


## Burden of vaccine-preventable diseases, trends in vaccine coverage and current challenges in the implementation of the expanded program on immunization: A situation analysis of Cameroon

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### ABSTRACT

The discovery and development of vaccines remain one of the major successes of global health with millions of lives saved every year through routine vaccination. Although vaccines provide a safe and cost-effective solution to vaccine-preventable diseases (VPDs), VPDs are still a serious public health problem in most parts of the world, especially in sub-Saharan Africa (SSA) and Asia. In this review, we discuss the burden of VPDs and vaccine coverage several decades after the introduction of the Expanded Program on Immunization (EPI) in Cameroon. We also discuss how different factors affect the implementation of the EPI, highlighting context-specific factors such as the ongoing civil conflict in Cameroon, and the presence of other infectious diseases like COVID-19.

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### Introduction

Vaccines for many decades have been pivotal in the prevention and control of many infectious diseases globally,<sup>1,2</sup> with millions of lives saved through routine vaccination.<sup>3</sup> Since the development of the first vaccine against smallpox by Edward Jenner in the seventeenth century,<sup>2</sup> several successes in global health have been recorded as a result of timely intervention with vaccines. About 2–3 million lives are saved from infectious diseases every year through routine vaccination. The global effort to use vaccination as a public health intervention began with the launching of the Expanded Program on Immunization (EPI) by the World Health Organization (WHO).<sup>4</sup>

The EPI was established in May 1974 to ensure universal access to all relevant vaccines for all targeted groups, including children, adolescents, and adults.<sup>5</sup> This safe and cost-effective program at onset targeted six major diseases, including tuberculosis, tetanus, diphtheria, poliomyelitis, pertussis and measles. Presently, other vaccines have been added to the EPI in different countries and regions of the world to broaden the range of infectious diseases covered, to target children and adults, including healthcare workers. More than 116 million children are vaccinated every year against over 20 vaccine-preventable diseases.<sup>6</sup> In Cameroon, the EPI was introduced as a pilot project in 1976<sup>7</sup> and later adopted as a national program in 1982. Since its introduction, there has been an overall increase in the national coverage of the vaccines within the EPI, albeit with some fluctuations between years. Notably, a steep increase in national vaccine coverage was recorded between 2001 and 2005,

from 43% to 80%. There has been a lot of improvements in the national coverage of the different vaccines within the EPI<sup>8</sup> but the coverage goals are still far from being achieved. Consequently, 1 of 7 children have not received all recommended vaccines and approximately 25% of vaccines are administered to children outside of the recommended schedule.<sup>9</sup> After introducing the EPI, the ministry of health projected reaching and maintaining a national coverage of at least 90% by 2011 and onward among different target groups.<sup>10</sup> To achieve this goal,<sup>7</sup> the EPI program in Cameroon adopted the Reach Every District (RED) strategy proposed by WHO<sup>10,11</sup> to address the common barriers to vaccination coverage. The implementation of this strategy is anchored on five components including: (1) ‘re-establishing outreach’ services for immunization such as the use of mobile teams to extend regular services to all communities,<sup>12</sup> (2) ‘Supportive supervision’ which involves providing onsite supervision to health staff at district levels during regular supervision meetings, (3) ‘Linking services with communities’ as a participatory approach to service delivery and identification of defaulters and drop-outs, (4) ‘Monitoring and use of data’ to assess progress and solve problems and finally, (5) ‘Planning and management of resources’ involving a context based plan at the district level for the implementation of the EPI.<sup>11,12</sup> The implementation of the RED strategy enhanced vaccine coverage at the district level to a certain degree but is still wanting in its capacity to get vaccine coverage to its targets. The EPI has helped create a global consensus on the prevention and control of diseases, developed effective training for healthcare workers and has been pivotal in elimination of some

infectious diseases.<sup>13</sup> However, vaccination programs worldwide still face several challenges that hinder the realization of the program's goals. In effect, over 19 million children in 2018<sup>14</sup> and 13 million children in 2019<sup>15</sup> did not receive any vaccine. In Cameroon, there is substantial heterogeneity in coverage rates at the regional level which precludes a comprehensive quantitative assessment of local barriers to vaccination and their potential effect on disease burdens.<sup>16</sup> The incomplete vaccine coverage across the country can in part explain the existing high mortality and morbidity of VPDs in the country, especially in the under 5 y population.<sup>17,18</sup> Data on the burden of VPDs is lacking in several parts of SSA as well as in Cameroon. Nonetheless, available data, although inadequate, provides some evidence to the current burden of VPDs despite the availability of vaccines. Here, we briefly discuss the burden of some VPDs including, Measles, Hepatitis B virus infection, Tetanus, and Pneumonia caused by *Streptococcus pneumoniae* and *Haemophilus influenzae* type b in Cameroon decades after the introduction of the EPI. We also examine the trends in vaccine coverage for the above-mentioned diseases and the EPI program bottlenecks, including possible approaches for mitigation.

