Original Article

Inequity in Access to Childhood Immunization in Enugu Urban, Southeast Nigeria

BS Uzochukwu[1,2,3], CC Okeke[4], E Envuladu[5], C Mbachu[2], C Okwuosa[2], OE Onwujekwe[2,3,6]

[1]Department of Community Medicine, College of Medicine, [2]Health Policy Research Group, College of Medicine, [3]Department of Health Administration and Management, College of Medicine, University of Nigeria, Enugu-Campus, [4]Department of Community Medicine, University of Nigeria, Teaching Hospital, Enugu, [5]Department of Community Medicine, Jos University, Teaching Hospital, Jos, [6]Department of Pharmacology and Therapeutics, College of Medicine, University of Nigeria, Enugu-Campus, Nigeria

Abstract

Background: The Nigerian National Programme on Immunization aims at increasing the immunization coverage of children under 1 year of age. However, there is still a gap between the national immunization targets and the immunization coverage rates, and data are rarely disaggregated according to socioeconomic status. As a result, there is a dearth of information about the coverage of subgroups, especially at the local level. This study determined the socioeconomic differentials in immunization coverage for children under 5 years and under 1 year in Enugu urban, Southeast Nigeria. **Methods:** This was a community-based, descriptive cross-sectional study in Enugu urban of Southeast Nigeria. A modified 30 × 7 cluster sampling design was adopted as the sampling method to select and interview 462 mothers of 685 children under the age of 5 years on their sociodemographic and economic characteristics and immunization status of their children. Principal components analysis in STATA software was used to characterize socioeconomic inequity. **Results:** Immunization coverage was as follows: Diphtheria, pertussis, tetanus third dose(DPT3), 3, 65.3%; oral polio vaccine 3, 78.0%; hepatitis B3, 65.2%; and measles, 55.8%. The full immunization rates for children 1–5 years and <1 year were 49.8% and 65.2%, respectively. The very poor, poor, and least poor socioeconomic levels significantly had a higher rate of full immunization than the poorest socioeconomic level for children aged <5 years (odds ratio [OR] 1.934, 95% confidence interval [CI] 1.513–2.820). When the 1st year of life was selected as the reference group, the immunization rates in all other age groups decreased significantly. Using the same logistic regression model for children under 1 year of age, every added month of the child's life increased the full immunization coverage, and this was statistically significant (OR 2.752, 95% CI 2.304–3.418). **Conclusions:** Full immunization coverage for children aged <1 year was lower than the national target of 95%. There are differences in immunization coverage rates between different wealth quartiles in the area with the least poor benefiting more than the poorest, thus creating equity problems. Health managers need such community-based information about the vaccination status of their target population to plan and implement interventions that aim to improve immunization coverage in these areas.

Keywords: *Immunization coverage, inequity, Nigeria, socioeconomic status*

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Introduction

Immunization is one of the most cost-effective public health interventions to reduce child mortality.[1] Routine immunization schedule in Nigeria involves administration of six vaccines to children to prevent the childhood killer diseases. The vaccines

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Address for correspondence: Prof. BS Uzochukwu, Department of Community Medicine, College of Medicine, University of Nigeria, Enugu Campus, Nigeria. Health Policy Research Group, College of Medicine, University of Nigeria, Enugu Campus, Nigeria. Department of Health Administration and Management, College of Medicine, University of Nigeria, Enugu Campus, Nigeria.
E-mail: bscuzochukwu@gmail.com, Benjamin.uzochukwu@unn.edu.ng

