Determinants of Stunted Children in Indonesia: A Multilevel Analysis at the Individual, Household, and Community Levels

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Abstract
This study aimed to examine the risk factors of childhood undernutrition in Indonesia. Determinants of childhood stunting were examined by using the 2013 Indonesia Basic Health Research Survey dataset. A total of 76,165 children aged under 5 years were included in this study. The analysis used multivariate multilevel logistic regression to determine adjusted odds ratios (aORs). The prevalence of stunting in the sample population was 36.7%. The odds of stunting increased significantly among the under-five boys, children living in slum area, and the increase of household member (aOR = 1.11, 95%CI: 1.06–1.15; 1.09, 95%CI: 1.04–1.15; and 1.03, 95%CI: 1.02–1.04 respectively). The odds of stunting decreased significantly among children whose parents more educated (aOR = 0.87, 95%CI: 0.83–0.91 and 0.87, 95%CI: 0.83–0.9, respectively), who live in urban area, in a province with higher Gross Domestic Product (GDP) per capita, and in a province with higher ratio of professional health worker per 1,000 population aged 0-4 years (aOR = 0.85, 95%CI: 0.81–0.89; 0.89; 95%CI: 0.79–1.00; and 0.99; 95%CI: 0.99–1.00, respectively). The study found that stunting was resulted from a complex interaction of factors, not only at the individual level, but also at household and community levels. The study findings indicate that interventions should implement multi-level approaches to address various factors from the community to the individual level.

Keywords: children, multilevel regression, stunting, undernutrition

Introduction
Childhood undernutrition is an ongoing problem in many developing countries. Approximately, 159 million children under 5 years of age were estimated to be stunted worldwide in 2014; this statistic is an indicator of chronic undernutrition. Childhood stunting has considerable human and economic costs. It increases the risk of child death, adversely affects child development and learning capacity, increases the risk of infections and non-communicable diseases, and reduces productivity and economic capability in adulthood. Hence, global efforts have been directed toward the development of policies and programs aimed at reducing stunting. Reducing childhood stunting is the first of six goals in the Global Nutrient Targets for 2025 and a key indicator in the second Sustainable Development Goals (SDGs) to Achieve Zero Hunger.

Despite such efforts, however, childhood stunting remains at a high level and continues to be a serious public health problem in Indonesia, in which progress in reducing childhood undernutrition has been slow over the past decade. A previous report published in 2013 indicated that over one-third (37%) of children under 5 years of age are approximately stunted, while 18% are estimated severely stunted. Indeed, Indonesia even ranked the fifth among countries with the highest burden of stunted children.

A child’s nutritional status is largely determined by his or her dietary intake, disease exposure, and treatment, which in turn, they are affected by several individual, household, and community factors. Many previous studies emphasized the importance of socio-economic, demographic, household, environmental factors, parental characteristics, child health and feeding practice factors, and geographical locations on childhood nutrition status. Prior studies in Indonesia on factors associated with stunting indicated that maternal education, poverty, and water and sanitation were associated with stunting.

Although many scholars have examined risk factors for childhood undernutrition in Indonesia and many other developing countries, most of the work done thus
far focuses on individual-level factor affecting stunting rather than community-level factor. Studies focusing only on individual-fixed effect factors could ignore group membership and concentrate exclusively on inter-individual variations and on individual-level attributes. Such studies, would, thus, tend to disregard the potential importance of group-level attributes in influencing individual-level outcomes. The risk of stunted growth and development is affected by the context in which a child is born and raised. Including interdependent influences, such as the political economy, health and health care, education, society and culture, agriculture and food systems, water and sanitation, and the environment. Moreover, if outcomes for individuals within groups/communities are correlated, the assumption of independence of observations is violated, resulting in incorrect standard errors and inefficient estimates.

A multilevel study design allows the simultaneous examination of the effects of group and individual-level predictors. Thus, the present study was designed to identify both the individual and community-level factors contributing to stunting in Indonesia.

Method

This study used data from the 2013 National Basic Health Research dataset. The 2013 National Basic Health Research is a periodic community-based research initiated in 2007 that aims to collect basic data and health indicators depicting health conditions at the national, provincial, and district/municipality levels. It is designed as a descriptive cross-sectional survey. This survey used a three-stage sampling technique by probability proportional to size (PPS) to select a sample of 300,000 households spread across 33 provinces and, 497 districts/municipalities in Indonesia. In this study, the unit of analysis was children under five years old living with both of their parents. Given this limitation, 76,165 children under 5 years and living within 66,917 households and 33 provinces were eligible for inclusion in this study.

