ORIGINAL ARTICLE

# Effect of COVID-19 on immunization coverage of children aged 0-11 months in the center region of Cameroon

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**Abstract.** The occurrence of epidemics is known to contribute in reducing the capacity of health facilities to deliver care and the predisposition of populations to seek care through several mechanisms. The objective was to assess the effect of the COVID-19 on vaccination coverage of the expanded program of immunization (EPI) vaccines in children aged 0-11 months. The study involved a descriptive and case control designs exhaustively targeting health facilities in health areas from selected health districts. The descriptive part explored the distribution of immunization coverage 12 months before and during COVID-19. Data were extracted from monthly EPI reports of health areas. Cases were months with immunization coverages of Bacille Calmette-Guerin (BCG), Measles Mumps-Rubella 1 (MMR1) or Diphtheria-Pertussis-Tetanus Hepatitis B + Hemophilus influenzae type b dose 3 (DPT-Hi+Hb3) less than 80%. The exposure were months belonging to the pandemic period. Of the 78 targeted health areas, 74 (94.87%) were reached. The monthly immunization coverage of BCG, RR1, DPT-Hi+Hb 1 and 3 decreased during the pandemic period by minimum 30%. Being a health-area month belonging to the COVID-19 pandemic period was found to be significantly associated to lower BCG [OR=2.00 (1.61; 2.50); P<0.001], MMR1 [OR=2.45 (1.76; 3.41); P<0.001] and DPT-Hi+Hb3 [OR=2.11 (1.68; 2.640); P<0.001] immunisation coverage. COVID-19 had a significant effect on the decrease of immunization coverages of antigens offered in the EPI program. This raises the need to develop interventions during health emergencies to prevent disruption of health services access.

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*Key words:* effect of COVID-19 on vaccination, vaccination coverage, COVID-19 pandemic, Cameroon, Central Africa

## Introduction

COVID-19 since its onset was characterised by its rapid spread and high severity (1). As response to its propagation and as response, several measures were taken at international, population and person-centered level, creating enormous mobilisations of human and financial resources due to several restructurings in health systems and rapid adaptation (2-4). Person centered measures included among others social distancing through community periodic confinement or simply distance maintenance during daily activities and the prohibition of groupings and therefore a decrease in the number of visitors to public places (5,6). To evaluate the effect of these measures, the World Health Organisation (WHO) published the results of a first indicative survey on the impact of COVID-19 on health systems, based on reports from 105 countries and showed that almost all the countries (90%) experienced disruptions on their health services, with low and middle-income countries reporting the most severe difficulties (7).

The Expanded program on immunisation is responsible to ensure the availability and appropriate distribution of vaccines to targeted groups (8). In Cameroon, the EPI program is dispensed in health facilities (9). During the COVID-19 pandemic most of services turned into online or distance modes to comply with the control measures but in the case of immunization programs and other health programs this couldn't be feasible (10,11). The contradictory effect of these measures with the need to get closer to health facilities to benefit from EPI services has had consequences on the demand and supply of these services (12). Several studies were carried out around the world on the subject and documented declines in coverage of immunisation antigens of the EPI program since the onset of the COVID-19 pandemic but very few studies have been carried out in Africa and to date, none in Cameroon (13-15).

The first case of COVID-19 in Cameroon was registered in March 2020 and led to a rapid adaptation of the response system and the adoption of recommendations for the prevention of the transmission of COVID-19 (4). The aim of the present study was to assess the effect of COVID-19 onset on the

immunisation coverage of some key EPI antigens in children aged 0 to 11 months in the Centre region of Cameroon.

## Materials and methods

*Ethical considerations*. Participants were informed of the study objectives and procedures. Only health areas whose heads provided written consent were included in the study. All collected data were anonymous. The protocol was reviewed and approved by the Regional Ethics Committee for Human Health Research of the Centre region of Cameroon (N°1134/CRERSHC/2021).

