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ORIGINAL RESEARCH

Determinants of apparent rural-urban differentials in measles vaccination uptake in Indonesia

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ABSTRACT

Introduction: Regional differences in vaccination uptake are common in both developed and developing countries, and are often linked to the availability of healthcare services and socioeconomic factors. In 2007, 0.9 million eligible Indonesian children missed measles vaccination, and 19 456 cases of measles were documented among Indonesian children. The authors investigated rural-urban differentials in measles vaccination coverage among young Indonesian children, and sought to identify key factors influencing the probability of a child receiving the first dose of measles vaccination in Indonesia.

Methods: Data used in the analyses were sourced from the nationally representative *Indonesia Demographic and Health Survey 2007*. The influence of location of residence, household wealth, maternal and paternal education, total children ever born and use of skilled birth attendants on measles vaccination coverage was investigated using bivariate analysis and chi-square tests. The independent effects of these variables were established using binomial logistic regression analysis.

Results: Indonesia's 2007 first-dose measles national vaccination coverage was, at 72.8%, lower than the 2008 global first-dose measles vaccination average coverage of 82%. Bivariate analysis revealed that the first-dose measles vaccination coverage in rural areas of Indonesia was 68.5%, compared with 80.1% in urban regions ($p < 0.001$). The apparent significance of rural residence in impairing vaccination coverage was marginal after controlling for the sex of the child, maternal age, maternal and paternal education, wealth, and access to skilled health workers.

Conclusion: Apart from sustainable initiatives to increase measles vaccination coverage globally, it is important to close the rural-urban gap in Indonesia's measles vaccination uptake. Addressing critical determinants of inferior measles vaccination coverage in Indonesia's rural regions will facilitate major improvements in Indonesia's child health trends. This article suggests



initiatives for addressing three of such determinants in Indonesia's rural areas: poverty, parental education and access to skilled health workers.

Key words: Indonesia, maternal education, measles, poverty, rural-urban divide, vaccination, vaccination workers.

Introduction

Measles is a highly contagious and vaccine preventable respiratory paramyxovirus infection, and a major cause of child morbidity and mortality. The incubation period is 10–12 days from exposure to the virus to the onset of fever, and a rash usually appears at around day 14 (range 7–18 days). Patients are contagious from about 4 days before eruption of the rash until 4 days after the eruption¹. The severity of measles varies widely, depending on a number of host and environmental factors. The risk of developing severe or fatal measles increases for those aged less than 5 years, living in overcrowded conditions, who are malnourished (especially with vitamin A deficiency); and those with immunological disorders, such as advanced HIV infection.

In developing countries, case-fatality rates among young children may reach 5–10%. The complications of infection, including, severe diarrhoea, protein-energy malnutrition, respiratory infection and encephalitis, are often the ultimate causes of mortality in developing countries¹. Worldwide, the number of reported measles cases declined 67%, from 852 937 in 2000 to 278 358 in 2008, and reported measles mortality declined from 733 000 deaths in 2000 to 164 000 in 2008². Improvements in measles control is reflected in a remarkable drop in the number of measles cases reported globally, from 278 358 in 2008 to 222 408 by the end of 2009. However, the dissonance between the estimated case-fatality rate of 5–10%, and the apparent case-fatality rate of over 60% between 2000 and 2008 suggests under-reporting of clinical measles cases, because mortality reports are relatively more reliable.

Measles vaccination coverage is used as an indicator of progress towards the Millennium Development Goal 4 of

reducing infant mortality, because the infection contributes significantly to increased child morbidity and mortality, and because vaccination coverage provides an indication of the level of access to child health services. Measles vaccination provides a safe, efficacious and cost-effective method for disease prevention, and is credited with preventing over 2 million infant deaths per year, accounting for a 78% decrease in measles-related deaths between 2000 and 2008³. Effective measles vaccination programs may also help to ease resource constraints in healthcare systems by preventing infection and, therefore, the number of cases presenting to hospitals for medical care⁴.

