

Original Research Paper

Building an Efficient and Effective Vaccination Programme for Poliomyelitis Immunisation in Bamenda Health District, Cameroon

Ndipowa James Attangeur Chimfutumba¹, Kamga Henri Lucien², and Paul Mbangwana²

¹Faculty of Health Sciences, Bamenda University of Science and Technology, (BUST)

²Faculty of Medicine and Biomedical Sciences, University of Bamenda (UBA)

²Faculty of Health Sciences, Bamenda University of Science and Technology, (BUST)

Accepted 30th August, 2020.

The North West Region of Cameroon including the Bamenda Health District has frequently been having upsurges of vaccine-preventable diseases. This motivated the research topic “Building an Efficient and Effective Vaccination Programme for Poliomyelitis Immunisation in the Bamenda Health District”. The main objective was to carry out an exhaustive audit of the Polio vaccination programme in the Bamenda Health District (BHD). A descriptive, cross-sectional, explorative and comparative design was used for the study in which multistage random sampling was carried out to obtain a sample size of 414 participants. Key findings revealed insufficient mobilisation of resources; lack of robust bottom-up micro-plans for the campaigns; ineffective advocacy and communication plans resulting to weak involvement of related sectors; poor organisation; limited capacity building for vaccinating personnel; obsolete and inadequate cold chain system in many health facilities. This justified the acceptance of the Null Hypothesis. With the current socio-political climate in the country aggravated by a dual warfare, the situation would definitely worsen despite the efforts of external donors and funding agencies. As a recommendation, every public health stakeholder and the government should redouble their efforts to right the flaws and lapses, both in vaccinations, health promotion, disease surveillance, and epidemic preparedness. The Cameroon government should revamp the health sector as well as create an enabling environment for efficient and effective vaccination campaigns.

Keywords: Vaccination, Immunisation, Efficiency, Health Promotion, Epidemics.

INTRODUCTION

Disease prevention and control has constituted a challenging problem for the public health sector in Cameroon in general and in the North West Region in particular for a pretty long time. This has led to an upsurge of many diseases and epidemics in the North West Region in particular and Cameroon in general. The North West Region is currently experiencing an upsurge of epidemics of vaccine-preventable diseases such as Poliomyelitis, Measles, Meningitis, Tetanus, Tuberculosis, Hepatitis B, Yellow Fever, and even Cholera.

The current vaccination coverage for the North West region is 68%, far from herd immunity. This is probably due to a poor, inefficient, and ineffective vaccination programme over the years. The situation has become very challenging and aggravated by the socio-political crisis and the war raging on in the Region. Many families have been displaced into the bushes and refugee camps, the adverse consequences notwithstanding. These displaced populations are at very high

risk of contamination, infection, and epidemics, given that they are staying in forests, slumps, and overcrowded refugee camps.

With such mass displacements, disease exposure, incidence, and prevalence tend to rise significantly. Consequently vaccination and immunisation as well as follow up by way of surveillance, monitoring, and case tracking become even less efficient. Access to vaccination and immunisation for newborns and the under-fives in such circumstances is either absent or inadequate.

We therefore require a more robust, flexible, and mobile or transferable vaccination and immunisation system that caters for the affected and vulnerable populations and on a large scale. This will go a long way to curb the upsurge of infectious diseases and improve access to health care for the most vulnerable people.

