | 67.19                      | 80.07 | 3                 | 91.2                                 | < 0.001 |                             |
| 2014-2020                              | 281         | 81.14          | 76.14                      | 85.30 | 3                 | 0.0                                  | 0.544   |                             |
| 2021-2023                              | 3,421       | 57.50          | 40.44                      | 72.93 | 6                 | 98.9                                 | < 0.001 |                             |
| <b>Study setting</b>                   |             |                |                            |       |                   |                                      |         | < 0.001                     |
| Community                              | 2,533       | 55.72          | 40.55                      | 69.90 | 6                 | 97.5                                 | < 0.001 |                             |
| Hospital                               | 682         | 76.49          | 67.47                      | 83.62 | 4                 | 85.1                                 | < 0.001 |                             |
| Online                                 | 1,225       | 83.02          | 80.80                      | 85.08 | 1                 | -                                    | -       |                             |
| School                                 | 553         | 78.84          | 75.20                      | 82.18 | 1                 | -                                    | -       |                             |
| <b>Region</b>                          |             |                |                            |       |                   |                                      |         | < 0.001                     |
| Centre                                 | 1,441       | 67.88          | 52.97                      | 79.87 | 7                 | 96.9                                 | < 0.001 |                             |
| North-West                             | 890         | 78.09          | 75.25                      | 80.69 | 2                 | 0.0                                  | 0.487   |                             |
| South-West                             | 1,438       | 47.39          | 38.59                      | 56.36 | 2                 | 92.6                                 | < 0.001 |                             |
| Multiregion                            | 1,225       | 83.02          | 80.80                      | 85.08 | 1                 | -                                    | -       |                             |
| <b>Sampling method</b>                 |             |                |                            |       |                   |                                      |         | 0.139                       |
| Non-probabilistic                      | 4,234       | 72.16          | 62.31                      | 80.25 | 9                 | 97.9                                 | < 0.001 |                             |
| Probabilistic                          | 759         | 53.68          | 30.57                      | 75.31 | 3                 | 98.3                                 | < 0.001 |                             |
| <b>Risk of bias</b>                    |             |                |                            |       |                   |                                      |         | 0.037                       |
| Moderate                               | 1,235       | 76.97          | 70.24                      | 82.57 | 5                 | 86.4                                 | < 0.001 |                             |
| Low                                    | 3,758       | 60.66          | 44.94                      | 74.44 | 7                 | 98.7                                 | < 0.001 |                             |

**Participant**

&lt; 0.001

|                                   |       |       |       |       |   |      |         |
|-----------------------------------|-------|-------|-------|-------|---|------|---------|
| Women from the general population | 250   | 40.40 | 34.26 | 46.77 | 1 | -    | -       |
| Healthcare worker                 | 1,739 | 77.79 | 68.63 | 84.87 | 4 | 94.5 | < 0.001 |
| Parent <sup>4</sup>               | 2,419 | 62.03 | 43.34 | 77.73 | 5 | 98.1 | < 0.001 |
| Community health worker           | 32    | 68.75 | 49.99 | 83.88 | 1 | -    | -       |
| Adolescent girl                   | 553   | 78.84 | 75.20 | 82.18 | 1 | -    | -       |

<sup>1</sup> Random effects model; <sup>2</sup> <2014 = Pre-HPV vaccination in Cameroon, 2014-2020= HPV vaccination demonstration in Cameroon, 2021-2023= post-HPV vaccine introduction in Cameroon; <sup>3</sup> Parents of HPV vaccine eligible children