## Method

A narrative review based on extensive reading of published literature on the burden of VPDs, vaccine coverage, challenges faced by the EPI program and proposed strategies for addressing these challenges. Relevant articles for this research were obtained through a thorough search using relevant keywords in Medline, PubMed, Cochrane, and Google Scholar. The title and abstract of published papers from the search were reviewed and either excluded or included for further review based on whether the article is relevant to the objective of this study. This research considered only papers published in English. To examine the current burden of VPDs, we used four diseases within the EPI as examples based on the amount of available data. We used R software version 3.5.2 to plot the trends in vaccine coverage for the selected diseases with coverage data from the WHO.<sup>19</sup>

## The burden of vaccine-preventable diseases and vaccine coverage

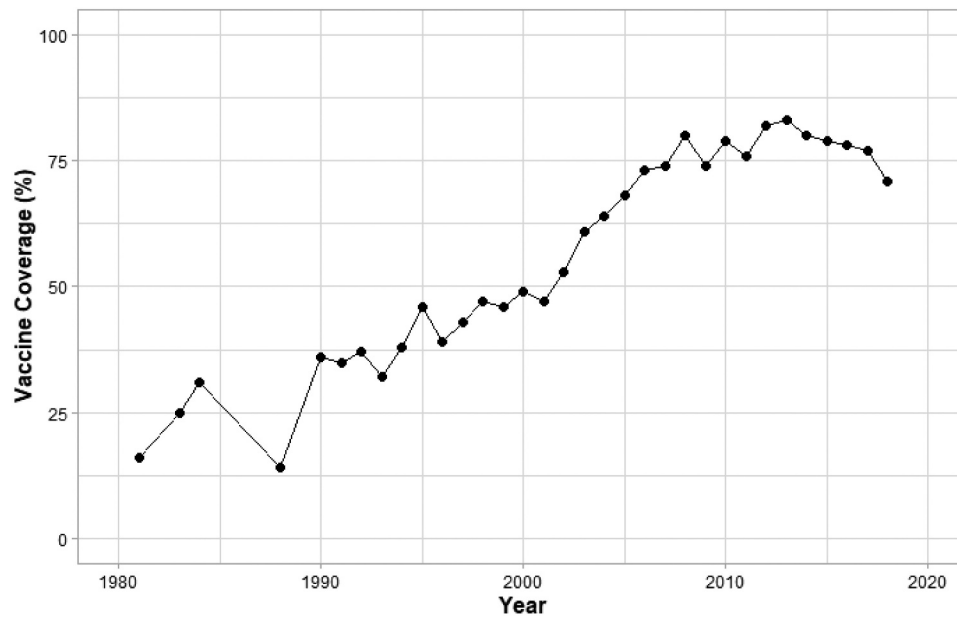
### Measles

The measles vaccination program began in Cameroon in 1965.<sup>20</sup> Following effective implementation, a reduction in the incidence of measles infection among all age groups was observed.<sup>21</sup> However, vaccine coverage has not been consistent over time and there has been a steady decrease in national vaccine coverage levels beginning from 2013 till date, with a reported coverage of only 60% in 2019 at the national level.<sup>22,23</sup> Unsurprisingly, Cameroon persistently experiences sporadic measles epidemics in different parts of the country, conveniently described as an endemo-epidemic trend with outbreaks occurring between February and April.<sup>20,22</sup> For instance, there was an increase in the incidence of measles between January 2000 and June 2001 in all regions of the country with 23934 documented cases.<sup>20</sup> Moreover, between 2001 and 2009, several outbreaks were reported in different regions of the country, with an average