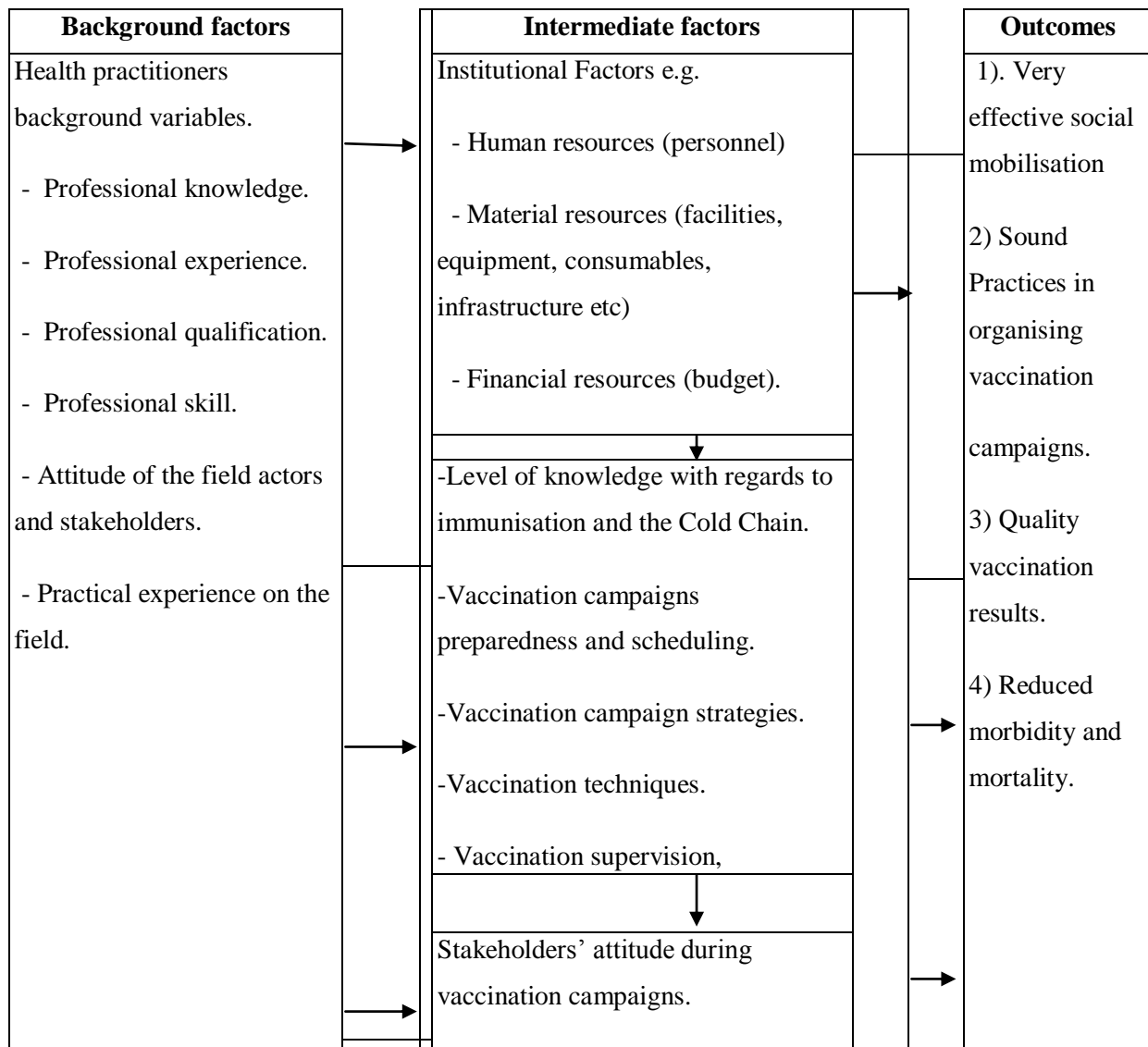


Fig 1: Conceptual Framework

Conceptual Framework

There exists an inter-relationship between the background factors, intermediate factors, and the outcomes of vaccination. The professional knowledge, professional experience, professional qualification, and professional aptitude greatly rely on the institutional resources in order for the outcomes to be yielded in terms of the prevention of morbidity and mortality through vaccination and immunisation. Meanwhile, the institutional factors such as human, material, and financial resources will facilitate the acquisition of professional knowledge by the personnel especially as concerns organisation of vaccination campaigns, epidemic preparedness, suitable strategies, techniques of vaccination, as well as influence stakeholders' attitude during vaccination campaigns. The effective galvanisation of these factors will culminate in sound vaccination organisation and specific disease prevention through effective vaccination and immunisation.