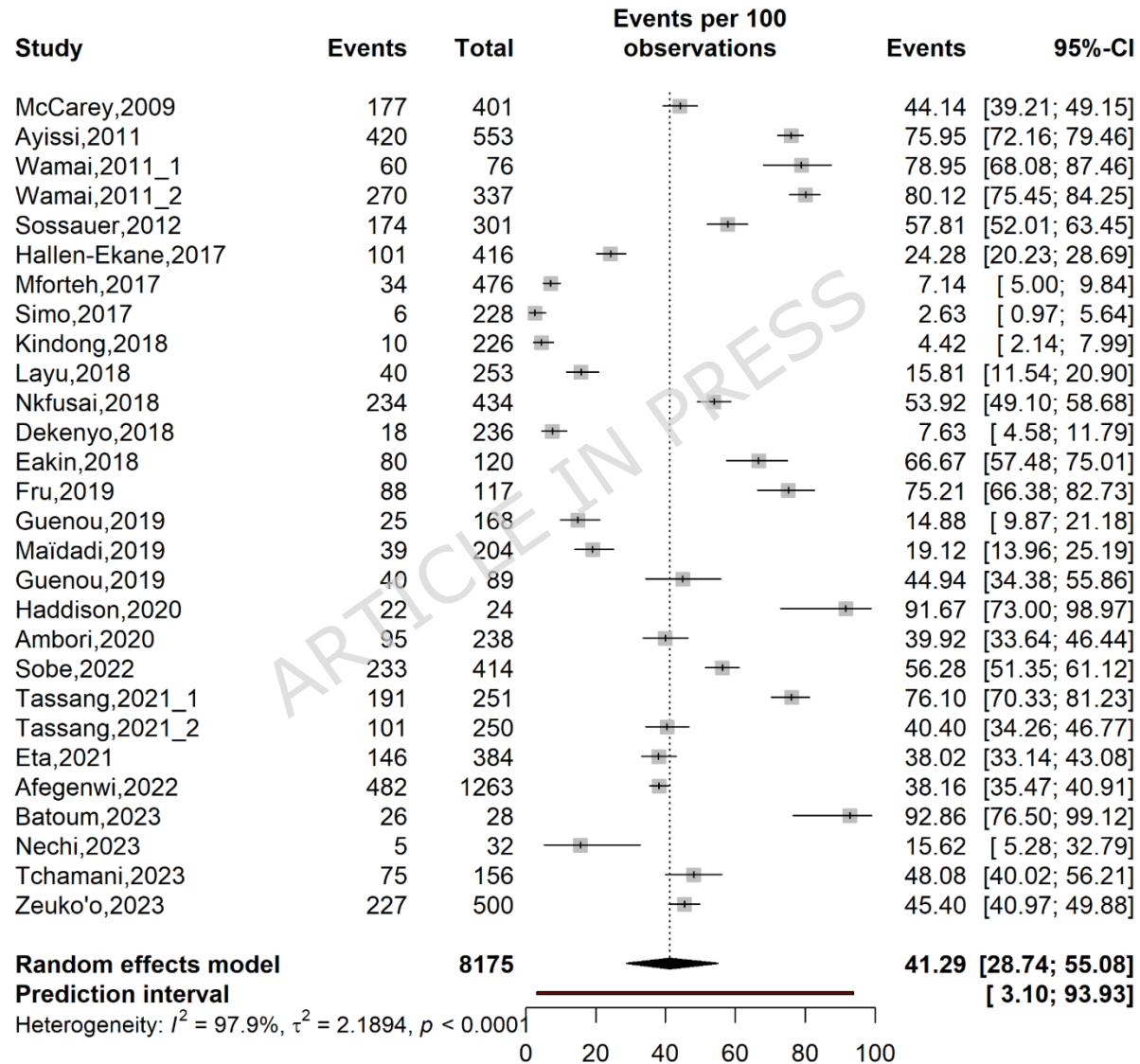


**Fig. 3** Forest plot displaying the pooled prevalence of human papillomavirus vaccine knowledge in Cameroon

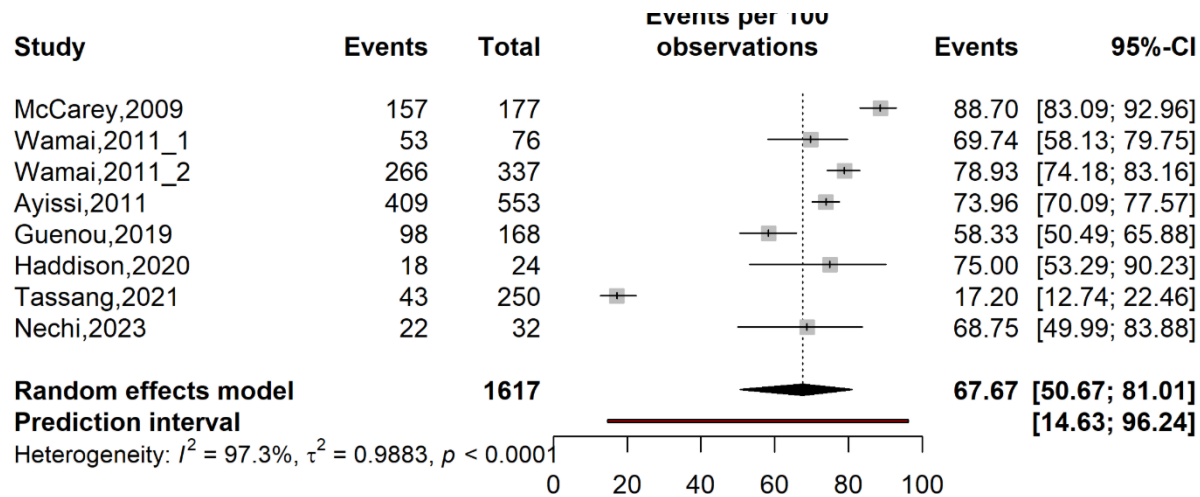


**Fig. 4** Forest plot displaying the pooled prevalence of human papillomavirus vaccine recommendation in Cameroon

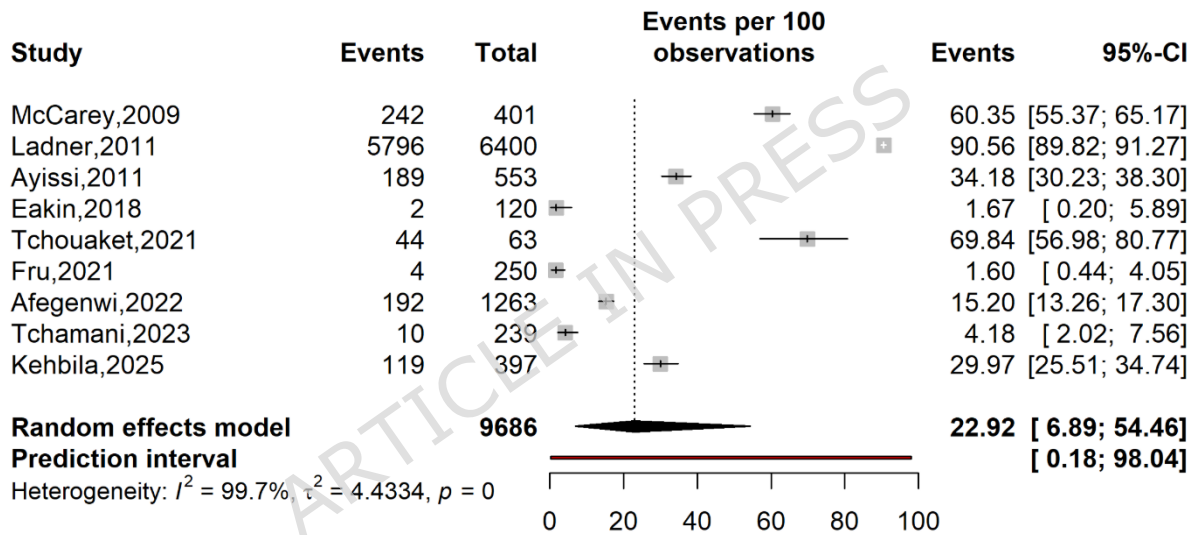


**Fig. 5** Forest plot displaying the pooled prevalence of human papillomavirus vaccine uptake in Cameroon

**Table 3** Subgroup meta-analysis of the pooled prevalence of human papillomavirus vaccine knowledge in Cameroon

| Subgroup                         | Sample size | Prevalence <sup>1</sup> (%) | 95% CI limits <sup>1</sup> |       | Number of studies | Heterogeneity statistic <sup>1</sup> |         | Subgroup difference |
|----------------------------------|-------------|-----------------------------|----------------------------|-------|-------------------|--------------------------------------|---------|---------------------|
|                                  |             |                             | Lower                      | Upper |                   | I <sup>2</sup> (%)                   | p-value | p-value             |
| Study period (year) <sup>2</sup> |             |                             |                            |       |                   |                                      |         | 0.002               |
| <2014                            | 1,668       | 68.49                       | 55.12                      | 79.38 | 5                 | 97.3                                 | < 0.001 |                     |
| 2014-2020                        | 3,229       | 26.42                       | 13.33                      | 45.62 | 14                | 97.8                                 | < 0.001 |                     |
| 2021-2023                        | 3,278       | 50.65                       | 35.38                      | 65.80 | 9                 | 95.1                                 | < 0.001 |                     |
| Study setting                    |             |                             |                            |       |                   |                                      |         | 0.113               |
| Community                        | 3,657       | 33.39                       | 19.17                      | 51.45 | 14                | 98.3                                 | < 0.001 |                     |
| Hospital                         | 1,668       | 46.24                       | 20.24                      | 74.46 | 9                 | 96.1                                 | < 0.001 |                     |