*Study design*. The design of the study involved a descriptive and case control designs targeting health facilities exhaustively selected from selected health areas. Data were extracted from monthly EPI reports of Health Areas (HA) using a grid. The descriptive part explored the distribution of immunization coverage 12 months before and during the COVID-19 pandemic. The analytical design involved case control designs targeting months in each health areas (area-month) where cases were the area-months with immunization coverages of each antigen less than 80% and controls with a coverage greater than 80%. The exposure was the status of belonging to the epidemic period.

*Study period*. The study period covered the period from March 2019 to February 2021. Data collection was done from March to May 2021.

*Study location*. This study was conducted in the centre region of Cameroon which comprises 30 health districts, 6 of which are located in the regional capital and 24 outside the capital. At the time of data collection, it was the most affected region by COVID 19 in Cameroon. Fig. 1 presents the geographic location of the health districts reached during the study.

*Study population*. All the health areas of the selected health districts were eligible. The health districts include Akonolinga, Awae, Bafia, Biyem-Assi, Djoungolo, Mbankomo, Obala and Soa health districts. All their activity reports from March 2019 to February 2021 were included for the descriptive component. Months with antigens coverage <80% were included as cases and matched to controls which are months with antigens coverage ≥80%. Cases and controls for other antigens were selected with the same design. Health areas visited more than three times or permanently closed at the time of data collection were excluded.

*Sampling procedure*. Probabilistic sampling was done to select eight health districts in the centre region, two urban health districts (more than two health area entirely urban), two semi-urban health districts (at least one health area fully urban) and four rural health districts (all health areas urban). Exhaustive sampling of health areas was done in each district.

*Sample size*. No sample size was estimated for the descriptive design as it targeted all health areas. For the case control design, the minimum sample size was estimated at 524 (262 cases and 262 controls) health area-months, assuming the proportion of health facilities offering vaccination at 50%, the odd ratio at 1, a precision of 25% and a confidence interval of 95% (16).

Table I. Distribution of health areas reached per targeted health districts.

| Health Districts | Number of existing health areas | Number of reached health areas | Proportion reached (%) |
|---|---|---|---|
| Akonolinga | 12 | 11 | 91.67 |
| Awae | 5 | 4 | 80.00 |
| Bafia | 19 | 18 | 94.74 |
| Biyem-Assi | 11 | 11 | 100.00 |
| Djoungolo | 8 | 8 | 100.00 |
| Mbankomo | 5 | 5 | 100.00 |
| Obala | 12 | 11 | 91.67 |
| Soa | 6 | 6 | 100.00 |
| Total | 78 | 74 | 94.87 |

*Data collection tools*. Data was collected using a predeveloped grid that collected the numbers of children vaccinated by antigens per months. The monthly target populations were obtained from the national EPI program. The offer of vaccination was explored using a semi-structured questionnaire to assess the probable barriers of vaccination before and during COVID-19. All data collection tools were adapted electronically. The data collection tools were pre-tested in three health facilities in the Dschang health district.

*Implementation procedure*. The head of each health area was met and was presented the study objectives and procedures. If consenting, a written informed consent was signed and the questionnaire administered. Data were collected from review of monthly activity reports of the health area covering the period from March 2019 to February 2021.

*Data management and analysis*. The data collected was checked and revised at the time of data collection. Data were downloaded weekly to ensure a second quality control.

Analysis was done to estimate the monthly coverage of vaccination and these were compared before and during the pandemic using the student test. The effect of the COVID-19 pandemic on the coverage of the selected vaccines was estimated using crude and adjusted odd ratios. Confounding factors used for the adjusted model were the availability of cold chain, energy source and input supply. Data were analysed using SPSS 26 and MS Excel version 2016.

## Results

*Coverage of health areas*. A total of 74 (94.87%) health areas were surveyed out of 78 targeted and 1776 reports were reviewed. A total of 04 health areas did not consent to participate or could not be reached during the study period. Data were collected from 888 reports before the pandemic and 888 during the pandemic period in Cameroon. Table I presents the number of health areas reached per health district.

