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Disentangling the rural-urban immunization coverage disparity in The Gambia: A Fairlie decomposition

Alieu Sowe [a,*], Klara Johansson [b]

[a] Ministry of Health and Social Welfare, Gambia
[b] Department of Epidemiology and Global Health, Umeå University, Sweden

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ABSTRACT

Introduction: Exploring factors underlying disparities in immunization uptake is highly relevant and can contribute to improved immunization interventions globally. The Gambia is an interesting case, since higher immunization coverage in rural areas has been shown for many years, yet the factors explaining this unexpected rural-urban disparity have not been studied. The aim of our study was to quantify the rural-urban disparity in immunization coverage and identify factors that contribute to explaining it.
Methods: Data from the nationally representative Demographic and Health Survey 2013 was used to select children aged 12–23 months (Weighted n = 1644) for the study. The outcome measure was full immunization status, the grouping variable was area of residence. Descriptive statistics were used to analyze the proportions of full immunization and rural-urban residence across the exposure variables. The Fairlie decomposition technique was used to decompose factors contributing to explaining the coverage disparity.
Results: The findings show that there is a disparity of 16.06 percentage points to the advantage of the rural areas and the exposure variables explained 76.49% of the disparity. Material factors explained 92.03% of the explained disparity with maternal occupation and household wealth quintile being the only significant individual material variable contributors to the explained disparity. Lower household wealth quintile and working especially in agriculture were associated with higher immunization coverage and they were more common in rural areas. Religion and mother's age group e each contributed somewhat to the explained inequality.
Conclusions: There was a large immunization coverage disparity between rural and urban areas in The Gambia. This disparity was mainly explained by mothers working in agriculture and living in the poorest households, being more likely to immunize their children – unexpected findings. Our study showed that the drivers of healthcare disparities differ by setting and deserve more research.

1. Introduction

Despite success in global immunization coverage [1], significant disparities exist between and within countries [2,3]. To ensure a sustained and continued decrease in the incidence of vaccine-preventable diseases, high immunization coverage needs to be attained and maintained for all required vaccines (i.e. full immunization coverage – FIC) in all communities. The analysis of factors that explain differences in immunization coverage between communities can help increase full coverage and decrease inequalities in coverage.

Factors influencing immunization coverage have been widely studied in low- and middle-income countries [4–7]. Unsurprisingly, similar factors seem to explain both immunization coverage and disparities therein [3,8,9]. Generally, socioeconomic and demographic characteristics, immunization systems/services, information and belief-related factors have been associated with immunization coverage [5,6].

Access to immunization service delivery points (or distance to health facilities) is an important determinant of a child's immunization status [6]. Children that live farther away from immunization service delivery points are less likely to be immunized [6,10]. Mother/ caregiver's age, mother's marital status, child's sex, and ethnicity have also been related to immunization coverage. Children born to mothers less than 30 years of age and children of married mothers have been found more likely to be fully immunized

* Corresponding author.
E-mail addresses: sowea1@yahoo.com (A. Sowe), klara.johansson@umu.se (K. Johansson).

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compared to children born to mothers in older age groups and unmarried mothers respectively in Nigeria [11]. Male children have been observed to have a higher likelihood of full immunization compared to female children, in Ethiopia [12].

Maternal and household characteristics such as maternal education, maternal occupation and household wealth quintile influence children's immunization status. Higher maternal education level strongly predicts children being immunized, in different parts of the world [11,13,14]. One suggested explanation is that educated mothers are believed to have better access to health services and to be more aware of the benefits of immunization. In terms of wealth, children in richer households usually have higher likelihood of immunization in comparison with those living in poorer households [2,10]. For maternal occupation, working mothers have been shown to be less likely to have their children fully immunized than non-working mothers [11], at least in settings, such as The Gambia, where provision of immunization is not dependent on health insurance tied to employment. This has been attributed to the busy work schedules of working mothers.

The Gambia, in West Africa, has a successful immunization program, but with some perplexing variations within the country. The country has attained and maintained high immunization coverage (>90% for individual vaccine doses) for almost all individual antigens in the national immunization schedule as per administrative reports [15]. However, nationally representative surveys (Multiple Indicator Cluster Surveys (MICS) and a Demography and Health Survey (DHS)) have highlighted surprising gaps in coverage between rural and urban areas of the country [16–20] to the advantage of rural areas. In addition to these surveys, other studies have also highlighted disparities in immunization between rural and urban areas in The Gambia [21,22] in a direction similar to the surveys. Since the first MICS in the country in 1996 [16] which could be considered the reference point for observing such a disparity, through other surveys afterwards, to the most recent DHS in 2013 [20], the FIC gap between rural and urban areas has only appeared to widen. MICs and DHS surveys are highly comparable [23] and data from the two have been merged and used in many studies [24,25]. Supplemental Table 1 summarizes rural-urban coverage as reported by four MICS and one DHS.

Immunization coverage, timeliness, cost-effectiveness, and the impact of selected vaccines in The Gambia have been studied [21,22,26–28], as well as factors associated with timeliness and coverage [21,22,29] and local vaccination cultures [30]. However, there is a lack of knowledge regarding factors that might explain the disparity in immunization coverage between rural and urban areas in The Gambia. Such a study could be of global interest, shedding some light on the complexities of immunization programs and health systems, which may hinder or facilitate high immunization coverage and drive inequalities in immunization. The understanding of these is an ongoing pursuit to improving immunization coverage and closing coverage gaps between groups. Thus, this study aims to disentangle the factors explaining rural–urban disparities in FIC in The Gambia.

1.1. Context

The Gambia, located in West Africa, is one of the smallest countries in mainland Africa, with a population of about 1.9 million people based on the 2013 census preliminary results [31]. About 60% of the country's population lives in urban areas and the rest in rural areas [32]. Agriculture is the main source of income, especially in rural areas. Poverty rates are higher in the rural than urban areas of the country (73.9% vs 32.7%) [33].

