



Control of Measles in Nigeria: A Critical Review of the Literature

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The Millennium Development Goals identify the health and wellbeing of children as important indices of meaningful development. An important aspect of child survival is the control of vaccine-preventable diseases. Measles remains an important cause of death among young children globally, despite the availability of a safe and effective vaccine. Although global measles deaths have been reduced by 74% between year 2000 and 2010, the world measles burden still resides in the developing world with measles epidemics occurring in a large and recurrent manner with associated high mortality. These outbreaks can forestall the effects of the control and eradication of measles globally. Nigeria has been experiencing the incidence of measles outbreaks which have occurred in the year 2004, 2005, 2006, 2007, 2008, and 2011. These outbreaks are a cause of

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concern particularly the outbreak in 2011 which occurred following a mass measles vaccination campaign earlier that year. Efforts to improve control have been on-going and progress has been made particularly with the establishment in 2006 of a system of measles case-based surveillance, however in the myriad of factors plaguing the control of measles in the country, low immunization coverage is still the main factor involved. The inability to control measles is a reflection of the work that needs to be done as regards our immunization coverage and structures that are needed to be put in place.

Chronic low immunization and the factors that contribute to it should be addressed with measures and structures that can achieve long term effect. These factors have already been identified and solutions tailored to them need to start taking place. The effect of political and financial commitment in achieving this is invaluable especially if the country would achieve the fourth millenium development goal to reduce under-five mortality by two-thirds to which measles is a significant contributor in this part of the world.

Keywords: Measles; control; immunization; Nigeria.

1. INTRODUCTION

Measles is a highly contagious viral disease and a leading cause of vaccine preventable deaths among children affecting mainly children who are under-five. It's occurrence is all over the world but its major burden is still in the developing world. It remains an important cause of death among young children globally, despite the availability of a safe and effective vaccine [1,2].

According to the World Health Organization African Region (WHO AFRO), a measles outbreak is defined as five or more reported suspected cases of measles in a health facility or local government area in one month with a plausible means of transmission [2-5]. Between 1990 and 2008, increased measles vaccination reduced the overall under-five mortality by 23%. More than 190 million children were vaccinated against measles through large-scale campaigns in 2010. Globally, measles deaths have decreased by 74 percent worldwide in recent years - from 535 300 deaths in 2000 to 139 300 in 2010 - However, measles is still common in many developing countries, particularly in parts of Africa and Asia. Over 20 million people are affected by measles each year with more than 95% of measles deaths occurring in countries with low per capita incomes and weak health infrastructures [6].

There were over 200 000 measles cases and 1400 deaths reported during measles outbreaks in Africa in the year 2010. It has been estimated that these figures could be 10 times higher due to under-reporting. This wave of measles outbreaks pose serious threats to measles mortality reduction efforts and are due to increasing pockets of unvaccinated children and adolescents [6].

According to the World health organization (WHO), several large measles outbreaks were reported from member states in the European and African regions in 2011, with several reported outbreaks in the Americas linked to Europe or Africa. In Europe, there were 26 025 confirmed cases of measles between the period of January and July 2011 in 40 of the 53 member states of the WHO European region with the highest number of cases reported from France. In Africa, The Regional Office reports that as at September 2011 large measles outbreaks are being reported by the Democratic Republic of the Congo, with over 103 000 cases, Nigeria, with 17 428 cases, and Zambia, with 5 397 cases, and Ethiopia, with 2 902 cases. In the Americas which had the last case of endemic measles reported from the region in 2002, In 2011 the Region has received reports of several outbreaks linked to importation of measles virus from other regions [7].

In West Africa, measles epidemics have been large and recurrent with associated high mortality. These have occurred in Niger (2003), Nigeria (2004) and Chad (2004). Countries that have not fully implemented the WHO strategy continue to experience frequent epidemics. These occurrences may in no doubt be mainly connected with several setbacks including lack of political will to conduct high quality measles campaigns, competing health priorities, insufficient financial support to reach underserved communities amongst other factors which result in resurgence of measles and have the capacity to place the recent gains in reducing measles mortality at risk [3,6,8-10].