incidence rate of 5% per year. An incidence of 4% was reported in 1998, 6% in 2001, 1% in 2002, and 4% in 2009.<sup>20,21,24</sup> In 2010, 10 health districts in the northern part of the country reported measles outbreaks with over 800 cases and a case fatality of 2%.<sup>25</sup> In 2012, about 43 (25%) of the 173 health districts in the country had a measles outbreak, with over 14000 cases reported.<sup>25</sup> In 2015, a locality in the Northwest region recorded 223 measles cases with a case fatality of 9%.<sup>26</sup> Furthermore, a model of the incidence pattern of measles across the country revealed that the three northernmost regions experience major epidemics every year, while the southern regions show evidence of experiencing major epidemics every third year.<sup>20,26</sup> This is not surprising given that the northern regions are the poorest and have the least access to healthcare facilities, and therefore less access to vaccines. However, the endemicity of measles is not restricted to Cameroon as other countries around the world, especially in Sub-Saharan Africa, have reported sporadic occurrences of measles within their territories. There is a global increase in measles cases, with the highest number of cases reported within the African region.<sup>17,20,26</sup> Of note, between 2013 and 2017, 224 093 cases (approximately 36% of the global incidence) were reported from the African region, 66% of which were classified as programmatically preventable since the cases did not receive age-appropriate doses of the measles vaccine (MCV).<sup>17</sup> This endemicity and increasing incidence of measles in Cameroon and to an extent the entire African region could in part be fueled by the poor vaccination coverage in several regions and the inadequate health policies in place to ensure measles control. The uptake of the Measles vaccine has been on an overall rise since its introduction in 1980 until 2013, after which the coverage began decreasing steadily until 2017 (Figure 1). The steep decrease in coverage experienced from 2017 could be attributed in part to the displacement and interruption of vaccination schedules of inhabitants due to the ongoing crisis in Cameroon.

### Pneumonia (*Streptococcus pneumoniae* and *Haemophilus influenzae* type b)

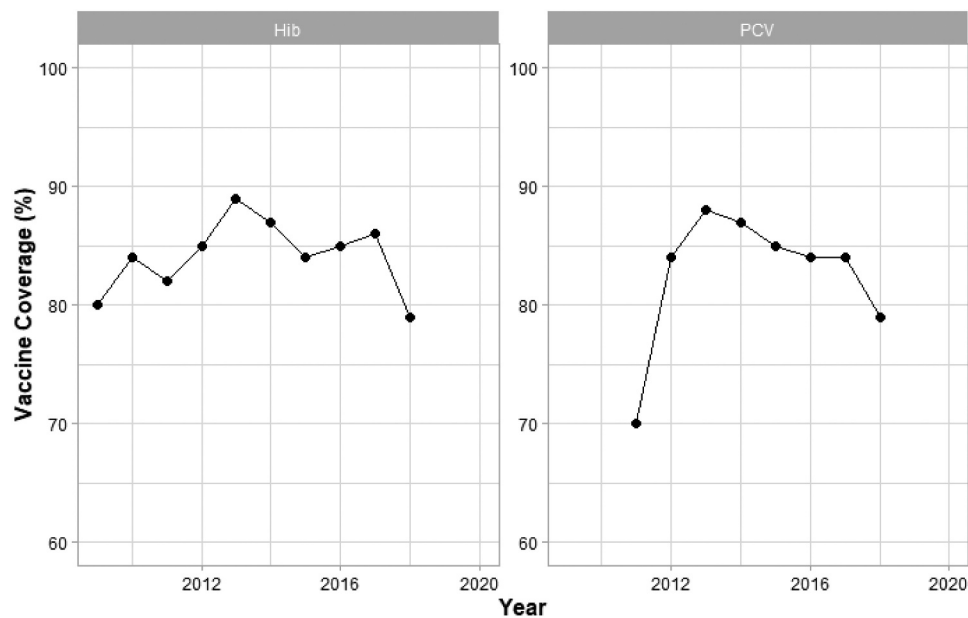
About 2 million pneumonia deaths occur each year in children aged less than 5 y, mainly in the African and South-East Asia Regions.<sup>27</sup> In Cameroon, 18% of deaths among children below 5 y are due to pneumonia.<sup>28</sup> *Streptococcus pneumoniae* (pneumococcus) (30–50% of pneumonia cases) and *Haemophilus influenzae* type b (Hib) (10–30% of cases), are common causes of pneumonia, meningitis, and other serious infections in children.<sup>27</sup> They are the main bacterial causes of clinical pneumonia in developing countries. In 2015, incidence rate of pneumonia was 1603 and 2509 per 100 000 children in the African and Southeast Asian region, respectively, compared to a global incidence of 1419 per 100 000.<sup>18</sup> Pneumococcal deaths in 2015 reflected a 51% decline compared to approximately 600 000 pneumococcal deaths estimated to have occurred in children aged between 1 and 59 months in 2000.<sup>18</sup> The effectiveness of pneumococcal conjugate vaccines (PCV) and the *Haemophilus influenzae* type b (Hib) vaccine in preventing pneumonia has been established.<sup>29</sup> The Hib3 and the 13-valent PCV(PCV13) were first introduced in Cameroon in 2009 and 2011, respectively.<sup>30,31</sup> Since their introduction, there have been regional differences in vaccine coverage in Cameroon with yearly fluctuations as with the Meningococcal vaccine.<sup>22</sup>