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include bacillus Calmette–Guérin (BCG), oral polio vaccine (OPV), diphtheria pertussis tetanus (DPT), measles, yellow fever, and hepatitis B. In addition, tetanus toxoid vaccine is given to women of child-bearing age (usually at antenatal clinics) and meningitis vaccine is given to high-risk groups. However, in the year 2012, Nigeria replaced the childhood DPT and hepatitis B vaccines with the pentavalent vaccine which contains DPT, hepatitis B, and H-influenza type B vaccines.[2] It is expected that with this introduction, nearly 400,000 cases of *Haemophilus Influenzae* type B would be prevented with about 27,000 lives saved annually in Nigeria.[2] In 2013 also, the pneumococcal conjugate vaccine was introduced in the country; however, this is yet to be scaled up to all states of the federation. In February 2015, Nigeria also introduced the inactivated polio vaccine into the nation's routine immunization schedule which is very safe and highly effective in preventing paralytic disease caused by all three types of polioviruses.[3] Plans are on the way to introduce the Rotavirus vaccine in 2017.[4]

Currently, routine immunization is carried out in fixed facilities, particularly in primary health-care centers in each ward in all the local government areas (LGAs) in addition to frequent immunization campaigns done on certain days, either on a national, state, or local government level. This is done to increase coverage of the immunization program. The private sector also plays a role, in providing immunization services though largely in conjunction with the LGA in which it is situated. The immunization program falls under the National Primary Health Care Development Agency (NPHCDA), a parastatal agency of Nigeria's Federal Ministry of Health. The NPHCDA's mandate is to develop National Primary Health Care policies, including immunization, and to support states and LGAs in implementing these policies. At the subnational level, implementation of the immunization program is the responsibility of the State Ministry of Health and the LGA.

Despite all these strategies' innovations, Nigeria still has one of the lowest routine immunization coverages in the world. Consequently, vaccine-preventable diseases contribute significantly to the death of children, especially those <5 years.[5] It accounted for approximately 22% of childhood deaths, amounting to over 200,000 deaths per year.[6] The proportion of fully immunized children have only increased from 13% in 2003 to 25% in 2013.[7] This represents the proportion of children who have received all the standard antigens: BCG, DPT – 3 doses, Polio – 3 doses, HB – 3 doses, and measles vaccines, before their second birthday. Measles immunization coverage by 12 months increased from 31.4% in 2003 to 49.2% in 2011 and 42% in 2013.[7] This pace of progress is still far from satisfactory, falling below the increase needed to achieve the MDG target of more than 90% by 2015. Nonetheless, Nigeria has made appreciable progress in polio eradication. As at July 1, 2014, the total case count remains four in Nigeria out of a global total of 112 cases compared to 26 cases in same period in 2013, giving an 86% reduction in polio cases in 2014 compared to the same period in 2013.[8] However, there was a resurgence of polio cases in July 2016.[9]

One of the goals of the millennium development goals is a two-third reduction in infant and child mortality by 2015 and one of the targets to be monitored was proportion of children immunized against measles. Infant mortality has reduced from 186 deaths per 1000 live births in 2000 to 143 deaths per 1000 live births in 2010 and 69 deaths per 1000 live births in 2013. Under-5 mortality has also decreased from 201 deaths per 1000 live births in 2003 NDHS to 128 deaths per 1000 live births.[7] Thus, Nigeria was not able to MDG target of reducing the under-5 mortality to 64 deaths per 1000 live births and the infant mortality to 30 deaths per 1000 live births respectively by 2015.

A number of assessments, evaluations, and reviews conducted over the past several years have identified and listed key challenges and bottlenecks impacting immunization performance in Nigeria, some of which are the poor engagement of the community and the hard to reach areas, especially in the routine immunization.[10-13]

With the end of MDGs and the sustainable development goal now at the front burner, there has been a heightened concern for socioeconomic inequities in health and access to healthcare and the need for social determinants of health approach to public health programs. Health inequities formally defined are avoidable inequalities that are unfair and unjust. It is mainly applied to unfair and unjust differences in access to health services between regions and population subgroups within a country. These inequities in health status are mirrored in inequities in access to health services.[14,15] There is increasing evidence demonstrating that the poor and marginalized segments of society have the worst health status and access to health-enhancing interventions.[16-19]