Measles is highly infectious, with life-threatening complications that are entirely preventable by

safe vaccines [11]. When countries achieve 95% coverage with the measles vaccine among children up to 15 years of age, measles outbreaks can be prevented. Recent outbreaks of measles in countries that have large volumes of international travellers can lead to exportation to regions previously free of measles, which can lead to large outbreaks and associated deaths [7]. This paper critically reviews various scholarly articles, documents and journal publications on measles outbreaks in Nigeria and makes recommendations based on the findings from the review.

2. MEASLES CONTROL IN NIGERIA: THE JOURNEY SO FAR

The earliest stage in measles eradication is measles control which involves reduction in mortality and morbidity. Following measles control is the elimination stage. Many African countries including Nigeria are at the measles control stage [12].

Routine measles vaccination started in Nigeria in 1979 through the Expanded Program on Immunization (EPI) a dose of the measles vaccine was given to children at or shortly after 9 months of age. The EPI has since been upgraded to the National Programme on Immunization (NPI) in 1997 [13-15]. Supplementary immunization activities commenced in Nigeria in 2005 with a nation-wide catch up program that targeted all children aged 9 months to 14 years, carried out in two phases. The first phase was implemented in December 2005 in the 19 northern states and the Federal Capital Territory, whereas the second phase targeted children in the 18 southern states in October 2006 [16].

A system of measles case-based surveillance was established in 2006 and four sub-national measles serological laboratories were established across the country with the support of the WHO. The field surveillance system for measles was built upon the established surveillance for the detection of acute flaccid paralysis cases as part of Nigeria's polio eradication efforts [16]. This efforts reflects increased commitment in measles control in Nigeria, however it appears that in various parts of the country, measles cases are still under-reported and that health workers need to be trained in disease notification and surveillance [3,17]. Even when suspected measles cases are

identified, the blood samples are transported across several states to Lagos where the public health laboratory is located using a reverse cold chain system. This makes transport logistics difficult, especially in a resource – constrained setting like Nigeria.

Successful implementation of strategies to reduce measles mortality viz: strengthening routine immunization programme; providing additional doses through large scale immunization campaigns, case-based surveillance and improved management with vitamin A supplementation has helped Nigeria reduce its measles cases. These efforts in reducing case-load however has not had a lasting effect thus resulting in outbreaks or resurgences after the catch-up campaign which has been largely attributed to a chronic low immunization coverage. WHO- UNICEF estimates that MCV1 coverage in Nigeria increased from 33% in 2000 to 44% in 2006 and remained at 41% during 2007–2008. The national MCV1 coverage reported through the JRF by Nigeria to the WHO and UNICEF was 38% in 2005, 100% in 2006, 86% in 2007, and 68% in 2008 [16,18,19].

3. THE RECENT MEASLES OUTBREAKS IN NIGERIA

In Nigeria, measles outbreaks have been increasingly common with 30, 194 and 256 outbreaks reported in 2006, 2007 and 2008 respectively. Most of these outbreaks affect children under-five years and occurred in the first quarter of the year [3,20].

Measles still accounts for the highest number of vaccine preventable deaths and Nigeria is one of the 47 countries of the world with a very high burden of measles where cases of measles can even be under-reported. According to WHO/UNICEF, Vaccination coverage of measles containing vaccine (MCV) in Nigeria is currently put at 62% with a very wide variation in a country that has once achieved coverage of 80% with routine immunization [13,14,17].

In 2005, measles killed more than 500 children in Nigeria. 90% of the 23, 575 cases reported in 2005 were in northern Nigeria where people are wary of vaccinations largely for religious reasons [21,22]. For instance, Adamawa state in Nigeria experienced 3,974 cases and 238 measles deaths in 2005 [23].

In 2007, there were measles outbreaks in Sokoto, Kaduna and Zaria. Poor hygiene and sanitation conditions as well as non-acceptance of immunization are among factors implicated in these outbreaks. The northern part of Nigeria has been experiencing different types of epidemics in the last few years [24].

In 2011, Nigeria experienced another measles outbreak and was listed together with Somalia and DR Congo as a country that experienced the most devastating measles outbreak. Nigeria recorded more than 21,000 suspected measles cases in 2011 compared with more than the 14,000 suspected in 2010. The measles incidence was 12.89 per 100,000 in 2011. The outbreak in 2011 was particularly worrying because a nation-wide measles campaign had just been conducted in early 2011 which should have stopped the outbreaks if the routine immunization and campaign coverage had been high enough. This result was startling because some southern African countries mounted responses to large measles outbreaks in 2010 and succeeded in dramatically reducing its incidence in 2011 [25].