**Figure 1.** Coverage of the Measles vaccine in Cameroon.

Overall, national Hib3 and PCV coverage has been on a steady decline with a decrease from 86% in 2017 to 79% in 2018, and from 84% in 2017 to 79% in 2018, respectively.<sup>22</sup> This suboptimal vaccine uptake is reflected on the unaltered prevalence of pneumonia in some regions of the country despite the introduction of PCV-13.<sup>32</sup> Particularly, in 2015, a prospective study from the Bamenda regional hospital reported prevalence of pneumonia of 22% in children under 5 y.<sup>33</sup> Furthermore, using nationally representative samples of children under 5 y from 28 countries in sub-Saharan Africa, *Abdul-Aziz et al.* reported an overall prevalence of Acute Lower Respiratory Infections (LRTI) (including pneumonia) of 25% with 12% for Cameroon, which is higher than what has been reported in other parts of the world.<sup>34</sup> In Cameroon, Hib

and pneumococcus have been reported as the most common cause of LRTI.<sup>35,36</sup> Nonetheless, the causes of these LRTI could not only be limited to bacteria but could also include viruses and parasites. On the other hand, reports from Italy, South Africa and the Gambia, have shown a decrease in the number of pneumonia cases and mortality after introduction of the PCV-13 vaccine.<sup>32</sup> Nevertheless, the study population in this study was relatively small and unrepresentative of the national population. Moreover, the follow-up period of 2 y following the vaccine introduction was quite short, indicating that longer follow-up time, and more studies and larger sample sizes are necessary to make definite conclusions. **Figure 2** shows coverage of the third dose of *Haemophilus Influenza* type b (Hib3) vaccine (Left) which



**Figure 2.** Coverage of the third dose *Haemophilus Influenza* type b (Hib3) and 13-valent pneumococcal vaccine in Cameroon.

was introduced in 2009 and the uptake has failed to reach optimal rates for herd immunity with associated fluctuations in uptake over the years. Also, the uptake of the 13-valent pneumococcal vaccine (Right) has been on a steep decrease since 2014 till date.

## Hepatitis B infection

Hepatitis B virus infection (HBV) is a major public health concern worldwide, with about 257 million people living with HBV.<sup>37</sup> While 70% of the global HIV burden is found in SSA, HBV is very prevalent within the Asian (15%) and African populations (8–40%).<sup>38</sup> Even though Cameroon is experiencing declining trends of HBV infections (12% to 11% in 2019) among adults and adolescents aged 15–49 y,<sup>38</sup> the country is still experiencing a generalized epidemic of HBV infections, suggesting the need for evidence-based strategic interventions. This high endemicity seems to be concentrated only in adults (11%),<sup>39</sup> health-care workers (HCWs) (9%)<sup>40</sup> and pregnant women (8%),<sup>41</sup> as a recent study reported a moderate prevalence of 2% in the pediatric population with similar pattern reported in Ethiopia, Democratic republic of Congo, Tanzania, and Malawi.<sup>38</sup> This relatively moderate pediatric HBV prevalence could be attributed in part to the wide pediatric coverage of anti-HBV vaccination in Cameroon. Similarly, global reports have stated that universal vaccination has globally decreased HBsAg prevalence in children younger than 5 y from 5% in the pre-vaccination era (1980s to early 2000s) to 1% in 2015.<sup>42</sup> A number of studies in Cameroon reported a prevalence of HBV of 8% among pregnant women in 2012<sup>41</sup> and 11% among the general population in 2016,<sup>37</sup> which are considered high according to WHO's threshold. The highest prevalence of HBV was 13% in 2011 in the Menoua division of the western region, followed by 13% and 11% reported in 2012 and 2014, respectively.<sup>37,43</sup> The prevalence of HBV increased linearly between 2008 and 2014.<sup>43</sup> This is not surprising given that the vaccine coverage has equally been fluctuating between 79% and 89% within the same period, and

