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Influence of Maternal Education on Child Immunization and Stunting in Kenya

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Abstract In 2003, the child mortality rate in Kenya was 115/1000 children compared to 88/1000 average for Sub-Saharan African countries. This study sought to determine the effect of maternal education on immunization ($n = 2{,}169$) and nutritional status ($n = 5{,}949$) on child's health. Cross-sectional data, Kenya Demographic Health Survey (KDHS)-2003 were used for data analyses. 80% of children were stunted and 49% were immunized. After controlling for confounding, overall, children born to mothers with only a primary education were 2.17 times more likely to be fully immunized compared to those whose mothers lacked any formal education, $P < 0.001$. For nutrition, unadjusted results, children born to mothers with primary education were at 94% lower odds of having stunted growth compared to mothers with no primary education, $P < 0.01$. Policy implications for child health in Kenya should focus on increasing health knowledge among women for better child health outcomes.

Keywords Child health · Maternal education · Immunization · Child nutrition · Health knowledge · Kenya

Introduction

Prevention of child mortality is one of the Millennium Development Goals (MDGs) expected to be achieved by 2015 [1]. However, in 2008, the infant and child mortality rates for Sub-Saharan African countries and Kenya stand at 88 deaths per 1,000 and 77 per 1,000 children born, respectively [2]. In Kenya, the under five mortality rate is equally high at 115 for every 1,000 children born [3], 70% of the children succumb to death before their fifth birthday from childhood diseases that are preventable [3, 4]. Child health remains a critical issue in Kenya, where infant and child mortality is still substantially high; with 67% of the under five mortality occurring among infants. Although polio had been declared not a threat to children in Kenya, 25 years ago, recent reports indicate that the disease is now a real threat [5, 6].

Child health is a significant marker of the quality of life in less developed countries (LDCs) [7–10]. Existing research continues to show a strong correlation between maternal education and improved child health [7, 11–14].

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Increased years of schooling of mothers have been shown to have a positive effect on a child's health; therefore, the role of maternal education has a greater impact on children's health outcomes than fathers' education, use of modern health services, and socioeconomic status [15, 16]. Cross country comparisons have shown that in developing countries, there is an inverse relationship between higher levels of education (particularly maternal education) and child deaths [16–20], a sign that education is still an important factor in the fight against infant and child mortality in developing countries.

Despite the consensus that maternal education is associated with better health outcomes in children, caveats still remain in the causal effect of maternal education on child health, and on the potential pathways linking the two variables [21]. Additional research is still needed to unravel the links. The current study highlights the role of mother's education on two key child health outcomes—immunization and nutritional status. Immunization and nutritional status are measured by complete vaccination and height for age, respectively. Immunization protects children against five childhood diseases namely: pertussis (whooping cough); neonatal tetanus, contracted through contamination of umbilical cord at birth; polio (a major course for lameness in the developing world); tuberculosis, which can be especially severe in young children; and diphtheria, which is less common but kills 10–15% of its victims [22]. One indicator that a child is in poor health is physical stature. Height for age is a measure of a child's linear age—used as a measure for stunting [3]. According to the Kenya Demographic and Health Survey (KDHS) [3], stunting is an outcome of lack of adequate nutrition for a child that usually occurs over a long period of time—representing long-term malnutrition effects on a population of children.

In Kenya, national estimates indicate that among children under 5 years, 30% are stunted, while 11% suffer from severe stunting. Stunting is highest among children who are between 12 and 23 months. Additionally, male children (33%) are more likely to suffer from stunting than female children (28%) [3]. The purpose of this study is to highlight the importance of mother's education on child health in Kenya. We seek to answer the following questions: (1) Does mother's education affect the immunization status of children in Kenya? and (2) Does mother's education affect child nutritional status in Kenya?