The nutritional status of children under 5 years of age was assessed from their age and body length/height. The height of children aged < 2 years was measured while they were in a recumbent position, while the height of children aged ≥ 2 years was measured while they were in a standing position using length/height measuring tools with a precision of 0.1 cm. The scores of height-for-age of children were converted into standardized value (Z-score) using the anthropometric standards of the WHO. Children with a Z-score of < -2 standard deviations relative to height-for-age WHO standards were defined as being stunted.

The individual, household, and community-level variables included in this study as explanatory variables, along with the corresponding coding definitions, are shown in Table 1. Here, individual-level variables include children characteristics (level one), household-level variable describe the cluster of children living in the same household (level two), and community-level variable describe the cluster of communities living in the same provincial living environment (level three). These three hierarchical levels were used to create a multilevel analysis of the study. Communities were based on sharing a common primary sampling unit within the 2013 National Basic Health Research data.

This study used a three-level regression model (level 1: individual; level 2: household; level 3: provincial) to estimate the effects of predictors on the risk of childhood undernutrition after controlling for other confounding factors. Children living in the same community and belonging to the same household may be more similar to each other than individuals from different communities and different households. Thus, the multilevel regression model was used to adjust correlated individual responses because the same household is nested under a single community.

Multilevel models recognize the existence of data hierarchies by allowing for residual components at each level in the hierarchy. For example, a two-level model

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>Sex of children</td>
<td>Categorized into (1) male and (0) female.</td>
</tr>
<tr>
<td></td>
<td>Vaccination status</td>
<td>Categorized into (1) ever vaccinated and (0) no.</td>
</tr>
<tr>
<td></td>
<td>Slum dwelling</td>
<td>Categorized into (1) yes and (0) no.</td>
</tr>
<tr>
<td></td>
<td>Father’s education</td>
<td>Categorized into (1) senior high school or higher and (0) less than senior high school.</td>
</tr>
<tr>
<td></td>
<td>Maternal education</td>
<td>Categorized into (1) senior high school or higher and (0) less than senior high school.</td>
</tr>
<tr>
<td></td>
<td>Household wealth</td>
<td>Categorized into (0) (first and second quintiles) (poorest); (1) (third quintile) (middle; and (2) (fourth and fifth quintiles) (richest).</td>
</tr>
<tr>
<td>Household</td>
<td>Number of household member</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td>Type of residence</td>
<td>Categorized into (1) urban and (0) rural.</td>
</tr>
<tr>
<td></td>
<td>Log GDP per capita</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td>Poverty rate</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td>Ratio of professional health worker per thousand population aged 0-4</td>
<td>Continuous</td>
</tr>
</tbody>
</table>
that allows for grouping of child outcomes within households could include residuals at the child and household level. Thus, the residual variance is partitioned into a between-household component (e.g., the variance of the household-level residuals) and a within-household component (e.g., the variance of the child-level residuals). Household residuals, which are often called “household effects”, represent unobserved household characteristics affecting child outcomes. These unobserved variables lead to correlations among outcomes for children from the same household.

Data analysis was carried out by using STATA version 16.0 (StataCorp, College Station, Texas, USA) statistical software, and the results of the multivariate analysis were reported as adjusted odds ratio (aORs) with p-values and 95% CIs.

Results

In total, 76,165 children aged 0 - 4 years and living in 66,917 households within 33 provinces were analyzed in this study. Approximately 36.7% of the children were stunted. The sample characteristics are presented in Table 2.

The results of multilevel logistic regression models for individual, household, and community level factors are displayed in Table 3. A child’s sex, type of residence (urban or rural), parental education (mother and father), household wealth, slum area residence, number of household member, Gross Domestic Product (GDP) per capita, and ratio of professional health worker per 1,000 population aged 0 - 4 years were important risk factors influencing childhood stunting at the individual, household, and community levels.