currently stands at 79% nationwide.<sup>22,43</sup> This of course underscores the huge discrepancies between regions which as observed for MCV and PCV-13, is lowest in the northern and southern regions of the country, clearly reflecting the high (greater than 15%) HBV seroprevalence reported in the Far-North, North and South regions compared to the 8% to 15%; in the Center, East and South-West regions and the less than 8%; in the Littoral, North-West and West regions.<sup>37</sup> Foreseeably, a recent study reported very poor vaccine uptake in HBV high-risk groups including HCWs, household and sexual contacts to chronically infected HBV individuals.<sup>44–46</sup> This high prevalence of HBV in the general and specific subpopulations of Cameroon despite the prominent campaign of hepatitis B vaccine introduced in 2005, may be due to the fact that screening, and vaccination are not subsidized for the general population, whereas the cost of the vaccination and screening is still high for an average Cameroonian. Nevertheless, prevalence results must be interpreted with caution since there is paucity of prevalence studies in certain regions. These findings indicate the need of comprehensive and effective strategies to interrupt the transmission of HBV infection in the Cameroonian population. Specific attention is needed for rural settings and certain regions of the country. Figure 3 shows fluctuations in the uptake of Hepatitis B vaccine over the years ranging between 82% and 88% but decreased to 78% in 2018.

## Tetanus

Although preventable, tetanus still claims tens of thousands of lives each year. Neonatal tetanus (NT) is more likely to occur in low- and middle-income countries (LMICs), especially in places such as urban slums and rural areas where unhygienic deliveries at home are common, and coverage of antenatal care services and maternal tetanus toxoid vaccinations are usually inadequate.<sup>47,48</sup> During the past two decades, there has been a dramatic decline in tetanus cases and deaths due to the scale-

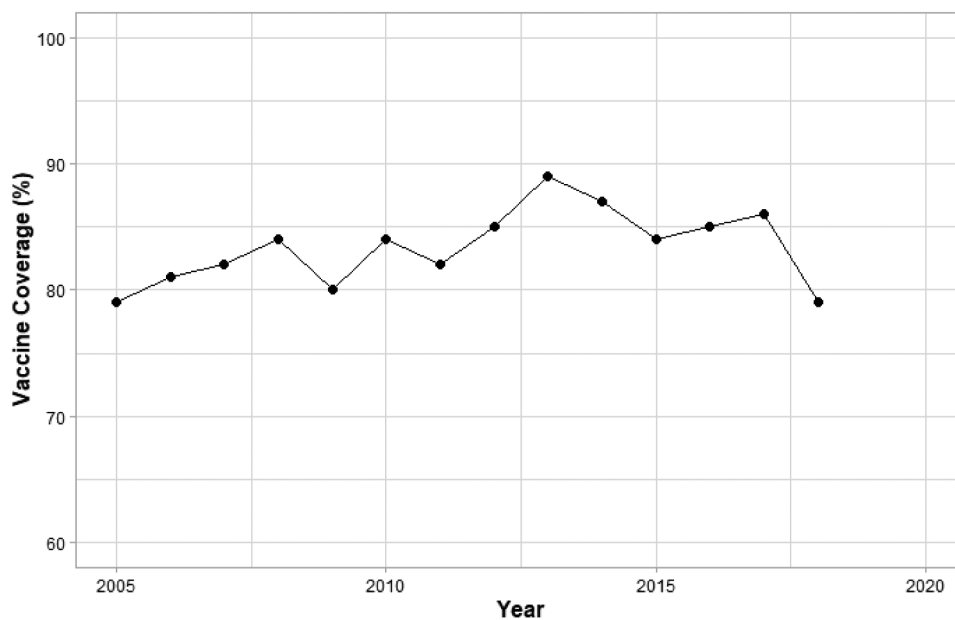


Figure 3. Coverage of the third dose of Hepatitis B vaccine in Cameroon.

