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

Abstract

Introduction: In 2007, 0.9 million eligible Indonesian children missed measles vaccination, and 19,456 cases of measles were documented among Indonesian children. In contrast to a 78% decline in measles deaths globally, Indonesia recorded a decline in measles mortality of only 46% during the same period. Regional differences in vaccination uptake are common in both developed and developing countries, and are often linked to the availability of health care services and socioeconomic factors. The authors investigated rural-urban differentials in measles vaccination coverage among young Indonesian children, and sought to identify the key factors influencing the probability of a child receiving the first dose of measles vaccination in Indonesia.

Methods: Data used in our analyses were sourced from the nationally representative 2007 Indonesia Demographic and Health Survey. Literature review was conducted to relate our results to findings of measles vaccination studies from other centres.

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 83%. 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 < .001). This apparent significance of rural residence in impairing vaccination coverage was neutralised after controlling for child sex, maternal age and education, wealth, and access to skilled health workers.

Conclusion: Indonesia is one of the five countries with the highest numbers of children missing measles vaccination globally. The most effective public health measure for
preventing measles transmission is vaccination. 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.

**Keywords:** Indonesia, Measles, Vaccination, Rural-urban divide, Maternal education, poverty, 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 10–14 days (range, 8–15 days) from exposure to onset of rash, and patients are contagious from about 4 days before eruption of the rash until 4 days after eruption. 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 <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%.1 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 2008.2 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, since 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, as 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 2008.3 Effective measles vaccination programs may also help to ease resource constraints in health care systems by preventing infection, and therefore, the number of cases presenting to hospitals for medical care.4 Indonesia is the fourth most populous nation in the world with an estimated population of 228 million people in 2008, and 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 Southeast Asian nations. Estimates from Indonesia’s 2007 Demographic and Health Survey show that measles vaccination coverage for Indonesian children aged below 6 years was 72.8%, compared with 84% in the South-East Asian region in the same year. In 2007, about 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 Asia.

The primary aims of this study are; (1) to use the nationally representative 2007 Indonesian Demographic Health Survey (IDHS) dataset to determine if rural residence is a significant determinant of measles vaccination uptake in Indonesia; (2) to explore other factors presumed to influence the likelihood of children receiving the first dose of measles vaccination in rural and urban areas.

**Methods**

The IDHS is a cross-sectional survey administered by Statistics Indonesia (BPS), 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 has granted permission for the 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 (response rate 99%). 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 the 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 bias. Information about living children aged between 9 and 59 months was collected through the married women’s questionnaire and separated into a children’s dataset by DHS. The final sample for this analysis contained 15,065 children.

The dependent variable of interest is the likelihood of measles vaccination amongst children under 5 years of age. This variable relies on two response options - vaccination card records and mother’s recall. The question on measles vaccination uptake was asked of every mother with a child aged under 5 years. As only 21% of the sample had their vaccination history recorded on a vaccination card, measles vaccination was re-coded into dichotomous (no/yes) variables, 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. The fact that they have responded ‘don’t know’ is likely to reflect that the child was not vaccinated and fits better with the ‘no’ response. 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 were also measured using dichotomous (no/yes) variables.

There is no universally accepted definition of rurality. In the IDHS, “urban areas” refer to large cities (capital cities and cities with populations greater than one million), smaller cities (more than 50000 people) and towns, and all countryside areas are considered rural. Bivariate analysis was conducted to investigate the pattern of vaccination coverage across urban and rural areas for measles and 11 other vaccinations on the Indonesian childhood vaccination schedule. To further investigate regional differences in measles vaccination uptake, bivariate analysis was used to investigate urban/rural coverage across the 33 Indonesian provinces.
Contingency table analysis was used to investigate the characteristics of urban and rural residents in terms of access to skilled birth attendants, total number of children per woman, wealth (measured using wealth quintiles; poorest, poorer, middle, richer, richest) and maternal education (measured as a categorical variable indicating the highest level of schooling attained by the child’s mother, that is, no education, primary, secondary or higher education).

The presence of a skilled birth attendant during delivery was used as a proxy for the availability of skilled health workers in the community. 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 such as a friend, family member, traditional birth attendant, other, no one or don’t know were coded as ‘no’ for this variable. 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’, since it is unlikely that a skilled attendant was present and only a small number (0.07%) of cases were affected. The IDHS also contained data relating to the place of birth, for example at home, hospital or private clinic. The presence of a skilled birth attendant was selected over place of delivery, as 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. Traditional birth attendants however, do not receive formal medical training. The continuous variable, total children ever born, from the DHS was used to investigate the average number of children per woman in urban and rural areas and between wealth quintiles. Significance testing for bivariate analyses and contingency tables was conducted using Pearson Chi-square tests to establish the influence of any differentials identified during bivariate analysis at the 5% level. Significant differences in mean children ever born were assessed using independent sample T-Tests.
To investigate the relative importance of wealth in urban and rural areas, the measles vaccination coverage rates for poor and rich 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 as they have been identified since 2006 as priority areas for improving measles vaccination by the Indonesian Ministry of Health. East Java was chosen as this province has above average measles vaccination coverage. 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. 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.