Data and Methods

The data source for this study was the 2003 Kenya Demographic and Health Survey (KDHS). The 2003 KDHS is the first in a series of the Demographic Health Surveys to cover all parts of the country, including marginal areas that were not previously surveyed—Turkana, Samburu, Isiolo, Marsabit, and Moyale. The survey was administered to both women and men. Of the 9,865 households selected in the sample, 8,889 were occupied and 8,561 (96% response rate) were successfully interviewed with 8,717 women identified as being eligible for interviews. Of the 8,717 eligible women, 8,195 (94% response rate) completed the interview. The survey collected information on family planning methods, maternal and child health including immunization and child nutritional status, sexual behavior, education, knowledge levels and other demographic and behavioral information on a sample of women aged 15–49 years. A sample selection [immunization ($n = 2{,}169$) and nutritional status ($n = 5{,}949$)] allowed for estimation of key indicators for each of the eight provinces, and at the same time estimate rural–urban differences [23].

Measurement

This analysis focuses on the effect of mother's education on child health, while establishing the mediating effect of socioeconomic status (SES), access to information, attitudes, autonomy, and mother's reproductive variables. The covariates include partner's education, region of residence, mother's age, and rural/urban differences. The dependent variables are immunization status and height for age. Child immunization information is collected for children born 35 months preceding the 2003 KDHS. For the immunization analysis, the sample was restricted to children who were between 12 and 35 months at the time of the survey ($n = 2{,}169$). This restriction is based on the premise that children less than 12 months may not be fully immunized and according to the World Health Organization (WHO) recommendations, child vaccination coverage should be assessed for children who are older than 12 months [24]. The 35 month threshold is included in the analysis to cover the cases where children were late in getting all eight vaccines as stipulated by the 24 month immunization schedule which is common in developing countries.

Immunization is operationalized as the number of vaccinations a child receives. To be fully immunized, a child should have received the following eight vaccinations: one dose of Bacille Galvette-Guerin (BCG) vaccine, one dose of measles vaccine, three doses of polio vaccine, and three doses of Diphtheria-Pertusis-Tetanus (DPT) vaccine [24]. The 2003 KDHS contains data on all eight forms of childhood immunizations. Data on the immunization cards—both "vaccine marked on card" and "vaccine date on card", as well as vaccine "reported by mother" (those children whose mother reported that they were immunized

but the vaccination card was missing) were used in determining receipt of vaccinations. The cases from the latter category (vaccination card missing) were not dropped from the analysis. Immunization status was coded as a dummy variable, where "1" means that a child has received all the eight vaccines and "0" if otherwise.

Nutritional status is measured by a child's height for age; $n = 5{,}949$ were retained for analysis. Child height for age is a dichotomous variable, coded as "1" for children who are below negative two standard deviations of the median population and "0" otherwise [25]. Height for age is an anthropometric index that shows the growth of a child during the pre- and post-natal period. It denotes the long term deficiencies and effects of malnutrition on health [26]. The National Center for Health Statistics and the WHO growth reference classify children who are below two standard deviations on the height-for-age growth curve to be stunted [27].

Maternal education is the main predictor variable. The three education categories (no education, primary, and secondary and higher) were coded as "0", "1", and "2", respectively. Socioeconomic status is measured by the wealth index variable, which indicates the poverty level in a household. Wealth index thus gives one consistent measure of SES without having to build an index out of the household ownership and household environment—which varies across different studies. Wealth index has three categories—poor, middle, and rich coded as "0", "1", and "2", respectively.

Access to information is measured by three variables: listening to radio, newspaper reading and watching television. Each of the variables is coded as "0" does not listen to radio, reads no newspaper, and watches no television, and "1" listens to the radio, reads the newspaper and watches television. Direct measures of knowledge, attitude, and autonomy are limited in the KDHS 2003. Several measures are used as proxies to capture mothers' knowledge, attitude, and autonomy. Mothers' knowledge is an index computed using the following variables: whether the mothers have ever heard of oral rehydration therapy for the treatment of diarrhea (ORS); whether the mothers received AIDS information at antenatal visit; and whether the mothers recognized signs of illnesses in their children (coughing, crying, diarrhea, fever/shivering, not able to drink, and repeated vomiting). The index for knowledge ranges from (0 to 7), where "0" denotes no health knowledge and "7" indicates that a mother is highly knowledgeable.