|                                   |       |       |       |       |    |      |         |         |
|-----------------------------------|-------|-------|-------|-------|----|------|---------|---------|
| School & University               | 2,850 | 56.90 | 43.94 | 68.98 | 5  | 98.2 | < 0.001 |         |
| <b>Region</b>                     |       |       |       |       |    |      |         | < 0.001 |
| Centre                            | 1,403 | 48.02 | 26.44 | 70.37 | 9  | 94.8 | < 0.001 |         |
| Littoral                          | 610   | 14.58 | 2.69  | 51.28 | 2  | 98.3 | < 0.001 |         |
| North-West                        | 1,619 | 39.59 | 10.70 | 78.19 | 4  | 99.4 | < 0.001 |         |
| South-West                        | 2,489 | 49.98 | 38.94 | 61.01 | 8  | 95.7 | < 0.001 |         |
| West                              | 464   | 4.73  | 2.23  | 9.75  | 2  | 81.5 | 0.020   |         |
| Far North                         | 251   | 76.10 | 70.33 | 81.23 | 1  | -    | -       |         |
| Centre & North-West               | 76    | 78.95 | 68.08 | 87.46 | 1  | -    | -       |         |
| Multiregion <sup>3</sup>          | 1,263 | 38.16 | 35.47 | 40.91 | 1  | -    | -       |         |
| <b>Sampling method</b>            |       |       |       |       |    |      |         | < 0.001 |
| Non-probabilistic                 | 4,720 | 55.07 | 41.10 | 68.28 | 19 | 97.7 | < 0.001 |         |
| Probabilistic                     | 3,455 | 17.57 | 8.50  | 32.85 | 9  | 97.5 | < 0.001 |         |
| <b>Participant</b>                |       |       |       |       |    |      |         | < 0.001 |
| Women from the general population | 3,370 | 27.05 | 13.93 | 45.93 | 13 | 98.2 | < 0.001 |         |
| Healthcare worker                 | 618   | 74.49 | 49.46 | 89.71 | 5  | 92.2 | < 0.001 |         |
| Student (male and female)         | 3,266 | 51.11 | 36.34 | 65.68 | 6  | 98.3 | < 0.001 |         |
| Parent <sup>4</sup>               | 505   | 45.72 | 8.62  | 88.27 | 2  | 99.3 | < 0.001 |         |
| Community health worker           | 32    | 15.62 | 5.28  | 32.79 | 1  | -    | -       |         |
| Female sex worker                 | 384   | 38.02 | 33.14 | 43.08 | 1  | -    | -       |         |

<sup>1</sup> Random effects model; <sup>2</sup> <2014 = Pre-HPV vaccination in Cameroon, 2014-2020= HPV vaccination demonstration in Cameroon, 2021-2023= post-HPV vaccine introduction in Cameroon; <sup>3</sup> The multi-region study was conducted in several regions including Adamawa, Littoral, North-West, and South-West; CI: Confidence interval; <sup>4</sup> Parent of HPV vaccine eligible children

### 3.6. Publication bias, sensitivity analysis and GRADE assessment

There was a slight asymmetry in the funnel plot assessing the risk of publication among studies assessing the prevalence of willingness to vaccinate against HPV. However, the Egger's ( $p = 0.707$ ) and Begg's ( $p = 0.784$ ) tests revealed non-significant risk of publication bias for this estimate (**Supplementary Fig. 12**). The sensitivity analysis showed no study significantly influenced the pooled prevalence of willingness to vaccinate against HPV (**Supplementary Fig. 13**).

For the pooled prevalence of HPV vaccine knowledge estimates, a symmetrical funnel plot was observed suggesting low risk of publication bias; the Egger's ( $p = 0.455$ ) and Begg's ( $p = 0.323$ ) tests further confirmed this conclusion (**Supplementary Fig. 14**). Moreover, no single study significantly influenced the resulting pooled estimate (**Supplementary Fig. 15**).

Sensitivity analysis of the pooled HPV vaccine recommendation showed that no single study significantly influenced the overall estimate, confirming the robustness of the findings. Although, the funnel plot appeared slightly asymmetrical, the trim and fill analysis identified no missing studies, suggesting an absence of publication bias (**Supplementary Fig. 16-18**).

In contrast, sensitivity analysis for the HPV vaccine uptake showed no single study significantly influence the pooled HPV vaccine uptake (**Supplementary Fig. 19-21**).

According to the GRADE assessment, the certainty of evidence was moderate for willingness to vaccinate, low for knowledge of the HPV vaccine and recommendation practices, and very low for vaccine uptake, primarily due to substantial heterogeneity, indirectness, imprecision, and suspected publication bias (**Supplementary Table 5**).