Notwithstanding the successes achieved in control of outbreaks all over the world, especially between 2000 and 2010, there is a need to critically examine the factors responsible for the persistence of pockets of measles outbreaks in some countries of sub-Saharan Africa and Asia. The attainment of the 4th millennium development goal which is to reduce under-five mortality by two-thirds in 2015, is highly dependent on the ability of public health workers to effectively address the factors so noted.

4. FACTORS RESPONSIBLE FOR THE OUTBREAK OF MEASLES IN NIGERIA

The World Health Organization and the United Nations Children's fund developed a four pronged strategy viz improved routine immunization, providing all children with a second opportunity for measles immunization through either periodic supplemental immunization activities (SIAs) or a routine second dose of measles vaccine, improved measles case management, and careful measles surveillance. It is a strategy for sustainable measles mortality reduction with the goal of 90% reduction in measles deaths (compared with 2000 levels) by 2010 [8,26].

This strategy has been responsible for the substantial reduction in measles mortality as well

as the significant progress made in the control of measles in Africa over the past decade. However in the background of this achievement, measles still remains a leading cause of mortality among children under five in some sub-Saharan countries [8].

The factors responsible for the outbreak of measles in Nigeria include a low or a sub-optimal routine immunization coverage and effectiveness; a weak health system, the wide interval between the catch-up and follow-up campaigns-the quality of mass immunization campaigns are not high enough and the incomplete implementation of the WHO/UNICEF measles mortality-reduction strategy. Nigeria's population is among the world's poorest and is one of the countries identified as a priority for measles reduction by the WHO/UNICEF strategic plan. Nigeria still has to a large extent, a routine measles vaccination schedule that aims to provide infants with a single dose at 9 months of age, with no formal second opportunity for measles vaccination. Routine vaccination programs have not been able to consistently provide a high proportion of infants and young children with measles vaccine in addition to limited efforts to reach older children who missed opportunities for measles vaccination. Failure to deliver at least one dose of measles vaccine remains the primary reason for high measles mortality. Poor access to appropriate treatment is implicated in the high measles mortality, as well as the long term sequelae of vaccine-preventable diseases [8,26-29].

Further more, two factors that have contributed to the pre-vaccination measles morbidity and mortality commonly reported among Nigerian infants are the fast rate of waning of maternal antibodies and the passage of maternal antibodies that cannot neutralise the circulating wild type measles virus [20,30,31]. A link between the outbreak of measles in Africa has been drawn to the HIV-1 epidemic. Studies have shown that there is a faster rate of waning of maternal antibodies in HIV-1-infected and HIV-1 exposed non-infected children compared to HIV-1 negative children who retained high antibody levels at 6 months thus confirming previous observations that a low titre of maternal antibodies were transferred to infants of mothers with HIV-1. Children born to mothers with HIV-1 have a higher risk of contracting early measles independently of whether they are themselves HIV-1 infected. Measles outbreaks were also said to occur in countries with high HIV-1 prevalence [32,33].

Also the inability of the Nigerian government to establish itself as a credible authority to implement immunization programmes because it fails to acknowledge the risk involved in vaccination and these raises the people's doubts. Also, because measles predominantly affects children and who do not constitute a pressure group, their needs may not be given high priority in developing countries like Nigeria. Lack of a good road network, poor attitude of vaccination record keeping among Nigerians, overcrowding in the cities and the illiteracy among our people are also factors involved in the persistence of the measles outbreak in Nigeria [12,20,34]. The measles surveillance system, even though much improved, is still sub-optimal. Much of the surveillance is carried out at the local government level by the Disease Surveillance and Notification Officers, who fill out forms, known as Integrated Disease Surveillance and Response (IDSR) forms. These forms contain a list of cases of measles, weekly reports of number of cases of febrile illness with rash in children and a monthly report on the diseases found at the local government area. Active case finding is done by the DSNO, but this has been often hampered by poor funding, bad roads and difficult terrain, especially in rural areas. When the State Epidemiology Units are contacted on occurrence of outbreaks, several challenges are encountered including logistics, mobilization of funds, lack of adequate transport arrangements and bad roads.