The Gambia's Expanded Program on Immunization was initiated in 1979 and has been successful in reducing child morbidity and mortality [26,34,35]. The success of the program is believed to be driven by good access to immunizations and the population being receptive to immunization services [30]. Vaccines are offered free of charge at all immunization points regardless of whether the immunization service point is run by government or non-government employed health workers. Immunization services are delivered through static/fixed clinic sessions conducted at health facilities (commonly called base clinics) and through regular monthly outreach services to hard-to-reach or distant communities [22]. Immunization clinic sessions are part of the integrated reproductive and child health (RCH) package, which encompasses services such as pediatric and pregnant women immunizations, antenatal services, weighing of children, and treatment of minor illnesses. Since fixed clinics are located in health facilities and health facilities are more commonly found in urban areas (bigger settlements/towns), base clinics are therefore more frequent in urban areas whilst outreach clinics are more common in rural areas. Similarly, private health facilities are more prevalent in urban than in rural areas because of customer availability.

2. Materials and methods

2.1. Data collection and study subjects

The data source for this study was the nationally representative The Gambia Demographic and Health Survey (DHS) conducted in 2013 [20]. The DHS was a stratified cross-sectional study based on two-stage sampling. All but two (urban) local government areas were stratified into urban and rural areas. The first stage involved the selection of census Enumeration Areas (EAs), the Primary Sampling Units (281 EAs), using probability proportional to estimated size. The second sampling stage was the selection of households, the Secondary Sampling Units, from the selected the EAs. Twenty-five households were selected per EA using equal probability systematic selection. The response rates were 95% for households and 91% for women, [20]. Children's immunization information was collected in the women's questionnaire.

Trained interviewers administered survey questionnaires to eligible respondents in the selected households. All women aged 15–49 years resident in selected households or who spent the night before the survey in the selected household were eligible to be interviewed. The total number of women interviewed for the DHS was 10,233 with 8765 children less than 5 years [20]. Data including immunization history was collected for every child less than five years old, born to an interviewed woman. The target age group for our study was children aged 12–23 months because the last immunization dose of interest for a child to be considered fully immunized was the first measles dose [36]. This is the commonest and WHO-recommended age cohort for coverage surveys when the last dose of interest is given from 9 months as in this case. The number (unweighted) of children within the age bracket of our study was 1637. The weighted number of children in our study was 1644. Of these, 878 children live in rural areas while 766 live in urban areas.

2.2. Ethical considerations

DHS surveys are standardized surveys that have been implemented in more than 90 countries [37]. The ICF Institutional Review Board reviews and approves all procedures and questionnaires for the surveys prior to their implementation [38]. Prior to administering the questionnaires, interviewers were required to clearly read a consent statement to a respondent and obtain her informed consent [20].

2.3. Measures

2.3.1. Health outcome variable

Full Immunization status, a dichotomous variable, was derived from the children's immunization history. A child was considered fully immunized if he/she had received 1 dose of BCG, 1 dose of measles, and 3 doses each of DPT (Diphtheria, Pertussis, and Tetanus Toxoid) or pentavalent and polio vaccine as per immunization card or caregivers' recall based on The Gambia's immunization schedule at the time of data collection for the DHS [20]. Immunization card retention was high during the DHS – at 90.2% [20].

2.3.2. Grouping variable

Area of residence (urban or rural) was the variable used to group the study participants.

2.3.3. Exposure variables

Exposure variables were selected based on findings from the literature and grouped as demographic variables, material, cultural, or sociodemographic. Exposure variable categories were entered as dummy variables in the decomposition models.

2.3.4. Demographic variables

Children's mothers' ages and child's birth order number were presented as categorical variables in the descriptive analysis (see Tables 1 and 2). In the regression and decomposition analyses, these variables were included as continuous variables (Tables 3 and 4). Sensitivity analyses using these variables as categorical gave similar results.

2.3.5. Material variables

Household wealth quintile was calculated in the DHS through principal component analysis using ownership of specified household assets, housing construction materials, access to potable water, and sanitation facilities [20]. The poorest household was made the reference. Occupation was categorized into five categories - not working, manual/household/domestic, agriculture (a diverse group that also includes foresters, fishermen, etc), sales, and professional/technical/managerial/clerical (referred to as just "professionals" hereafter). The reference category was Not working. Maternal education was categorized as no education, primary education, and secondary or higher education. The reference category was No education. There was no direct question asking mothers about the distance from their homes to a health facility to get their children immunized. However, they were asked whether distance was a big problem or not when they needed medical advice or treatment. This question was used as a proxy for distance to health facility to immunize children. The responses were categorized into those who said it was a big problem and those who said it was not a big problem, with the latter as the reference group.

2.3.6. Behavioral/cultural variables

Religion was categorized into Islam and Christianity. Christianity was set as the reference category. Ethnicity was identified by Mandinka (reference group), Wolof, Jola/Karoninka, Fula, Serahuli, Serer, Others and Non-Gambians.

2.3.7. Sociodemographic variables

Marital status was categorized into currently married and not currently married with not currently married being made the reference category. More than half of those not currently married were never married. A child's sex was recorded as either male or female. Male children were made the reference category.

2.4. Data analysis

2.4.1. Descriptive statistics

Descriptive statistics were used to analyze the proportions of full immunization and rural–urban residence across the exposure variables (see Tables 1 and 2).

2.4.2. Main analyses – Fairlie decomposition

The Fairlie decomposition technique was used to estimate and decompose the disparity in FIC between rural and urban areas. The technique is an extension of the Blinder-Oaxaca for logit and probit models [39] implemented in Stata using the module developed by Jann [40] and can be mathematically expressed as in Equation 1 in the supplemental material.

Table 1
Weighted full immunization coverage across all the variables.