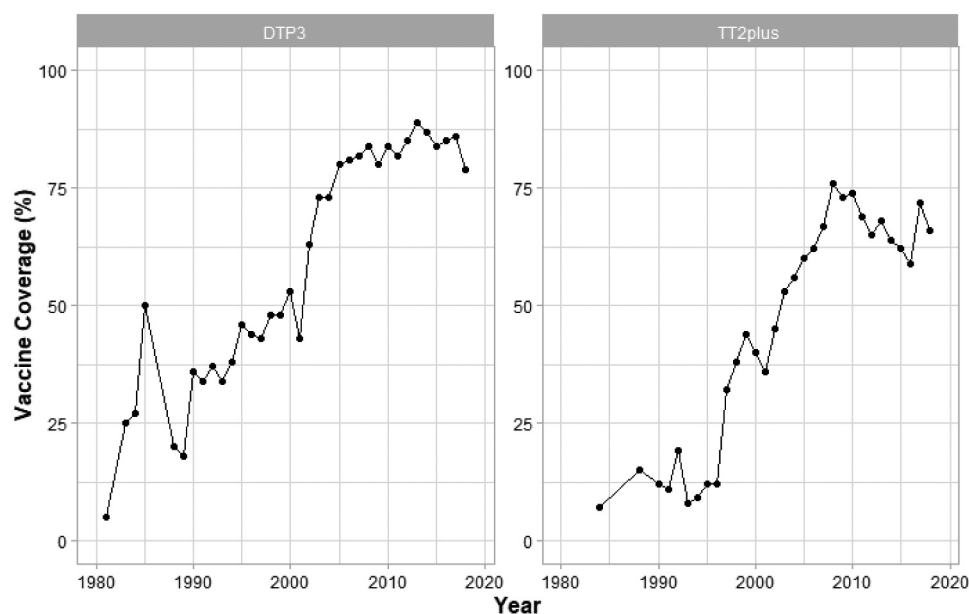
up of vaccination programs.<sup>47</sup> However, many people in low- and middle-income countries continue to die from tetanus despite the availability of an inexpensive and effective tetanus vaccine. For instance, high NT mortality (more than 1000 deaths per 100 000 population) is still reported in several countries including, Somalia, South Sudan, Afghanistan, and Kenya.<sup>47</sup> In Cameroon, NT mortality rates have been ranging between 12 and 110 deaths per 100 000 population since 2015, which is considerably high.<sup>47</sup> This finding puts into question the WHO's report on the elimination (less than 1 case of NT per 1000 live births) of NT and maternal tetanus (MT) in all areas of Cameroon released 2 y before the above study was conducted in 2013.<sup>49</sup> The WHO's declaration was based on a lot of quality assurance and cluster sampling survey (LQACS) indicating that there were no NT deaths among the 1361 live births surveyed. Faced with such contrasting results, one can only highlight the need for more nationwide epidemiological studies. On the other hand, non-NT accounts for about 0.1 to 0.4 deaths per 100 000 population in Cameroon compared to 5 deaths per 100 000 populations in Somalia, and Kenya.<sup>47,49</sup> This is evidence that the scale-up of vaccination coverage has not been universal, with low vaccination coverage being documented in several countries. In effect, the coverage of the third dose of pediatric toxoid vaccine, which is administered as a trivalent diphtheria-tetanus-pertussis (DTP3) vaccine, has been on a steady decline since 2015 till date in Cameroon with an increasing percentage of dropouts.<sup>22,47,48</sup> Similarly, the TT2plus (two or more doses of tetanus toxoid vaccine) for women of reproductive age and pregnant women has never reached a coverage of above 76% (a coverage of more than 80% recommended by WHO) since its introduction in 1984 in the national EPI program. Coverage rates fluctuate from year to year and have been on a continuous downward spiral since 2010.<sup>22</sup> Although it can be concluded from the findings above that tetanus is still a major public health in Cameroon, the extent of its burden cannot be confirmed due to the poor availability of data. The coverage of DTP3 increased

up to 88% in 2013 after its introduction in 1981, albeit with fluctuations and then coverage percentages have been decreasing until date while the highest coverage of the TT2 vaccine since its introduction in 1984 was 76% in 2008 (Figure 4). Since then, the national coverage has decreased from year to year until 2017, when there was an increase and then in 2018, the coverage decreased again.

## Current challenges in reaching coverage goals and strategies for mitigation

### Religious and cultural affiliation

Several key cultural perspectives on vaccination stem from<sup>50</sup> individual rights and public health stances toward vaccination,<sup>51</sup> various religious standpoints,<sup>52</sup> suspicion and mistrust of vaccines among Cameroonians. Christianity (69%), Islam (21%) and others (animists, Orthodox Jews and the Bahai Faith) (10%) are the three main religious divisions in Cameroon.<sup>53</sup> The Christian population is divided between the Roman Catholics (38%), Protestants (26%), and other Christian denominations (including Jehovah's Witnesses) (4%).<sup>53</sup> Even though each of these religious groups differ in one way or another in their core belief system, they are all equally largely associated with a reduction in vaccine coverage in certain communities. Recently, a study showed that full vaccination of children below 5 y is significantly lower for children whose mothers belong to reformist religions, including Islam.<sup>54</sup> This is not so much the case for the Catholic Church, which recognizes the value of vaccines and the importance of protecting individual and community health but asserts, however, that its members should seek alternatives, when available, to vaccines that are made using cell lines derived from aborted fetuses.<sup>50</sup> The objections of the Muslims and Jehovah's Witnesses on the other hand are based generally on<sup>50</sup> the ethical dilemmas associated with using human tissue cells to create vaccines.<sup>51</sup> They believe



**Figure 4.** Coverage of the third dose diphtheria-tetanus-pertussis (DTP3) and TT2plus (two or more doses of tetanus toxoid vaccine) vaccine in Cameroon.