Brief review of related literature

The World Health Organisation asserts that immunisation prevents illness, disability, and death from vaccine-preventable diseases including cervical cancer, poliomyelitis etc, and that immunisation currently averts an estimated 2 to 3 million deaths every year. Yet an estimated 21.8 million infants worldwide are still missing out on basic vaccines of whom nearly half live in India, Nigeria, and Pakistan. [1][23] The last reported cases of wild polio in India were in West Bengal and Gujarat on 13 January 2011. [1][15] On 27 March 2014, WHO declared India a Polio-free country, since no cases of wild Polio had been reported in the previous three years. [11] As of mid-2015, only Afghanistan and Pakistan still had wild Polio cases. The most recent WPV case in West Africa (excluding Nigeria) occurred in Tahoua province, Niger, with the onset of paralysis on 15 November 2012.

Table 1: Case Breakdown by Country

Countries	Year-to-date 2015		Year-to-date 2014		Total 2014		Onset of paralysis of most recent case	
	WPV	cVDPV	WPV	cVDPV	WPV	cVDPV	WPV	cVDPV
Afghanistan	12	0	10	0	28	0	06-Sep15	NA
Pakistan	32	0	173	19	306	22	22-Aug-15	13-Dec-14
Cameroon	0	0	5	0	5	0	09-Jul-14	NA
Equatorial Guinea	0	0	5	0	5	0	03-May-14	NA
Ethiopia	0	0	1	0	1	0	05-Jan-14	NA
Guinea	0	1	0	0	0	0	NA	20-Jul-15
Iraq	0	0	2	0	2	0	07-Apr-14	NA
Madagascar	0	9	0	0	0	1	NA	07-Jul-15
Mali	0	1	0	0	0	0	NA	20-Jul-15
Nigeria	0	1	6	17	6	30	24-Jul-14	16-May-15
Somalia	0	0	5	0	5	0	11-Aug-14	NA
South Sudan	0	0	0	0	0	2	NA	12-Sep-14
Syrian Arab Republic	0	0	1	0	1	0	21-Jan-14	NA
Ukraine	0	2	0	0	0	0	NA	07-Jul-15

Problem statement

Poliomyelitis eradication is on the cusp of success, yet with some regions still maintaining transmission. Improving our understanding of why some regions have been successful and others have not will help with both global eradication of Poliomyelitis and the development of more efficient and effective vaccination strategies for other pathogens. [26] Given these dynamic properties, attention should be given to intervention strategies that complement childhood vaccination. For example, improvement in hygiene and sanitation can reduce the reproduction numbers in problematic regions, and adult vaccination can lower adult transmission. [26][19].

With the world on the verge of global eradication of Poliomyelitis, eliminating the disease from the remaining few countries has proved difficult. Local elimination efforts have focused on both fine-tuning vaccine design and developing strategies to attain effective and intensive vaccination coverage of children. Since global Polio eradication is in its final stages, to ensure success, intensive, efficient, and effective efforts are needed in the few remaining countries.

These same lapses and challenges obtain in the Bamenda Health District and therefore need to be addressed and improved upon, as well as in the North West Region of Cameroon in general, in order to ensure an efficient and effective vaccination programme.

Furthermore, currently, there are epidemics of measles in the Menchum Valley, and Ndop in the North West Region, and parts of the Centre Region. According to the National Luncheon Date News presented by Chonko Becky Bisong at 14: 48 pm on the 24th November 2015, [20] about 638 cases of Rubella were diagnosed in the Centre Region of Cameroon between 2008 and 2010. This same source reported that in 2014, 49 deaths were registered due to measles and 74 deaths were registered from measles in 2015. On this same news programme Ngoningeh Swaibu Nchari also reported that only 80% of children had been vaccinated against measles in the West Region of Cameroon.

Therefore, one can rightly say there is no herd immunity acquired. In a nutshell, the vaccination programme in Cameroon is plagued with problems at various levels rendering it quasi inefficient and ineffective and the Bamenda Health District is not exempted. These problems probably include managerial and technical problems, a defective cold chain originating right from CENAME in Yaoundé, poor programming, and poor management of logistics characterised by stock-outs in some health districts.