Variables	Fully immunized		Chi Square
(n = 1644)	Yes n (row %)	No n (row %)	P value
Residence			**<0.001**
Rural	735 (83.8%)	143 (16.3%)	
Urban	518 (67.7%)	248 (32.3%)	
Demographic Variables			
Birth order number			**0.009**
1	243 (67%)	119 (33%)	
2 and 3	447 (79.6%)	115 (20.4%)	
3 and 4	269 (75.9%)	85 (24.1%)	
6 and above	296 (80.7%)	71 (19.4%)	
Mother's age group			**0.007**
15–24	389 (76.9%)	117 (23.1%)	
25–34	578 (72.6%)	218 (27.4%)	
35–49	287 (83.7%)	56 (16.3%)	
Material Variables			
Mother's education			**0.012**
No education	736 (78.6%)	200 (21.4%)	
Primary	201 (81.7%)	45 (18.3%)	
Secondary & +	318 (68.7%)	145 (31.3%)	
Maternal occupation			**<0.001**
Not working	506 (72.5%)	192 (27.5%)	
Manual/Household	62 (65.6%)	32(34.4%)	
Agriculture	416 (89.1%)	51 (10.9%)	
Sales	241 (68.1%)	113(31.9%)	
Professional	30 (92.4%)	2 (7.6%)	
Wealth quintile			**<0.001**
Poorest	277 (83.7%)	54 (16.3%)	
Poorer	278 (77%)	83 (23%)	
Middle	287 (80.3%)	70 (19.7%)	
Richer	245 (76.8%)	74 (23.2%)	
Richest	167 (60.5%)	109 (39.5%)	
Distance to health facility			0.504
Not a big problem	851 (75.6%)	275 (24.4%)	
A big problem	403 (77.8%)	115 (22.2%)	
Behavioral/Cultural variables			
Ethnicity			**0.001**
Mandinka	479 (81.8%)	107 (18.2%)	
Wolof	162 (72.6%)	61 (27.4%)	
Jola/Kar	102 (73.1%)	38 (26.9%)	
Fula	290 (74.5%)	99 (25.5%)	
Serahuli	101 (88%)	14 (12%)	
Serere	34 (78.2%)	10 (21.8%)	
Others	31 (54.5%)	26 (45.5%)	
Non-Gambian	39 (52.4%)	36 (47.6%)	
Missing	17 (92.8%)	1 (7.2%)	
Religion			**0.001**
Islam	1239 (77%)	370 (23%)	
Christianity	14 (41.7%)	20 (58.3%)	
Sociodemographic variables			
Child's gender			0.149
Boys	661 (78.2%)	183.8 (21.8%)	
Girls	593 (74.2%)	206.4 (25.8%)	
Mother's current marital status			0.207
Not married	67 (69.9%)	29 (30.1%)	
Married	1187 (76.7%)	362 (23.3%)	

Table 2
Weighted frequencies of exposure variables by residence.

Variable (n = 1644)	Rural n (col %)	Urban n (col %)	Chi Square P value
Mother's age group			0.063
15–24	292 (33.2%)	214 (27.9%)	
25–34	392 (44.6%)	404 (52.7%)	
35–49	195 (22.2%)	148 (19.4%)	
Child's birth order number			**<0.001**
1	177 (20.1%)	185 (24.2%)	
2 and 3	258 (29.4%)	304 (39.7%)	
4 and 5	213 (24.2%)	141 (18.5%)	
6 & +	231 (26.3%)	136 (17.7%)	
Household wealth quintile			**<0.001**
Poorest	294 (33.5%)	37 (4.9%)	
Poorer	309 (35.1%)	53 (6.9%)	
Middle	240 (27.4%)	117 (15.2%)	
Richer	33 (3.8%)	285 (37.2%)	
Richest	2 (0.2%)	274 (35.8%)	
Maternal occupation			**<0.001**
Not working	300 (34.2%)	398 (51.9%)	
Manual/Household	19 (2.1%)	75 (9.8%)	
Agriculture	441 (50.3%)	26 (3.3%)	
Sales	113 (12.8%)	241 (31.4%)	
Pro/Tec/managerial	5 (0.6%)	27 (3.5%)	
Maternal education			**<0.001**
No education	605 (68.9%)	331 (43.2%)	
Primary	128 (14.5%)	118 (15.4%)	
Secondary	145 (16.6%)	317 (41.4%)	
Distance to health facility			**<0.001**
Not a big problem	496 (56.4%)	630 (82.3%)	
Big problem	383 (43.6%)	136 (17.7%)	
Religion			0.177
Islam	866 (98.6%)	744 (97.1%)	
Christianity	12 (1.4%)	22 (2.9%)	
Ethnicity			**<0.001**
Mandinka	288 (32.8%)	298 (38.9%)	
Wolof	127 (14.4%)	96 (12.5%)	
Jola/Karoninka	50 (5.7%)	90 (11.8%)	
Fula	263 (30%)	126 (16.4%)	
Serahuli	79 (9%)	36 (4.7%)	
Serere	11 (1.3%)	33 (4.3%)	
Others	25 (2.8%)	32 (4.1%)	
Non-Gambian	23 (2.6%)	52 (6.8%)	
Missing ethnicity	13 (1.5%)	5 (0.6%)	
Mother's marital status			0.057
Not currently married	39 (4.4%)	57 (7.4%)	
Currently married	840 (95.6%)	709 (92.6%)	
Child's gender			0.963
Male	451 (51.3%)	394 (51.5%)	
Female	428 (48.7%)	372 (48.6%)	

Table 3
Weighted marginal effects of multivariable logit regression of full immunization on the exposure variables.

Variable	dy/dx[a] (SE[b])	P Value
Child's birth order	<0.001 (0.011)	0.969
Mother's age	−0.013 (0.016)	0.408
Mother's age squared	<0.001 (<0.001)	0.310
Maternal occupation		
Not working (reference)		
Manual/Household	−0.054 (0.067)	0.420
Agriculture	**0.105 (0.032)**	**0.001**
Sales	−0.065 (0.040)	0.104
Professional	**0.215 (0.031)**	**< 0.001**
Maternal education		
No education (reference)		
Primary	0.065 (0.037)	0.077
Secondary & above	−0.024 (0.045)	0.593
Household wealth quintile		
Poorest (reference)		
Poorer	**−0.067 (0.031)**	**0.033**
Middle	−0.037 (0.032)	0.255
Richer	−0.032 (0.041)	0.435
Richest	**−0.19 (0.065)**	**0.004**
Distance to health facility		
Not a big problem (reference)		
A big problem	−0.016 (0.028)	0.572
Religion		
Christianity (reference)		
Islam	**0.341 (0.132)**	**0.011**
Ethnicity		
Mandinka (reference)		
Wolof	**−0.084 (0.042)**	**0.046**
Jola/Karoninka	−0.044 (0.057)	0.445
Fula	**−0.093 (0.033)**	**0.005**
Serahuli	0.051 (0.048)	0.282
Serere	−0.005 (0.070)	0.945
Others	−0.112 (0.101)	0.268
Non-Gambian	**−0.244 (0.093)**	**0.009**
Missing	0.089 (0.067)	0.184
Marital status		
Not married (reference)		
Married	−0.044 (0.072)	0.536
Gender		
Male (reference)		
Female	−0.035 (0.025)	0.165

Bold indicates results are statistically significant.
[a] Marginal effect.
[b] Standard Error.