Indonesia is the fourth most populous nation in the world with an estimated 228 million population in 2008. Approximately 52% of the population resides in urban areas. Despite steady economic growth over the last three decades, Indonesia's measles vaccination coverage is lower than that of other South-East Asian nations. Estimates from Indonesia's *Demographic and Health Survey 2007*⁵ (IDHS) show that measles vaccination coverage for Indonesian children aged below 6 years was 72.8% (based on mother's report or health card records), compared with 84% in the South-East Asian region in the same year⁴. In 2007, approximately 0.9 million eligible Indonesian children were not vaccinated against measles, and 19 456 measles cases were reported among Indonesian children, the second highest caseload in the South-East Asian region after India. Indonesia's measles incidence of 6.73 cases per 100 000 people is the third highest in South-East Asia⁶.

The primary aims of this study were to: (i) use the nationally representative IDHS dataset to determine if rural residence is a significant determinant of measles vaccination uptake in Indonesia; and (ii) explore other factors presumed to



influence the likelihood of children in rural and urban areas receiving the first dose of measles vaccination.

Methods

Data

The IDHS is a cross-sectional survey administered by Statistics Indonesia, with financial assistance from the Government of Indonesia, the United Nations Population Fund, the Ford Foundation and UNICEF. Datasets are produced by Macro International for the Measure DHS (Demographic and Health Surveys) Project, which is funded by the US Agency for International Development. Measure DHS permitted download and use of the 2007 IDHS datasets for this study.

The household questionnaire was completed by 40 701 out of 42 341 sampled households (99% response rate)⁵. The objectives of the DHS include measurement of child health indicators such as vaccination coverage and nutritional status, assessing coverage of maternity services and investigating the direct and indirect factors that influence maternal and child health. The DHS is considered a reliable benchmark for comparison of vaccination data. Investigations of the quality of DHS methodologies concluded that it is nationally representative and relatively free of systematic bias⁷. Information about living children aged between 0 and 59 months was collected through the 'married women's questionnaire' and separated into a children's dataset by DHS.

Variables

The dependent variable of interest was the likelihood of measles vaccination among children under 5 years of age. The question on measles vaccination was asked of every mother with a child aged under 5 years. The IDHS provided five response options: 'yes (marked on vaccination card)', 'yes (date recorded on vaccination card)', 'yes (mother's recall)', 'no' and 'don't know'. Because only 21% of the

sample had their vaccination history recorded on a vaccination card, measles vaccination was re-coded into a dichotomous (no/yes) variable, with vaccinated children recorded as 'yes' regardless of the source of the information. Children whose mother indicated that they did not know whether measles vaccination had been given (1.33%) were classified as not having received the vaccination because it was likely to reflect that the child was not vaccinated and fits better with the 'no' response. In addition, the small size of the 'don't know' sample indicates that there is little likelihood of a bias in combining this group with the 'no' responses. All other vaccinations from the Indonesian childhood vaccination schedule that were considered in this study (Bacillus Calmette-Guérin vaccine [BCG], Diphtheria Tetanus and Pertussis vaccine [DTP], polio and hepatitis B) were also measured using dichotomous (no/yes) variables.

Type of residence was defined as either urban (reference category) or rural location. There is no universally accepted definition of rurality⁸. In the IDHS, 'urban areas' refer to large cities (capital cities and cities with populations greater than one million), smaller cities (more than 50 000 people) and towns. All 'countryside' areas are considered rural⁹. The region of residence variable indicates in which of the 33 Indonesian provinces the respondent resided at the time of the survey.

Household economic status is defined using the DHS wealth index quintiles, ranging from poorest (reference category) to richest. The wealth index is calculated by ORC Macro and is produced by combining as many indicators of household assets and utilities as possible. Indicators are any variable that may reflect the household's economic status, including, but not limited to, type of flooring, water supply, television, persons sleeping per room and ownership of agricultural land. Indicator variables are then weighted and an index is produced. The index is divided into quintiles (poorest, poorer, middle, richer, richest) based on the household population, and each member of a household receives the household's quintile category. The DHS wealth index is considered more stable, reliable and accurate compared with traditional measures of economic status, such as household



income and expenditure, which are difficult to collect in developing countries¹⁰.