Access to healthcare still follows the inverse care law, where the wealthiest who have relatively less need for healthcare consume more of it;[20] yet, every child needs immunization whether the rich or poor. Thus, any immunization service utilized is a right not a privilege. In Nigeria, significant disparities exist in the access and uptake of routine immunization. There are zonal differences in fully immunized children with more

children from the South being fully immunized than children from the North for example, North central 45%, North East 34%, North West 45%, Southeast 66%, Southwest 62%, and South 57% with a national average of 53%.[4] Furthermore, measles vaccination coverage was more among the urban dwellers than rural and among the wealthiest 20% than the poorest 20%.[7] In addition, children whose mothers have no education are far less likely to be fully vaccinated than children whose mothers have more than secondary education.

A study in Nigeria has demonstrated that the pattern of full immunization clusters within families and communities and socioeconomic characteristics are important in explaining the differentials in full immunization among the children.[21] The findings from the study showed that the individual level, ethnicity, mothers' occupation, and mothers' household wealth were characteristics of the mothers that were found to be associated with full immunization of the children. For example, children of mothers from the Igbo ethnic group had more than twice the likelihood of receiving full immunization compared to children of Hausa/Fulani/Kanuri mothers. Furthermore, increased socioeconomic position increases the likelihood of children being fully immunized.

At the community level, the proportion of mothers that had hospital delivery was a determinant of full immunization status.[21] Socioeconomic status (SES) (especially education) of individuals and populations strongly influences the behavior of individuals and thereby influences health-seeking behavior and ultimately child survival and higher SES is associated with better health.[22]

Furthermore, a study on demand for reproductive health and child mortality in Nigeria revealed an inverse relationship between child immunization and child mortality in rural and urban areas.[23] A similar study in Kenya found that though socioeconomic inequalities in stunting do exist in both urban and rural areas, they are significantly larger in urban areas.[24] In another study, it was shown that child survival interventions are inequitably distributed within low- and middle-income countries.[25]

Routine methods of assessment of health and healthcare do not show large or growing disparity between groups as data are rarely disaggregated according to socioeconomic status. This can mask inequities if efforts are not made to disaggregate data to ensure that health programs are reaching the poor and vulnerable groups. While national and state-level immunization coverage information for vaccines against childhood diseases highlight the variations in coverage of different subpopulation groups, there is little information about the extent to which these variations result in inequities particularly affecting the most vulnerable considering the low status of immunization coverage, especially in the rural settings where the economically disadvantaged are predominant. Some studies have identified socioeconomic differentials of household as one of the factors influencing health-seeking behavior and therefore utilization of health services.

Health managers in LGAs and states therefore need more community-based information about the immunization status of their population to prioritize health-care services, determine the disadvantaged groups, and plan and implement interventions that aim to improve immunization coverage in their areas. Hence, this study determined the socioeconomic differentials in immunization coverage for children under 5 years and under 1 year in Enugu urban, South East Nigeria. It is important to look at under 5 years because at this age, a greater number of children are expected to have been immunized to prevent childhood diseases. The study also provides new knowledge on SES inequities in childhood immunization coverage and generates recommendations that could contribute in designing interventions that target the poorest.

Methods

Study area

This study was conducted in Enugu urban, Southeast Nigeria. Enugu urban is the capital city of Enugu state. It comprises Enugu North and parts of Enugu South and East LGAs. The state operates the District Health System (DHS) and has a total of seven districts with 17 LGAs. The districts include Awgu, Udi, Enugu-Ezike, Nsukka, Enugu metropolis, Isi-Uzo, and Agbani.[26] Each health district is made up of at least two to three LGAs and has a range of public health facilities including a district hospital and primary health centers. Enugu urban houses about five public tertiary health institutions, 384 mission/private hospitals and clinics, 440 primary health centers, 40 cottage hospitals, and large number of drug retailers scattered all over the place. There are also good roads in the urban and these are indications of physical access to the health facilities in all seasons of the year.

Study design

This was a community-based descriptive cross-sectional study in Enugu urban of Southeast Nigeria.