### 3.7. Meta-regression analysis

The meta-regression analysis identified participant type as a significant moderator of HPV vaccine awareness, with women from the general population showing significantly lower awareness compared to healthcare workers (adjusted  $\beta = -2.841$ ,  $p = 0.023$ ). In contrast, study year, region, setting, and sampling method were not significantly associated with awareness of HPV vaccine in the multivariate models. For willingness to vaccinate, none of the examined moderators including study year, region, setting, sampling method, or participant type were significantly associated with the pooled estimate heterogeneity (**Table 4**).

**Table 4** Meta-regression analysis of pooled estimates of human papillomavirus knowledge and willingness to vaccinate in Cameroon, 2009-2025

| Estimate         | Moderator                           | Univariate                         |            | Multivariate                     |            |
|------------------|-------------------------------------|------------------------------------|------------|----------------------------------|------------|
|                  |                                     | Unadjusted coefficient ( $\beta$ ) | $p$ -value | Adjusted coefficient ( $\beta$ ) | $p$ -value |
| <b>Knowledge</b> | Study year                          | -0.038                             | 0.597      | -0.037                           | 0.623      |
|                  | Region                              | Ref                                |            | Ref                              |            |
|                  | Littoral                            | -1.623                             | 0.119      | 1.883                            | 0.187      |
|                  | North-West                          | -0.292                             | 0.714      | -0.210                           | 0.824      |
|                  | South-West                          | 0.132                              | 0.839      | 0.850                            | 0.314      |
|                  | West                                | -2.912                             | 0.006      | -1.025                           | 0.398      |
|                  | Far-North                           | 1.282                              | 0.785      | 1.883                            | 0.187      |
|                  | Multiregion                         | 0.524                              | 0.614      | -1.014                           | 0.817      |
| Setting          | Community                           | Ref                                |            |                                  |            |
|                  | Hospital                            | 0.472                              | 0.467      | -1.335                           | 0.161      |
|                  | School & university                 | 0.966                              | 0.214      | 0.036                            | 0.984      |
| Sampling method  | Probabilistic vs. non-probabilistic | 1.706                              | 0.001      | -0.768                           | 0.277      |
| Participant      | Healthcare worker                   | Ref                                |            |                                  |            |
|                  | Parent of vaccine eligible children | -1.211                             | 0.306      | -1.732                           | 0.148      |
|                  | Student (male and female)           | -1.001                             | 0.247      | -2.148                           | 0.247      |
|                  | Women from general population       | -2.024                             | 0.008      | -2.841                           | 0.023      |
|                  | Other                               | -2.102                             | 0.080      | -2.226                           | 0.174      |

|                              |                                     |        |       |        |       |
|------------------------------|-------------------------------------|--------|-------|--------|-------|
| <b>Willingness</b>           |                                     |        |       |        |       |
| Study year                   | Year                                | -0.040 | 0.364 | -0.001 | 0.983 |
| Region                       | Centre vs. others                   | 0.031  | 0.951 | 0.1662 | 0.819 |
| Setting                      | Community                           | Ref    |       |        |       |
|                              | Hospital                            | 0.972  | 0.033 | 1.087  | 0.271 |
|                              | Others                              | 1.228  | 0.025 | 1.162  |       |
| Sampling method <sup>1</sup> | Probabilistic vs. non-probabilistic | 0.811  | 0.127 |        |       |
| Participant                  | Healthcare worker vs. others        | -0.737 | 0.136 | 0.04   | 0.172 |

<sup>1</sup> Redundant predictor dropped from the model

### 3.8. Determinants of human papillomavirus vaccine hesitancy

Individuals with no knowledge of HPV were nearly three times more likely to be hesitant toward HPV vaccination compared to their counterparts (OR: 2.58; 95% CI: 2.06-3.22); 2 studies;  $I^2 = 0.0$ ;  $p = 0.606$ ) (Table 5 and Supplementary Fig. 22-24).

**Table 5** Determinants of human papillomavirus vaccine hesitancy in Cameroon

| Predictor                           | Modality        | OR <sup>1</sup> | 95% CI |       | Reports included | Heterogeneity |            |
|-------------------------------------|-----------------|-----------------|--------|-------|------------------|---------------|------------|
|                                     |                 |                 | Lower  | Upper |                  | $I^2$ (%)     | $p$ -value |
| <b>Gender</b>                       | Female vs. Male | 1.18            | 0.82   | 1.6   | 3                | 63.7          | 0.064      |
| <b>Knowledge of HPV</b>             | No vs. Yes      | 2.58            | 2.06   | 3.22  | 2                | 0.0           | 0.606      |
| <b>Knowledge of cervical cancer</b> | No vs. Yes      | 7.97            | 0.46   | 137.8 | 2                | 97.6          | < 0.001    |
|                                     |                 |                 |        | 3     |                  |               |            |

<sup>1</sup> Random effect model; OR: Odds ratio; CI: Confidence interval; HPV: Human papillomavirus

## 4. Discussions

This meta-analysis offers a comprehensive synthesis of the current evidence on HPV vaccine knowledge, willingness to vaccinate, and actual uptake of this vaccine in Cameroon, revealing a disconnect between intention and practice. While parental willingness to vaccinate children was above average, overall knowledge of the HPV vaccine remains insufficient, and actual vaccination coverage was low.