5. REASONS FOR LOW IMMUNIZATION COVERAGE

There has been fluctuations in the measles vaccine coverage in Nigeria, from 55% in 1981 through 59% in 1988 and 35% in 2003 [12,35]. The current vaccine coverage is placed at 62% [13]. Several challenges have been faced by Primary Health Care departments at the various local government areas in Nigeria. Some of the technical issues faced include a problematic cold chain system and transport logistics. In most states, there are no zonal cold chain stores for vaccine storage. Some states have only one large capacity store, while some others have not more than two, a situation where several local government areas have to travel a very long distance to obtain the needed quantity of vaccines. This definitely does not enhance the potency of the vaccines. Also, a good number of local government health departments do not have project vehicles for immunisation. This

makes it difficult for workers to access hard-to-reach areas for routine service delivery and more so during outreach programmes. Poor funding by governments at all levels, has made supervision of field workers a very challenging exercise for public health workers. When DSNOs do not have adequate running costs for monitoring, supervision and even active case finding, lapses in service delivery are not easily identified. Supervision at the LGA level is the worst of the three levels – federal, state and local government.

Abdulraheem et al. conducted a study in a rural area in Nasarawa state of Nigeria and identified the reasons for partial immunization and factors contributing to missed opportunities for vaccination in children less than 1 year of age. The main reasons attributed by the mothers for partial immunization included parents objection, disagreement or concern about immunization safety, long distance walking and long waiting time at the health facility. The mothers also gave reasons for the missed opportunities for vaccinating their children, these reasons were sicknesses, social engagement, traveling, long distance walking and complications from previous infections [36].

Ignorance, cultural and religious objections to vaccination particularly among the muslim north where the wrong information has been passed by muslim clerics that vaccines are dangerous and can cause sterility. These objections have resulted in a persistently low immunity in the north which is still ravaged by vaccine preventable diseases like measles and polio [11,37]. Also, inadequate community awareness, poor quality of services, a weak social mobilization as well as inadequate monitoring and evaluation of immunization programmes are implicated as causes of low immunization coverage [12,29]. Poor perception of childhood immunization has been identified by several researchers as a main cause for the persistence of vaccine-preventable diseases in the developing world [38-43]. Low levels of maternal education, several misconceptions about childhood immunization and missed opportunities, were recurrent findings in many studies from Africa, Asia and among poor communities in the developed world [40-44].

6. IMPLICATIONS FOR CHILD SURVIVAL

Child survival remains a daunting challenge for many developing countries like Nigeria, with very

poor child health indices. With sub-optimal immunization coverage, the protective value of immunization is not available to children in many parts of the country. Even though the Ward Health System has been adopted as the mode of healthcare delivery in the country, through the Primary Health Care (PHC) approach, not all communities have benefitted from PHC services since its adoption [45]. Immunization remains a major component of PHC as well as a significant, cost-effective strategy for child survival. Where the required logistic support for immunization is lacking, adequate coverage remains an impossibility. Furthermore, maintenance of the cold chain system will be a herculean task, particularly when power supply is grossly inadequate. The main concern with this is the efficacy of the vaccine administered when standard procedures are not followed [46]. Therefore renewed efforts at ensuring the right interpretation of findings on the VVM is essential. The fourth Millennium Development Goal (MDG) aims at reducing child mortality by two-thirds by the 2015. Almost half of all child deaths in 2006 occurred in sub-Saharan Africa. Evidence-based projections from available data show that developing countries, as a whole, are making very slow progress at the attainment of MDG 4 [47]. The challenge of reducing global measles deaths by 90% by the year 2010 is still in existence despite the remarkable success recorded in measles control across the world, particularly in Africa, where deaths from measles decreased by 75%. The proportion of 1-year-old children immunized against measles is an important indicator for the attainment of MDG 4 [48]. Malnutrition increases the susceptibility of children to infections, including measles, just as measles worsens malnutrition in children. Mortality and morbidity is higher in malnourished children than their well-nourished counterparts [49-51]. Therefore, reducing the incidence and case-fatality of measles in Nigeria requires concerted efforts at reduction of childhood malnutrition. All other components of the child survival strategy proposed by UNICEF and its partners complement the role of measles immunization in promoting survival of the African child. Maternal education is also a very important determinant of immunization coverage and child survival. The level of awareness of the importance of childhood immunization and the careful retention of vaccination records, are well documented factors associated with uptake of immunization services [52].

