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Analysis of the effects of individual and community level factors on childhood immunization in Malawi

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ABSTRACT

Background: Empirical evidence regarding the relationship between childhood immunization and individual- and community-level factors in low-income countries has received little attention. We compared the trends and the effects of a wide range of individual- and community-level socioeconomic factors on the likelihood of a child being immunized between 2004 and 2010 in Malawi.
Methods: We used data from the 2004 and 2010 Malawi Demographic and Health Survey and applied generalized estimating logistic regression equation to analyze data respectively on 2042 and 3496 children aged 12–23 months. We compared the relationship between individual- and community-level socioeconomic factors and a child's vaccination status for four basic vaccines recommended by the World Health Organization: bacillus Calmette-Guérin (BCG) vaccine, diphtheria-tetanus-pertussis (DPT3) vaccine, oral polio vaccine (OPV3), and measles-containing vaccine 1 (MCV1).
Results: The trends of vaccination had a similar pattern in 2004 and 2010. The coverage of the four vaccinations was highest for BCG and lowest for OPV3 and complete immunization was higher in 2010. The multivariate analyses show that mother's low education, having one or none antenatal visits, having no immunization card, having immunization card but not seen, residing in poor households, and living in central region were the most significant factors associated with decreased odds of achieving vaccination coverage and complete vaccination in both 2004 and 2010. However, maternal education was more likely to be associated with children's immunization in 2010, while the geographical region was more likely to be associated with children's immunization in 2004.
Conclusions: There were marked improvements in the national immunization coverage from 2004 to 2010. In order to achieve complete immunization, to further enhance the national immunization coverage as well as to lessen the gaps and disparities in childhood vaccination in Malawi, policy makers should design interventions based on the factors addressed in this study.

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1. Introduction

The most cost-effective public health initiative to prevent childhood morbidity and mortality has proven to be immunization. Immunization has greatly reduced 2–3 million under-5-year mortality each year due to infectious diseases such as diphtheria, tetanus, pertussis, tuberculosis, polio, and measles [1–3]. Even though the global immunization coverage has remained steady for the past few years, the coverage in low-income countries is still far from universal [1,4,5]. The World Health Organization (WHO) estimates that 19.4 million infants worldwide are still missing out on basic vaccines [4]. In Malawi, the proportions of children who were fully immunized by 12 months were 51% in 2004 and 72% in 2010 [6,7]. These statistics fall short of the benchmark of 90% recommended by the WHO through the Expanded Immunization Program (EPI) [2,3,8].

It is well established that individual-level factors such as child's characteristics [9–13], mother's age [1,9,11], education status [1,5,11,13,14], healthcare utilization [1,5,15–19], distance to health care facilities [20–23], household wealth [11,12,14,16,17], immunization plan [1,9,15,17], maternal and paternal occupation [12,18], and exposure to media [1,18,23] have significant effects on childhood immunization. However, very few studies have

investigated the influence of community-level factors on childhood immunization and whether the effects still exist after controlling for individual-level characteristics [5,12,14]. Prior studies reported that the community constitutes a key component of socioeconomic challenges to good health, since it shapes individual opportunities and exposes residents to multiple risks and resources over their life course [24]. Thus concentrating on one level can lead to practical and methodological problems at other levels [25].

To the best of our knowledge, no study has until now been conducted in Malawi using a wide range of individual- and community-level factors to assess the likelihood of childhood vaccination coverage and complete immunization. We thus aimed to examine both individual- and community-level risk factors of childhood immunization and addressed the relationships with different types of vaccination in Malawi. Specifically, we aimed to compare immunization coverage and trends in relation to the individual- and community-level factors between 2004 and 2010 MDHS.