It was in the light of the ongoing situation that we perceived the need to investigate the impediments, flaws, and lapses affecting the vaccination programmes in the Bamenda Health District so as to build an efficient and effective Polio vaccination and immunisation programme for the health district.

OBJECTIVE OF THE STUDY

The general objective of the study was to carry out an exhaustive audit of the Polio vaccination and immunisation programme in the Bamenda Health District.

Rationale & need for the Study

The North West Region that includes the Bamenda Health District is currently experiencing an upsurge of epidemics of vaccine-preventable diseases amidst a raging warfare. This inevitably brings to question the efficiency and effectiveness of the vaccination and immunisation programme. We therefore require a more robust, flexible, and mobile or transferrable vaccination and immunisation system that caters for the affected populations and on a large scale.

Hypotheses (H₀)

The Polio vaccination campaigns in the Bamenda Health District are substandard and consequently, there is a high risk of an upsurge of morbidity and mortality from Poliomyelitis and other vaccine-preventable diseases.

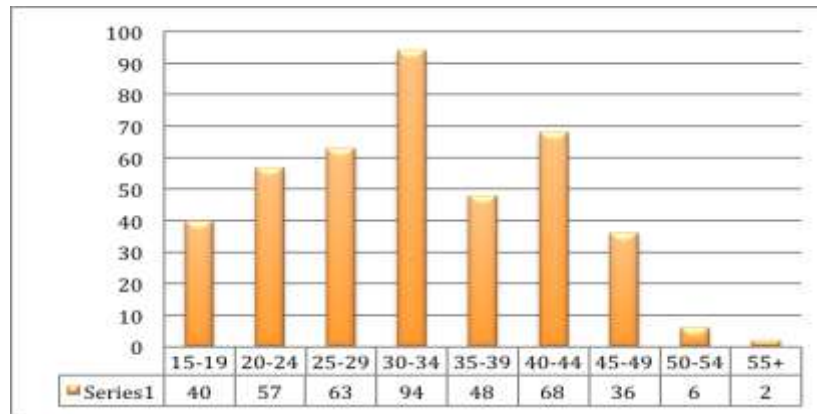


Fig. 2: Bio-demographic Characteristics of Respondents (n=414)

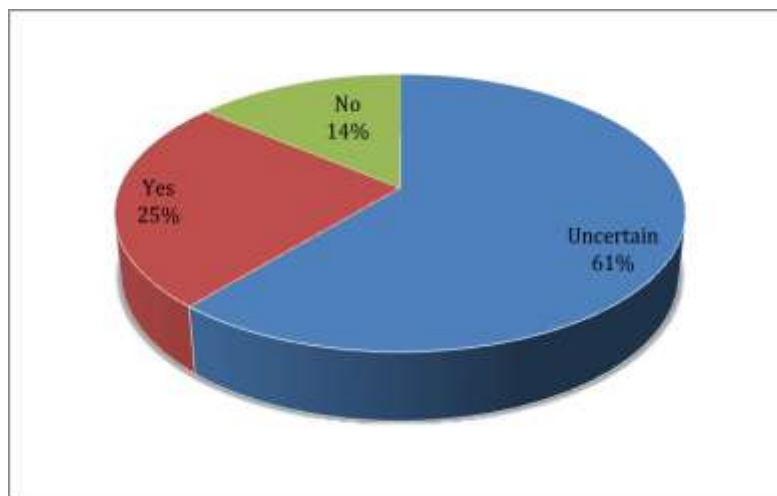


Fig 3: Vaccination Coverage Among Adults (n = 384)

Table 2: Reasons for Vaccine Resistance and Denial. Statistical Analysis (n = 384)
 * CI = 1.96 - 95% and Significance Level = 5% (0.05); Software: Stata.

VARIABLES	YES	NO	T-stat	P-value	DF
In the early 1990s Tetanus Toxoid was allegedly used to render women of childbearing age sterile for political reasons.	305	79	14.06	0.00	383
In 2016 it was rumored the Ebola Trial Vaccine in Bamenda was intended for the gradual reduction of the North West population.	371	13	46.56	0.00	383
Last year political activists discouraged the populations of the Anglophone regions from receiving vaccines from the Cameroon government, describing them as having been poisoned.	376	8	61.65	0.00	383

*All variables have a P-value of less than 0.05. They are therefore significant to the prevalence in question.