The Fairlie decomposition technique basically tests how much of the difference in FIC between rural and urban areas is due to (explained by) rural-urban differences in variables included in the analysis. It also goes further to estimate the contribution of each variable to the explained FIC difference between rural and urban areas.

A logit regression model was fitted to estimate the effects of each of the variables on FIC. Marginal effects, their standard errors, and p values were reported. Following this, we ran two decomposition models. The first model estimated the rural-urban FIC disparity, explained disparity, and the individual contribution of each exposure variable to the explained differential. In the second model, the difference in FIC between urban and rural areas, the explained difference, and the contribution of each group of exposure variables (demographic, material, behavioural/cultural, and sociodemographic) to the explained differential was measured. We used a type I error rate of 0.05. For all analyses, we used survey weights, for the Tables 1–3 using the STATA "svy" command, and for the Fairlie decomposition, which is not compatible with svy, there is an option for declaring survey weights, which we used.

In the Fairlie decomposition technique, a positive coefficient would result in a positive contribution to the rural-urban FIC inequality and it is interpreted as supporting (increasing) the rural-urban FIC inequality if the inequality is positive, which is the case here. A negative coefficient would similarly yield a negative contribution to the FIC inequality and consequently works to decrease the inequality if the inequality is positive, as is the case here.

2.4.3. Additional analyses

All variables were examined for missingness and patterns in missingness. Ninety-eight percent of the children had complete information for all the variables. Of the 2% with missing values, 1% (22) had missing information on ethnicity alone. The remaining 1% was constituted by missingness in the other variables. There was no pattern in missingness i.e. missingness in one variable was not related to missingness in another variable. Since 19 of the 22 with missing data in ethnicity resided in rural areas and 19 of the 22 were fully immunized, it was thought wise to include them as a category called "Missing ethnicity" (instead of dropping them). A complete case analysis was then applied – dropping those with missingness in the other variables.

We conducted a sensitivity analysis (see supplemental Tables 2 and 3) by using only immunization history obtained through

immunization cards to check the effects of parent's recall on our results. This analysis increased the explained disparity by 7 percentage points and shrank the rural-urban coverage disparity by about 3 percentage points. The second poorest household quintile became insignificantly associated with FIC during the sensitivity analysis. Vaccination history by parents' recall was more frequent in urban areas.

Possibility of multicollinearity was investigated by computing variance inflation factors (VIF). The highest VIF was 2.28 indicating that all the VIFs were within acceptable limits. Therefore, multicollinearity was not likely to be a problem in the models.

All analyses were performed using Stata version 13.1 [41].

3. Results

3.1. Descriptive statistics

There was 1644 weighted number of children aged 12–23 months, a majority lived in a rural area.

Table 1 presents FIC across the exposure variables. Full immunization coverage was highest in rural areas, among children with birth order numbers 6 or more, children born to mothers in the age group 35–49 years, children of mothers with only primary education, children of professionals and agricultural workers and in the poorest wealth quintile. The Serahuli and Mandinka ethnic groups had the highest proportions of FIC and Fulas and Non-Gambians had the lowest. In terms of religion, FIC was significantly higher among Muslims than among Christians.

Table 2 shows the proportions of different categories of the exposure variables by residence. In rural areas, there was a significant overrepresentation of higher birth order numbers, poor and middle-income households (those in the three lower wealth quintiles), low education, and reporting distance to a health facility to be a problem. For maternal occupation, in urban areas, there was an overrepresentation of women who were not working, professional women, and sales/services work, while agricultural work was more common in rural areas.

The Mandinka ethnic group is the biggest ethnic group in The Gambia and accounted for the highest proportions in both rural and urban areas but more common in urban areas. Fulas were overrepresented in rural areas whilst non-Gambians were more commonly found in urban areas.

3.2. Regression

In the multivariable regression controlling all variables for each other (Table 3) the factors that remained significantly and positively related to FIC was mothers being agricultural workers or professionals compared to non-working, and Muslim faith. The factors that remained significantly and negatively related to FIC was living in the richest households (fifth quintile) compared to those in the poorest households and Non-Gambians, Fulas, and Wolofs compared to the Mandinka ethnic group (see Table 3).

3.3. Decomposition

Table 4 presents the decomposition results. The rural-urban disparity in FIC was 16.06 percentage points. Of the 16.06 percentage points difference, 12.29 percentage points, representing 76.49% of the percentage points difference, was explained by differences in the exposure variables included in our analysis. Material factors accounted for 92.03% (Fig. 1) of the explained 12.29 percentage points disparity in FIC between rural and urban areas, of which maternal occupation contributed 43.21 percentage points and household wealth quintile contributed 48.17 percentage points. Maternal education and distance to health center did not contribute significantly to explaining the rural-urban immunization coverage disparity. Religion explained 4.56% of the rural-urban disparity in FIC. Ethnicity had no significant contribution to the coverage gap. When religion and ethnicity (cultural factors) were grouped as one, they did not contribute significantly to explaining the rural-urban differences in FIC. Demographic and sociodemographic variables did not contribute significantly to explaining the rural-urban immunization disparity.

Table 4
Weighted decomposition of the disparity in FIC between rural and urban residences The Gambia.

