



Article

Explaining the fall of socioeconomic inequality in childhood stunting in Indonesia

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ABSTRACT

In spite of the enormous economic progress and development witnessed in Indonesia in the last few decades, still more than 30% of Indonesian children under the age of five suffer from stunting, or low height for age. This concern is exacerbated by the fact that stunting remains more concentrated among the poorer households, leading to further intergenerational transmission of poverty and ill health.

We examine recent trends in the evolution of the prevalence of childhood stunting and severe stunting, its socioeconomic inequality and the factors that appear to have contributed to these developments. Using the two most recent waves of the *Indonesia Family Life Survey (IFLS)*, we study the changes in the prevalence of (severe) stunting between 2007 and 2014 for children aged 0–59 months and their socioeconomic-inequality using the Erreygers Concentration Index (EI) and its regression-based decomposition.

We find a significant drop in the rate of severe stunting but not in stunting, as well as a significant reduction in the degree of absolute inequality of stunting. A decomposition analysis shows that household wealth, maternal education, institutional delivery, and availability of adequate sanitation contribute most to socioeconomic inequality in under-five stunting. Further analysis of the change in inequality over time indicates that the reduction in the association of wealth with stunting and a substantial improvement of health care access of the poor (as proxied by immunizations and institutional deliveries) play the most important role in narrowing the stunting gap between richer and poorer kids.

General economic growth, poverty reduction, and implementation of pro-poor health and social programs during the studied period such as the expansion of health insurance coverage for the poor (*Jamkesmas*) and Conditional Cash Transfer program (*Program Keluarga Harapan, PKH*) are some plausible explanations of the observed result.

Introduction

Stunting, or low height for age, is a growth problem caused by long-term inadequacy of nutrition intake coupled with frequent cases of diseases, mainly during the first 1000 days of life (de Onis & Branca, 2016). It is associated with significant long-term impact in adulthood in the form of reduced cognitive and physical development, higher risk of metabolic disease, and reduced work productivity that might potentially harm future economic growth at national level (Reinhardt & Fanzo, 2014). Globally, stunting affected 161 million children under five years old in 2013, mostly in low-middle income countries (de Onis & Branca, 2016). Although there was a significant reduction compared to its level

in 1990, when around 257 million children suffered from stunting, this improvement was not equally distributed. Asian countries showed a more impressive result with 23 percentage-points reductions (from 48% to 25%) while only eight percentage-points reduction was recorded in African countries (from 42% to 34%) (de Onis & Branca, 2016).

Amidst the impressive Asian regional progress, Indonesia—the most populous country in Southeast Asia—is still left behind. In spite of its significant economic growth and poverty reduction in the last decade (OECD Economic, 2016), the prevalence of under-five stunting has not fallen. Based on the Indonesia Basic Health Research report (NIHRD, 2013), an even slightly higher prevalence of under-five stunting was found in 2013 (37.2%) compared to 2010 (35.6%) and 2007 (36.8%).

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This burden puts Indonesia at the same average stunting level as Cambodia, a neighboring country with less than a half of Indonesian income per capita, and it compares even worse to the rates of countries with more comparable income levels such as The Philippines and Vietnam (Chaparro, Oot, & Sethuraman, 2014). At this pace, it will be difficult for Indonesia to achieve the 2012 World Health Assembly goal to reduce stunting by 40% in 2025 (de Onis et al., 2013).

Moreover, the prevalence of stunting in Indonesia is higher among poorer households (Rachmi, Agho, Li, & Baur, 2016; De Silva & Sumarto, 2018; The World Bank, 2017). The association with living standards might be explained by several factors, including insufficiency of food (both quality and quantity), worse sanitation, unavailability of clean water, difficult access to health care and other health-related behaviors (Torlesse et al., 2016). In order to address some of those problems, between 2007 and 2014, several government programs were implemented. Starting from 2007, the Indonesia government has piloted a Conditional Cash Transfer (CCT) program called *Program Keluarga Harapan* (Family Hope Program) and a community level intervention called *Generasi* which were aimed to reward child health, maternal health, and child education inputs such as immunization, growth monitoring, ante and post-natal care, and nine years of compulsory schooling (Olken, Onishi, & Wong, 2014). Other notable efforts include the implementation of *Jamkesmas*, a central government-financed health insurance for the poor and of several local government programs called *Jamkesda* (Harimurti, Pambudi, Pigazzini, & Tandon, 2013). Additionally, a specific scheme for maternal health care called *Jampersal* was introduced, but only for a short period between 2011 and 2013 (Achadi, Achadi, Pambudi, & Marzoeki, 2014). Subsequently, all of those schemes were integrated into a single national health insurance program named *Jaminan Kesehatan Nasional* (JKN) in 2014 (Mboi, 2015).