that the body is sacred and should not receive certain chemicals or blood or tissues from animals. These beliefs are almost always further aggravated by false rumors and conspiracy theories surrounding the safety and authenticity of vaccines as history has proven. One such rumor surfaced in 1990, with fears that public health officials were administering a vaccine to sterilize girls and women, which thwarted the country's immunization efforts.<sup>51</sup>

Moreover, recent studies in Cameroon have shown that there are difficulties recommending the Human papillomavirus (HPV) vaccine to target groups due to vaccine hesitancy/stigma and misinformation surrounding the HPV vaccine.<sup>55,56</sup> Many parents had either general anti-vaccine sentiments against all vaccines or they had negative opinions of the HPV vaccine specifically.<sup>52</sup> A recent report communicated that some communities in the Yaounde municipality in the center region of Cameroon, which were previously for the HPV vaccine, are now hesitant toward receiving the HPV vaccine, claiming that what is being administered now are dangerous experimental COVID-19 vaccines.<sup>57</sup> Similar misinformed perceptions have negatively impacted polio vaccine campaigns in Pakistan, Afghanistan, and Nigeria.<sup>58</sup> Several studies in SSA have repeatedly highlighted the negative role of socio-cultural factors on vaccine uptake,<sup>59</sup> the most common being the discrimination against female children, the preference for traditional medicine as compared to western medicine and lack of trust in the quality of the health services. It is evident that in Cameroon, the people have deep cultural roots and religious values. As such, these values should be reflected in health messages to maximize the impact of the message on behavioral changes. Better relationships with prominent religious and cultural leaders who are a major influence in many communities' decision-making processes should be prioritized. Educating these elites in layman language on the importance of vaccines such that they themselves can in turn educate their communities may be more efficient due to the already established trust with them.<sup>60</sup>

### Poor governance and stewardship

Good governance or stewardship entails strengthening policy decision-making processes, regulations and improving health intelligence. Various studies suggest that to have accurate vaccination coverage reports in a country, there is a need to develop efficient monitoring information systems.<sup>61</sup> Accurate monitoring and evaluation of vaccination coverage is necessary to inform decision-making, measure success in delivering vaccines, and provide knowledge of health system bottlenecks. Developing ways of measuring change in key dimensions of the health system can guide resource allocation to where it is needed most and will improve accountability.

### Limited resources

Successful implementation of the vaccination program requires sufficient resources in terms of vaccines, supply chain (cold chain equipment and storage points), vaccinators and other aspects. The availability of sufficient resources for the vaccination program would require that training schools and training facilities be well equipped and are in functioning status to produce sufficient human-resource and facilities to deliver

vaccines in a safe and effective manner. Reports from Cameroon have indicated that there are still health facilities that do not have functional refrigerators, while many other facilities have a refrigerator that lack the accessories for appropriate cold chain and vaccine management; such as thermometers, a temperature chart and an alternative power supply.<sup>62</sup> This is an indication of limited resources available for vaccine and cold chain management. Similar results were obtained by other studies conducted in other parts of the country explaining why some health facilities ran out of vaccine stock due to lack of storage capacity.<sup>63,64</sup> The knowledge of health personnel on vaccine management, cold chain management, and diseases under epidemiological surveillance by the EPI has also been very limited in Cameroon.<sup>62</sup> More to this, insufficient financial investment on vaccine research and setting up new vaccine manufacturing units often delay the availability of new vaccines in Cameroon. Cameroon currently relies almost exclusively on external funding for the financing of its EPI and the introduction of new vaccines, which is very unsustainable in the long run. Overcoming this challenge will require a restructuring of the country's available resources to different sectors within the country to strategically allocate near-adequate budgets to support vaccination programs in a sustainable way.

### Poor infrastructural development

Organization of vaccination outreach strategies are usually hampered by bad roads, hilly and sloppy topographies of some areas usually with muddy and slippery roads, especially during the rainy season. In Cameroon, reports have shown that about 25% of the EPI target populations in the districts live further than 5 Km from a health facility. This implies that parents travel long distances to reach health facilities to get their child vaccinated.<sup>62</sup> Though it is worth the sacrifice for these parents, doing this regularly is costly, tiring, and inconvenient. Consequently, they may not always be able to meet up with vaccination schedules. On the other hand, an outreach strategy is expensive; it requires transportation avenues and motivated personnel to carry out this task. In some villages, the only possible means of transportation is a motorcycle or bicycle. Given that most health centers in the district have only one or two health personnel in the facility, conducting outreach strategies may have serious impacts on the other activities offered in the health facility, since they are also the ones involved in providing other healthcare services in the facility. Also, planning outreach services in rural areas where the main occupation is farming must take into consideration the timing of the outreaches which must match the time the target populations are present in their homes. Language barriers have been reported as an important bottleneck to the implementation of the EPI. Establishing mobile vaccinations stations closer to inaccessible communities, Using a motorbike ambulance for vaccination, door to door vaccination and engagement of community health workers who are knowledgeable about the population and language are all interventions which have been shown to be effective in improving vaccination uptake in most rural communities<sup>65,66</sup>