Rural full immunization coverage		83.75%	
Urban full immunization		67.69%	
Rural-Urban disparity		16.06% percentage points	
Total explained disparity		12.29% percentage points	
% total explained disparity		76.49%	
Variable	**Coefficient**[a]	**% Contribution to the explained disparity**	**P value**
Demographic variables			
Child's birth order	0.0003	0.24%	0.966
Mother's age	0.0034	2.77%	0.367
Sub-total	0.0037	3.01%	0.640
Material variables			
Mother's occupation	0.0531	**43.21%**	**<0.001**
Mother's education	0.0057	4.64%	0.578
Household wealth quintile	0.0592	**48.17%**	**0.018**
Distance from health facility	−0.0045	−3.66%	0.575
Sub-total	0.1131	**92.03%**	**<0.001**
Behavioral/Cultural variables			
Religion	0.0056	**4.56%**	**0.006**
Ethnicity	0.0015	1.22%	0.847
Sub-total	0.0075	6.10%	0.326
Sociodemographic variables			
Mother's marital status	−0.0014	−1.14%	0.553
Child's gender	0	0%	0.994
Sub-total	−0.0013	−1.06%	0.591

Bold indicates results are statistically significant.

[a] Note: Two models were used to decompose the results presented above. The first model decomposed the rural-urban disparity using individual variable grouped dummy variables and the second model decomposed the disparity using theoretical perspective grouped (biological, material, cultural, and Psychosocial) dummy variables.

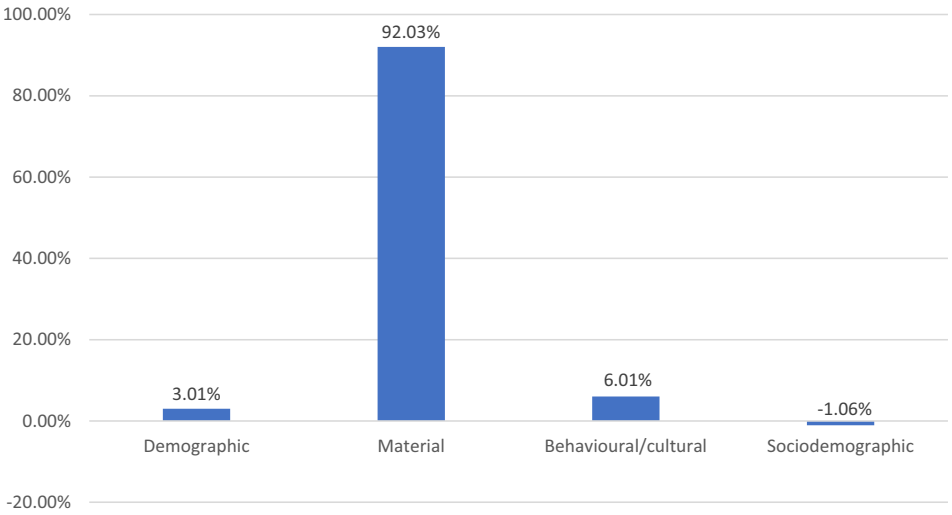

Fig. 1. Percentage contribution of each group of variables.

4. Discussion

Our study confirmed that there is FIC inequality between rural and urban areas as shown by previous studies [16–19,22] in that rural areas have higher FIC among young children. Achieving higher FIC in rural areas is an indication that immunization services are accessible even to rural communities in The Gambia [22]. Most of the disparity was explained by maternal occupation and household wealth, but in somewhat unexpected directions. Mother's age group and religion also contributed to explaining the inequality, while maternal education and perceived distance to a health center did not, surprisingly.

Higher immunization coverage in rural compared to urban areas is a notable trend given that much research has reported rural-dwelling residents as having significantly lower use of preventive services across many countries. Cassell et al. (2006) have highlighted that in The Gambia, in rural areas there are stronger women-centered social networks which promote immunization clinic attendance in rural compared to urban areas [30]. They likened immunization clinic attendance in rural areas to a social event, during which women are expected to take their children for immunization [30]. In urban areas, on the other hand, crowd problems and long waiting times at immunization clinics may be barriers to immunization [30].

Material factors were the singular most important issue to explain the urban-rural difference in immunization. Just as the rural advantage in immunization was unexpected, so was the direction in which material factors explained this difference. Most surprisingly, children in the richest households were the least likely to be fully immunized. Immunization inequalities have been shown in cross country studies to be mostly to the disadvantage of the poorest households [2,42,43]. Our finding differed from studies carried out for example in Nigeria, India, and Ethiopia where belonging to the richest household quintile positively predicted FIC [8–10]. However, our finding is consistent with findings by Barata et al. (2012) in Brazil where children in the richest households of the highest socioeconomic census tracts had the lowest immunization coverage [44]. One of the potential explanations mentioned by Barata et al. is that reduction in vaccine-preventable diseases over the last three decades might have made wealthier people complacent on immunizing their children [44]. An extension of that line of argument could be that the poorest group are the ones most acutely aware of the need for immunization. Another reason Barata et al. [44] mentioned is the possibility that children of wealthier parents may miss Oral Polio Vaccine during national immunization days due to advise from private service providers and consequently miss other vaccinations in the routine schedule as children who miss nationally immunization days are likely to also miss other vaccines. These reasons may apply in The Gambian context.

Somewhat easier to explain, yet still puzzling, was the impact of maternal occupation. It has been stated in previous research that children born to non-working mothers may be more likely to be fully immunized because non-working mothers would have more time to take their children to immunization clinics [11]. On the other hand, working mothers may have more financial resources and a stronger position within the family. The high immunization coverage we found among children of professional mothers can be expected given that they may be more empowered in the family, have a high awareness of the importance of immunization, and may have solid finances to employ household helps to either do domestic chores or care for their children. However, it is noteworthy that mothers in the professional group are more common in the urban areas, and thus they contributed to reducing the immunization inequality between rural and urban areas instead of increasing it. Also, they accounted for a small proportion of the study sample, and so did not contribute much. Our findings suggest that empowering women for example by encouraging them to take up professional jobs has the potential to not only improve their livelihood but possibly also increase national immunization coverage.