Mother's attitude is influenced by her education and consequently she learns to challenge the traditional attitudes and beliefs making it possible for her to utilize modern healthcare services [28]. According to Frost, Forste, and Haas [28], a measure of attitude assumes that the use of preventive health services by mothers is a sign of how receptive they are to modern health care compared to those mothers who do not frequent emergency and curative heath care services. Therefore, we base our measure of attitude on how receptive mothers are to and use of preventive healthcare services. Thus, our measure for utilization of healthcare (a proxy indicator for mothers' attitude toward modern medicine) combines measures of receipt of prenatal care, doctor/nurse attendant at birth, receipt of tetanus injection before birth, and use of any modern method of contraception. The attitude index has a range of (0–6); "0" denoting no receptivity to modern healthcare use, and "6" denoting high receptivity to use of modern healthcare. The KDHS 2003 lacks measures of autonomy; therefore, autonomy is measured using two proxy variables—who made the decision for using contraception and who decides how to spend money in the household. The autonomy index ranges from (0 to 2), with "0" referring to no autonomy and "2" referring to high autonomy regarding health related decisions.

The reproductive variables that are included in the analysis are mother's age, birth interval and birth parity. Maternal age is a continuous variable measured in single years. Birth parity/order is measured from the first birth to the sixteenth birth. Birth interval is measured in months and is coded into three dummy categories: $\leq$24 months, 25–47 months, and $\geq$48 months. We also controlled for rural/urban settings, region of residence, partners' education, and mothers' age.

Method of Analysis

The dependent variables (complete immunization and child nutrition-height for age) in the analysis are dichotomous and hence the estimation is done using logistic regression. The logit equation is $\log [p/1 - p] = a + bX$, where $p/(1 - p)$ is the odds of an outcome occurring given the independent measure of explanatory variable X, and where "a" indicates the constant and "b" represents the coefficient being estimated. Therefore, this equation estimates the log odds of a child being fully vaccinated and whether the child is stunted. The derived coefficients are interpreted based on their significance and are then exponentiated to give odds ratios [24], which show the effect of the independent variables and covariates on the probability of complete immunization and child stunting.

Given that the 2003 KDHS employed a complex survey design, adjustments were made to account for clustering, stratification, and unequal weighting. According to An [29] and Cassell [30], accounting for complex survey design in data analysis is important, because it allows for estimation of accurate standard errors in cases where the sample has

been drawn using clusters, stratification, and unequal weights.

Findings

Descriptive statistics for child immunization and nutrition

The descriptive statistics presented in Table 1 show that almost half of the children who are between 0 and 36 months are fully immunized in Kenya. Overall, the level of maternal education is low as well with only 57% of women having primary education, 23% with secondary education and higher, and 20% of the women having no education at all. Socioeconomic level as measured by the wealth index variable shows that a higher proportion of women in Kenya are still poor: 44% of women are categorized as poor; 18% are in the middle rich wealth index; and 38% are in the rich wealth index. The results show that the mothers in this sample have moderate health knowledge as indicated by an average score of 3.4 out of the total score of seven. The attitude index is low with mothers' attaining an average score of 2.17 out of a total score of six. The autonomy score is modest with mothers scoring an average of 0.93 out of a possible score of two.

The reproductive measures show that 26% of children were born within an interval of 2 years. Forty-nine percent of the children have a birth spacing of 2–4 years, and 25% of children were born after 4 years. The average age of mothers was 28 years. Overall, the level of partners' education is low, with 48% of men having primary education, 36% with secondary education and higher, and 16% of the men having no education. Seventy-five percent of mothers live in the rural areas. A majority of the mothers live in the Rift valley Province (21%) followed by Western (14%). The most common source of information for mothers was the radio, with 78% reporting they listen to radio.