Sampling and sample size calculation

A modified 30 × 7 cluster sampling design was adopted as the sampling method. Clusters were defined as streets

and 30 streets were selected by simple random sampling from a frame of 40–48 streets depending on the district unit area in Enugu urban. In numbered streets, the first household was selected from the first house on the street and the next household was the one whose door or gate was closest to it. In streets without numbered houses, the first house was randomly picked and the next house was the one closest to it. In each street, interviews were conducted with seven households who had children under the age of 5 years irrespective of the number of mothers and children under-five found in a household.

The immunization status of each child (9 months to <5 years) was determined by interviewing the mother or another family member over the age of 18 years. These children were supposed to have completed their immunization schedule. The data collectors were trained for 2 days on procedures for conducting the survey and involved in the pretesting and revision of the questionnaires. Vaccination cards were checked if they were available. Where the mothers or family members are unable to remember the immunization status of the child, the child was considered not to be fully immunized. Full immunization means receipt of BCG, three doses each of DPT, OPV, and HB and one dose of measles vaccines for children under 1 year,[27] and for children under 5 years old, it means the above plus any number of additional doses of OPV[28] usually given during immunization plus days campaign in Nigeria.

An interviewer-administered questionnaire was used to generate information on the sociodemographic and socioeconomic characteristics of the parents and the immunization status of the children (9 months to <5 years). To characterize socioeconomic differences, principal components analysis (PCA) in STATA software 14 (College Station, TX, StataCorp LP) package was used to create an SES index that was based on information on households' asset holdings and their weekly cost of food. This method of assessing SES index has been validated in Nigeria and used on several occasions.[29-36] In the PCA, the first principal component was used to derive weights for the SES index. Households were therefore divided into quartiles (poorest, very poor, poor, and least poor) on the basis of the value of the SES index. Information on ownership of radio, bicycle, refrigerator, television, motorcar, and motorcycle and on the mean (market) value of the food consumed by each member of a respondents' household were used to generate the index. Adjusted OR for the sociodemographic and socioeconomic characteristics was evaluated as possible related factors with the immunization coverage rate for children under 5 years and under 1 year using logistic regression.

Ethical consideration

Ethical clearance was obtained from the ethical committee of University of Nigeria Enugu Campus. This was reconfirmed verbally on the day of the actual survey. Also on the day of the interview, the women were explained the purpose of the survey and informed written consent collected from them.

Results

Table 1 shows that the mean and median ages of the children were 30.26 and 30 months, respectively, with males being more (54.3%) than females. The majority (70.5%) of the children were more than 12 months old. The immunization coverages for DPT3, OPV3, hepatitis B3, and measles were 65.3%, 78%, 65.2%, and 55.8%, respectively. The full immunization rates for children <5 years and <1 year were 49.8% and 65.2%, respectively.

As shown in Table 2, the very poor, poor, and least poor socioeconomic levels significantly had a higher rate of full immunization than the poorest socioeconomic level for children aged under 5 years (odds ratio [OR] 1.934, 95% confidence interval CI 1.513–2.820).

When the 1st year of life was selected as the reference group, the immunization rates in all other age groups

Table 1: Sociodemographic and socioeconomic status and immunization coverage data for children in the study sample

Variable	n (%)
Sample size	685
Mean age, months (SD)	30.26 (13.64)
Median age (months)	30.0
Sex, *n* (%)	
Males	372 (54.3)
Females	313 (45.7)
Children aged >12 months, *n* (%)	483 (70.5)
SES, *n* (%)	
Quartile 1 (Q1) poorest	172 (25.1)
Quartile 2 (Q2) very poor	171 (25.0)
Quartile 3 (Q3) poor	170 (24.8)
Quartile 4 (Q4) least poor	172 (25.1)
Immunization coverage (%)	
DPT3	65.3
OPV3	78.0
Measles	55.8
HB3	65.2
Full immunization coverage (%)	
1-5 years of age	49.8
Under 1 year of age (9-<12 months)	65.2