2. Materials and methods

2.1. Data and sampling design

The data came from the Malawi Demographic and Health Survey (MDHS) 2004 and 2010. The MDHSs are designed to produce representative samples at the national, regional and rural levels using a two–stage proportional probability to the size sampling. The MDHS first selected 522 clusters (enumeration areas, EAs) in 2004 and 849 clusters in 2010 and then selected 15,091 households in 2004 and 27,345 households in 2010 from the respective clusters. Data were collected using face-to-face interviews from women of reproductive age 15–49 years on the measures of population health, socioeconomic, demographic, environmental, anthropometry, HIV/AIDS, immunization, and child health care indicators. We selected mothers who had a child below the age of 5 years prior to the surveys from 522 and 849 clusters respectively. We further restricted our analyses to children of age group 12–23 months (n = 2042 in 2004 and n = 3496 in 2010) since the Malawi Expanded Program on Immunization recommends that children should receive the complete schedule of vaccinations before 12 months of age [6,7]. Children were excluded from the analysis if they had missed data either on the outcome variables or any other covariates.

3. Measures

3.1. Outcome variables

The outcome variables of this study were vaccination coverage and complete vaccination. The WHO recommends that by 12 months all children should receive four-type with eight-dose of vaccines, including one dose of Bacillus Calmette-Guérin vaccine (BCG) against tuberculosis, three doses of diphtheria–pertussis–tetanus vaccine (DPT3), at least three doses of oral polio vaccine (OPV3), and one dose of a measles containing vaccine 1 (MCV1) [6,7,26]. Since 2002, Malawi has replaced the DPT vaccines with a pentavalent vaccine that protects against DPT, hepatitis B (HepB), and Haemophilus influenza type b (Hib): DPT-HepB-Hib [7]. Information on vaccination coverage was obtained in two ways. Mothers were asked to show whether they had a vaccination card for each child born 5 years prior to the data collection. If the mother could not show an immunization card, she was asked to report whether the child had received any vaccination. Vaccination coverage was defined as whether the children received each of the four specific types of the vaccines. Complete immunization was defined as the child having received all eight shots of vaccination.

3.2. Individual–level factors

Individual–level factors included child and maternal factors; sex of the child (male and female), the birth order (1, 2–3, 4–5, and 6 and above), place of delivery (health facilities or homes and other places), mother's age (15–24, 25–34, and ≥35 years), the mother's and husband's education (no formal education, primary school education, and secondary and higher education), antenatal (ANC) visits (1 or less, 2–3, and 4 and above), immunization card (no card/no longer had a card, had a card and its whereabouts known, and had card but its whereabouts not known), the household wealth index (poorest, middle and richest), tetanus toxoid injection during pregnancy (received or not received), number of children under the age of 5 years (one child or none, two, three or more). The household wealth index is a composite measure and was calculated according to the ownership of selected assets, such as televisions and bicycles, materials used for constructing the house, access to water and sanitation facilities, and other characteristics of a household. The household asset scores were generated through a principal component analysis [6,7]. The resulting asset scores were standardized and categorized into quintiles.

3.3. Community–level factors

The community-level factors were constructed by aggregating individual-level data to the cluster level. We included five continuous variables namely community wealth, distance to the nearest health facility, female education, ANC visits, and institution delivery. Community wealth was defined as the percentage of households in the community categorized as the richest wealth (upper 40% quintile), whereas community female education was defined as the percentage of women aged 15–49 in the community with primary and above education. Community distance to the nearest health facility was defined as the proportion of women aged 15–49 in the community who perceived distance to the nearest health facility as a big problem. Community institution delivery was defined as the percentage of women aged 15–49 in the community whose birth delivery occurred at a health facility. Community ANC visits was defined as the percentage of women aged 15–49 years in the community who had four and above antenatal visits. All continuous community-level factors were categorized as "low", "medium" and "high" depending upon each variable's tertiles. In addition, we included two variables indicating the area of residence, i.e. the place of residence (urban or rural), and geographical region (northern, central, and southern region).

3.4. Statistical analyses

All analyses were performed using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA). All analyses were conducted separately for 2004 and 2010 respectively. Univariate and bivariate analyses were performed to describe the main variables and the relationship between explanatory factors and childhood vaccination. The multivariate analyses were conducted using a series of three-level logistic models (e.g. children, mother, and community) with generalized estimating equations (GEE) for estimating the effects of predictors on the risk of childhood undernutrition after controlling for other confounding factors. Because children living in the same community and belonging to the same mother may be more similar to each other than individuals from different communities and different mothers, GEE models were used to adjust the correlated individual responses because of the same mother nested under a single community. The results of the multivariate