Eighty percent of children in Kenya are stunted. In addition, poor nutrition is greater among children who are 0–60 months. Overall, among the sample of children ($n = 5{,}949$) whose data were used to estimate height for age, their mothers' level of education can be termed as low; 58% of the women have primary education, 22% have secondary education and higher, and 20% of the women have no education at all. Socioeconomic level as measured by the wealth index variable shows that among women with children between 0 and 60 months, 44% are categorized as poor, 18% are in the middle rich, and 38% are rich. The results show that mothers in this sample have low levels of health knowledge as indicated by an average score of 2.87 out of the total score of seven. For the attitude

Table 1 Study summary descriptive statistic, KDHS-2003

Study characteristics	Nutrition $N = 5{,}949$	Immunization $N = 2{,}169$
Dependent variables		
Child's nutrition status		
Stunted (Yes)	80%	–
Not stunted (No)	20%	–
Child's immunization status		
Immunized (Yes)	–	49%
Not Immunized (No)	–	51%
Primary independent variable		
Mother's education		
No education	20%	20%
Primary	58%	57%
Secondary +	22%	23%
Secondary independent variables		
Socioeconomic status		
Household wealth index		
Poor wealth index	44%	44%
Middle wealth index	18%	18%
Rich wealth index	38%	38%
Knowledge index		
Range	0–7	0–7
Mean	2.84	3.4
(SD)	1.44	1.24
Attitude index		
Range	0–6	0–6
Mean	1.88	2.17
(SD)	1.44	1.41
Autonomy		
Range	0–2	0–2
Mean	0.58	0.93
(SD)	0.57	0.47
Reproductive variables		
Birth interval		
0–24 months	27%	26%
25–27 months	49%	49%
48+ months	24%	25%
Mother's current age		
Mean	28	28
(SD)	6.66	6.5
Birth parity		
Range	1–16	1–16
Mean	3.48	3.53
(SD)	2.46	2.46
Control variables		
Partner's education level		
No education	16%	16%
Primary	49%	48%
Secondary +	35%	36%

Table 1 continued

Study characteristics	Nutrition $N = 5,949$	Immunization $N = 2,169$
Place and type of residence		
Rural	74%	75%
Urban	26%	25%
Region of residence		
Nairobi	9%	9%
Central	12%	13%
Coast	12%	12%
Eastern	12%	12%
Nyanza	13%	12%
Rift Valley	20%	21%
Western	14%	14%
North eastern	8%	7%
Sources of information		
Listen to radio		
Yes	78%	78%
No	22%	22%
Read newspapers		
Yes	32%	33%
No	68%	67%
Watch TV		
Yes	28%	27%
No	72%	73%

SD Standard deviation

index, the average score was 1.88 out of a total score of six. The autonomy score was slightly lower with the mothers' average score being 0.58 out of a possible of two items.

Multivariate Logistic Regression Results (Effect of Maternal Education on Complete Child's Immunization)

Table 2 presents the univariate/unadjusted logistic regression (model 1) and multivariate logistic regression (model 2–8) predicting the effect of maternal education on child health in Kenya. In model 1, children born to mothers with a primary education were 2.17 times more likely to be fully immunized compared to those who do not have any education at all, $P < 0.001$. In addition, those children born to mothers with a secondary education were 2.68 times more likely to be fully immunized compared to those who do not have any education at all, $P < 0.001$. After controlling for confounding (place of residence, mother's current age, partner's education, and region of residence), i.e., model 2, mother's education effect attenuated, such that children born to mothers with a primary education were 1.85 times more likely to be fully immunized compared to those who do not have any education at all, $P < 0.01$. Those children born to mothers with a secondary education were 2.16 times more likely to be fully immunized compared to those who do not have any education at all, $P < 0.01$. Furthermore, women from North Eastern, Nyanza, and Western Provinces were significantly at less odds of having their children fully immunized (OR: 0.23, $P < 0.001$, OR: 0.38, $P < 0.001$, and OR: 0.59, $P < 0.05$, respectively) compared to those in Nairobi Province.