Table II. Distribution of immunization coverage per antigen among children before and during the COVID 19 pandemic.

| | BCG | | MMR1 | | DPT-Hi+Hb1 | | DPT-Hi+Hb3 | |
|---|---|---|---|---|---|---|---|---|
| | Before n (%) | During n (%) | Before n (%) | During n (%) | Before n (%) | During n (%) | Before n (%) | During n (%) |
| March | 4217 (127.5) | 3587 (113.0) | 3516 (106.3) | 3054 (96.0) | 4258 (128.7) | 3645 (114.8) | 4ss570 (138.2) | 4011 (184.6) |
| April | 4592 (138.8) | 4247 (133.8) | 3930 (118.8) | 2683 (84.5) | 4231 (127.9) | 3486 (109.8) | 4591 (138.2) | 3659 (115.3) |
| May | 5265 (159.2) | 3889 (122.5) | 4019 (121.5) | 3229 (101.7) | 4791 (144.9) | 3526 (111.1) | 4811 (145.5) | 3659 (115.3) |
| June | 4792 (144.9) | 3146 (99.1) | 4071 (123.1) | 2982 (93.9) | 4894 (148.0) | 3487 (109.8) | 4823 (145.9) | 3257 (102.6) |
| July | 5044 (152.5) | 4613 (145.3) | 4133 (125.0) | 3108 (97.9) | 5116 (154.7) | 4045 (127.4) | 5308 (160.6) | 4084 (128.7) |
| August | 5198 (157.2) | 3503 (110.4) | 4565 (138.1) | 3012 (94.9) | 4898 (148.1) | 3673 (115.7) | 5370 (162.4) | 4021 (126.7) |
| September | 5153 (155.8) | 4397 (138.5) | 4170 (126.1) | 3059 (96.4) | 4780 (144.6) | 3605 (113.6) | 5416 (163.8) | 4216 (132.9) |
| October | 5709 (172.6) | 4103 (139.3) | 4357 (131.7) | 3431 (108.1) | 5154 (155.8) | 3900 (122.9) | 5569 (168.5) | 4082 (128.6) |
| November | 5563 (168.2) | 4063 (128.0) | 4319 (130.6) | 2982 (93.9) | 5194 (157.1) | 3811 (120.1) | 5366 (162.3) | 4044 (127.5) |
| December | 5230 (158.1) | 3543 (111.6) | 4266 (129.0) | 2661 (83.8) | 4980 (150.6) | 3688 (116.2) | 5419 (163.9) | 3843 (121.1) |
| January | 4660 (146.8) | 3551 (101.9) | 3966 (124.9) | 2986 (85.7) | 4208 (132.6) | 3268 (93.8) | 4630 (145.9) | 3635 (104.4) |
| February | 4047 (127.5) | 2820 (80.9) | 3624 (114.2) | 2442 (70.1) | 3644 (114.8) | 2827 (81.1) | 4366 (137.6) | 3305 (94.9) |
| Mean coverage | 150.82 | 117.91 | 124.15 | 92.31 | 142.36 | 111.41 | 139.13 | 108.20 |
| Difference coverage / T-test (p) | | 5.78 (<0.001) | | 8.69 (<0.001) | | 11.68 (0.001) | | 6.94 (0.001) |

Vaccination target population from March to December 2019=3306, Vaccination target population from January to December 2020=3173, Vaccination target population from January to February 2021=3482.

*Distribution of immunisation coverage among children before and during the COVID-19 pandemic*. Table II presents the monthly distribution of immunisation coverage of targeted vaccines before (March 2019 to February 2020) and during (March 2020 to February 2021) the COVID-19 pandemic period. A drop of immunisation coverage during the pandemic period compared to before the pandemic period was noted with all vaccine types and doses investigated. Figs. 2,3 and 4 present respectively the change of coverages of targeted antigens in rural, semi-urban and urban health districts.

*Comparison of cases and controls characteristics with respect to DPT-Hi+Hb 3 coverage*. A total of 717 (50.28%) health area-months had a DPT-Hi+Hb 3 coverage below 80% out of the 1426 health area-months included. The distribution of the availability of cold chain, energy source, and input supply was statistically different between the cases and controls (Table III).

