Family factors associated with immunization uptake in children aged between twelve and fifty-nine months: a household survey in Kakamega Central district, Western Kenya

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Abstract

In this study, we assessed immunization uptake and identified family factors associated with immunization in children aged between 12 and 59 months in Kakamega Central, Western Kenya. A cross sectional study was conducted in 13 sub-locations between June and July 2013. Data on 577 children were collected from their respective caregivers, by trained research assistants. The proportion of fully immunized children was 80.9% (95% confidence interval 76.9-85.3%). Immunization coverage was higher among caregivers who had completed secondary school (88%), those who had attended antenatal care clinics (81%) and children born in a health facility (85%). Some evidence was seen of increasing coverage with increasing socio-economic *status*. No evidence for a gender difference in coverage was seen. In the logistic regression model, the risk factors for incomplete immunization were: low educational level of the caregiver [adjusted odd ratio (AOR)=0.25; P<0.005], never attending any antenatal care (ANC) (AOR=0.14; P<0.05) and delivery outside of health facilities (AOR=0.40; P<0.005). Further inquiry is required into this area to fully comprehend the inextricable linkage between factors affecting immunization.

Introduction

In 1974, the World Health Organization (WHO) launched the Expanded Program on Immunization (EPI) initiative. Its aim was to ensure that children aged below 5 years in all countries benefited from vaccination against diphtheria, pertussis, tetanus (DPT), poliomyelitis, measles and tuberculosis. In some countries, more vaccines have now been added to the schedule including hepatitis B, haemophilus influenza type B and yellow fever.[1] Despite this, in 2013, an estimated 14% of the infants (mostly from low income countries) failed to access three of these vaccines (DPT) during their first year of life.[2]

In Kenya, the Ministry of Health is charged with the delivery of efficient immunization services, through the Division of Immunization (DVI) department. Within one year of birth, each child should receive one dose of Bacillus Calmette-Guérin (BCG) as protection against tuberculosis, three doses of vaccination against DPT, four doses of oral polio vaccine (OPV), three doses of hepatitis B vaccine (HBV), three doses of haemophilus influenza type B vaccine (HIB), three doses of pneumococcal conjugate vaccine and one dose of measles vaccine. The DPT, Hepatitis B and Haemophilus influenza type B vaccines are administered as a pentavalent vaccine.[3]

Despite the aim to vaccinate all children, vaccine-preventable disease outbreaks have been recorded,[4] indicating that this is not being achieved. The most recent official estimates support this, with the national coverage being approximated as: BCG 79%; DPT-3 76%; OPV 82%; HBV 83%; HIB 83%; and measles 79%.[5] Variations in immunization uptake have been documented in different areas of Kenya, with the highest rates being in Nandi County (93.9%) and the lowest in Mandera (27.7%).[6] However, it is acknowledged that there are limitations to the accuracy of all official estimates with possible variations between 8% and 16%.[5]

A number of factors have been associated with immunization uptake. These include maternal education or literacy,[7-9] maternal age at birth,[10,11] paternal education level[12] and antenatal care utilization during pregnancy.[13] Children born in a health facility have been found to be more likely to be immunized than those born at home,[14,15] but there is no strong evidence that a child's sex is associated with vaccination uptake.[16,17] Household characteristics that have been documented to correlate with immunization include socioeconomic *status*,[18] proximity to a health facility[19] and whether the household is located in a rural or urban area.[20]

Despite studies showing association between socio-demographic factors and immunization uptake, this relationship is not conclusive. A study in Ethiopia failed to show any significant association between immunization and socioeconomic *status*, maternal age, total number of children, age of the father, education level of the father and sex of the child.[13] In Kenya, the following factors were not associated with immunization; maternal age, socioeconomic *status*, partner's education level, sex of the child and place of delivery.[9,19,21,22] This highlights the need for further studies to understand these associations.

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Key words: Immunization; Vaccination; Factors; Kenya.