Consistent attenuation of the odds ratios was observed through model 5 after controlling for socioeconomic factor (measured by wealth index), knowledge index, mother's attitudes index, and autonomy index. Children born to mothers with a primary education were 1.53 times more likely to be fully immunized compared to mothers with no education at all, $P < 0.05$. After further controlling for reproductive behavior birth interval and source of information, mothers who have completed a primary education were notably associated with complete immunization of children. Those children born to mothers with a primary education were 2.20 times more likely to be fully immunized compared to children born to mothers with no education at all, $P < 0.05$.

Multivariate Logistic Regression Results (Effect of Maternal Education on Child's Nutritional Status)

Table 3 indicates results predicting the effect of maternal education on child's nutritional status in Kenya. Model 1 (unadjusted results), mother's primary education is significantly related to stunted growth among children. Children born to mothers with a primary education were at 94% lower odds of having stunted growth, $P < 0.01$) compared to children born to mothers with no education at all. However, after control for place of residence, mother's current age, partner's education, region of residence, and wealth index (models 2 and 3), there was no significant association between maternal education and child's nutritional status. However, after controlling for knowledge index (model 4) children born to mothers with a primary education were 15% more likely to have stunted growth compared to those born to mothers with no education at all, $P < 0.05$.

There was association between maternal education and child's nutritional status after further controlling for mother's attitude index, autonomy index, birth order parity, birth intervals, and information source (model 8). Children under mothers care with a primary education were 4% less likely to have poor nutritional status (stunted growth) compared to mother who had no education at all. In addition, this was notable for mothers with a secondary education. Children under mothers care with secondary education were 33% less likely to have stunted growth compared to those whose mother had no education at all.

Table 2 Adjusted odds ratios showing the effect of maternal education on children's complete immunization, KDHS-2003

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Maternal education								
No education (REF)								
Primary education	2.168***	1.846**	1.805**	1.631*	1.527*	2.291**	2.083*	2.201*
	(0.19)	(0.22)	(0.22)	(0.22)	(0.22)	(0.29)	(0.30)	(0.31)
Secondary education	2.680***	2.158**	2.036**	1.650*	1.41	1.951*	1.60	1.80
	(0.20)	(0.25)	(0.25)	(0.25)	(0.25)	(0.33)	(0.34)	(0.36)
Place of residence								
Urban (REF)								
Rural		0.84	0.79	0.77	0.73	0.76	0.73	0.74
		(0.17)	(0.19)	(0.18)	(0.18)	(0.25)	(0.25)	(0.26)
Age								
Mother's current age		0.99	0.99	0.99	0.99	1.00	1.04	1.04
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Partner's education								
No education (REF)								
Primary education		1.18	1.17	1.12	1.13	0.93	1.02	0.91
		(0.16)	(0.16)	(0.16)	(0.16)	(0.26)	(0.26)	(0.26)
Secondary education		1.38	1.36	1.25	1.23	1.33	1.44	1.35
		(0.18)	(0.18)	(0.18)	(0.18)	(0.26)	(0.25)	(0.25)
Region of residence								
Nairobi (REF)								
Central		1.59	1.51	1.682*	1.59	1.69	1.60	1.55
		(0.23)	(0.26)	(0.27)	(0.28)	(0.34)	(0.35)	(0.34)
Coast		1.49	1.50	1.54	1.62	1.63	1.62	1.66
		(0.27)	(0.26)	(0.26)	(0.27)	(0.31)	(0.32)	(0.33)
Eastern		1.07	1.04	1.07	1.06	1.18	1.19	1.22
		(0.27)	(0.27)	(0.27)	(0.27)	(0.34)	(0.34)	(0.35)
North eastern		.225***	.234***	.188***	.239***	0.65	0.65	0.69
		(0.37)	(0.38)	(0.37)	(0.37)	(0.71)	(0.68)	(0.71)
Nyanza		.375***	.385**	.370***	.388*	.384**	.409*	0.391**
		(0.30)	(0.30)	(0.29)	(0.30)	(0.36)	(0.37)	(0.36)
Rift Valley		0.92	0.93	0.92	0.96	1.08	1.12	1.10
		(0.26)	(0.25)	(0.25)	(0.26)	(0.34)	(0.35)	(0.35)
Western		.587*	0.60	.584*	0.62	0.57	0.61	0.58
		(0.27)	(0.28)	(0.27)	(0.27)	(0.33)	(0.34)	(0.32)
Socioeconomic factors								
Poor wealth index (REF)								
Middle wealth index			1.31	1.32	1.28	1.04	1.22	0.99
			(0.17)	(0.17)	(0.17)	(0.20)	(0.14)	(0.20)
Rich wealth index			1.21	1.19	1.11	0.90	0.82	0.84
			(0.16)	(0.16)	(0.16)	(0.17)	(0.17)	(0.17)
Knowledge index				1.296***	1.268***	1.229***	1.224***	1.237***
				(0.05)	(0.05)	(0.06)	(0.06)	(0.06)
Mother's attitude index					1.200***	1.167**	1.144**	1.137*
					(0.04)	(0.05)	(0.05)	(0.05)
Autonomy index						0.77	0.76	0.76
						(0.11)	(0.11)	(0.11)