Recent studies in Vietnam, Zambia, and Bangladesh find that the rich-poor disparity in stunting prevalence has grown. In Vietnam and Bangladesh, the main driver of that change was the growing inequality of household wealth (Huda, Hayes, & Dibley, 2017; Kien et al., 2016) while in Zambia, the largest contributor is institutional delivery (Hangoma, Aakvik, & Robberstad, 2017). In Indonesia, whether and to what extent socioeconomic-related inequality in childhood stunting has changed over time and what accounts for that is largely unknown. Available evidence to date (Mani, 2014; Rachmi et al., 2016; De Silva & Sumarto, 2018; Torlesse, Cronin, Sebayang, & Nandy, 2016) has only focused on the trend and the potential determinants of childhood stunting. Better evidence about the change and degree of socioeconomic inequality and its contributing factors may help guide and improve any policies aimed at narrowing this gap. That is why this study mainly aims to examine: (1) trend of childhood stunting's prevalence over time; (2) the magnitude and trend of socioeconomic-related inequality in childhood stunting; and (3) the contributing factors to those inequalities and their change over time.

We analyse individual and household level data from the fourth and fifth wave of the *Indonesia Family Life Survey* (IFLS) collected in 2007 and 2014. Child's nutritional status is measured using the WHO growth standard (WHO, 2006) while socioeconomic status is measured using household wealth index. Inequality analysis is measured using the Erreygers Concentration Index (EI), as well as the decomposition of the index and of its change (Erreygers, 2009; Van Doorslaer & Van Ourti, 2011; Wagstaff, Van Doorslaer, & Watanabe, 2003). Discussion of the determinants of stunting on the basis of the UNICEF (1990) conceptual framework and as measured in the IFLS is deferred until section 2.4 below.

Data and methods

Data

We use the two latest waves of the *Indonesia Family Life Survey* (IFLS) collected in 2007 (fourth wave) and 2014 (fifth wave). The IFLS is an

ongoing longitudinal individual-level, household-level, and community-level survey covered 13 out of 26 provinces when it started in 1993 and representing 83% of the Indonesian population. In the first IFLS, stratified random sampling at province level was used based on National Socioeconomic Smith & Haddad, 2015 sampling frame with household as its primary sampling unit. Later waves also included split-off households. The 4th and 5th IFLS contain 10,435 households and 15,349 households respectively (Strauss, Beegle, Sikoki, & Wattie, 2009; Strauss, Witoelar, and Bondan, 2016).

All children aged 0–59 months in each wave with complete records of anthropometric measurement (height and weight), age, and gender are included. Because of the long (seven years) interval between surveys, the two waves were treated as two separate cross-sections. While none of the children could be in the analysis in both waves, only about 1 in 7 households are in both waves (1081 from 6993 households, 15.46%).

Outcome variables

Height/length-for-age Z-score (HAZ-score) is measured using the WHO, 2006 growth standard. It categorizes children as stunted if their HAZ-score is below -2 and categorized as severely stunted when it is below -3 (de Onis, 2007). In the IFLS, physical health measurement, including anthropometrics, was done by professional nurses who accompanied the interviewer¹ (Frankenberg, Karoly, Gertler, Peterson, & Wesley, 1995). We excluded statistically implausible values — i.e. HAZ less than -6 and more than +6 — based on WHO Anthro software manual (WHO, 2006).

Socioeconomic status

Socioeconomic status was measured using a household wealth index, obtained from a Principal Components Analysis (PCA) (Filmer & Pritchett, 2001). We pooled both waves to avoid any difference in the wealth index deriving from changes in the weighting factors (Houweling, Kunst, & Mackenbach, 2003). The index is based on the ownership of assets such as home, land, building, electronic devices (television, radio, refrigerator, etc), any type of vehicle, jewelry, savings, poultry and some household characteristics such as their roof, floor, and wall materials, the use of pipe water source, and the type of fuel used for cooking. From the predicted wealth index, wealth quintiles and wealth tertiles in each wave were created.

Explanatory variables

For identifying the explanatory variables, we rely on the UNICEF (1990) conceptual framework of the determinants of child nutritional status (Smith and Haddad, 2015) and the previous work of Torlesse et al. (2016) and Beal, Tumilowicz, Sutrisna, Izwardy, and Neufeld (2018) as presented in Fig. 1. Generally, we divide the determinants into non-modifiable and potentially modifiable factors. For non-modifiable factors, the most crucial determinants are child's age and sex (Victora, de Onis, Hallal, Blossner, & Shrimpton, 2010). Additionally, mother's height is also considered as a nonmodifiable factor (in the short run, for any given child) since some part of a child's height is explained by genetic factors (Sinha et al., 2018).