DPT=Diphtheria Pertussis Tetanus; OPV=Oral polio vaccine; HB3=Hepatitis B3; SES=Socioeconomic status; SD=Standard deviation

Table 2: Adjusted odds ratios by socioeconomic factors, influencing full immunization coverage under 5 years of age

	n	Adjusted OR	95% CI
SES			
Quartile 1 (Q1) poorest	172	1.000	
Quartile 2 (Q2) very poor	171	1.282	1.014-1.362
Quartile 3 (Q3) poor	170	1.612	1.321-2.214
Quartile 4 (Q4) least poor	172	1.934	1.513-2.820
Age (years)			
<12 months (*r*)	100	1.000	
1	95	0.347	0.182-0.351
2	113	0.288	0.224-0.379
3	179	0.318	0.234-0.435
4	198	0.223	0.159-0.309

OR=Odds ratio; CI=Confidence interval; SES=Socioeconomic status

decreased significantly. When the same logistic regression model was used for children under 1 year of age, it was determined that every month of the child's life increased the full immunization coverage, and this was statistically significant (OR 2.752, 95% CI 2.304–3.418).

Discussion

Immunization coverage in the study area was poor. OPV3 coverage was higher, with DPT3 being higher than the measles. The differences in the coverage were statically significant. These differences could be from the demand side of the of immunization services such as nonadherence to immunization schedules usually caused by the reluctance of caregivers and mothers. This was also found in other studies.[37]

However, only OPV3 reached the national coverage target of 75% probably due to the effort of the national and state immunization days which mostly focus on giving OPV to under-fives while the others were below target. These are matters of concern that must be addressed if the sustainable development goal for child health is to be achieved.

This study found that the full immunization rate for children under 1 year was greater than that of children 1–5 years. The reasons for this differential in the immunization coverage rates were not studied in this study; however, several reasons have been documented by other studies such as unavailability of vaccines, distance, nonawareness of the subsequent uptake of vaccines, mother's educational level, mothers being too busy, inconvenient time, order of child, fear of side reaction, wrong ideas about contraindication, illness of child, long waiting time, family problem including illness of mother, health workers' attitudes and practices, lack of support from husbands, seasonal migration, and contribution to high dropout rates.[38,39] On the other hand, the vigorous immunization campaigns in recent years as shown in NDHS 2013 would have informed the better coverage rate seen among younger age group. Nevertheless, in both children under-five and under-1, full immunization coverage was below the national coverage target of 75%. This calls for rapid appraisal of the strategies and structures used to deliver immunization services to the communities so as to increase coverage.

In this study, it was found that the very poor, poor, and least poor socioeconomic groups significantly had higher rates of full immunization than the poorest socioeconomic group for children under 5 years of age, creating an equity problem. Other studies in Nigeria[21] have found same, and some other studies in Kenya found that socioeconomic inequities are significantly larger in urban areas.[24] This study also showed that there was a significant decrease in immunization coverage in all other age groups when the children under-1 was used as reference group. This finding illustrates that immunization rate decreases with increasing age. This is in line with other studies.[37] It was determined that every year of the child's life decreased the full immunization coverage. The reason for this decrease was not studied. However, it is possible that parents may tend not to be interested in immunization as a result of other competing interests. It is also possible that the differential criteria of classifying those who did not receive any number of additional doses of OPV during campaigns has incomplete immunization as defined by Topuzoglu *et al*.[28] This also may partly explain the observed lower coverage for children aged between one and 5 years. A qualitative study to tease out this is therefore needed.