Table 2 continued

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Reproductive behaviors								
Birth order/parity							.894*	.883*
							(0.05)	(0.05)
Birth interval								
≥48 months (REF)								
Less than 24 months							0.81	0.82
							(0.19)	(0.19)
Between 25 and 47 months							0.70	.701*
							(0.14)	(0.14)
Sources of information								
Listen to radio								
No (REF)								
Yes								1.36
								(0.20)
Read newspaper								
No (REF)								
Yes								.665*
								(0.16)
Watch TV								
No (REF)								
Yes								1.07
								(0.17)
−2 Log likelihood	2996.352	2876.17	2870.79	2822.83	2799.02	1711.61	1694.19	1678.35
N	2169.00	2169.00	2169.00	2169.00	2169.00	2169.00	2169.00	2169.00

Standard errors are reported below the odds ratios

REF Reference category

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

However, there was no statistical significance observed for these two scenarios. Also, there was a significant association between wealth index (model 8). Children who lived in a richer household (rich wealth index) were 39% less likely to have stunted growth compared to those who lived in a poor household (poor wealth index), $P < 0.05$.

Discussion

The objective of this study was to assess the effect of maternal education on child health in Kenya as measured by complete immunization and nutritional status. We find that mother's health knowledge, receptive attitude toward modern medicine, reading newspapers, and birth interval (25–47 months) are significantly related to children's complete immunization. The findings on receptive attitude and use of modern health care are similar to those of previous studies [7, 28, 31], which demonstrated that there is an important link between mothers' attitudes toward modern medicine, maternal education, and child health. Therefore, we conclude that transforming the attitudes of mothers in Kenya, is one way of encouraging them to seek immunization services, hence increasing the number of children who are fully vaccinated against childhood diseases and illnesses.