Multivariate logistic regression analysis was used to investigate whether rural-urban differentials remained after controlling for child sex, skilled birth attendant, household wealth, maternal age and education. Maternal education and age were included in the analysis as this is a well-established determinant of vaccination coverage. Skilled birth attendant, household wealth and maternal education were included as categorical variables (as defined above). Maternal age was measured as a continuous variable. A binomial logistic regression model was developed with measles vaccination as the outcome variable. The independent variables – child sex, birth attendance, household wealth, maternal age and education 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 Version 17.

**Results**

The socio-demographic characteristics of the sample are presented in Table 1. Overall, 72.8% of children in the sample had received measles vaccination. The mean age of children in the
sample was 33.9 months, 52.3% were male, and 61.9% of the sample resided in rural areas, compared with 38.1% in urban regions. Table 1 also shows that 69.3% of births were attended by a skilled birth attendant.

Bivariate analysis revealed that measles vaccination coverage was significantly higher (P < .001) among urban children (80.1%) compared to rural children (68.5%). As illustrated in Table 2, the rural-urban differential was not unique to the measles vaccination. Vaccination coverage was significantly higher (P < .001) amongst urban children for all 12 vaccinations listed on the Indonesian vaccination schedule.

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 out 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 levels. In Papua, where the rural-urban differential is greatest, coverage was 47.3% among rural children and 81.0% among urban children.

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 workers. Rural-urban differentials in skilled birth attendants were significant, with skilled attendance at 57.8% of births in rural areas compared to 87.9% of births in urban areas (Chi-Square = 1514.915; P < .001). This trend reflects the rural-urban distribution of skilled health workers in Indonesia and most developing nations. Of the 4623 births that were not attended by a skilled health worker, 3941 were attended by traditional birth attendants. Of the 682 births that were therefore, attended only by a family member, friend or no one, 87.7% took place in rural areas. 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 to 2.46 (SD = 1.492) for urban women (t = -16.755; P < .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 < .001) than the mean number of children for the middle, richer and richest quintiles combined, which was 2.45 (SD = 1.481).

To 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 in Table 4 show that for all four provinces, measles vaccination coverage was not significantly different between the poorest 2 wealth quintiles and wealthiest 3 quintiles in urban areas. In rural areas, measles vaccination coverage was significantly higher amongst the wealthier group. This was most significant in Papua and East Java (P < .001), followed by South Kalimantan (P < .01) and West Sumatera (P < .05).

When socio-economic status is analysed across urban and rural areas overall, 70% of rural residents fall into the poor or poorest wealth quintiles compared to 18% of urban residents. A significantly higher proportion of rural mothers were in the poorest and poorer wealth quintile (P < .05). The proportion of mothers in the middle, richer and richest wealth quintiles was significantly higher in urban areas (P < .05). Higher poverty in rural areas adversely impacts on measles vaccination in several ways. First, deprived neighborhoods generally have inferior social amenities, and therefore create disincentives for health skilled health staff to
relocate to such areas. Poverty reduces the capability of mothers to take children to vaccination centers. Ironically, uptake of childhood immunization offsets the detrimental effects of poverty and low maternal educational attainment.\textsuperscript{13,14}

Multivariate logistic regression analysis was performed to assess the independent effect of rural-urban residence on measles vaccination coverage, while controlling for child sex, skilled birth attendance, wealth, and maternal and education. After controlling for these variables, the rural-urban differential in measles vaccination coverage was no longer significant (Table 5). Lack of significance of the rural-urban variable following multivariate analysis has also been found in other studies.\textsuperscript{9,15} This suggests that it is not rural residence per se that influences measles vaccination coverage, but the cumulative effects of several other determinants of vaccination in rural areas. The presence of a skilled health worker during delivery, wealth, and maternal education and were significantly and independently correlated with measles immunisation coverage.

As shown in Table 5, the odds of measles immunisation were not significantly different for male and female children. 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 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.

The main factors found to adversely influence rural-urban variations in measles vaccination in Indonesia were low maternal education, inadequacy of skilled birth attendants, and higher poverty. Maternal highest education level was significantly correlated with measles
vaccination after adjusting for all other factors. The greatest increase in the odds of vaccination was found when mothers had secondary level education or higher compared to no education. 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. 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, availability of quality health staff is likely to be continued early childhood.