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Kakamega County is in a predominately rural area of Kenya. The district consists of 13 administrative units, called sub-locations. The average population in each sub-location is 13,000. The main language is Luhya followed by Swahili and English. The majority of the population is subsistence farmers with a small number of business people working in an urban center. Like the other 47 counties, Kakamega County has a devolved governance system. Each county draws revenue from the central government allocation and levies taxes at the county level.

Immunization uptake in Kakamega County is estimated to be 62.2%.[6] However, as is the case with national vaccination uptake estimates, these may not be accurate. Clearly, there is a need to gather accurate estimates of complete immunization and the factors associated with this. Understanding factors associated with immunization are important in informing stakeholders to implement key

interventions aimed at improving immunization uptake.

The purpose of this study therefore was to measure completeness of immunization uptake and the factors associated with this in children aged between 12 and 59 months living in Kakamega County, Western Kenya.

Materials and Methods

A cross-sectional study design was used, specifically a stratified survey of households. It was determined that a sample size of 520 children (40 per sub-location or stratum) was required, based on the recommended single proportion formula for immunization, with a 95% confidence level, 5% margin of error and assuming 80% immunization coverage rate.[23] A 5% non-response rate and a design effect of two were considered.

Inclusion criteria were: a caregiver to a child aged between 12 and 59 months who had lived in the caregiver's home in Kakamega Central District for at least six months. In households with two or more children qualifying for inclusion, the youngest was selected. In houses where twins lived, the tossing of a coin determined for which child the information should be collected. All those not meeting the inclusion criteria were excluded from participation.

Three weeks before data collection began, six research assistants from the district public health office were trained by the principal investigator on the rationale for the study, ethical issues, inclusion and exclusion criteria, the study method and how to record and return the information gathered. Five research assistants were public health officers while the other was a health records and information officer. All had attained tertiary level training (diploma and/or degree).

Two weeks before the study, chiefs, village elders and research assistants made announcements about the study in local schools, churches and market places and encouraged participation.

The selection of participants was done through stratified sampling followed by simple random sampling of households within strata. Kakamega Central district consists of 13 administrative units, called sub-locations. Each sub-location constituted a *stratum* from which households were drawn for the survey. The first household to be visited within each sub-location was selected randomly from a sampling frame listing all households available from the Ministry of Provincial Administration. The person who answered the door was informed about the study and asked if a child in the household met the inclusion criteria. The next house to be visited was the nearest household, which met the inclusion criteria. For those who met the inclusion criteria, one caregiver was interviewed with a short structured questionnaire. Information was collected on: caregiver's relationship to the child; mother's age at delivery of the child; age and level of education of the principal caregiver and partner; the number of antenatal visits made; place of delivery; the birth order and sex of the child and the number of immunizations for the child. Socio-economic *status* was measured using a principal component analysis used in other household surveys in Kenya.[23,24] In addition to responding to the questionnaire, all study participants were asked to produce the child's vaccination card, national identification cards of the caregiver, birth certificates and academic certificates. These were used to corroborate the information given by the care-

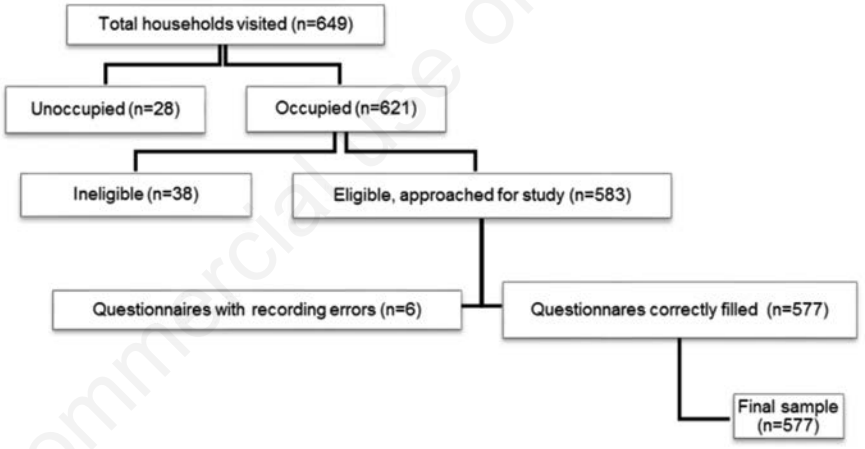

Figure 1. Baseline characteristics of the survey.