Concurrent with previous research [7, 31], our findings support the association between health knowledge and children's complete immunization. We can conclude that formal education is important in imparting health knowledge to women, which, in turn, leads to important improvements in child health. In addition, as indicated in the multivariate analysis, the significance of reading newspapers as a source of information and maternal education makes us conclude that education is critical in enhancing women's understanding and synthesis of information about health issues. These issues include immunization campaigns appearing in the print media. We had expected to find a significant relationship between mother's autonomy and child health (both complete immunization and stunting) as shown in previous literature. One plausible reason is the lack of reliable measures of autonomy in the

Table 3 Adjusted odds ratios showing the effect of maternal education on children's nutritional status, KDHS-2003

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Maternal education								
No education (REF)								
Primary education	.063**	1.07	1.15	1.152*	1.21	0.88	0.90	0.96
	(0.14)	(0.16)	(0.17)	(0.17)	(0.16)	(0.24)	(0.24)	(0.25)
Secondary education	0.32	0.72	0.85	0.86	0.95	0.68	0.64	0.67
	(0.15)	(0.17)	(0.17)	(0.17)	(0.17)	(0.26)	(0.25)	(0.27)
Place of residence								
Urban (REF)								
Rural		1.09	0.85	0.84	0.82	0.88	0.93	0.94
		(0.14)	(0.16)	(0.16)	(0.16)	(0.19)	(0.21)	(0.21)
Age								
Mother's current age		0.99	0.99	0.99	0.99	0.99	1.01	1.02
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Partner's education								
No education (REF)								
Primary education		1.794***	1.791***	1.800***	1.770***	1.760**	1.18	1.32
		(0.14)	(0.14)	(0.14)	(0.14)	(0.20)	(0.25)	(0.26)
Secondary education		1.09	1.13	1.13	1.14	1.17	0.82	0.93
		(0.14)	(0.13)	(0.13)	(0.13)	(0.20)	(0.25)	(0.26)
Region of residence								
Nairobi (REF)								
Central		1.679*	1.797*	1.775*	1.849*	1.57	1.41	1.38
		(0.25)	(0.25)	(0.25)	(0.25)	(0.34)	(0.38)	(0.38)
Coast		1.67	1.61	1.60	1.57	1.18	0.94	0.89
		(0.27)	(0.26)	(0.26)	(0.26)	(0.35)	(0.38)	(0.38)
Eastern		1.852*	1.850*	1.838*	1.832*	1.48	1.57	1.49
		(0.26)	(0.26)	(0.26)	(0.26)	(0.34)	(0.37)	(0.37)
North eastern		0.69	0.62	0.62	.532*	.309*	.202**	0.162**
		(0.30)	(0.30)	(0.30)	(0.31)	(0.47)	(0.56)	(0.37)
Nyanza		1.23	1.11	1.11	1.07	0.91	0.85	0.84
		(0.24)	(0.23)	(0.23)	(0.23)	(0.31)	(0.34)	(0.34)
Rift Valley		1.784*	1.740*	1.732*	1.661*	1.78	1.44	1.37
		(0.23)	(0.23)	(0.23)	(0.22)	(0.30)	(0.32)	(0.32)
Western		1.54	1.38	1.37	1.31	1.25	1.14	1.13
		(0.24)	(0.24)	(0.24)	(0.24)	(0.32)	(0.35)	(0.35)
Socioeconomic factors								
Poor wealth index (REF)								
Middle wealth index			0.84	0.84	0.86	0.84	0.76	0.78
			(0.14)	(0.14)	(0.13)	(0.18)	(0.19)	(0.19)
Rich wealth index			.601***	.603***	.637**	.595**	.564**	.607*
			(0.14)	(0.14)	(0.15)	(0.18)	(0.21)	(0.22)
Knowledge index				0.98	1.00	0.98	1.02	1.01
				(0.04)	(0.04)	(0.05)	(0.06)	(0.06)
Mother's attitude index					.886***	.905*	0.91	1.92
					(0.03)	(0.04)	(0.05)	(0.05)
Autonomy index						0.95	0.99	0.99
						(0.11)	(0.12)	(0.12)