Table 3: Knowledge about Vaccines & Training: Test of Significance:
 * CI = 1.96 - 95% and Significance Level = 5% (0.05); Software: Stata.

Variables	Yes	No	T-stat	P-value	DF
1. Sound Knowledge of vaccines for self (n=188)	120	68	3.9359	0.0001	187
2. Sound knowledge of vaccines for children (n = 300)	204	96	6.6723	0.000	299
3. Sound knowledge of how vaccines work (n = 384)	215	169	2.3124	0.0213	383
4. Sound training on vaccine administration? (n = 188)	111	77	2.4451	0.0154	187
5. Satisfied with the skills acquired? (n = 188)	98	90	0.5824	0.5610	187

* Variables 1,2,3, & 4 are statistically significant (P-value < 0.05); while Variable 5 is not statistically significant (P-value > 0.05).

Table 4: Significance Test of Attitude
 * CI = 1.96 - 95% and Significance Level = 5% (0.05); Software: Stata

Attitude Statement on Vaccine Administration	Yes	No	T-stat	P-value	DF
1. Confused about number / scheduling of vaccines? (n=384)	134	250	- 6.2016	0.000	383
2. Satisfied with the Health Care Worker's answers to questions, (n=188)	111	77	2.5146	0.013	187
3. Trust for health care provider about risks and benefits of vaccines, (n=188)	85	103	- 1.3153	0.190	187

* Variables 1&2 are statistically significant (P-value < 0.05) while variable 3 is not statistically significant to the prevalence in question (P-value > 0.05).

Table 5: Penta 3 Vaccination Coverage (2017 and 2018)

Health District	2017		2018	
	Number of Children Vaccinated	Vaccination Coverage (%)	Number of Children Vaccinated	Vaccination Coverage (%)
AKO	2 038	111%	980	71%
BAFUT	1 004	54%	660	46%
BALI	552	51%	541	62%
BAMENDA	10 181	77%	7 570	75%
BATIBO	1 962	69%	796	36%
BENAKUMA	1 755	93%	620	44%
FUNDONG	3 507	70%	2 074	56%
KUMBO EAST	4 581	96%	2 683	72%
KUMBO WEST	2 680	78%	1 917	72%
MBENGWI	1 429	80%	615	47%
NDOP	5 325	63%	3 074	48%
NDU	2 462	81%	1 290	58%
NJIKWA	690	96%	202	38%
NKAMBE	3 623	78%	2 419	70%
NWA	2 263	112%	1 398	91%
OKU	2 034	65%	1 278	54%
SANTA	2 741	85%	1 458	62%
TUBAH	1 621	72%	1 224	75%
WUM	3 583	84%	1 880	59%
REGION	54 031	78%	32 679	62%

?

METHODOLOGY

Design: The research design was a descriptive, cross-sectional, explorative, and comparative one.

Random Sampling: Sample size (n) = 414 Respondents.

This was determined by the Fisher et al formula:

$$n = \frac{Z^2 P(1-P)}{d^2} \quad (\text{Fisher et al 1998})$$

Where:

- n = the desired sample size where the study population is equal to or greater than 10,000.
- Z = Standard normal deviate corresponding to 95% level of confidence (CI = 1.96).
- p = Estimated prevalence of characteristic of interest (unsound practices) = 0.5 (Since that of the Bamenda Health District is not known).
- d = Level of precision (set at $\pm 5\%$).

Research Tools

- An observation checklist
- A Semi-Structured Questionnaire
- Focus Group Discussion
- Key Informants Questionnaire

KEY FINDINGS

- Poor mobilisation of resources, both local and otherwise.
- A hostile and non-conducive socio-political environment for efficient and effective vaccination and immunisation programmes.
- Lack of robust bottom-up realistic micro-plans for the campaigns.
- Lack of effective advocacy and communication.
- Poor organisation of vaccination campaigns.
- Obsolete and inadequate cold chain system in many health facilities.