Of interest from an international perspective is the high immunization rate among children of mothers working in agriculture, which were the dominating group of working mothers and thus contributed strongly to the urban-rural difference in FIC. Like many low-income countries, agriculture is a dominating economic activity in The Gambia, representing about 70% of the work force and 33% of national GDP [45]. The agricultural workers were a diverse group, and about 40% of them were self-employed, and these might control their working hours and thus be able to attend vaccination events. Women in urban areas are more engaged in petty trading than those in rural areas [30]. Choosing between taking a child for immunizations bearing in mind potential long waiting times and engaging in petty trading or carrying out pending domestic chores could be tough for non-working mothers especially if there is no one to continue on their behalf.

Religion contributed to the rural-urban FIC disparity, but only to a small extent. Religion is a known factor to influence immunization

coverage [6], but which religion is linked to lower or higher immunization coverage is context-specific – in our study, immunization was considerably higher among Muslims than among Christians. In other studies, the Amish in the United States and Orthodox Protestants in the Netherlands are religious groups associated with lower immunization coverage [46]. In Ghana, Christian children were reported to be more likely to be fully immunized than Muslim children [47]. Similarly, Muslim children were less likely to be immunized compared to Hindus and other religious groups in India [8]. The difference in immunization by religious groups could be due to norms or practices within the group. But it is notable that the groups with lowest immunization rates, in our study as well as in previous studies, tend to be minority groups – it is possible that it is the status of being a minority, rather than the specific religion, that affected immunization rates. For example, Christians, being a minority, might be more hesitant to visit immunization clinics due to fear of discrimination or feeling unfamiliar with the setting. This is an interesting venue for further research. The contribution of religion was minor because Christians are a small minority in The Gambia. If the variation in religions in The Gambia had been larger, religion might have contributed more.

Maternal education is a common predictor of immunization status in many countries, with higher coverage usually observed in higher education categories [27]. However, education and occupation tend to be related, and in the current study, the importance of maternal education on FIC was fully explained by other factors, probably occupation. Distance to immunization sites is a commonly cited reason for non-immunization [6]. In our study, even though perceived problems with distance to health facilities differed significantly between urban and rural areas, it did not contribute to explaining the differences in FIC. This might be due to the efficacy of the national immunization program's service delivery strategies (fixed and outreach immunization services) for example the regular monthly outreach health clinic sessions (including immunization services) to distant communities. Our measure was for perceived distance from a health center and not perceived distance from an immunization service point (fix or outreach).

Our findings have important implications for immunization programs both in The Gambia and internationally. Immunization is vital for population health, and sufficiently high coverage can protect even the unvaccinated and even, in the long run, has the potential to eradicate many infectious diseases. Thus, it is important to understand the ever-evolving factors that drive or limit immunization in different settings and groups. When considering specifically The Gambia, these results highlight that more research is needed to point out what specific factors are driving lower immunization coverage in urban areas. Our study also suggests that it might be time to reconsider interventions in urban areas to shrink the coverage gap between urban and rural areas and further improve total coverage. One potential intervention is to increase the number of vaccination sessions in urban areas. This could be done by both increasing the number of vaccination days at the health facilities and opening outreach vaccination points in urban communities. Our study might even have implications for health systems research in general because it highlights the question of whether interventions targeting areas that have traditionally been considered disadvantaged can in some cases even turn the tables and create a reversal in health inequities.

Other potential directions for future research include examining whether lower immunization coverage in the unexpected groups may be due to vaccine hesitancy or other individual- or family-level factors, or to what extent it is due to differences in health system structures between urban and rural areas. Structural differences could concern access-related issues such as long waiting times, inadequate information, service provider behaviour, or the presence of community health workers (Village Health Workers, Traditional Birth Companions, and Village Support Groups). To fully understand how our findings, relate to differences in FIC, mix methods studies would be required.

One of the main strengths of this study is that the data used was from a nationally representative survey. The high proportion of immunization card availability (90.2%) is another major strength [20]. A high frequency of immunization records availability minimizes recall bias, which is a risk in studies relying completely on caregivers' recall for all the doses. That variables are self-reported can be both a strength (because some information is best known by the individual) and, a limitation (due to recall bias).

From the sensitivity analysis (see supplemental Tables 2 and 3) it became apparent that vaccination history by recall might have led to an underestimation of FIC especially in urban areas and consequently increased the gap between rural and urban areas. FIC in rural and urban areas was 83.75% and 67.69% including parents' recall, and 87.76% and 74.63% without parents' recall (only vaccination history by card). With parents' recall, the gap between rural and urban areas was 16.06 percentage points of which 12.29 percentage points was explained by the explanatory variables. This reduced to 13.13 percentage points without parents' recall with 10.94 percentage points being explained by the explanatory variables. One key observation is that, with or without parents' recall, the direction of the inequality remains the same and substantial.

Among the limitations of this study is that women of childbearing age were used to determine the sample size and immunization history of young children born to the interviewed women collected [20]. Therefore, these findings could be generalizable to immunization of young children with their mother present in the household and we cannot say for sure if they are generalizable to children with absent mothers. Although more than half of Gambians live in the urban areas, over half of our weighted sample is from the rural areas. A possible explanation for this is that women in rural areas have more children than those in urban areas [20]. Another limitation of our study is also that reasons for non-immunization were not collected during the survey but deserve examination in future studies. Perhaps such information could influence our results for example by increasing the explained differential. The cross-sectional nature of the data limits causal inference. Looking at the trend of the FIC gap between rural and urban areas from the first MICS conducted in 1996 to the most recent DHS (conducted in 2013), one might tend to believe that this trend and the identified explanatory factors in our study would project well into the long-term future. That might not be the case. The gap observed might just represent a temporary phase of The Gambia's health system transition or of the social factors affecting immunization. Therefore, continuous monitoring of inequalities would be important.

5. Conclusions

There is a substantial disparity in full immunization coverage between rural and urban areas in The Gambia, to the advantage of the rural areas. The disparity is mostly explained by material factors – mothers working in agriculture and living in the poorest households being more likely to immunize their children and also more likely to live in rural areas, which are relatively unexpected findings in relation to previous research. Professional mothers were also more likely to immunize their children, as expected. But since professional mothers were more likely to live in urban areas, this instead worked to decrease the urban-rural difference, albeit to a relatively small degree, since professional mothers were a small group. The findings suggest that accounting for geographic

and socioeconomic differences when planning interventions aiming to improve coverage of health interventions would key in improving total coverage and decreasing inequalities. It also highlights that equity assessment and monitoring in immunization coverage and possibly other health services should examine equity from all angles because lower coverage/utilization could be found where it might not be expected.