Despite differences in participant characteristics, all included studies measured the same core outcomes, knowledge of the HPV vaccine, willingness to vaccinate, recommendation practices, and vaccine uptake using almost similar definitions and assessment tools. This measurement homogeneity warrants statistical pooling, as all estimates reflect HPV vaccine acceptability as perceived by different segments of the Cameroonian population.

#### 4.1. Willingness to vaccinate against human papillomavirus

The pooled prevalence of parental willingness to vaccinate targeted children against HPV in Cameroon was 68%, with high heterogeneity. Similar findings were reported in a meta-analysis globally (68%), in China (66%), in sub-Saharan Africa (73%) and in Ethiopia (72%) [58–61]. This consistency may reflect the strong prioritization of children's health within many communities, where vaccination may be perceived as a means of protecting daughters' future health and fertility. This favorable perception is likely reinforced by the persistently high burden of HPV infection in the region [9, 15, 58]. Such parental and healthcare professionals' compliance with this vaccine could represent a critical opportunity for public health policymakers to strengthen the implementation and scale-up of HPV vaccination, particularly through school- and community-based delivery strategies.

The prevalence of willingness to vaccinate significantly declined over time, decreasing from 74% before 2014 to 57% thereafter. This decline may be attributable to the growing influence of misinformation, the spread of rumors related to vaccine safety, and fluctuating levels of trust in vaccination programs [56]. Furthermore, the HPV vaccination campaign, launched in October 2020 during the COVID-19 pandemic, occurred within a context of widespread vaccine hesitancy. This environment may have exacerbated fears and facilitated the dissemination of misinformation surrounding the HPV vaccine [43]. Nevertheless, this trend warrants cautious interpretation, as the observed decline may be partially attributable to changes in study populations and methodologies rather than a true temporal decrease in vaccine acceptability.

Studies conducted in community settings reported a significantly lower prevalence of vaccine acceptability (56%) compared with those carried out in hospital settings (76%). This disparity could be explained by more limited access to reliable health information in community environments, which may promote misinformation and could perpetuate sociocultural beliefs unfavorable to vaccination [62]. Conversely, hospital-based participants may benefit from closer interaction with healthcare professionals, greater exposure to awareness campaigns, and trusted sources of information from healthcare providers, thereby possibly enhancing vaccine acceptability [63].

Regarding the type of participants, the willingness to vaccinate was particularly high among healthcare professionals (78%), which may reflect their level of scientific knowledge, their perception of the burden of HPV-related diseases, as well as their confidence in the efficacy and safety of the vaccines [51].

## 4.2. Knowledge of the preventive vaccine against cervical cancer

The present meta-analysis estimated a pooled HPV vaccine knowledge prevalence of 41% in Cameroon, with high heterogeneity. These findings are consistent with observations in a meta-analysis conducted in Ethiopia (55%) [64]. A much lower prevalence was observed in a meta-analysis from China (16%) [65]. This insufficient level of knowledge observed in our context is likely multifactorial. Health system constraints, such as staff shortages, heavy workloads, and geographic barriers, may impede access to information and vaccination services. The dissemination of information might also be hindered by sociocultural factors, including perceptions linking HPV vaccination to sexuality, taboos surrounding reproductive health discussions, and reluctance from some community leaders [14, 66, 67]. Study reports identified significant factors associated with HPV knowledge in sub-Saharan Africa such as level of education (OR = 3.81, 95% CI: 2.11–6.8) and higher income (OR = 1.96, 95% CI: 0.72–5.29) [68].