7. CONTROL OF MEASLES IN NIGERIA: THE WAY FORWARD

With the background of the reduction in measles mortality and morbidity in Africa as a whole and also in Nigeria, it is imperative that we do not rest on our oars as we must raise the bar in the control efforts that should be undertaken.

The outbreaks of measles in Nigeria have occurred because of our background of a low vaccine coverage with wide and fluctuating variations. The setbacks in measles control are a reflection of the state of the nation's immunization coverage as a whole as well as the factors affecting it.

Low vaccine coverage having been identified as one of the major causes of measles outbreaks should be adequately addressed, particularly the factors contributing to it. There should be a drive to improve our vaccine coverage and stop its present wide variations and fluctuations. One key factor is removing the ignorance and sentiments attached to vaccination especially in the northern part of Nigeria. Once we can improve our fluctuating vaccine coverage, making sure we achieve at least 95% for protective herd immunity according to WHO and UNICEF standards, this would then go a long way in reducing mortality and morbidity of measles. Another aspect would be to ensure the effectiveness of our measles vaccines by ensuring a proper and effective cold chain. Thus the primary goal should be producing increased vaccine coverage with effective vaccines and strategies should be mapped out to put this into effect.

There have also been drives toward making a two-dose vaccine policy take place as regards immunization with the measles vaccines. This would offer a second opportunity to children who missed their doses at nine months and serves as a booster dose to those previously vaccinated children with vaccine failures [12]. This is also in line with the WHO and UNICEF's four pronged approach of which providing children with a second opportunity for vaccination either through a periodic supplementary immunization activity or routine second dose of measles vaccine is recommended.

There should be a continued partnership in ensuring initiation and sustainability of the control programmes for measles as well as as establishing an effective surveillance for measles

and monitoring of vaccination coverage [12]. The role of political and financial commitment can also not be over-emphasized. Adequate political and financial commitment is important in helping us achieve the fourth millenium development goal and achieve measles control in this respect.

8. CONCLUSION

There have been significant improvements in the control of measles outbreaks in Nigeria, in the present decade. However, concerted efforts at improving surveillance and routine immunization activities will go a long way in reducing the burden of disease.

CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Fatiregun AA, Adebowale AS, Fagbamigbe AF. Epidemiology of measles in Southwest Nigeria: An analysis of measles case-based surveillance data from 2007 to 2012. *Trans R Soc Trop Med Hyg.* 2014;108(3):133-140.
2. Ntshoe GM, McAnerney JM, Archer BN, Smit SB, Harris BN, Tempia S, et al. Measles outbreak in South Africa: Epidemiology of laboratory-confirmed measles cases and assessment of intervention, 2009 – 2011. *PLoS ONE.* 2013;8(2):556-862. DOI: 10.371/journal.pone.0055682.
3. Adeoye IA, Dairo MD, Adekunle LV, Adedokun HO, Makanjuola J. Investigation of a measles outbreak in a rural Nigerian community – The Aladura experience. *African Journal of Microbiology Research.* 2010;4(5):360-366.
4. Federal Ministry of Health/ World Health Organization. Guidelines for measles surveillance and outbreak investigation in Nigeria. Abuja, Nigeria. 2006;5-40.
5. Machingaidze S, Wiysonge CS, Hussey GD. Strengthening the expanded programme on immunization in Africa: looking beyond 2015. *PLoS Med.* 2013;10(3):1001-405.
6. World Health Organization. Reaching more people with existing vaccines. Immunization Highlights, Immunization, Vaccines and Biologicals; 2010. Accessed on 14 September 2012. Available at: www.who.int/immunization/newsroom/highlights/2010.
7. World Health Organization: Global Alert and Response. Measles outbreaks: Region of the Americas, Europe and Africa. Available at: www.who.int/csr/don/2011. Accessed 26 August 2012.
8. Grais RF, Dubray C, Gersti S, Guthmann JP, Djibo A, Nargaye KD, Coker J, Alberti KP, Cochet A, Ihekweazu C, Nathan N, Payne L, Porten K. Unacceptably high mortality related to measles epidemics in Niger. Nigeria and Chad *Plos Med.* 2007;4(1):1-8.
9. Alemu W, Masresha BG, Phiri ML, Kezaala. Measles outbreak investigation in Malawi: Lessons to learn. Communicable disease epidemiological report. World Health Organization African Region. 2004;1-3.
10. Granty County Health District. Measles outbreak investigation granty county; 2008. Available at: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm573a1.htm>. Accessed 24 August 2012.
11. Okonko IO, Nkang AO, Udeze AO, Adedeji AO, Ejembi J, Onoja BA, Ogun AA, and Garba KN. Global eradication of measles: A highly contagious and vaccine preventable disease - what went wrong in Africa? *Journal of Cell and Animal Biology* August. 2009;3(8):119-140.
12. United Nations Children's Fund. State of the World's children 2005. New York. UNICEF; 2004.
13. Adeboye M, Adesiyun O, Adegboye A, Eze E, Abubakar U, Ahmed G, Usman A, Amos S, Rotimi BF. Measles in a Tertiary Institution in Bida, Niger State, Nigeria: Prevalence, immunization status and mortality pattern. *Oman Med J.* 2011;26(2):114–117.
14. World Health Organization. Eliminating measles and rubella and preventing congenital rubella infection. WHO