*Association between exposure to the COVID-19 pandemic period and low immunisation coverage*. Table IV presents the association between health area-months exposure to the COVID-19 pandemic period and low BCG, MMR1 and DPT-Hi+Hb3 coverage respectively. Being a health-area month belonging to the COVID-19 pandemic period was found to be significantly associated to lower BCG [OR=2.00 (1.61; 2.50); P<0.001], MMR1 [OR=2.45 (1.76; 3.41); P<0.001] and DPT-Hi+Hb3 [OR=2.11 (1.68; 2.64); P<0.001] immunisation coverage.

## Discussion

This study was conducted to assess and compare the immunisation coverage of BCG, MMR1, DPT-Hi+Hb 1 & 3 before and during the COVID-19 pandemic and assess if a decrease in the immunisation coverage may be associated to the COVID-19 pandemic period.

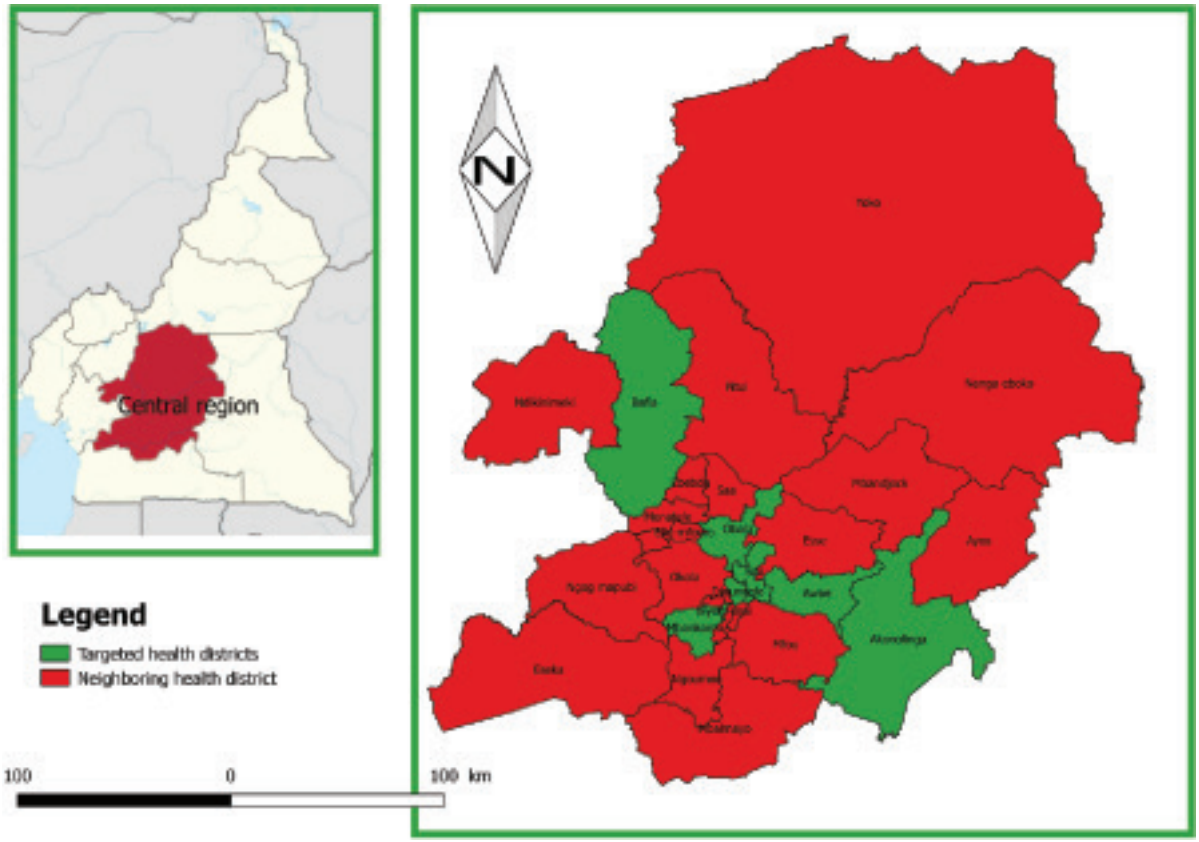


Figure 1. Map of the Centre region of Cameroon with targeted health districts.