Although the poorest socioeconomic group is known to have the poorest immunization rate and are the most likely to need interventions to prevent illness in children, yet the findings from this study imply that they are not accessing these interventions. It has been noted that interventions such as immunization that is supposed to be provided free of charge in the public sector showed that in India, children in the richest quintile were 3 times more likely to be immunized.[40] Moreover, in Nigeria, a benefit incidence analysis of immunization service was in favor of the richest quintile.[41] According to Countdown to 2015 report, the wealthy receive far higher coverage of key interventions than the poor.[42] For example, in Nigeria, there is highly inequitable coverage for DPT3 and measles vaccines.[43]

Reducing inequities was not a key element in the health-related MDGs, but it is an important focus of the post-2015 agenda. Hence, as we move toward the post-MDG agenda within the context of attaining the SDGs and universal health coverage in child health, it is

important to address inequities in health and health-care access. This is necessary since it is among the poorest groups that the indicators are unfavorable. This has been echoed by the United Nations Global Health and Foreign Policy[44] and stressed by some authors.[45]

Limitation of the study

We recognized that recall may be poor and some mothers may not have their children's immunization cards. Hence, we classified poor recall with unavailable card as not fully vaccinated. This is a limitation in validity that we acknowledge.

Conclusions

Full immunization coverage for children aged <1 year is lower than the national target of 95%. There are differences in immunization coverage rates between different socioeconomic groups in the area with the least poor benefiting more than the poorest, thus creating equity problems. Health managers need community-based information about the vaccination status of their population to define their priorities, determine the disadvantaged and vulnerable groups, and plan and implement interventions that aim to improve immunization coverage in these areas. This is important against the backdrop of achieving universal health coverage. It is also important that strategies to reach the unreached are implemented. This will include revitalizing the "Reaching Every Ward" and "Reaching Every Child" strategies. More qualitative studies however are needed to discern why such inequities exist in healthcare utilization especially against the background that immunization services are free in Nigeria. A study of immunization dropout rates and reasons for the dropout will also improve policy and practice.

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Conflicts of interest

There are no conflicts of interest.