The modifiable factors can be further categorized as immediate, underlying, and basic determinants. Immediate factors are the channels through which the underlying determinants influence the child's nutritional status. It includes adequacy of child's dietary intake and the presence of child's diseases. The adequacy of nutritional needs is determined by food security and feeding practice. Adequacy of feeding

¹ Shorr measuring boards Model 420 was used for the measurement of child's length/height, and Seca Model 770 scales (SECA, Los Angeles, CA, USA) was used for measuring the weight.

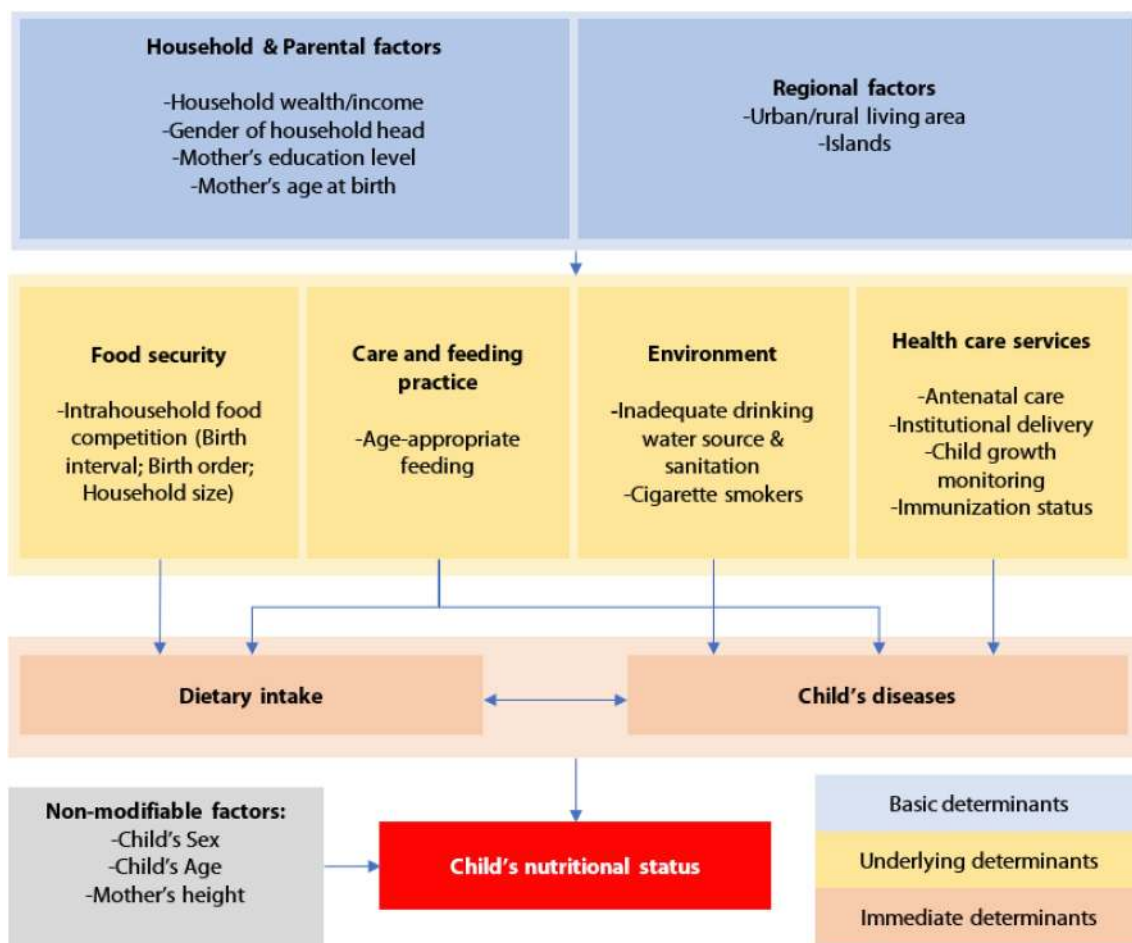


Fig. 1. Conceptual Framework on the determinants of child's nutritional status. Source: Author, based on the UNICEF (1990)conceptual framework.

practice is partially reflected by proper infant and young child feeding (IYCF) practices (Campbell et al., 2017) as measured using the definition of age-appropriate feeding by WHO (2009). The other causes, grouped as food security, can be measured by a proxy for intrahousehold food competition, captured by their birth order and interval as well as the number of children and their household size (Ali Naser et al., 2014).