Table 3 continued

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Reproductive behaviors								
Birth order/parity							0.93	0.93
							(0.05)	(0.05)
Birth interval								
≥48 months (REF)								
Less than 24 months							1.36	1.38
							(0.20)	(0.20)
Between 25 and 47 months							1.19	1.20
							(0.16)	(0.16)
Sources of information								
Listen to radio								
No (REF)								
Yes								.602*
								(0.22)
Read newspaper								
No (REF)								
Yes								1.13
								(0.16)
Watch TV								
No (REF)								
Yes								0.09
								(0.15)
−2 Log likelihood	4589.625	4493.53	4471.92	4470.27	4453.97	2646.33	2055.14	2040.97
N	5949.00	5949.00	5949.00	5949.00	5949.00	5949.00	5949.00	5949.00

Standard errors are reported below the odds ratios

REF Reference category

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

KDHS data set, which could have affected the results of the current study. In addition, the socioeconomic indicators did not have a significant impact on children's immunization status, which is contrary to previous research by Desai and Alva [21].

Our findings further support the association between maternal education and child's nutritional status; however, there was no statistical significance reached. This lack of significance could be explained by the small sub-sample for primary and secondary education among mothers in the sub-analysis. Furthermore, SES was one of the covariate's that was associated with child's nutritional status with a statistical significance being observed, a finding similar to previous studies [32, 33]. We also find surprising results in North Eastern Province, where the findings suggest that children are less likely to be stunted. Because of the nomadic lifestyle, harsh living conditions, and low levels of education associated with this region, we expected a reverse relationship. We speculate that three factors may be influencing this outcome. First, ownership of large herds of cattle provides the families with milk, which is a rich source of nutrients for their children at early ages. Secondly, because of low levels of education, most mothers in the province do not work outside the home. Thus, the mothers are available to breastfeed their infants for longer durations. Third, children in North Eastern province may be benefiting from the food supplies provided by the various government agencies and non-governmental organizations (NGOs) that operate in the province. Equally as important listening to radio was associated with a lesser likelihood of children being stunted. This means that radio broadcasts are important tools for disseminating public health awareness and information campaigns in Kenya.

Our results are *limited* by the absence of direct measures for attitude and autonomy of mothers in relation to child health; these indices were constructed using proxy and not direct indicators. This construction might have affected the impact of these variables on the dependent variable. Since this study was cross–sectional in nature, it was not possible to assess the impact of maternal education on children's health over time. In addition, our findings are limited to one context—Kenya; therefore, the findings cannot be

generalized to other African countries. Future research should seek to establish the determinants of low immunization coverage (particularly in Nyanza province) as well as the reasons why children in North Eastern are not stunted.

Overall, our findings have significant *policy implications* for child's health in Kenya. Increasing levels of health knowledge among women is important in achieving better children health outcomes, especially complete immunization. One way of improving the knowledge levels is through incorporating health knowledge into the primary school curricula so as to reach the majority of children—among them young girls who are future mothers and more likely to be mothers themselves at a younger age [34]. Transforming mothers' attitudes toward modern medicine is critical in ensuring that the majority of children in Kenya are fully immunized against childhood diseases and illnesses. Thus, targeted information campaigns—through media sources such as the radio and newspaper that are aimed at changing women's attitudes toward modern health care should be implemented in order to educate mothers about the benefits of having their children fully immunized. In addition, the importance of proper nutrition for healthy growth and development should be emphasized. This is a key issue to reducing the infant/child mortality rates in Kenya, hence, bringing Kenya a step closer to achieving the MDG goal of improving child health and reducing child mortality.

A closer government attention is required in Nyanza Province to boost the immunization coverage for children between 12 and 35 months in the province. These results show that an integrated approach that includes improving schooling levels, increasing the levels of health knowledge, and developing positive attitudes toward modern health care among mothers are beneficial for children immunization. However, improved wealth in the household is a primary driving force behind better nutrition of children. Thus, targeted policy initiatives aimed at eradicating poverty and malnutrition are critical to ensuring that children across all the eight provinces have access to nutritious food critical for healthy growth and development.

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