The logistic regression analysis conducted here was carried out at the individual level. The type of residence (urban/rural) 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 is not considered, potentially important community level effects may be overlooked. This model does not take into account contextual effects on decision making, such as social learning and social influence, 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 coverage. However, we believe that these limitations will have minimal impact on our findings because type of residence is not consistently treated as a community-level variable in studies of DHS data.

Conclusion
The relatively lower vaccination coverage in rural regions of Indonesia is due, not to rural location per se, but to determinants such as poverty, limited access to skilled health workers,
and low maternal education. Thus, an important starting point for addressing rural-urban disparities in measles vaccination uptake is to address these determinants in rural areas.

Although Indonesia has, particularly in the past decade, implemented poverty alleviation programmes 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 quintiles. Improved governance of this and related initiatives to improve access to health care for poor Indonesians is urgently required. A 2006 study found that, in terms of elasticity of poverty, urban services growth has the largest for all sectors except urban agriculture and that rural agriculture growth strongly reduces poverty in the rural agriculture sector, the largest contributor to 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 rural agriculture as well as urban services.

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 system. In relation to improving vaccination in rural regions, a study in India found that revitalization of rural health systems has positive effects 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 supply.

Improvements in female education in rural areas need to address two impediments - cultural antipathy towards female education, and relatively high parity. 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%. One effective initiative is a national measles supplementary vaccination programme,
such as the pilot supplementary vaccination program organised in three Indonesian provinces
with assistance from UNICEF in 2009.
References


25. UNICEF Indonesia. A Supplementary Measles Immunization Campaign [Internet].
### Appendix

**Table 1:** Descriptive statistics showing the socio-demographic characteristics of the sample. N= 15065 living children aged under 5 years.

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
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<td>Maternal age (in years)</td>
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</tr>
<tr>
<td>Child age (in months)</td>
<td>33.9</td>
</tr>
<tr>
<td>Sex of the child</td>
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<tr>
<td>Male</td>
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<tr>
<td>Female</td>
<td>47.7</td>
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<td>Yes</td>
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</tr>
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<td>No</td>
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<tr>
<td>Yes</td>
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</tr>
<tr>
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<td>38.1</td>
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<tr>
<td>Wealth</td>
<td></td>
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<tr>
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<tr>
<td>Middle</td>
<td>17.1</td>
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<tr>
<td>Richer</td>
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<td>Maternal education</td>
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<td>Higher</td>
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Table 2 Vaccination coverage (%) among rural and urban children for 12 vaccinations listed on the Indonesian vaccination schedule.

<table>
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<tr>
<th>Vaccine</th>
<th>Vaccination coverage (%)</th>
<th>P value</th>
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<tr>
<td>BCG</td>
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<td>88.2</td>
</tr>
<tr>
<td>DTP 1</td>
<td>74.3</td>
<td>87.0</td>
</tr>
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<td>DTP 2</td>
<td>64.8</td>
<td>80.3</td>
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<td>DTP 3</td>
<td>54.0</td>
<td>71.3</td>
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<td>Polio 1</td>
<td>81.3</td>
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<td>Polio 4</td>
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<td>Hepatitis B 1</td>
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<td>84.8</td>
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<td>Hepatitis B 2</td>
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<tr>
<td>Measles</td>
<td>68.5</td>
<td>80.1</td>
</tr>
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*Bacillus Calmette-Guérin vaccine, *Diphtheria Tetanus and Pertussis vaccine
Table 3 Measles vaccination coverage (%) amongst rural and urban children in each of the 33 Indonesian provinces.

<table>
<thead>
<tr>
<th>Province</th>
<th>Vaccination Coverage (%)</th>
<th>P-value</th>
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<tr>
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</table>

†DKI Jakarta is a completely urban province.

*P < .05, **P-value < .01, ***P < .001.
Table 4  Measles vaccination coverage (%) by economic status for rural and urban children in four Indonesian provinces.

<table>
<thead>
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<th>Measles vaccination coverage (%)</th>
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<td>Urban</td>
<td>84.2</td>
<td>88.6</td>
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<td>Rural</td>
<td>59.6</td>
<td>85.1</td>
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† Not significant (n.s) at the 5% level
Table 5 Logistic regression results for measles vaccination coverage after controlling for child sex, residence, maternal age and education, wealth and the presence of a skilled birth attendant.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Odds ratio</th>
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<td>1.103</td>
<td>1.051 – 1.157**</td>
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<td>Maternal age</td>
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<td>squared</td>
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<td>0.998 – 0.999***</td>
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<tr>
<td>Education</td>
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<td>1.816 – 2.160***</td>
</tr>
</tbody>
</table>

†Reference category  
*P < .05, **P < .01, ***P < .001.