To investigate the relative importance of household wealth in urban and rural areas, the measles vaccination coverage rates for poor and wealthy children were compared in rural and urban areas of Papua, South Kalimantan, East Java and West Sumatera provinces. Papua, South Kalimantan and West Sumatera were selected because they have been identified since 2006 as priority areas for improving measles vaccination by the Indonesian Ministry of Health. East Java was chosen because this province has above average measles vaccination coverage.

Maternal education was included in the analysis because this is a well-established determinant of vaccination coverage¹¹. The influence of maternal education on vaccination uptake was measured using categorical variables indicating the highest level of schooling attained by the child's mother (ie no education [reference category], primary, secondary or higher education). Paternal education level was defined using the same 5 categories.

The presence of a skilled birth attendant during delivery was used as a proxy for the availability of skilled health workers in the community¹². Skilled attendance at birth is considered an indicator of general access to health services and is closely linked to overall health system capacity¹³. Skilled attendants included doctors, nurses, midwives or village midwives. Women who indicated that they were not assisted by skilled attendants but who reported that they had received informal assistance (ie from a friend, family member, traditional birth attendant), 'other', 'no one' or 'don't know' were coded as 'no' for this variable. For the purposes of this article, a traditional birth attendant is defined as someone who has not received formal medical training¹². The 10 women who indicated that they did not know whether a skilled attendant was present at the birth of the child were also coded as 'no', because it is unlikely that a skilled attendant was present and only a small number (0.07%) of cases was affected. The IDHS also contained data relating to the place of birth (eg at home, hospital or private clinic). The

presence of a skilled birth attendant was selected over place of delivery, because many women may prefer to give birth at home and with the advent of skilled village midwives, home delivery does not necessarily mean that a skilled attendant was not present. The continuous variable 'total children ever born' from the DHS was used to investigate differences in average parity between urban and rural areas and among wealth quintiles.

Analysis

Contingency table analysis was used to investigate the urban-rural differences in the socio-demographic characteristics of the sample, including maternal age, child age, mean total children ever born per woman, sex of the child, measles vaccination coverage, access to skilled birth attendants, wealth and maternal and paternal education. For categorical variables, Pearson's χ^2 tests were used to establish the significance of differences in socio-demographic and measles vaccination coverage across groups at the 5% level. Independent sample *t*-tests were used to assess significance of urban-rural differences in the continuous variables (maternal and child age, total children ever born) at the 5% level.

Bivariate analysis was used to further investigate the education and wealth the characteristics of women who did not give birth with the assistance of a skilled birth attendant. Pearson's χ^2 tests were again used to establish the significance of differences between groups at the 5% level. Significant differences in mean children ever born among urban and rural residents and wealth quintiles were assessed using independent sample *t*-tests.

Bivariate analyses were used to investigate the pattern of vaccination coverage across urban and rural areas for measles and the 11 other vaccinations in the Indonesian childhood vaccination schedule. Regional differences in measles vaccination uptake across the 33 Indonesian provinces were also investigated using bivariate analysis. Significance testing was again conducted using Pearson's χ^2 tests.



Contingency table analysis was used to compare the measles immunisation coverage rate for poor and rich children residing in rural and urban areas of Papua, South Kalimantan, East Java and West Sumatera provinces. Chi-square tests were again used to establish the significance of differences in measles vaccination coverage for poor and rich groups in each area at the 5% level. For this analysis respondents were classified as 'poor' if they were in the poorest or poorer DHS wealth quintiles and 'rich' if they were in the middle, richer or richest wealth quintiles.

Multivariate logistic regression analysis was used to investigate whether rural–urban differentials remained after controlling for sex of the child, maternal age, maternal age squared, maternal and paternal education, household wealth and the presence of a skilled birth attendant. Maternal age was measured as a continuous variable; all other variables were included as categorical variables. A binomial logistic regression model was developed with measles vaccination as the outcome variable. All independent variables were entered simultaneously into the model. The results are reported as odds ratios (OR) and the 95% confidence intervals (CI) for the odds ratios. All data analysis was conducted using PASW v17 (<http://www-01.ibm.com/software/analytics/spss/>).

Results

The sample contained 15 065 living children aged 9–59 months. The socio-demographic characteristics of the sample are presented according to location of residence (Table 1). A greater proportion of the sample resided in rural areas (61.9%). Overall, 72.8% of children in the sample had received measles vaccination. The mean age of children was 33.9 months in urban and rural areas, and the number of males and females was similar.