Table 1. Summary of the survey data per stratum.

Strata	Population distribution		Sample distribution		Survey results		Weights
	N*	%	N*	%	$\hat{p}_i$	$Var\ (\hat{p}_i)$	
Emukaya	1235	3.3	33	5.7	0.818	0.00465	0.57
Lurambi	1130	2.9	45	7.8	0.844	0.00299	0.38
Eshisiru	989	2.6	48	8.3	0.896	0.00198	0.32
Indangalasia	1566	4.2	44	7.6	0.432	0.00571	0.54
Shibuli	2417	6.4	38	6.6	0.868	0.00310	0.97
Shirakalu	1173	3.1	46	8.0	0.935	0.00135	0.39
Shiyunzu	1919	5.1	45	7.8	0.956	0.00096	0.65
Sichilayi	10,475	27.8	48	8.3	0.771	0.00376	3.34
Shirere	7738	20.5	46	8.0	0.870	0.00251	2.58
Township	2691	7.2	39	6.8	0.846	0.00343	1.06
Matioli	1387	3.7	49	8.5	0.673	0.00458	0.43
Murumba	2104	5.6	48	8.3	0.646	0.00487	0.67
Mahiakalo	2865	7.6	48	8.3	0.896	0.00198	0.91
Total	37,689	100	577	100			

*N refers to number of households from which respondents were picked.

giver. Respondents' information was coded by the primary researcher into numerical responses and double-entered in excel before being exported to SPSS (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY, USA). Statistical analysis was conducted using the software SPSS v20 for Windows, with an alpha value of 0.05 used to indicate significance. Data were initially checked for consistency and outliers through use of tables, histograms and box plots. Mean, median and standard deviations were used to describe continuous data, while frequencies were used for categorical data. A multiple logistic regression model was used to estimate associations and check for potential confounders among variables. To ensure accurate estimation of immunization in Kakamega Central district, each sample proportion (with the respective 95% confidence intervals) was weighted (Table 1).

The sample weights, w_i were derived from the formula:

$$w_i = \frac{\%\text{ of population in stratum } i}{\%\text{ of sample in stratum } i}$$

Ethical approval for the study was obtained from Auckland University of Technology Ethics Committee. Permission to proceed with the study was also obtained from the Kenyan Ministry of Health.

Results

Baseline characteristics

After visiting 649 households (oversampling was done due to availability of more household for interviews), caregivers from 577 households were interviewed, translating to a response rate of 90.1% (Figure 1). The mean age of the caregivers was 27.6 years, whilst that of the children was 24.8 months, with slightly more than half being boys (53.2%). Table 2 summarizes the sample characteristics.

Immunization coverage

Among the households visited, the proportion of completely immunized children was 80.2%. Adjusting for the stratified design, the estimated coverage for the district was 80.9%. Every child had received at least one form of vaccine against the diseases in the Kenyan immunization schedule. The vaccination coverage rates for BCG, the third polio dose (OPV-3), pentavalent 3 and measles were 99.5, 85.1, 94.5 and 90.8% respectively.

Bivariate analyses

The coverage was higher (88%) among caregivers who had completed secondary school than among those who had not (74%), P<0.001. A similar result was seen for the education level of the partners. Although there were relatively few caregivers who did not attend any antenatal care (ANC) visits, there was evidence of a significantly lower coverage (54%) for them, compared to those who had attended ANC (81%), P<0.001. No evidence for a gender difference in coverage was seen, P=0.74. Children born in a health facility had greater coverage (85%) than those who were not (71%), P<0.001. Some evidence was seen of increasing coverage with increasing socio-economic *status*. Coverage decreased for children born into larger families, down to 69% for children with a birth order of six or more (Table 3).

Logistic regression analysis

Complex samples logistic regression was performed to assess the impact of the factors measured on the likelihood that children would be fully immunized. Prior to interpretation of regression coefficients, the model was tested to determine its fitness. The Hosmer-Lemeshow goodness of fit test indicated that the logistic regression model was fit to test the association between socio-demographic variables and immunization uptake.