- European Region Strategic Plan 2005-2010. Copenhagen; 2005.
15. National Program on Immunisation. Basic guide for routine immunisation service providers. Abuja, Nigeria. National Program on Immunization/Federal Ministry of Health; 2004.
 16. Adu FD. That our children will not die. An inaugural lecture delivered at the University of Ibadan, on Thursday 11th December 2008. Ibadan University Press. 2008;34.
 17. Odega CC, Fatiregun AA, Osagbemi GK. Completeness of suspected measles reporting in a southern district of Nigeria. *Public Health Jan.* 2010;124(1):24-27.
 18. World Health Organization. Vaccine-preventable diseases: Monitoring system 2009 global summary. Reported estimates of measles-containing vaccine coverage. Geneva. World health, Organization; 2009. Available:http://apps.who.int/immunization_monitoring/en/globalsummary/timeseries/swucoveragemcv.htm.
 19. Report of a measles consultative group in preparation for measles follow-up SIAs. Nigeria; 2008.
 20. World Health Organization. Measles Surveillance and Outbreak. Geneva. 2008;1-4.
 21. Kassem TG, Ndam JN. A stochastic modeling of recurrent measles epidemics. *Science World Journal.* 2008;3(4):29-32.
 22. Dubray C, Gerstl S, Schimmer B, Ihekweazu C. High morbidity and mortality related to a measles outbreak in Adamawa State, Nigeria, Tenth European Programme for Intervention Epidemiology Training (EPIET) Scientific Seminar Mahon, Menorca, Spain; 2005. Available: www.epiet.org/seminar/2005/index.html. Accessed on 19 September 2012.
 23. International Federation of Red Cross and Red Crescent societies. DREF operation final report: Nigeria Measles. The International Federation's Disaster Relief Emergency Fund. Available at: http://w3.ifrc.org/docs/appeals/08/MDRNG_005dfr.pdf. Accessed on 21 September 2012.
 24. Measles and Rubella Initiative. Measles in 2011: Devastating, Surprising Outbreaks and Some Success; 2012. Available: www.stopmeaslesrubella.org/2012/02/20. Accessed on 23 August 2012.
 25. World Health Organization / United Nations Children's Fund. Measles mortality reduction and regional elimination strategic plan 2006-2010. Geneva, Switzerland. WHO/UNICEF; 2006.
 26. World Health Organization. Measles. Fact sheet no. 286. Geneva, Switzerland. WHO; 2006. Available:<http://www.who.int/mediacentre/factsheets/fs286/en>.
 27. Okonko OI, Onoja BA, Adedeji AO, Ogun AA, Udeze AO, Ejembi J, Garba KN, Egun OC, Fowotade A. The role of vaccines in elimination and global eradication of measles: A review of literature. *African Journal of Pharmacy and Pharmacology* September. 2009;3(9):413-425.
 28. Weldegebriel GG, Gasasira A, Harvey P, Masresha B, Goodson JL, Pate MA, Abanida E, Chevez A. Measles resurgence following a nationwide measles vaccination campaign in Nigeria, 2005-2008. *J Infect Dis.* 2011;204(1):226-231.
 29. Federal Ministry of Health. Revised national health policy. Abuja. FMOH. 2005;30.
 30. Klingele M, Harker HK, Adu F, Ammerlaan W, Iksika W, Muller C. Resistance of recent measles virus wild-type isolates to antibody mediated neutralization by vaccines with antibody. *J Med Virol.* 2000;62:91-98.
 31. Nilsson A, Chiodi F. Measles outbreak in Africa-is there a link to the HIV-1 Epidemic? *Plos Pathog.* 2011;7(2):100-1241.
 32. De Moraes-Pinto MI, Almeida AC, Kenj G, Filgueiras TE, Tobias W, et al. Placental transfer and maternally acquired neonatal IgG immunity in human immunodeficiency virus infection. *J Infect Dis.* 1996;173:1077-1084.
 33. Ogundiji OT. Determination of measles haemagglutination inhibiting antibody levels among secondary school students in Ibadan Nigeria. M.Sc. Project in the department of virology, faculty of basic medical sciences, College of medicine. University of Ibadan, Ibadan Nigeria. 2008;62.
 34. Nnebe-Agumadu U. Measles control in Nigeria: The case for a two-dose vaccine policy. *Nigerian Journal of Paediatrics.* 2005;32:41-45.
 35. Abdulraheem IS, Onajole AT, Jimoh AAG, Oladipo AR. Reasons for incomplete vaccination and factors for missed