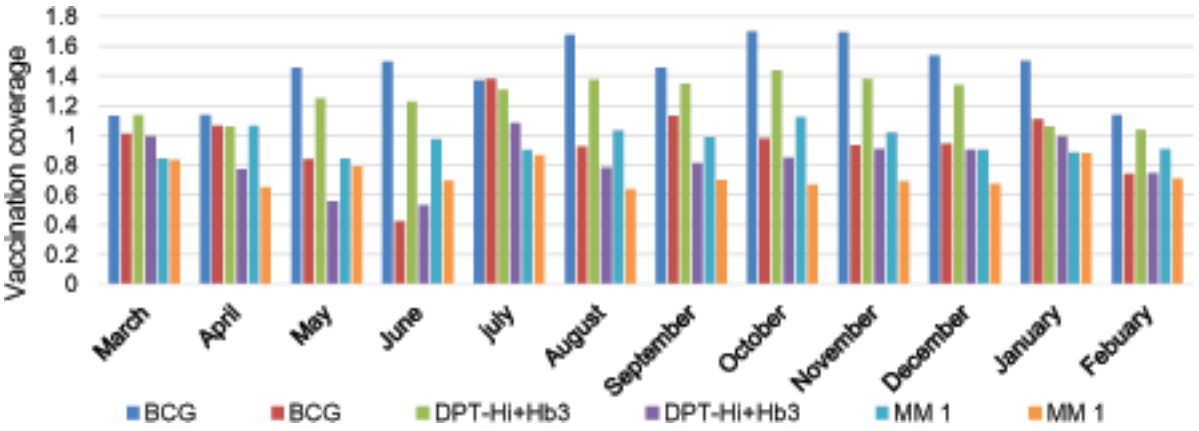


Figure 2. Immunization coverage evolution before and during the COVID-19 pandemic in rural health districts per antigen.

The supply of vaccines to population are ensured by countries EPI program following the WHO recommendations. In Cameroon, the EPI program targeting mainly children are offered at health facilities level through weekly immunisation sessions exception made for localities with non-geographical access to offering health facilities where community immunisation sessions are offered at a monthly basis (17). With the knowledge of the demography of each country and therefore of each locality, the EPI program has per given period of time a certain number of children targeted for each antigen per health districts set as an objective to reach the herd immunity (17). The results of the present study reveal the immunisation coverage of BCG, MMR1, DPT-Hi+Hb 1 & 3 vaccines decreased with the appearance of the COVID-19 pandemic by an average decrease in coverage of 30%. Similar results were observed for studies conducted around the world (14,18). Similar results were also documented in Senegal where a drop of up to 50% per antigen was noted, and in the Mifi health district in Cameroon which showed that there is a drop in coverage of about 20% for BCG. The COVID-19 pandemic had as direct effect on population habits who had to cope with the need of containment measures to limit the spread of the virus which included non-aggregation of people, social distancing and lockdowns (19). This could explain the decrease in coverage of these antigens, assuming that the rate of people attending public places such as health facilities has decreased. The effect of COVID 19 on hospital attendance has been documented in

Table III. Comparison of cases and controls characteristics.

| Variables | Low DPT-Hi+Hb3 coverage | | Chi-square | P-value |
|---|---|---|---|---|
| | Yes | No | | |
| Reduction in the number of health personnel | | | | |
| Yes | 283 | 264 | 0.75 | 0.20 |
| No | 434 | 445 | | |
| Availability of cold chain | | | | |
| Yes | 497 | 442 | 14.93 | 0.001 |
| No | 220 | 287 | | |
| Availability of energy source | | | | |
| Yes | 303 | 353 | 8.76 | 0.004 |
| No | 414 | 356 | | |
| Constant supply of input | | | | |
| Yes | 480 | 527 | 9.37 | 0.002 |
| No | 237 | 182 | | |