After backward stepwise elimination, the final model contained three explanatory vari-

Table 2. Sample characteristics (n=577).

Variable	N	%
Caregiver's relationship to the child		
Mother	547	94.8
Father	13	2.3
Other	17	2.9
Marital status of the caregiver		
Married	483	83.7
Single	70	12.1
Divorced	12	2.1
Widowed	12	2.1
Caregiver's age (years)		
≤20	71	12.3
21-30	357	61.9
31-40	123	21.3
40+	26	4.5
Caregiver's higher school level		
<Secondary	322	55.8
≥Secondary	255	44.2
Parther's higher school level		
<Secondary	266	47.0
≥Secondary	300	53.0
Sex of the child		
Male	307	53.2
Female	270	46.8
Child's place of delivery		
Health facility	377	65.3
Home or other place	200	34.7
Age of the child (months)		
≤20	243	42.1
21-30	173	30.0
31-40	140	24.3
41-50	17	2.9
51+	4	0.7
Vaccine coverage		
BCG	574	99.5
Polio birth dose	568	98.4
OPV-1	565	97.9
OPV-2	549	95.1
OPV-3	491	85.1
Pentavalent 1	565	97.9
Pentavalent 2	561	97.2
Pentavalent 3	545	94.5
Measles	524	90.8

BCG, Bacillus Calmette-Guérin; OPV, oral polio vaccine.

ables, all of which were statistically significant. The model as a whole correctly classified 83.5% of cases. The risk factors for incomplete immunization identified by the final model (Table 4) were: low educational level of the caregiver [adjusted odd ratio (AOR)=0.25; P<0.005], never attending any ANC (AOR=0.14; P<0.05) and delivery outside of health facilities (AOR=0.40; P<0.005).

Discussion

In Kenya the aim is for 100% uptake of BCG, OPV birth dose, measles, and pentavalent vaccination (a combination of DPT, OPV and haemophilus influenza type B). Full delivery of these vaccinations ensures compliance with the aims of the EPI initiative and ensures that all children are protected from the vaccine-preventable diseases. In the research reported here, it was found that although the estimated completed immunization was higher than the 62.2% reported in official estimates,[6] and all children had received at least one vaccination, only 80.2% received full vaccination. Understanding the reasons why immunization is not complete is important to focus future interventions appropriately. In this study, maternal education level, antenatal clinic attendance and place of delivery were found to be significant according to the multivariate analysis. This is similar to previous studies.[7-9,13-15] In this study, educated mothers were more likely to take their children for immunization. This could be due to the fact that educated mothers have more knowledge about good medical practices (perhaps through courses undertaken within learning institutions) and are thus aware of the benefits of medical care. Also, educated mothers are likely to be more active and assertive within their households and the public arena. Such women are more likely to advocate for better healthcare for their children. In the research reported here, 17% of women who had been educated to at least secondary level did not have their children immunized, suggesting that although maternal education is valuable, other factors need to be in place to ensure full coverage.

The second factor shown to be strongly associated with full vaccination coverage was attendance of antenatal clinics. The WHO recommends that pregnant mothers attend at least four antenatal classes during which mothers are taught about the importance of immunization to their children.[25] Interestingly, in the study reported here, only 3% of care givers reported they had not attended antenatal classes and it is surprising that this did not result in higher immunization, with nearly 100 women who attended these classes not having fully immunized their children.

Children delivered within a health facility were more likely to be immunized than those delivered at home. The children of Kenyan mothers delivering at health facilities are given the polio birth dose and BCG and advised when to return for the next set of vaccines. Children born from home only access the first set of vaccines on first contact with their health care provider, often when they are brought to hospital for other reasons such as sickness. Home-based vaccination programs are not in place for routine immunization and children are only vaccinated from home during campaigns to control outbreaks such as measles and polio. Despite the advantage for those children who are born in a health facility being given at least some protection, this did not result in complete immunization. Strengthening messages about the importance of the child receiving all vaccinations should be considered. Whilst these findings are in line with those of other studies, the results presented here show that despite these three factors being significant, none determines full coverage. Other factors must also play a part. Variations in the uptake of different vaccines revealed missed opportunities especially for vaccines administered concurrently. For

Table 3. Factors associated with immunization (n=577).