Author contributions

Conceptualization, A.S.; Methodology, A.S. and K.J.; Validation, A.S. and K.J.; Formal Analysis, A.S with input from K.J.; Writing-Original Draft Preparation, A.S.; Writing-Review & Editing, K.J. All authors approved the final version of the manuscript.

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Declarations of interest

A.S. works for the Ministry of Health and Social Welfare of The Gambia. However, the Ministry of Health and Social Welfare had no role in the formulation of the research question nor in the analysis.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2019.04.062.

References

[1] WHO|Immunization coverage. WHO; n.d. <http://www.who.int/mediacentre/factsheets/fs378/en/> [accessed March 16, 2018].
[2] Arsenault C, Harper S, Nandi A, Mendoza Rodríguez JM, Hansen PM, Johri M. Monitoring equity in vaccination coverage: a systematic analysis of demographic and health surveys from 45 Gavi-supported countries. Vaccine 2017;35:951–9. https://doi.org/10.1016/j.vaccine.2016.12.041.
[3] Restrepo-Méndez MC, Barros AJ, Wong KL, Johnson HL, Pariyo G, França GV, et al. Inequalities in full immunization coverage: trends in low- and middle-income countries. Bull World Health Organ 2016;94:794–805A. https://doi.org/10.2471/BLT.15.162172.
[4] Nelson KN, Wallace AS, Sodha SV, Daniels D, Dietz V. Assessing strategies for increasing urban routine immunization coverage of childhood vaccines in low and middle-income countries: a systematic review of peer-reviewed literature. Vaccine 2016;34:5495–503. https://doi.org/10.1016/j.vaccine.2016.09.038.
[5] Crocker-Buque T, Mindra G, Duncan R, Mounier-Jack S, Immunization. urbanization and slums – a systematic review of factors and interventions. BMC Public Health 2017;17. https://doi.org/10.1186/s12889-017-4473-7.
[6] Favin M, Steinglass R, Fields R, Banerjee K, Sawhney M. Why children are not vaccinated: a review of the grey literature. Int Health 2012;4:229–38. https://doi.org/10.1016/j.inhe.2012.07.004.
[7] Awoh AB, Plugge E. Immunisation coverage in rural–urban migrant children in low and middle-income countries (LMICs): a systematic review and meta-analysis. J Epidemiol Community Health 2016;70:305–11. https://doi.org/10.1136/jech-2015-205652.
[8] Prusty RK, Kumar A. Socioeconomic dynamics of gender disparity in childhood immunization in India, 1992–2006. PLoS ONE 2014;9:. https://doi.org/10.1371/journal.pone.0104598e104598.
[9] Ataguba JE, Ojo KO, Ichoku HE. Explaining socio-economic inequalities in immunization coverage in Nigeria. Health Policy Plan 2016;31:1212–24. https://doi.org/10.1093/heapol/czw053.
[10] Lakew Y, Bekele A, Biadgilign S. Factors influencing full immunization coverage among 12–23 months of age children in Ethiopia: evidence from the national demographic and health survey in 2011. BMC Public Health 2015;15(1). https://doi.org/10.1186/s12889-015-2078-6.
[11] Fatiregun AA, Okoro AO. Maternal determinants of complete child immunization among children aged 12–23 months in a southern district of Nigeria. Vaccine 2012;30:730–6. https://doi.org/10.1016/j.vaccine.2011.11.082.
[12] Kassahun MB, Biks GA, Teferra AS. Level of immunization coverage and associated factors among children aged 12–23 months in Lay Armachiho District, North Gondar Zone, Northwest Ethiopia: a community based cross sectional study. BMC Res Notes 2015;8. https://doi.org/10.1186/s13104-015-1192-y.
[13] Forshaw J, Gerver SM, Gill M, Cooper E, Manikam L, Ward H. The global effect of maternal education on complete childhood vaccination: a systematic review and meta-analysis. BMC Infect Dis 2017;17. https://doi.org/10.1186/s12879-017-2890-y.
[14] Gidado S, Nguku P, Biya O, Waziri NE, Mohammed A, Nsubuga P, et al. Determinants of routine immunization coverage in Bungudu, Zamfara State, Northern Nigeria, May 2010. Pan Afr Med J 2014;18. 10.11694/pamj.supp.2014.18.1.4149.
[15] WHO, UNICEF. WHO vaccine-preventable diseases monitoring system 2017 global summary. WHO UNICEF estimates time series for Gambia (The) (GMB); 2017. <http://apps.who.int/immunization_monitoring/globalsummary/estimates?c=GMB> [accessed January 4, 2018].
[16] Central Statistics Department. The Gambia multiple cluster survey report 1996. Banjul, The Gambia: Central Statistics Department; 1998.
[17] Central Statistics Department. The Gambia multiple indicator cluster survey report, 2000. Banjul, The Gambia: Central Statistics Department; 2002.
[18] The Gambia Bureau of Statistics (GBOS). The Gambia Multiple Indicator Cluster Survey report, 2005/2006. Banjul, The Gambia: Gambia Bureau of Statistics (GBOS); 2007.
[19] The Gambia Bureau of Statistics (GBOS). The Gambia Multiple Indicator Cluster Survey 2010, Final Report. Banjul, The Gambia: The Gambia Bureau of Statistics (GBOS); 2011.
[20] The Gambia Bureau of Statistics, ICF International. The Gambia Demographic and Health Survey 2013. Banjul, The Gambia, and Rockville, Maryland, USA: GBOS and ICF International; 2014.
[21] Miyahara R, Jasseh M, Gomez P, Shimakawa Y, Greenwood B, Keita K, et al. Barriers to timely administration of birth dose vaccines in The Gambia, West Africa. Vaccine 2016;34:3335–41. https://doi.org/10.1016/j.vaccine.2016.05.017.
[22] Payne S, Townend J, Jasseh M, Lowe Jallow Y, Kampmann B. Achieving comprehensive childhood immunization: an analysis of obstacles and opportunities in The Gambia. Health Policy Plan 2014;29:193–203.
[23] Hancioglu A, Arnold F. Measuring coverage in MNCH: tracking progress in Health for Women and Children Using DHS and MICS household surveys. PLoS Med 2013;10:. https://doi.org/10.1371/journal.pmed.1001391e1001391.
[24] Barros AJ, Ronsmans C, Axelson H, Loaiza E, Bertoldi AD, França GV, et al. Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries. The Lancet 2012;379:1225–33. https://doi.org/10.1016/S0140-6736(12)60113-5.
[25] Chao F, You D, Pedersen J, Hug L, Alkema L. National and regional under-5 mortality rate by economic status for low-income and middle-income countries: a systematic assessment. Lancet Glob Health 2018;6:e535–47. https://doi.org/10.1016/S2214-109X(18)30059-7.
[26] Mackenzie GA, Hill PC, Sahito SM, Jeffries DJ, Hossain I, Bottomley C, et al. Impact of the introduction of pneumococcal conjugate vaccination on pneumonia in The Gambia: population-based surveillance and case-control studies. Lancet Infect Dis 2017;17:965–73. https://doi.org/10.1016/S1473-3099(17)30321-3.
[27] Kazungu JS, Adetifa IMO. Crude childhood vaccination coverage in West Africa: trends and predictors of completeness. Wellcome Open Res 2017;2:12. https://doi.org/10.12688/wellcomeopenres.10690.1.
[28] Kim S-Y, Lee G, Goldie SJ. Economic evaluation of pneumococcal conjugate vaccination in The Gambia. BMC Infect Dis 2010;10:260. https://doi.org/10.1186/1471-2334-10-260.
[29] Scott S, Odutola A, Mackenzie G, Fulford T, Afolabi MO, Lowe Jallow Y, et al. Coverage and timing of children's vaccination: an evaluation of the expanded programme on immunisation in The Gambia. PloS One 2014;9:. https://doi.org/10.1371/journal.pone.0107280e107280.
[30] Cassell JA, Leach M, Fairhead JR, Small M, Mercer CH. The social shaping of childhood vaccination practice in rural and urban Gambia. Health Policy Plan 2006;21:373–91. https://doi.org/10.1093/heapol/czl020.
[31] Gambia Bureau of Statistics. The Gambia 2013 Population and Housing Census Preliminary Results. Banjul, The Gambia: The Gambia Bureau of Statistics (GBOS); 2013.
[32] World Bank. Rural population (% of total population) | Data 2016. <https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=GM> [accessed April 3, 2018].
[33] GBoS. Integrated Household Survey Income and Expenditure Poverty Assessment - 2010. Banjul, The Gambia: The Gambia Bureau of Statistics (GBOS); 2011.
[34] Howie SRC, Oluwalana C, Secka O, Scott S, Ideh RC, Ebruke BE, et al. The effectiveness of conjugate Haemophilus influenzae Type B Vaccine in The Gambia 14 Years after introduction. Clin Infect Dis 2013;57:1527–34. https://doi.org/10.1093/cid/cit598.