Our analysis also revealed marked regional disparities in HPV vaccine knowledge in Cameroon, with extremely low knowledge in the West region (4.73%) compared with the Centre (48.02%), South-West (49.98%), and Far North (76.10%) regions. In the Centre region, a high density of healthcare infrastructure and close integration with national vaccination initiatives may have improved access to trustworthy information and the dissemination of preventive messages [69]. These efforts appear to be reinforced by regular awareness campaigns, pilot projects in health facilities, and intensified media engagement designed to counter HPV vaccine-related misinformation [70, 71]. In the South-West, community-based approaches involving schools, religious leaders, and community health workers seem to enhance knowledge despite structural healthcare constraints [39]. Conversely, the very low knowledge observed in the West region may result from limited targeted awareness initiatives and persistent sociocultural beliefs unfavorable to vaccination, combined with reliance on informal information sources [72]. The unexpectedly high knowledge level reported in the Far North region might reflect targeted interventions in underserved areas, including community mobilization and proximity-based awareness campaigns, although this finding should be interpreted cautiously due to the limited number of studies [14]. The observed high heterogeneity suggests the need for context-specific regional strategies rather than uniform national approaches to sustainably improve HPV vaccine knowledge and acceptability in Cameroon.

Regarding participant type, marked disparities were observed, with knowledge highest among healthcare workers (74%) and students (51%), and considerably lower among women

from the general population (27%) and community health workers (15%). Elevated knowledge among healthcare workers likely results from professional training and continuous exposure to scientific information and immunization programs [32, 51]. Students may similarly benefit from school-based vaccination initiatives and greater access to digital information channels [15, 52]. Conversely, the limited knowledge among community health workers could point to insufficient training and a predominant focus on operational responsibilities rather than comprehensive health education, despite their critical intermediary role between health services and communities [43, 55]. Lower knowledge among women from the general population further suggests structural inequities in access to preventive information, particularly in rural and peri-urban settings [38]. Similar trends reported across Ethiopia, Nigeria, and Kenya underscore persistent population-level informational gaps across sub-Saharan Africa [73–75]. Collectively, these findings emphasize the need to strengthen community health worker capacity and implement context-specific communication strategies alongside sustained school-based interventions.

A significant variation in knowledge rates was also observed depending on the study period. A notable decline in knowledge was observed over time, with a significant drop during the 2014-2020 period (26%), compared to the higher estimates recorded before 2014 (68%). The decline in HPV knowledge observed after 2014 might be attributed to both programmatic and methodological factors. Early estimates coincided with pilot HPV vaccination initiatives characterized by intensive community sensitization and educational interventions, which appeared to substantially improve knowledge levels [13, 30]. Following program integration into routine health services, communication activities appear to have decreased, with greater emphasis placed on operational delivery rather than sustained education [43, 55]. Furthermore, later studies increasingly included community-based and rural populations with limited exposure to health information.

#### **4.3. Vaccine recommendation and uptake**

In this meta-analysis, more than two-thirds of the population (67%) reported recommending HPV vaccination to their relatives and peers, yet only 23% indicated having actually received the vaccine, suggesting a discrepancy between supportive attitudes and effective uptake. This discrepancy may illustrate a well-recognized intention-behavior gap in low-resource settings, potentially driven by persistent structural constraints, including limited vaccine availability, geographical barriers to healthcare access, and indirect costs such as transportation expenses and time required to obtain services. Beyond access-related barriers, individual and perceptual

determinants further contribute to low vaccine uptake [76, 77]. Many young women, who may mistakenly perceive themselves as being at low risk of cervical cancer because of their young age, could deprioritize vaccination despite expressing favorable views toward immunization [54]. In addition, ongoing security crises in the North-West, South-West, and Far North regions have substantially disrupted healthcare delivery, further restricting access to vaccination services and exacerbating structural inequities related to geographic isolation and insecurity [14].

The findings of this review can be interpreted through the lens of the Health Belief Model, which suggests that low perceived susceptibility to HPV infection, limited perceived benefits of vaccination, and high perceived barriers contribute to the low knowledge and uptake observed. Vaccine hesitancy frameworks additionally emphasize how these factors are compounded by misinformation, safety concerns, and sociocultural barriers. Consequently, interventions in Cameroon should focus on increasing knowledge, addressing these specific barriers, and leveraging trusted messengers, such as healthcare workers and community leaders, to improve vaccine acceptance [54].

Health system barriers likely influence vaccine uptake more than knowledge alone. Vaccine availability remains a critical challenge in Cameroon, particularly in remote areas where the HPV vaccine is frequently out of stock or unavailable. Despite national introduction into the Expanded Program on Immunization, supply chain issues persist, including delayed fund mobilization, inefficient procurement processes, and underutilization of data for vaccine forecasting and distribution [78]. In addition, the ongoing security crises in the North-West and South-West regions have substantially disrupted healthcare delivery, with attacks on health facilities, displacement of populations, and restricted movement of health workers severely limiting access to vaccination services and exacerbating structural inequities related to geographic isolation and insecurity [79–81]. These combined health system constraints, rather than lack of knowledge alone, likely account for much of the gap between high willingness and low actual uptake observed in this review.