- opportunities among rural Nigerian children. *Journal of Public Health and Epidemiology*. 2011;3(4):194-203.
36. Adeija A. Vaccine-derived polio spreads in Nigeria. *Science and Development Network*. Sci Dev Net; 2007. Available: <http://www.scidev.net/News/News/index.cfm?fuseaction=readNews&itemid=3958&language=1>.
37. Tagbo BN, Uleanya ND, Nwokoye IC, Eze JC, Omotosho IB. Mothers' knowledge, perception and practice of childhood immunization in Enugu. *Nigerian Journal of Paediatrics*. 2013;39(3):90-96.
38. Adorador A, McNulty R, Hart D, Fitzpatrick JJ. Perceived barriers to immunizations as identified by Latino mothers. *J Am Acad Nurse Pract*. 2011;23(9):501-508.
39. Manjunath U, Pareek RP. Maternal knowledge and perceptions about the routine immunization program – a study in a semi-urban area in Rajasthan. *Indian J Med Sci*. 2003;57:158-163.
40. Mojinyinola JK, Olaleye BA. Physical and psychological factors influencing maternal non-compliance with immunization schedule. *Continental J Nursing Science*. 2012;4(2):37-51.
41. Omole MK, Owodunni KO. Mothers' knowledge of immunisation programme and factors influencing their compliance at a children hospital in Southwest Nigeria. *J Pharm Biomed Sci*. 2012;21:1-4.
42. Adeyinka DA, Oladimeji O, Aimakhu C. Uptake of childhood immunization among mothers of under-five in Southwestern Nigeria. *The Internet Journal of Epidemiology*. 2009;7(2). DOI: 10.5580/14.
43. Ambe JP, Omotara BA, Mandu-Baba M. Perceptions, beliefs and practices of mothers in sub-urban and rural areas towards measles vaccination in Northern Nigeria. *Trop Doct*. 2001;31(2):89-90.
44. Tarrant M, Gregory D. Mothers' perceptions of childhood immunizations in first nation communities of the Sioux Lookout Zone. *Can J Public Health*. 2001;92(1):42-45.
45. National Program on Immunisation. Basic guide for routine immunisation service providers. Abuja, Nigeria. National Program on Immunization/Federal Ministry of Health; 2004.
46. Abosede OA. Primary Health Care in Medical Education. Lagos. University of Lagos Press. 2003;5.
47. United Nations. The millennium development goals report 2007. New York. United Nations Department of Economic and Social Affairs. 2007;4.
48. United Nations Children's Fund. The State of the World's Children 2009: Maternal and Newborn Health. New York. UNICEF. 2008;3.
49. United Nations Children's Fund. The State of the World's Children 2008. New York. UNICEF; 2007.
50. Bhaskaram P. Measles and malnutrition. *Indian J Med Res*. 1995;102:195-199.
51. Sinha DP. Measles and malnutrition in a West Bengal Village. *Trop Geogr Med*. 1997;29(2):125-134.
52. Odusanya OO, Alufohai EF, Meurice FP, Ahonkhal VI. Determinants of vaccination coverage in rural Nigeria. *BMC Public Health*. 2008;8:381.

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