## Women education

Although there has been a free and compulsory primary education instituted in Cameroon since the early nineties, there still exists a gap in parental knowledge about immunization. In a study designed to describe and analyze the socio-economic /demographic determinants and predictors to parental knowledge on immunizations, only 19% of those sampled were aware of the availability of the PCV-13.<sup>67</sup> This was in line with the study reported in Niger and Nigeria, with a low rate (4%) of knowledge about Oral Polio Vaccine (OPV)<sup>66</sup> and the low rate of awareness (1%) that measles was vaccine-preventable, respectively.<sup>67</sup> Health education, training, and refresher courses for healthcare workers on vaccination will ensure that women attending antenatal care get adequate information on vaccination.<sup>68</sup>

## Ongoing conflict in Cameroon

The ongoing conflict in Cameroon started in 2016 as a peaceful protest of teachers and lawyers over marginalization of the anglophone people in Cameroon which developed into an armed conflict since then. The armed conflict characterized by burning of villages, kidnappings<sup>69</sup> and destruction of property has contributed to at least 679 000 internally displaced persons by December 2019.<sup>70</sup> The displacement of families leads to disruption of vaccination schedules and implementation of the EPI program in the affected regions. Destruction of homes and healthcare facilities due to military and separatist activities has contributed greatly to the underutilization of the vaccination program and other health services.<sup>71</sup> As a result, the EPI program has experienced a general decrease in the vaccination coverage for all vaccines since 2017.<sup>19</sup> Clearly, civil and/or political crises greatly impact primary healthcare interventions, including vaccination against VPDs. In this case, the uptake of vaccines will remain low and disease burden of VPDs will likely increase until the crisis is abated. Nonetheless, it is possible to set up in the midst of the crisis, a surveillance system that can track displaced populations such that low-cost mobile clinics can be established in their new settlements and refugee camps to ensure ongoing access to vaccines.<sup>66</sup>

## Other infectious diseases

Other infectious diseases like the coronavirus (COVID-19) have interrupted the implementation of the EPI program by shifting healthcare resources to the COVID-19 response.<sup>72</sup> This shift in healthcare attention may result in secondary health crises such as the outbreak of infectious diseases like measles. Restrictions due to COVID-19 hinder access into healthcare facilities and rural areas for vaccination.<sup>65</sup> During an outbreak like COVID-19, public health efforts are directed more toward addressing the outbreak leading to less children receiving vaccines. During times of quarantine, vaccination services among all age groups have been interrupted, delayed, re-organized or completely suspended in many parts of the world. A balance in healthcare resources, priorities and efforts will greatly reduce the possibilities of infectious disease outbreaks. Developing vaccination campaigns while respecting

infection prevention and control guidelines, using mobile EPI centers and awareness from the media about vaccination and nearby EPI centers are effective measures to achieve optimal vaccination coverage<sup>65</sup>

## Conclusion

VPDs still present a huge public health burden in Cameroon several decades after the introduction of the expanded program on immunization. The vaccination coverage for most vaccines has been experiencing a steady decline in recent years. This review discussed several context and program-specific challenges faced by the EPI program in Cameroon in addition to the impact of other infectious diseases and the ongoing political conflict, in achieving national optimal vaccination coverage. This review adds to the existing literature by pulling together recent evidence to help guide policy changes to improve the implementation of the EPI and vaccination coverage.

## Limitations

This review presents findings published in indexed journals and online reports. The non-indexed local journals may contain several studies that are relevant in strengthening the current observation. Also, the estimates reported in this review could be subject to underreporting, poor data quality or other problems associated with reporting in LMIC and should be interpreted with caution. Furthermore, we limited our narrative to only four VPDs which do not fully reflect the overall impact of vaccination on the other VPDs.

## Author contribution

All authors have made significant contributions to the manuscript, reviewed, and approved the manuscript for submission.

## Disclosure of potential conflicts of interest

The authors declare that they have no known competing financial interest or personal relationships that could have appeared to influence the work reported in this review.

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