Boys had higher odds ratio (ORs) of being stunted (aOR = 1.11; 95% CI: 1.06-1.15) compared with girls. The odds of being stunted were higher (aOR = 1.09; 95% CI: 1.04-1.15) among children living in slum areas compared with children not living in slum areas. Children whose mothers graduated from senior high school or higher were less likely to be stunted compared with children whose mother did not graduate from senior high school (aOR = 0.87; 95% CI: 0.83 – 0.91). Children whose fathers graduated from senior high school or higher were also less likely to be stunted compared with those whose fathers did not graduate from senior high school (aOR = 0.87; 95% CI: 0.83 – 0.91). The risk of being stunted decreased with an increase in household wealth, and the ORs were lowest in children who belong to the richest households. The risk of being stunted was increased with increasing number of household member (aOR = 1.03; 95% CI: 1.02 – 1.04).

Children living in urban areas were by 15% less likely to be stunted compared with children living in rural areas (aOR = 0.85; 95% CI: 0.81 – 0.89). Children living in a province with higher GDP per capita had decreased odds to be stunted than those who lived in a province with lower GDP (aOR = 0.89; 95% CI: 0.79 – 1.00). Finally, children living in a province with a higher ratio of professional health workers per 1,000 population aged 0 - 4 had decreased odds to be stunted than those who lived in a province with a lower ratio of these health workers (aOR = 0.99; 95% CI: 0.99 – 1.00).

Discussion

In this study, the prevalence of stunting in the sample

### Table 2. Sample Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Category</th>
<th>Yes</th>
<th>%</th>
<th>No</th>
<th>%</th>
</tr>
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<tbody>
<tr>
<td><strong>Individual level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex of the child</td>
<td>Male</td>
<td>14,522</td>
<td>52.0</td>
<td>24,220</td>
<td>50.2</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>13,405</td>
<td>48.0</td>
<td>24,018</td>
<td>49.8</td>
</tr>
<tr>
<td>Vaccination status</td>
<td>Yes</td>
<td>24,490</td>
<td>87.7</td>
<td>43,293</td>
<td>89.7</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>3,437</td>
<td>12.3</td>
<td>4,945</td>
<td>10.3</td>
</tr>
<tr>
<td><strong>Household level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slum dwelling</td>
<td>Yes</td>
<td>5,272</td>
<td>18.9</td>
<td>8,005</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>22,655</td>
<td>81.1</td>
<td>40,233</td>
<td>83.4</td>
</tr>
<tr>
<td>Father’s education</td>
<td>Senior high school or higher</td>
<td>8,600</td>
<td>50.8</td>
<td>18,779</td>
<td>58.9</td>
</tr>
<tr>
<td></td>
<td>Less than senior high school</td>
<td>19,327</td>
<td>69.2</td>
<td>29,459</td>
<td>41.1</td>
</tr>
<tr>
<td>Maternal education</td>
<td>Senior high school or higher</td>
<td>7,200</td>
<td>25.8</td>
<td>16,052</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Less than senior high school</td>
<td>20,727</td>
<td>74.2</td>
<td>32,186</td>
<td>66.7</td>
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<tr>
<td>Household wealth</td>
<td>Richest</td>
<td>9,453</td>
<td>33.8</td>
<td>22,225</td>
<td>46.1</td>
</tr>
<tr>
<td></td>
<td>Middle</td>
<td>5,371</td>
<td>19.2</td>
<td>9,217</td>
<td>19.1</td>
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<tr>
<td></td>
<td>Poorest</td>
<td>13,103</td>
<td>46.9</td>
<td>16,796</td>
<td>34.8</td>
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<tr>
<td><strong>Community level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of residence</td>
<td>Urban</td>
<td>10,937</td>
<td>39.2</td>
<td>2,343</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>16,990</td>
<td>60.8</td>
<td>24,808</td>
<td>51.4</td>
</tr>
</tbody>
</table>

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population was 36.7% which indicates that childhood under-nutrition in Indonesia requires urgent attention. A child’s sex, parental education (mother and father), household wealth, type of residence (urban or rural), slum area, and number of household member are important risk factors influencing childhood undernutrition. This study also revealed that community (provincial)-level variables, such as GDP per capita and ratio of professional health workers per 1,000 population aged 0 - 4 years, as proxies for economic and health development exerts independent effects on childhood undernutrition exceeding the effects of individual and household-level variables.

This study found that vaccination status exerted no significant effect on childhood undernutrition; it was likely that the proxy used to measure the vaccination status was only ever-vaccinated status, regardless of the completeness of basic vaccination in children (due to limited data).

The study found that male children were more likely to be stunted than their female counterparts. This finding is consistent with previous studies. Male children are believed to be more physically active and to expand more energy that should have been channeled to increase growth.