Variable and category	Total	Fully immunized N	Fully immunized %	Crude OR	P
Caregiver's highest school level					
≥Secondary	255	224	88	3.68	<0.001
<Secondary	322	239	74	1.00	
Partner's highest school level					
≥Secondary	300	249	83	1.42	0.104
<Secondary	266	205	77	1.00	
Mother ever attended ANC clinic					
Yes	553	450	81	3.70	<0.001
No	24	13	54	1.00	
Sex of the child					
Male	307	250	81	1.07	0.739
Female	270	213	79	1.00	
Place of delivery					
Health facility	377	321	85	3.96	<0.001
Home or other place	200	142	71	1.00	
Socioeconomic status (quintiles)					
First	113	82	73	1.00	-
Second	118	87	74	1.06	0.841
Third	115	92	80	1.51	0.187
Fourth	115	101	88	2.73	0.004
Fifth	116	101	87	2.54	0.006
Birth order of the child					
1-2	332	273	82	2.06	<0.001
3-5	219	172	79	1.63	0.920
6+	26	18	69	1.00	-
Age of the caregiver		Yes	No		
Mean age (years)		27.3	29.1		0.034

OR, odds ratio; ANC, antenatal care.

Table 4. Multivariable analysis of determinants of complete immunization.

Variable	AOR	95% CI
Caregiver's highest school level		
≥Secondary	3.40	1.28, 9.01*
<Secondary	1.00	
Ever attended ANC visit		
Yes	2.43	1.51, 3.95°
No	1.00	
Place of delivery		
Health facility	2.58	1.61, 4.15*
Home	1.00	

AOR, adjusted odd ratio; CI, confidence interval; ANC, antenatal care. *P<0.005; °P<0.05.

instance, there was a discrepancy between the coverage of the OPV-3 and the third dose of the pentavalent vaccine. These vaccines are administered together and could be expected to have similar coverage rates. Other factors impacting on incomplete coverage may be contextual and/or difficult to quantify using survey designs. One possible next step would be to carry out some qualitative research to explore these issues from the perspective of all stakeholders and a review of logistical factors relating to vaccination. Strength of the study was that all research assistants were trained before data collection commenced, which ensured that the method of data collection was standardized. Household selection was randomized, with all households having an equal chance of being asked to participate in the study. The number of participants exceeded the estimated required sample size. The response rate was high, and recall bias were minimized by the verification of the information provided by the majority of participants. One possible limitation of the study was that it was carried out in only one area of Kenya and as such, the results could not be extrapolated to other areas of this country. The study focused on the knowledge and behaviors of caregivers but did not investigate structural and other factors which might impact on immunization uptake. This was outside the scope of the study, and further work needs to be undertaken to investigate this. In this study, immunization uptake was generally good. However uptake of some vaccines was better than others. Factors associated with immunization uptake among children within the study area were identified. The main consumers of study findings include caregivers and their partners, healthcare workers, non-governmental organizations and the government of Kenya. Study findings highlight the importance of demand creation for immunization services through health education during immunization, outreach sessions and through the media. This would in turn improve the knowledge, attitude and practice of all the stakeholders hence increase immunization uptake. Health workers would use the study findings to encourage mothers to start antenatal clinics early and ensure that mothers attend more than four antenatal visits during their pregnancy.

Conclusions

This study explored the immunization uptake in an area of Kenya with relatively good health care facilities and the factors, which might nonetheless impact on incomplete immunization coverage. The vaccination coverage was found to differ from previous official estimates. The study also contributed to our understanding of the factors associated with full coverage. Despite factors significantly associated with greater coverage, it is demonstrated that a multi-faceted approach to vaccination coverage is essential as no single factor results in full coverage. Further detailed exploration of the complexity and interaction of factors affecting decision-making around vaccination uptake, and the logistics of vaccination provision would be worthwhile to enable the goal of complete vaccination coverage to be attained.

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