When socioeconomic status was analysed across urban and rural areas, 70% of rural residents fell into the poor or poorest wealth quintiles compared with 18% urban residents. A significantly higher proportion of rural mothers were in

the poorest and poorer wealth quintile ($p < 0.05$). The proportion of mothers in the middle, richer and richest wealth quintiles was significantly higher in urban areas ($p < 0.05$).

The proportion of children delivered with the assistance of a skilled birth attendant was used as a proxy for rural–urban disparities in the availability of skilled health workers¹². Rural–urban differentials in skilled birth attendants were significant under bivariate analysis, with skilled attendance at 57.8% of births in rural areas compared with 87.9% of births in urban areas ($\chi^2 = 1514.915$; $p < 0.001$). Analysis of the 4623 women who gave birth without any skilled assistance, showed that they were also likely to have lower levels of education and wealth. Of those who were not assisted by a skilled attendant, 70.9% had primary or no education. In addition, 80.6% were in the poorest or poorer wealth quintiles.

The mean number of children ever born among women in the sample was 2.75 with a standard deviation (SD) of 1.758. The mean number of children ever born per woman was significantly higher in rural areas and for poorer wealth quintiles. The mean total children ever born to rural mothers was 2.93 (SD = 1.881) compared with 2.46 (SD = 1.492) for urban women ($t = -16.755$; $p < 0.001$). The mean number of children per woman for the poorest and poorer wealth quintiles combined was 3.05 (SD = 1.946). This was significantly higher ($t = 21.275$; $p < 0.001$) than the mean number of children for the middle, richer and richest quintiles combined, which was 2.45 (SD = 1.481).

Bivariate analysis revealed that measles vaccination coverage was significantly higher ($p < 0.001$) among urban children (80.1%) compared with rural children (68.5%). As is shown, the rural–urban differential was not unique to the measles vaccination (Table 2). Vaccination coverage was significantly higher ($p < 0.001$) among urban children for all 12 vaccinations listed in the Indonesian vaccination schedule.



Table 1: Cross tabulation of the relationship between location of residence and socio-demographic characteristics
(*N* = 15 065 living children aged under 5 years)

Characteristic	Residence location		<i>P</i>
	Urban	Rural	
Mother – mean (SD)			
Age (years)	30.45 (5.96)	29.79 (6.53)	<.001
Total children ever born	2.46 (1.49)	2.93 (1.88)	<.001
Child age (months) – mean (SD)	33.92 (14.93)	33.91 (14.72)	NS
Sex – <i>n</i> (%)			NS
Male	2982 (51.9)	4901 (52.6)	
Female	2760 (48.1)	4422 (47.4)	
Measles immunisation – <i>n</i> (%)			<.001
No	1142 (19.9)	2931 (31.4)	
Yes	4591 (80.0)	6380 (68.4)	
No data	9 (0.2)	12 (0.1)	
Skilled birth attendant – <i>n</i> (%)			<.001
No	692 (12.1)	3931 (42.2)	
Yes	5050 (87.9)	5392 (57.8)	
Household wealth – <i>n</i> (%)			<.001
Poorest	365 (6.4)	4231 (45.4)	
Poorer	690 (12.0)	2329 (25.0)	
Middle	1083 (18.9)	1489 (16.0)	
Richer	1605 (28.0)	886 (9.5)	
Richest	1999 (34.8)	388 (4.2)	
Maternal education – <i>n</i> (%)			<.001
No education	92 (1.6)	568 (6.1)	
Primary	1395 (24.3)	4580 (49.1)	
Secondary	3449 (60.1)	3810 (40.9)	
Higher	806 (14.0)	368 (3.9)	
No data	0 (0.0)	2 (<0.01)	
Paternal education – <i>n</i> (%)			<.001
No education	57 (0.99)	457 (4.9)	
Primary	1238 (21.6)	4150 (44.5)	
Secondary	3524 (61.4)	4211 (45.2)	
Higher	896 (15.6)	469 (5.0)	
No data	27 (0.5)	36 (0.4)	

NS, Not significant at level 5%.