The study participants were aged between 15 years to slightly over 55 years. 62% of the respondents were aged 34 years or below. Only 8 (1.9%) subjects were aged over 49 years. Completion of routine childhood immunisation could not be ascertained in a majority of the study participants 235 (61%) due to lack of supporting documents. Only 95 (25%) of the respondents ascertained that they completed routine childhood immunisation while 54 (14%) of them responded that they had not completed the immunisation coverage.

Therefore the Null Hypothesis (H_0) is accepted as follows: The Polio vaccination campaigns in the Bamenda Health District are substandard and consequently, there is a high risk of an upsurge of morbidity and mortality from Poliomyelitis and other vaccine-preventable diseases.

DISCUSSION

On the overall, 414 subjects participated in the study with ages ranging between 15 years and slightly over 55 years, with a mean age of 30 years. This age range is closely similar to that of a sample of Angolan soldiers on whom a similar study was carried out by Bing et al (2005) on HIV Preventive and Control Interventions, even though in the present study we are dealing with the prevention of Polio through efficient and effective vaccination and immunisation. Participants' ages ranged from 18 to 51 years with a mean age of 29 years.

Meanwhile, a remarkable shortage of health workers was observed and this could negatively influence access to disease prevention and health care. In a similar study implemented in Uganda in September 2005 on infection prevention, the majority of participants were nursing assistants and support staff with minimal health professional qualifications. This was as a result of an acute shortage of health staff in Uganda.

Staff recruitment, retention, and motivation are therefore crucial as a solution to a shortage of personnel in health care delivery. Childhood vaccination and immunisation could not be ascertained by majority of the study participants – Two hundred and thirty-five (61%), due to lack of supporting documents. This is contrary to a study carried out by Omer Outaiba B Al-Iela et al (2014) on parents' knowledge and practice regarding immunisation related to pediatrics' immunisation compliance whereby Five hundred and twenty-eight children born between 1 January 2003 and 31 June 2008 were randomly selected from five public health clinics in Mosul, Iraq. The immunisation history of each child was collected retrospectively from its immunisation record/card. Therefore meticulous documentation of childhood immunisation is essential.

With regards to attitude and behaviour concerning the introduction of a vaccine, about three-fifths of the respondents, 238 (62%) would ask a friend what they think, and Seventy-Seven (20%) would simply refuse to take the vaccine. This is probably due to vaccination misconceptions. The situation is aggravated and made worse by insufficient resources; poorly managed and deficient cold chain system; current socio-political climate and warfare in the North West Region; poor organisation; weak involvement of related sectors; and rumors / negative campaign messages.

Rumours and negative campaign messages can be terribly devastating and ought to be addressed promptly every time they loom the air. This corroborates with the findings of Ndipowa et al (2016) on Vaccination and Immunisation Misconceptions in Cameroon. The findings revealed that the resistance against and refusal of vaccines by some populations has marred the efficiency and efficacy of vaccination campaigns against diseases of epidemic potential such as Poliomyelitis, Measles, Yellow Fever, Tetanus, etc. This problem could also be attributable to inadequacies in policy, management, and governance. Effective vaccination and immunisation coverage in Cameroon, therefore, needs to be reviewed and revamped.

According to WHO norms and standards, vaccine and immunisation quality and safety leading to herd immunity are primordial. This study revealed the following:

- There were no WHO guidelines, & protocols on the field for the actors.
- Only 59% of participants had training on vaccination.
- There was an obsolete and inadequate cold chain system in many health facilities.

- Little efforts were made by the actors on the field to get through to the hard-to-reach children and missed homes.
- A decline of vaccination coverage in the Bamenda Health District from 77% in 2017 to 75% in 2018 and a decline from 78% to 62% coverage for the whole Region (Table 5).

No herd immunity was achieved. The Polio vaccination and immunisation programme in the Bamenda Health District is therefore substandard.

The crucial reasons for differences in vaccination implementation in Bamenda Health District were revealed as follows:

- Insufficient mobilisation of resources
- Obsolete and inefficient cold chain system
- The precarious socio-political and security climate
- Poor management of rumours and misconceptions.