To translate these findings into action, policymakers should prioritize school-based vaccination programs to reach adolescent girls efficiently and implement sustained community-based awareness campaigns tailored to local sociocultural contexts, particularly in regions with persistently low awareness such as the West region.

## 5. Limitations

This review has several limitations. Substantial heterogeneity indicated considerable variability in study designs, populations, settings, time periods as well as differences in outcome definitions and measurement tools across studies. While we explored this heterogeneity through pre-specified subgroup analyses, the high heterogeneity suggested that the pooled estimates represent averages of diverse effects rather than precise national estimates. This heterogeneity likely reflects true differences in HPV vaccine acceptability across Cameroon, however it also limits the generalizability of our findings. Therefore, the pooled estimates should be interpreted as indicative rather than definitive, and readers are cautioned against overgeneralizing these results to all populations or settings in Cameroon. Many studies relied on non-probabilistic sampling methods, increasing the risk of selection bias. In addition, the use of self-reported data may have introduced recall and social desirability biases, potentially leading to overestimation of outcomes. The predominance of cross-sectional studies may limit the causal relationship of predictors identified. Geographic representation was uneven, with some regions underrepresented (possible overrepresentation of urban populations), and variations in survey instruments and definitions may have affected comparability. Given the substantial heterogeneity observed across studies, the Egger's and Begg's tests and funnel plots should be interpreted with caution, as asymmetry may reflect true differences in study populations, settings, or methodologies rather than publication bias. The meta-analysis of factors associated with vaccine hesitancy was constrained by the limited number of studies contributing to each predictor, which may affect the precision and generalizability of these estimates. Finally, the manual search of records on Google Scholar was not reproducible. The small number of included reports did not enable subgroup analysis or meta-regression for HPV vaccine recommendation and uptake.

## 6. Conclusions

This systematic review and meta-analysis synthesized existing evidence and contextualized previous findings within the evolving HPV vaccination landscape in Cameroon. Despite relatively moderate levels of knowledge and willingness reported in some populations, actual vaccine uptake remains critically low, highlighting a persistent gap between intention and practice. The results reveal marked regional disparities, including extremely low HPV vaccine knowledge in the West region compared with the Centre and South-West regions, as well as population disparities, with the lowest knowledge observed among women from the general population and community health workers. These findings should be interpreted as average summaries given the substantial

heterogeneity across included studies. These findings emphasize the need for coordinated, context-adapted strategies. Policymakers and public health stakeholders should prioritize the following actions: (1) expanding school-based vaccination programmes to reach adolescent girls efficiently; (2) strengthening healthcare worker training on HPV vaccine safety, efficacy, and communication skills to enhance their role as trusted messengers; (3) implementing sustained community engagement initiatives that involve religious and community leaders to address sociocultural barriers and build trust; (4) developing targeted communication strategies to counter misinformation and address vaccine safety concerns through culturally appropriate messaging. Future research should prioritize longitudinal studies to track changes in vaccine acceptability over time and intervention studies to evaluate the effectiveness of school-based vaccination programs and community-led awareness campaigns. Policymakers and public health stakeholders should prioritize sustainable HPV prevention programs to reduce the burden of cervical cancer in Cameroon.

## Abbreviations

|                 |                                                                    |
|-----------------|--------------------------------------------------------------------|
| <b>CI</b>       | Confidence interval                                                |
| <b>CS</b>       | Cross-sectional                                                    |
| <b>EPI</b>      | Expanded Program on Immunization                                   |
| <b>GLMM</b>     | Generalized linear mixed model                                     |
| <b>HPV</b>      | Human papillomavirus                                               |
| <b>JBI</b>      | Joanna Briggs Institute                                            |
| <b>MeSH</b>     | Medical subject headings                                           |
| <b>NR</b>       | Not reported                                                       |
| <b>OR</b>       | Odds ratio                                                         |
| <b>PLOGIT</b>   | Probit-Logit transformation                                        |
| <b>PRISMA</b>   | Preferred Reporting Items for Systematic Reviews and Meta-analyses |
| <b>PROSPERO</b> | International prospective register of systematic reviews           |
| <b>RCT</b>      | Randomized controlled trial                                        |
| <b>WHO</b>      | World Health Organization                                          |

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## Author contributions

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**Data availability**

All data generated or analyzed during this study are included in this published article and its supplementary data files.

**Declarations****Ethics approval and consent to participate**

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**Consent for publication**

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**Competing interests**

The authors declare no competing of interests.

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