References

1. National Primary Health Care Development Agency. Revised Nigeria National Immunization Policy; 2009. Available from: http://www.thephss.org/ppep/resource/National_Immunization_Policy_with_frwd_and_acknwldg.pdf. [Last accessed on 2013 Nov 17].
2. WHO Regional Office for Africa. Nigeria Launches Pentavalent Vaccine; 2012. Available from: http://www.afro.who.int/en/nigeria/press-materials/item/4735-nigeria-launches-penta-vaccine.html. [Last accessed on 2014 Nov 17].
3. WHO. Nigeria Introduces Inactivated Polio Vaccine into Routine Immunization Schedule. Available from: http://www.afro.who.int/en/nigeria/press-materials/item/7390-nigeria-introduces-inactivated-polio-vaccine-into-routine-immunization-schedule.html. [Last accessed on 2016 Dec 22].
4. Federal Ministry of Health Nigeria. Joint Annual Review 2011. Abuja, Nigeria: Federal Ministry of Health; 2012.
5. World Health Organization. Expanded Programme on Immunization: Country Activities; 2012. Available from: http://www.who.int/countries/nga/areas/epien/index.html. [Last accessed on 2012 Oct 12].
6. World Health Organization Child Survival Fact Sheets: Immunization Schedule in Nigeria; 2010. Available from: http://www.childsurvivalnetwork.info/resources/Immunizations+Factsheet.pdf. [Last accessed on 2014 Nov 17].
7. National Bureau of Statistics. National Demographic and Health Survey 2013. Abuja: Federal Government of Nigeria; 2013.
8. Polio Global Eradication Initiative. Available from: http://www.polioeradication.org/dataandmonitoring/poliothisweek.aspx. [Last accessed on 2014 Jul 07].
9. Atchon K. Resurgence of poliomyelitis in Nigeria: A big blow to the world eradication efforts? MOJ Public Health 2016;4:00099,1-2. DOI: 10.15406/mojph.2016.04.00099. Available at http://medcraveonline.com/MOJPH/MOJPH-04-00099.pdf. [Last accessed on 2016 Dec 05].
10. Chizoba W, Stokes-Prindle C, Aina M, Oni G, Olukowi T, Pate MA, *et al*. Land Scape Analysis of Routine Immunization in Nigeria International Vaccine Access Centre (IVAC); 2012. Available from: http://www.jhsph.edu/research/centers-and-institutes/ivac/projects/nigeria/IVAC-Landscape-Analysis-Routine-Immunization-Nigeria-Brief.pdf. [Last accessed on 2014 Nov 17].
11. GAVI. Penta PIE 2013, Report from GAVI Large Country Task Team on Nigeria; 2013.
12. GAVI. Report from Tasks Team on Reprogramming of GAVI Cash Support to Nigeria; 2012.
13. Nigeria EVM Assessment. Routine Immunization Programme of Nigeria Vaccine Audit Report WHO; 2012.
14. Exworthy M, Blane D, Marmot M. Tackling health inequalities in the United Kingdom: The progress and pitfalls of policy. Health Serv Res 2003;38(6 Pt 2):1905-21.
15. Mackenbach JP, Meerding WJ, Kunst AE. Economic implications of socioeconomic inequalities in health in the European Union. Luxembourg: European Commission; 2007.
16. Zere E, McIntyre D. Inequities in under-five child malnutrition in South Africa. Int J Equity Health 2003;2:7.
17. Houweling TA, Ronsmans C, Campbell OM, Kunst AE. Huge poor-rich inequalities in maternity care: An international comparative study of maternity and child care in developing countries. Bull World Health Organ 2007;85:745-54.
18. Zere E, Moeti M, Kirigia J, Mwase T, Kataika E. Equity in health and healthcare in Malawi: Analysis of trends. BMC Public Health 2007;7:78.
19. Yazbeck AS. Attacking Inequality in the Health Sector: A synthesis and evidence of tools. Washington, DC: The World Bank; 2009.
20. Gwatkin DR, Bhuiya A, Victora CG. Making health systems more equitable. Lancet 2004;364:1273-80.
21. Antai, D. Inequitable childhood immunization uptake in Nigeria: A multilevel analysis of individual and contextual determinants. BMC Infectious Diseases 2009;9:1-10. doi:10.1186/1471-2334-9-181. url:http://www.biomedcentral.com/1471-2334/9/181.
22. Lynch JW, Kaplan GA, Cohen RD, Kauhanen J, Wilson TW, Smith NL, *et al*. Do cardiovascular risk factors explain the relationship between socioeconomic status, risk of all-cause mortality, cardiovascular mortality and acute myocardial infarction? *Am J Epidemiol* 1996;144:934-42.
23. Adeoti AI. Demand for reproductive health and child mortality

in Nigeria. Population and Poverty Research Network 2009. Available at: http://poppov.org.search.aspx#/search/demand%2520for%2520reproductive%2520health%2520and%2520child%2520mortality%2520in%2520Nigeria. [Last accessed on 2015 May 05].