Investigation of rural–urban differences in vaccination coverage by province (Table 3) shows that measles vaccination coverage is significantly higher in urban areas for 16 of the 33 Indonesian provinces. The eastern provinces of Indonesia, such as Maluku and Papua, showed the greatest rural–urban differentials. These are predominantly rural regions with high poverty levels¹⁴. In Papua, where the rural–urban differential is greatest, coverage was 47.3% among rural children and 81.0% among urban children.

To further examine the influence of economic status, measles vaccination coverage among the poorest 2 wealth quintiles and the richest 3 quintiles was examined in urban and rural areas of Papua, South Kalimantan, East Java and West Sumatera. The results show that for all 4 provinces, measles vaccination coverage was not significantly different between the poorest 2 wealth quintiles and wealthiest 3 quintiles in urban areas (Table 4). In rural areas, measles vaccination coverage was significantly higher among the wealthier group. This was most significant in Papua and East Java ($p < 0.001$), followed by South Kalimantan ($p = 0.003$) and West Sumatera ($p \leq 0.03$).



Table 2: Vaccination coverage among rural and urban children for 12 vaccinations listed on the Indonesian vaccination schedule

Vaccine	Vaccination coverage <i>n</i> (%)		<i>P</i>
	Rural	Urban	
BCG	7026 (76.4)	5037 (88.2)	<.001
DTP 1	6784 (74.3)	4948 (87.0)	<.001
DTP 2	5904 (64.8)	4557 (80.3)	<.001
DTP 3	4926 (54.0)	4046 (71.3)	<.001
Polio 1	7480 (81.3)	5181 (90.8)	<.001
Polio 2	6943 (76.0)	4945 (87.4)	<.001
Polio 3	5939 (65.0)	4513 (79.8)	<.001
Polio 4	4146 (45.4)	3356 (59.3)	<.001
Hepatitis B 1	6301 (69.8)	4805 (84.8)	<.001
Hepatitis B 2	5476 (60.8)	4370 (77.4)	<.001
Hepatitis B 3	4389 (48.7)	3664 (64.9)	<.001
Measles	6380 (68.5)	4591 (80.1)	<.001

BCG, Bacillus Calmette-Guérin vaccine; DTP, Diphtheria Tetanus and Pertussis vaccine.

Multivariate logistic regression analysis was performed to assess the independent effect of rural–urban residence on measles vaccination coverage, while controlling for sex of the child, maternal age, maternal age squared, maternal and paternal education, household wealth and the presence of a skilled birth attendant.

The odds of measles immunisation were not significantly different for male and female children (Table 5). Maternal age was positively correlated with measles vaccination. Maternal age squared was also found to be significant, suggesting that the relationship between maternal age and measles vaccination is curved. Further analyses showed that the percentage of children immunised increased as maternal age group increased up to the 30–34 year age group and then decreased for the combined and rural samples. For the urban sample, the proportion of children immunised increased with each successive maternal age group up to 35–39 years and then began to decline.

After controlling for all other variables, the rural–urban differential in measles vaccination coverage was marginally

significant (OR = 1.10, 95% CI [1.00-1.10]). The main variables found to adversely influence rural–urban variations in measles vaccination in Indonesia were low maternal and paternal education, higher poverty and inadequacy of skilled birth attendants. Maternal and paternal highest education levels were significantly correlated with measles vaccination after adjusting for all other examined variables. The greatest increase in the odds of vaccination was found when mothers and fathers had reached secondary level education or higher, compared with no education ($p < 0.001$). Household wealth quintile was a significant and positive correlate of measles vaccination after adjusting for all other variables in the model. The odds of measles vaccination were increased for each level of wealth compared to reference quintile (poorest; Table 5). The odds of vaccination among the richest quintile were almost two-times higher (OR = 1.87, 95% CI [1.58-2.21]) compared with the reference group. The presence of a skilled attendant at the child’s birth significantly increased the odds of measles vaccination after adjusting for all other variables in the model (OR = 1.94, 95% CI [1.77-2.11]).