CONCLUSION

There exist massive flaws and inadequacies in the vaccination and immunisation programme in the Bamenda Health District in particular and in the North West Region in general. This makes it sub standard as compared to the WHO recommended standards.

The following suggestions may be helpful to remedy the situation

- The government and every public health stakeholder need to redouble their efforts to right the identified flaws, lapses, and impediments both in vaccinations, health promotion, and disease surveillance.
- The government should revamp the health sector and create an enabling environment for efficient and effective vaccination campaigns.

Suggestions for Further Research

1. Prevalence of Vaccine-Preventable Diseases among the vulnerable displaced Populations due to socio-political conflict in Cameroon.
2. Effective Vaccination and Immunisation Coverage of Displaced Populations in Cameroon: serum Immuno-Antigen level of various pathogens.
3. KAP study on Disease Prevention, Control, and Health Promotion in Bamenda Health District.
4. The Chemical Composition of the Polio and Tetanus Toxoid Vaccines used in Vaccination Campaigns in Cameroon.

CONTRIBUTIONS

All authors read and approved the final manuscript.

COMPETING INTERESTS

We declare we have no competing or conflicting interests. The research article is original and has not been submitted or accepted for publication elsewhere.

REFERENCES

- [1] World Health Organization (WHO), World Immunization Week (2015) Close the immunization gap Immunization coverage; 24-30 April 2015; Fact sheet N°378, Reviewed November 2014.
- [2] Republique du Cameroun, Group Technique Central (2000) Normes et Standards du Programme Elargi de Vaccination (PEV), MinSanté, PEV. 1776
- [3] Republique du Cameroun, 2009, Strategie Sectorielle de Santé (2001-2015) Edition 2009; Yaoundé.
- [4] Kounteya Sinha (15 May 2012). "WHO to declare polio global health emergency". The Times of India. Retrieved 3 June 2012.
- [5] Svea Closser (16 August 2010). Chasing Polio in Pakistan: Why the World's Largest Public Health Initiative May Fail. Vanderbilt University Press. pp. 40–41. ISBN 978-0826517098. Retrieved 27 May 2012.
- [6] Silver, Cary, ed. (May 2001). "Pakistani Rotarians help immunize 27 million children in NIDs". The Rotarian (Rotarian International): 54. ISBN: S5LQ-BE8-DD3Q. Retrieved 28 May 2012.
- [7] "Polio True Stories". Country Programme Human Interest Stories. UNICEF. Retrieved 27 May 2012. <http://www.polioeradication.org/mediaroom/newsstories/Polio-Teams-Support-Health-of-Remote-Communities-inNigeria/tabid/526/news/1273/Default.aspx#sthash.qpwl4TT.dpuf>
- [8] Gregory Warner (August 09, 2015 8:35 AM ET) Catholic Bishops In Kenya Call For A Boycott Of Polio Vaccines.
- [9] Cockburn WC: The work of the WHO Consultative Group on Poliomyelitis Vaccines. Bull World Health Organ. 1988; 66:143–154. [PMC free article] [PubMed].
- [10] Polio Global Eradication Initiative (2010) Infected Countries. Geneva, Switzerland: World Health Organization.; (<http://www.polioeradication.org/Infectedcountries.aspx>). (Accessed May 1, 2012).
- [11] Centers for Disease Control and Prevention (CDC)(2012) Progress toward interruption of wild poliovirus transmission - worldwide, January 2011–March 2012. MMWR Morb Mortal Wkly Rep. 2012;61:353–7. [PubMed]
- [12] Kaura G, Biswas T. (2012) India reaches milestone of no cases of wild poliovirus for 12 months. BMJ. 2012;344:e1328. [PubMed].
- [13] Center for Disease Control (2012) Update on Vaccine-Derived Polioviruses. MMWR Morb Mortal Wkly Rep 2012. 2006;55:1093–7. [PubMed]