[35] Adegbola RA, Secka O, Lahai G, Lloyd-Evans N, Njie A, Usen S, et al. Elimination of Haemophilus influenzae type b (Hib) disease from The Gambia after the introduction of routine immunisation with a Hib conjugate vaccine: a prospective study. The Lancet 2005;366:144–50. https://doi.org/10.1016/S0140-6736(05)66788-8.
[36] Word Health Organization. Vaccination coverage cluster surveys: Reference manual. Version 3 Working draft; 2015.
[37] The DHS Program - Team and Partners; n.d. <https://www.dhsprogram.com/Who-We-Are/About-Us.cfm> [accessed February 18, 2019].
[38] The DHS Program - Protecting the Privacy of DHS Survey Respondents; n.d. <https://www.dhsprogram.com/What-We-Do/Protecting-the-Privacy-of-DHS-Survey-Respondents.cfm> [accessed February 18, 2019].
[39] Fairlie R. An extension of the Blinder-Oaxaca decomposition technique to logit and probit models. Rochester, NY: Social Science Research Network; 2006.
[40] Jann B. A Stata implementation of the Blinder-Oaxaca decomposition. Stata J 2008;8:453–79.
[41] StataCorp. Stata Statistical Software. College Station, TX: StataCorp LP; 2013.
[42] Hosseinpoor AR, Bergen N, Schlotheuber A, Gacic-Dobo M, Hansen PM, Senouci K, et al. State of inequality in diphtheria-tetanus-pertussis immunisation coverage in low-income and middle-income countries: a multicountry study of household health surveys. Lancet Glob Health 2016;4:e617–26. https://doi.org/10.1016/S2214-109X(16)30141-3.
[43] Singh PK. Trends in child immunization across geographical regions in India: focus on urban-rural and gender differentials. PLoS ONE 2013;8. https://doi.org/10.1371/journal.pone.0073102.
[44] Barata RB, Ribeiro MCS de A, de Moraes JC, Flannery B, Group on behalf of the VCS. Socioeconomic inequalities and vaccination coverage: results of an immunisation coverage survey in 27 Brazilian capitals, 2007–2008. J Epidemiol Community Health 2007;2012(66):934–41. https://doi.org/10.1136/jech-2011-200341.
[45] Gambia at a glance|FAO in Gambia|Food and Agriculture Organization of the United Nations; n.d. <http://www.fao.org/gambia/fao-in-gambia/gambia-at-a-glance/en/> [accessed September 11, 2018].
[46] Dubé E, Laberge C, Guay M, Bramadat P, Roy R, Bettinger JA. Vaccine hesitancy. Hum Vaccines Immunother 2013;9:1763–73. https://doi.org/10.4161/hv.24657.
[47] Adokiya MN, Baguune B, Ndago JA. Evaluation of immunization coverage and its associated factors among children 12–23 months of age in Techiman Municipality, Ghana, 2016. Arch Public Health 2017;75(1). https://doi.org/10.1186/s13690-017-0196-6.