Table 3: Measles vaccination coverage among rural and urban children in each of the 33 Indonesian provinces

Province	Vaccination coverage n (%)		P
	Rural	Urban	
DI Aceh	192 (48.1)	49 (62.0)	.024*
North Sumatra	223 (50.5)	184 (64.1)	<.001***
West Sumatra	233 (67.1)	116 (82.9)	<.001***
Riau	183 (68.0)	158 (68.4)	.930
Jambi	175 (67.8)	63 (69.2)	.805
South Sumatra	238 (77.3)	114 (80.9)	.392
Bengkulu	179 (79.9)	86 (85.1)	.260
Lampung	219 (83.3)	78 (80.4)	.527
Bangka Belitung	149 (70.3)	123 (83.1)	.005**
Kep Bangka Belitung	51 (68.9)	279 (85.3)	.001**
DKI Jakarta†	–	547 (78.4)	–
West Java	234 (77.2)	286 (77.9)	.828
Central Java	251 (84.5)	179 (84.0)	.885
DI Yogyakarta	116 (95.1)	203 (92.7)	.390
East Java	161 (69.1)	187 (88.2)	<.001***
Banten	166 (59.5)	259 (80.4)	<.001***
Bali	171 (84.7)	228 (90.1)	.078
West Nusa Tenggara	231 (83.1)	147 (85.5)	.505
East Nusa Tenggara	348 (77.2)	50 (79.4)	.695
West Kalimantan	238 (69.8)	92 (75.4)	.239
Central Kalimantan	191 (78.3)	81 (77.1)	.814
South Kalimantan	164 (64.8)	102 (77.9)	.009**
East Kalimantan	128 (77.6)	187 (91.2)	<.001***
North Sulawesi	203 (86.4)	121 (79.6)	.078
Central Sulawesi	282 (72.7)	65 (76.5)	.474
South Sulawesi	277 (66.0)	131 (82.4)	<.001***
Southeast Sulawesi	273 (72.0)	67 (80.7)	.104
Gorontalo	165 (64.0)	80 (82.5)	.001**
Sulawesi Barat	205 (56.8)	57 (71.3)	.017*
Maluku	225 (56.7)	87 (78.4)	<.001***
Maluku Utara	216 (66.3)	57 (81.4)	.013*
Papua Barat	152 (53.3)	77 (70.6)	.002*
Papua	141 (47.3)	51 (81.0)	<.001***

†DKI Jakarta is only an urban province.

*P <.05; ** p<.01, *** p<.001.

Discussion

Measles vaccination coverage in rural regions of Indonesia appears weakly associated with place of residence after controlling for sex of the child, maternal age, maternal age squared, maternal and paternal education, household wealth and the presence of a skilled birth attendant. Although

education, wealth and access to skilled birth attendants were strongly correlated with measles vaccination, the marginally significant result obtained for place of residence means that it is not possible to exclude rural location *per se* as a determinant of vaccination uptake.



Table 4: Measles vaccination coverage according to economic status for rural and urban children in 4 Indonesian provinces

Province	Residence location	Measles vaccination coverage n (%)		P
		Poor [†]	Rich [§]	
Papua	Urban	6 (75.0)	45 (81.8)	NS
	Rural	115 (43.2)	26 (81.3)	<.001
South Kalimantan	Urban	32 (71.1)	70 (81.4)	NS
	Rural	117 (60.0)	47 (81.0)	.003
West Sumatera	Urban	21 (77.8)	95 (84.1)	NS
	Rural	151 (63.4)	82 (75.2)	.030
East Java	Urban	16 (84.2)	171 (88.6)	NS
	Rural	87 (59.6)	74 (85.1)	<.001

[†]Poor = household wealth quintile poorer or poorest; [§]rich = household wealth quintile middle, richer or richest; NS, not significant at 5% level.