- [14] Bancroft-Hinchey T. (2012) India Free of Polio [Internet]. Moscow:Pravda Ru; 2012 Jan 15[cited 2012 Mar 2]. Available from: http://english.pravda.ru/health/15-01-2012/120233-polio_india-0/.
- [15] Press Information Bureau, Government of India (2012) One year of polio free India [Internet]. New Delhi: National Informatics Centre;2012 Jan 12[cited 2012 Mar 2]. Available from: <http://pib.nic.in/newsite/erelease.aspx?relid=79524>.
- [16] United States Embassy Bangui (2010) U.S. assistance to eradicate polio [Internet]. Bangui: US Embassy Bangui; 2010 Mar 30 [cited 2012 Mar 2] Available from:http://bangui.usembassy.gov/pr_20100330.html.
- [17] Polio Global Eradication Initiative (2010) Infected Countries. Geneva, Switzerland:World Health Organization; 2010. (<http://www.polioeradication.org/Infectedcountries.aspx>). (Accessed May 1, 2012).
- [18] Australian Capital Territory (2013) ACT Immunization Inquiry Line (02) 6205 2300)
- [19] Taylor C. E., Cutts F., Taylor M. E. (1997) Ethical Dilemmas in Current Planning for Polio Eradication. American Journal of Public Health. 1997;87(6):922–25. [PMC free article] [PubMed].
- [20] CRTV Yaounde. (2015) National Luncheon Date News presented by Chonko Becky Bisong at 14: 48 pm on the 24th November, 2015.
- [21] Bryan T. Mayer et al (2013) Successes and Shortcomings of Polio Eradication: A Transmission Modeling Analysis. American Journal of Epidemiology, Volume 177, Issue 11, 1 June 2013, Pages 1236–1245, <https://doi.org/10.1093/aje/kws378>. Published: 06 April 2013.
- [22] World Health Organization. (2015) Vaccination coverage cluster surveys – reference manual. Geneva: World Health Organization; 2015.
- [23] World Health Organization. WHO vaccine-preventable diseases: monitoring system. 2016 global summary. http://apps.who.int/immunization_monitoring/globalsummary/countries?countrycriteria%5Bcountry%5D%5B%5D=LBN&commit=OK. Accessed 30 Jun 2017
- [24] <http://www.polioeradication.org/mediaroom/newsstories/Polio-Teams-Support-Health-of-Remote-Communities-inNigeria/tabid/526/news/1273/Default.aspx#sthash.qpwl4TT.dpuf>
- [25] WHO, "Kano, Nigeria, Informs WHO of the Intention to Resume Polio Immunization Campaigns," Press Release, 30 June 2004, <http://www.who.int/mediacentre/news/notes/2004/np16/en> (accessed 10 April 2009).
- [26] Bryan T. Mayer et al (2012) Successes and Shortcomings of Polio Eradication: A Transmission Modeling Analysis, 1245Am J.
- [27] "World J Virol" (2012) - World journal of virology NLM. ISSN:2220-3249 (Electronic) ; 2220-3249 (Linking). 2014-: Pleasanton, CA : Baishideng. Polio Global Eradication Initiative. Infected Countries.
- [28] Geneva, Switzerland:World Health Organization; 2010. (<http://www.polioeradication.org/Infectedcountries.aspx>). (Accessed May 1, 2012).
- [29] Abbink F, Buisman AM, Doornbos G, et al. Poliovirus-specific memory immunity in seronegative elderly people does not protect against virus excretion. J Infect Dis. 2005;191(6): 990–999.
- [30] Grassly NC, Jafari H, Bahl S, et al. (2012) Waning intestinal immunity after vaccination with oral poliovirus vaccines in India. J Infect Dis. 2012;205(10):1554–1561.
- [31] Swartz TA, Green MS, Handscher R, et al. (2008) Intestinal immunity following a combined enhanced inactivated polio vaccine/oral polio vaccine programme in Israel. Vaccine. 2008;26(8): 1083–1090.
- [32] Grassly NC, Jafari H, Bahl S, et al. (2010) Asymptomatic wild-type poliovirus infection in India among children with previous oral poliovirus vaccination. J Infect Dis. 2010;201(10): 1535–1543.