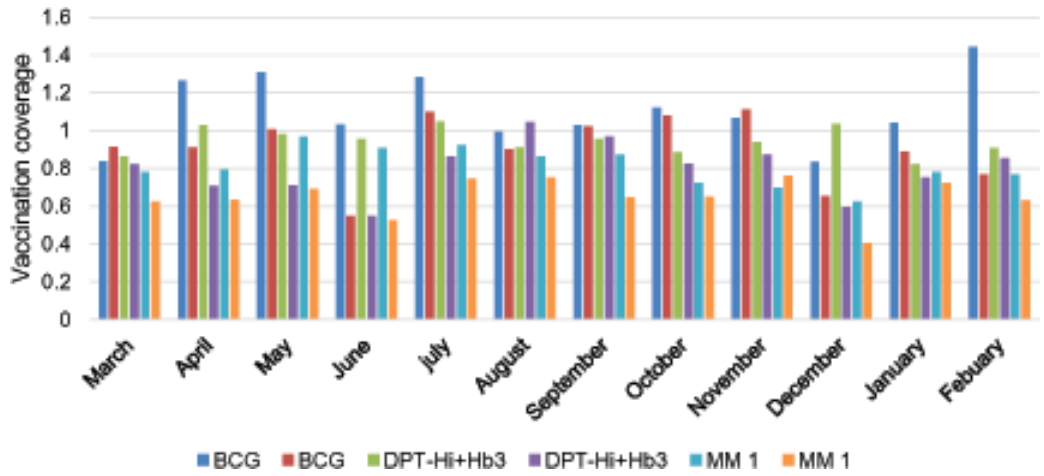


Figure 3. Immunization coverage evolution before and during the COVID-19 pandemic in semi-urban health districts per antigen.

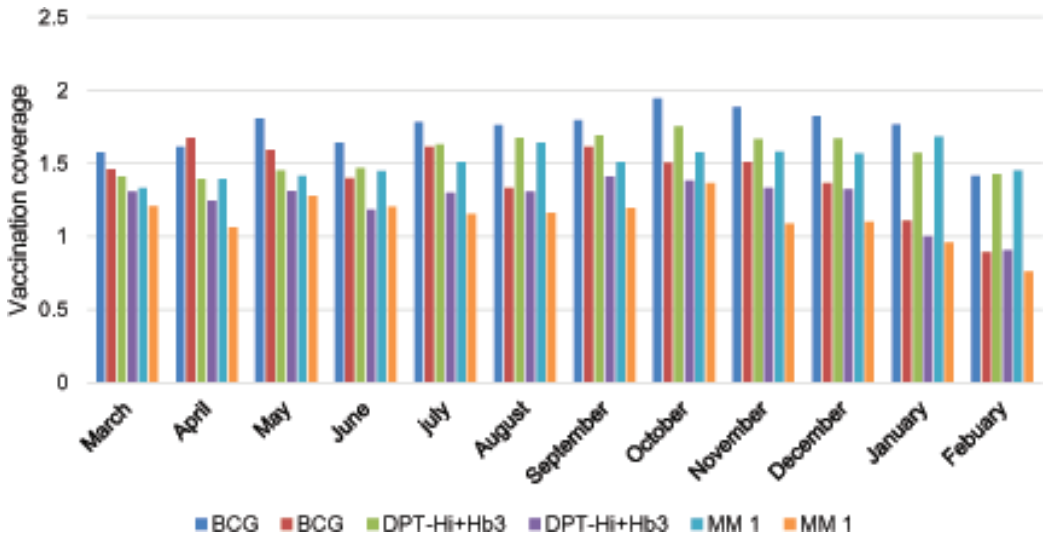


Figure 4. Immunization coverage evolution before and during the COVID-19 pandemic in urban health districts per antigen.