Table 5: Logistic regression results for measles vaccination coverage after controlling for sex and residence location of the child, maternal age, maternal and paternal education, wealth and the presence of a skilled birth attendant

Variable	Result	
	Odds ratio	95% CI
Sex of child		
Male	1	
Female	1.07	0.99 – 1.16
Residence location		
Urban [†]	1	–
Rural	1.10	1.00 – 1.22
Maternal age		
Years	1.09	1.04 – 1.15***
Years squared	1.00	0.99 – 1.00***
Maternal education		
No education [†]	1	–
Primary	1.79	1.49 – 2.14***
Secondary	2.48	2.04 – 33.01***
Higher	2.42	1.83 – 3.19***
Paternal education		
No education [†]	1	–
Primary	1.25	1.02 – 1.53*
Secondary	1.61	1.30 – 1.99***
Higher	2.18	1.64 – 2.89***
Household wealth		
Poorest [†]	1	–
Poorer	1.38	1.24 – 1.53***
Middle	1.58	1.40 – 1.79***
Richer	1.74	1.51 – 2.00***
Richest	1.87	1.58 – 2.21***
Skilled birth attendant		
No [†]	1	–
Yes	1.94	1.77 – 2.11***

[†]Reference category.

*P <.05; **p <.01; ***p <.001.



Ordinarily it would be expected that low education, higher birth rates, poverty and inadequate vaccination health staff in rural areas would lead to highly significant lower vaccination rates. The *Millennium Development Goals Report 2011* indicates a pronounced rural disadvantage, with rural children remaining at greater risk of dying, even in countries where child mortality rates are low overall¹⁵. A study of vaccination coverage among Indian children concluded that rural residence alone did not have a significant effect, but if coupled with poverty and minority status, rural residence amplified disparities in coverage¹⁶.

The findings presented here, however, suggest slightly higher adjusted-odds of measles vaccination coverage in rural areas. This may be explained by Indonesia's targeted approach to reducing the impact of rural residence on health. Indonesia's village based health clinics, or *Puskesmas*, and the village midwife program were established to improve access and reduce health inequalities among disadvantaged groups, including rural and remote communities¹⁷. Village midwives provide immunisation, as well as other maternal and child health services via the extensive POSYANDU (integrated health services post) network, which has significantly improved access to health care and health outcomes in Indonesia¹⁸. Outreach activities such as special vaccination days tend to target those villages that have reported poor vaccination coverage in the past. Therefore, more resources are directed towards activities to improve coverage and reduce drop out in rural and remote villages^{19,20}. Nevertheless, as this result was only marginally significant, the cumulative effects of several other determinants of vaccination in rural areas, such as poverty, low maternal education and limited access to skilled health workers, provide an important starting point for addressing rural-urban disparities in measles vaccination uptake.

Higher poverty in rural areas adversely impacts on measles vaccination in several ways. First, deprived neighbourhoods generally have inferior social amenities which create disincentives for skilled health staff to relocate to such areas²¹. Poverty reduces the capability of mothers to take

children to vaccination centres. Ironically, the uptake of childhood immunization offsets the detrimental effects of poverty and low maternal educational attainment^{22,23}. Given that poverty in Indonesia is concentrated among households in the rural agricultural sector, it is important to ensure that poverty reduction activities are targeted appropriately. A 2006 study found that growth in the urban services sector has the largest effect on poverty reduction for all sectors except urban agriculture. In addition, growth in rural agriculture strongly reduces poverty in the rural agriculture sector, which is the largest contributor to overall poverty in Indonesia. This implies that the most effective way to accelerate poverty reduction in Indonesia is by focusing on integrated and sustained support of urban services, as well as rural agriculture²⁴.

Although Indonesia has, particularly in the past decade, implemented poverty alleviation programs such as healthcare subsidy cards for the poor, a considerable leakage continues to flow to the non-poor. Conditional on ownership, the middle wealth quintiles were more likely to use the subsidized health cards than the poorest quintiles²⁵. Improved governance of this and related initiatives to improve access to health care for poor Indonesians is urgently required.

This study found that maternal education was a significant determinant of measles vaccination coverage. Maternal education has also been found to influence a mother's ability to recall whether their child has received vaccinations, and the likelihood that a vaccination card has been kept for the child⁵. This implies that education enhances a mother's understanding of the importance of immunisation and child health care. Ensuring access to education for females in rural areas could, therefore, help to reduce disparities in vaccination coverage. Improvements in female education in rural areas must address two impediments: cultural antipathy towards female education²⁶, and relatively high parity²⁷ among women.