24. Fotso JC, Kuate-Defo B. Socioeconomic inequalities in early childhood malnutrition and morbidity: Modification of the household-level effects by the community SES. Health Place 2005;11:205-25.
25. Victora CG, Huicho L, Amaral JJ, Armstrong-Schellenberg J, Manzi F, Mason E, *et al.* Are health interventions implemented where they are most needed? District uptake of the integrated management of childhood illness strategy in Brazil, Peru and the United Republic of Tanzania. Bull World Health Organ 2006;84:792-801.
26. Uzochukwu BS, Onwujekwe OE, Ezuma NK. The district health system in Enugu State, Nigeria: An analysis of policy development and implementation. Afr J Health Econ 2014;3:2.
27. Torun SD, Bakirci N. Vaccination coverage and reasons for non-vaccination in a district of Istanbul. BMC Public Health 2006;6:125.
28. Topuzoglu A, Ozaydin GA, Cali S, Cebeci D, Kalaca S, Harmanci H. Assessment of sociodemographic factors and socio-economic status affecting the coverage of compulsory and private immunization services in Istanbul, Turkey. Public Health 2005;119:862-9.
29. Onwujekwe O, Hanson K, Fox-Rushby J. Some indicators of socio-economic status may not be reliable and use of indices with these data could worsen equity. Health Econ 2006;15:639-44.
30. Onwujekwe O. Are Indices for Determining Socio-Economic Status (SES) Reliable and Valid Measures of Socio-Economic Status? Proceedings of the Meeting on Ensuring that Malaria Control Interventions Reach the Poor. London; September, 2002.
31. Uzochukwu B, Onwujekwe O. Selection of Indicators for Assessing Socio-Economic Status in Southeast Nigeria. Technical Workshop on Conduct of Household Surveys and Socio-Economic Analysis. Ahmedabad, India; 19 to 24 September, 2004.
32. Onwujekwe OE, Ibe O, Torpey K, Dada S, Uzochukwu B, Sanwo O. Examining geographic and socio-economic differences in outpatient and inpatient consumer expenditures for treating HIV/AIDS in Nigeria. J Int AIDS Soc 2016;19:20588.
33. Uzochukwu BS, Ajuba MO, Okwuosa CC, Onwujekwe OE. How do different socio-economic groups cope with payments and household functions when affected by tropical endemic diseases in Nigeria? Afr J Epidemiol 2014;2:7-15.
34. Mbachu CO, Onwujekwe OE, Uzochukwu BS, Uchegbu E, Oranuba J, Ilika AL. Examining equity in access to long-lasting insecticide nets and artemisinin-based combination therapy in Anambra State, Nigeria. BMC Public Health 2012;12:315.
35. Uguru NP, Onwujekwe OE, Tasie NG, Uzochukwu BS, Ezeoke UE. Do consumers' preferences for improved provision of malaria treatment services differ by their socio-economic status and geographic location? A study in Southeast Nigeria. BMC Public Health 2010;10:7.
36. Uzochukwu BS, Onwujekwe OE. Socio-economic differences and health seeking behaviour for the diagnosis and treatment of malaria: A case study of four local government areas operating the Bamako initiative programme in South-east Nigeria. Int J Equity Health 2004;3:6.
37. WHO. Vaccine-Preventable Diseases: Monitoring System: 2006 Global Summary (WHO/IVB/2006). Geneva: WHO; 2006. Available from: http://www.who.int/immunization_monitoring/data/en/. [Last accessed on 2015 Jul 05].
38. Latifur R, Haridas B, Tofazzel H, Abdul MK, Ishaq AK. Study on reasons of dropout of immunization in children in selected slum area of Dhaka city, Bangladesh. South East Asia J Public Health 2012;2:64-7.
39. Amin R, De Oliveira TJ, Da Cunha M, Brown TW, Favin M, Cappelier K. Factors limiting immunization coverage in urban Dili, Timor-Leste. Glob Health Sci Pract 2013;1:417-27.
40. Pande R, Yazbeck A. Beyond National Averages for Immunization in India: Income, Gender, and Regional Inequalities. Washington, DC: World Bank; 2002.
41. Onwujekwe O, Hanson K, Uzochukwu B. Are the poor differentially benefiting from provision of priority public health services? A benefit incidence analysis in Nigeria. Int J Equity Health 2012;11:70.
42. United Nations Development Programme. Nigeria Millennium Development Goals Countdown Strategy 2010-2015. Abuja: Federal Government of Nigeria; 2010.
43. National Population Commission: Nigeria Demographic and Health Survey 2003. Calverton, Maryland: National Population Commission and ORC Macro; 2004.
44. United Nations General Assembly, Global Health and Foreign Policy A/67/L.36. Sixty-Seventh Session, New York, USA; 06 December, 2012. Available from: http://www.daccess-dds-ny.un.org/doc/UNDOC/LTD/N12/630/51/PDF/N1263051.pdf?OpenElement. [Last accessed on 2016 Dec 28].
45. Rodney AM, Hill PS. Achieving equity within universal health coverage: A narrative review of progress and resources for measuring success. Int J Equity Health 2014;13:72.