This study further revealed that childhood stunting was inversely related to the maternal education level, which was in line with findings in previous studies. Maternal education affects child nutrition via multiple pathways. Higher educational levels, for example, can be associated with higher knowledge. Mothers with nutritional knowledge acquired in the community have been reported to choose a more diversified diet for their children and utilize food more effectively than those without.

Childhood stunting was also found to be inversely related to the father’s level of education and household’s wealth status. This finding is consistent with previous studies. Poverty affects a child’s nutritional status through insufficient food intake, increased exposure to infections, and a lack of basic health care. A father’s higher education level also translates to a higher household income and food security.

The study also found that higher numbers of household members increase the risk of stunting.
Children living in slum areas had higher odds to be stunted than children who did not. Children living in highly-dense household environment without sanitation were exposed to more fecal pathogens than children who did not. Such exposure could impede the nutrient absorption of children.

This study provides a good example of how childhood undernutrition cannot be entirely explained by individual-level factor. It reveals that children living in a province with higher GDP per capita and a province with a higher ratio of professional health worker per 1,000 populations aged 0 - 4 years are less likely to be stunted than those who do not.

The relationship between increased national income and nutrition functions is through two complementary channels. When economic growth stimulates average incomes, populations may spend a larger part of their incomes on the consumption of health and nutrition-relevant goods and services. Increased GDP may also boost the provision of nutrition-relevant services and social and health infrastructures because richer governments are more capable of dedicating higher public spending towards these investments.

Deployment of community health workers in the community is associated with households' better management of child illness, specifically the treatment of child fever and non-use of antibiotics in home treatment of diarrhea. Women are most likely than men to access the health care system during the first 1,000 days. Such contact provides opportunities for nutritional and health interventions to improve birth outcomes, and to place and keep children on the path to healthy growth. Hence, a higher ratio of professional health workers per 1,000 populations aged 0 - 4 years could lead to lower risks for undernutrition in children.

The study showed that children whose parents resided in rural areas have higher odds of childhood stunting than those living in urban areas, likely because the latter have better-equipped urban health-care systems and greater access to health-care facilities. Moreover, urban populations usually have a higher educational level and economic status.

This study has several strengths. First, the study used a nationally-representative household survey with large-scale sample size and broad geographic coverage as a dataset. Second, the study used multilevel regression estimation to enable the simultaneous examination of the effects of individual, household, and community-level risk factors on the risk of individual childhood undernutrition. Multilevel analysis provides an efficient means to link traditionally-distinct ecological/community levels and individual-level studies and overcomes the limitations inherent in focusing on only one level.

In terms of limitations, however, the use of secondary data restricted the ability to include other variables related to childhood undernutrition.

Conclusion
This study shows that stunting is resulted from a complex interaction of individual, household, and community-level factors, all of which contribute to a high prevalence of childhood undernutrition in Indonesia. A child’s sex, parental education (mother and father), household wealth, type of residence (urban or rural), slum area residence, and number of household member are important risk factors for childhood undernutrition. This study also reveals that community (provincial)-level variables, such as GDP per capita and ratio of professional health worker per 1,000 population aged 0 - 4 years, as proxies to economic and health development, are also important risk factors for childhood undernutrition. The study findings indicate the need for integrated interventions to reduce stunting rate in Indonesia. Interventions should use multilevel approaches to address various factors from the community to the individual level. A strong required effort to improve educational level, for both men and women, is uncovered. Efforts made to promote higher education will help improve a child’s nutritional status by empowering women, which can lead to better child care practices, and by improving household economic status, which is essential for better food intake, less exposure to infections, and better use of health care services. Boosting economic growth is also essential to improve a child’s nutritional status through a higher consumption of health and nutrition-relevant goods and services by households and the government. Increasing the number of professional health workers in community is also essential to ensure the accessibility of health care services, which can improve children’s nutritional status within the community.

Abbreviations
SDG: Sustainable development goals; PPS: Probability proportional to size; WHO: World health organization; GDP: Gross Domestic Product.

Ethics Approval and Consent to Participate
Not applicable.

Competing Interest
Author declares that there are no significant competing financial, professional, or personal interests that might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials
The data that support the findings of this study are available from the corresponding author upon reasonable request.
Authors’ Contribution
Febri Wicaksono and Titik Harsanti were involved in the design of the study and the data analysis. Febri Wicaksono prepared and revised the manuscript. All authors read and approved the final manuscript.

Acknowledgment
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References