The proportion of children delivered with the assistance of a skilled birth attendant was significantly lower in rural areas. This trend reflects the rural–urban distribution of skilled health workers in Indonesia and most developing nations²⁸. Although the first dose of measles vaccine is not administered until 9 months after birth, the availability of skilled birth attendants at birth appears to predict vaccination coverage; as such, the availability of quality health staff is likely to be continued into early childhood. Furthermore, the availability of skilled birth attendants is strongly influenced by factors known to directly influence measles vaccination. For example, a study into inequalities in maternal and child health in the Asia-Pacific found that the overall geographical, socioeconomic context and socioeconomic position contributed to 75% of the inequalities in skilled birth attendance in Indonesia¹³. Specifically, wealth contributed 27% and maternal education 12% to inequalities¹³. These determinants reflect the major determinants of inequalities in measles vaccination identified here.

A national strategy is required to improve the current inadequate distribution of health workers in rural regions. Good health infrastructure and a suitable mix of health workers in rural regions will help to restore the confidence of rural residents in the health system²⁸. In relation to improving vaccination in rural regions, a study in India found that revitalization of rural health systems has a positive effect on improving vaccination rates. However, the study also found that small incentives have large positive impacts on the uptake of vaccination services in resource-poor areas and are more cost-effective than purely improving supply²⁹.

Improvements in the quality and accessibility of rural health services could also overcome issues relating to vaccination drop out. The 2009 report on Expanded Program on Immunisation (EPI) immunisations in Indonesia indicated the complete drop-out rate for DTP as 4%, but partial dropout as 'significantly higher in all regions'³⁰. Thus, given that the measles vaccination is scheduled one month before the second DTP vaccination, it is possible that urban–rural

differences in measles vaccination coverage are influenced by drop out.

Over and above the need to reduce the urban–rural gap in measles vaccination coverage is the need to raise the national vaccination coverage at least to the current global measles vaccination coverage average of 83%. In addition to concomitantly targeting the socio-demographic determinants identified in this study, an effective initiative is a national measles supplementary vaccination program, such as the pilot supplementary vaccination program organised in 3 Indonesian provinces with assistance from UNICEF in 2009³¹. The ability of these programs to actively seek out children for vaccination, particularly the socioeconomically disadvantaged, will assist in raising national coverage by increasing coverage in these groups¹³.

The results presented here must be interpreted in light of several limitations. There are limitations to the use of skilled birth attendance as a proxy for access to health care. As not all skilled birth attendants provide immunisation services, it is possible that the positive correlation found here is due to the outreach and education activities of skilled birth attendants rather than the direct provision of immunisation services. Furthermore, EPI operations are restricted in their ability to provide outreach to rural areas by the need to maintain the cold chain of vaccination storage. Rural–urban differences in access to health care may also be influenced by other factors, such as the distance to a health facility and not wanting to attend unaccompanied. These were investigated in the IDHS, but were not considered here because they related specifically to the woman's ability to access health care for herself and, therefore, may not extend to obtaining health care for children⁵.

The logistic regression analysis conducted here was carried out at the individual level. The type of residence by classifying respondents as urban or rural residents, was collected at the individual level; however, it may also be considered a community or contextual level variable. Two limitations of our statistical approach in relation to type of residence are that statistically significant results may be



confounded by the higher-level variable and when the hierarchical nature of the data are not considered, potentially important community level effects may be overlooked^{32,33}. This model does not take into account contextual effects on decision-making, such as social learning and social influence³⁴, which can lead individuals in a similar social setting to act similarly, and the effect of location on the availability of public health infrastructure. The policy implications of this being that interventions must target community, as well as individual determinants of vaccination coverage³⁵. However, we believe that these limitations will have minimal impact on our findings because type of residence is has not been consistently treated as a community-level variable in studies of DHS data^{35,36}.

Conclusion

In addition to providing sustainable initiatives to increase measles vaccination coverage globally, it is important to close the rural–urban gap in Indonesia’s measles vaccination uptake. Addressing the critical determinants of inferior measles vaccination coverage in Indonesia’s rural regions will facilitate major improvements in Indonesia’s child health trends. Three such critical determinants for attention in Indonesia’s rural areas highlighted in this study are poverty, parental education and access to skilled health workers.

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