Table IV. Association between exposure to the COVID-19 pandemic period and low BCG, MMR 1 and DPT-Hi+Hb3 coverage.

BCG coverage

| | | Health area months with low BCG coverage | | Crude OR (95% CI) | P-value | Adjusted OR (95% CI) | P-value |
|---|---|---|---|---|---|---|---|
| | | Yes | No | | | | |
| Exposure of health area-months to COVID-19 | Yes | 367 | 364 | 1.8 (1.46; 2.24) | <0.001 | 2.00 (1.61; 2.50) | <0.001 |
| | No | 248 | 447 | | | | |

MMR 1 coverage

| | | Health area-months with low MMR 1 coverage | | Crude OR (95% CI) | P-value | Adjusted OR (95% CI) | P-value |
|---|---|---|---|---|---|---|---|
| | | Yes | No | | | | |
| Exposure of health area-months to COVID-19 | Yes | 474 | 71 | 2.31 (1.68; 3.18) | <0.001 | 2.45 (1.76; 3.41) | <0.001 |
| | No | 375 | 130 | | | | |

DPT-Hi+Hb3 coverage

| | | Health area-months with low DPT-Hi+Hb3 coverage | | Crude OR (95% CI) | P-value | Adjusted ORa (95% CI) | P-value |
|---|---|---|---|---|---|---|---|
| | | Yes | No | | | | |
| Exposure of health area-months to COVID-19 | Yes | 432 | 299 | 2.07 (1.69; 2.56) | <0.001 | 2.11 (1.68; 2.64) | <0.001 |
| | No | 285 | 410 | | | | |

several studies and was mainly due to fear of being infected or been diagnosed (12,20-23). In the case of BCG antigen, this is the child's first contact with the vaccination system and is therefore given just after delivery (24). The decline in coverage of this antigen could suggest that the number of women giving birth in health facilities has declined in favor of the community. This study did not collect information to confirm this hypothesis, but other studies conducted in other settings have documented a decline in the number of deliveries in health facilities (25,26). The effect of covid-19 on border closure regulations and shipment delays may also be a contributing factor to this decline in coverage. Indeed, the closure of borders at one point in the pandemic causing shipment delays could have made the supply of inputs to the immunization program difficult or impossible, thus countries' programs especially low- and middle-income countries like Cameroon vulnerable to stockouts and insufficient resources for maintaining vaccine programs. The consequence of COVID-19 on immunization disruption and the reality of the risk were documented in studies (13,15,27). To the best of our knowledge, no studies documenting the issue is for the moment published for the case of Cameroon.

The implementation of the present study had some limitations. Not all health areas of the targeted health districts were covered during data collection. No data on reasons of

non-attendance of health facilities were collected from health facilities from attendees and users.

## Conclusions

As in most of the reports worldwide, COVID-19 had a significant effect on the decrease of immunization coverages of antigens offered in the EPI program as in all cases a decrease of coverage of minimum 30% was noted. This decrease was significantly associated to the COVID-19 pandemic. Children vaccination is essential to children health and hence should not be neglected. Interventions should be developed to ensure the catch-up of missed vaccination sessions in health facilities and in communities. Also, there is a need to develop interventions representing alternatives to routine administration of vaccines in health facilities in case of health emergencies.

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## Contributions

LDDM, LLKT, data collection; LDDM, KHTN, LLKT, conducted data analysis and interpretation; LDDM, KHTN, WB, LLKT, JA, drafting of the manuscript; JA, study supervision. All authors were involved in critical revision of the manuscript and all authors approved the final version to be published.

## Ethical approval and consent to participate

Participants were informed of the study objectives and procedures. Only health areas whose heads provided written consent were included in the study. All collected data were anonymous. The protocol was reviewed and approved by the Regional Ethics Committee for Human Health Research of the Centre region of Cameroon (N°1134/CRERSHC/2021).

## Availability of data and material

Data and materials are available by the authors.

## Conflict of interest

The authors declare no potential conflict of interest.

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