Another immediate cause is the presence of diseases. Those are influenced by three other underlying factors namely inadequate feeding and care, unhealthy environment and inadequate health services. Environmental conditions are proxied by variables indicating water source, toilet sanitation, the presence of smokers in the household, and presence of animal or human faeces around the house (Best et al., 2008; D.; Headey et al., 2017; Torlesse et al., 2016). The sufficiency of health care services is represented by maternal antenatal care visits, place of birth delivery, and completeness of child immunization (Beal et al., 2018, pp. 1–10).

In addition to household wealth, maternal education is also known to have a substantial role in explaining child's health and nutritional status, either through its positive correlation with better health-seeking behavior or through enhanced capability to provide adequate care (Alderman & Headey, 2017; Onah et al., 2014). Regional variation was controlled for using a dummy variable for urban residence and for five of Indonesia's islands (Sumatra, Java, Kalimantan, Sulawesi, Bali and Nusa Tenggara). Details on the operational definition of each variable are provided in Appendix A.

Analysis

As all of our outcomes and determinants are binary (bounded to

0 and 1), we use the Erreygers Concentration Index (EI) (Erreygers, 2009), to analyse the degree of socioeconomic-inequality in childhood stunting. The EI values range between -1 and 1, with a negative value indicating that the health outcome is more concentrated amongst the poor (Kjellsson & Gertham, 2013). EI is formally defined as follow:

$$EI(h) = \frac{1}{n} \sum_{i=1}^n 4h_i(2R_i - 1) \tag{1}$$

where n is the sample size, h_i is the binary outcome variable of interest for person i and $(R_i = (i - 0.5)/n)$ is the fractional rank of individual i by wealth index (O'Donnell, O'Neill, Van Ourti, & Walsh, 2016).

To examine the contribution of each determinant to stunting inequality, the outcome variable is first explained using a linear regression (Equation (2)) and then decomposed using Equation (3).

$$h_i = \alpha + \sum_{k=1}^q \beta_k x_{ki} + \varepsilon_i \tag{2}$$

$$EI(h) = \sum_{k=1}^q \beta_k EI(x_k) + GCI(\varepsilon_i) \tag{3}$$

where x_{ki} is the set of determinants (in binary form) of stunting, β as its coefficient, $EI(x_k)$ as its adjusted concentration index, and ε_i as the error terms (Van Doorslaer & Van Ourti, 2011; Wagstaff et al., 2003).

Finally, the change in EI from 2007 (t-1) to 2014 (t) was decomposed using the Oaxaca-like decomposition to estimate the contribution of the change in determinants' inequality and the change of their partial associations with health outcome (Van Doorslaer & Van Ourti, 2011). The

formal decomposition of change in EI can be written as equation (4).

$$\Delta EI = \sum_j \beta_{k(t-1)} (\Delta EI(x_{jt}) - EI(x_{j(t-1)})) + \sum_j EI(x_{jt}) (\beta_{kt} - \beta_{k(t-1)}) + \Delta GCI(\varepsilon_i) \quad (4)$$

Statistical analysis was conducted using Stata 15.1 (StataCorp, College Station, Texas, USA). Household sample weights for cross-sectional analysis were applied when constructing household wealth index, wealth quintiles, and wealth tertiles. Individual sample weights were used for estimating national prevalence, regression analysis, and inequality analysis. Standard error estimates were adjusted for heteroskedasticity and household level clustering.

Results

Descriptive statistics

Due to statistically implausible values of anthropometric z-scores, we excluded 465 observations in 2007 and 204 observations in 2014. The final sample of children under five years old in 2007 and 2014 was 4247 and 4723 respectively. Results presented in Table 1 suggest that over this period Indonesia experienced a slight improvement in children's linear growth status, but the change is only statistically significant for the prevalence of severe stunting. The mean HAZ-score increased from -1.438 to -1.412, the stunting rate decreased from 35.4% to 34.2%, while the severe stunting rate decreased from 13.7% to 11.2%. Among the determinants, only age-appropriate feeding, full immunization (in all children aged 0–59 months), and clean household environment show some deterioration while most other variables show some improvement.

Trends in socioeconomic inequality in childhood stunting and severe stunting

The evolution in the distribution of stunting and severe stunting over time and by wealth quintiles is shown graphically in Fig. 2 and 3. We find that the reduction in stunting level mainly occurred in the first and second quintile (3.7 and 5.9-percentage point drops respectively) while, perhaps surprisingly, a slight increase was observed in the fourth and fifth quintile (2.9-percentage points and 1.9-percentage points, respectively). Severe stunting declined in all wealth quintiles with the greatest reduction observed in the second quintile (5.5-percentage points). However, the difference over time was only statistically significant in the 2nd quintile for both stunting and severe stunting.

Changes in the degree of wealth-related inequality of childhood (severe) stunting, as measured with the Erreygers Concentration Index (EI), are presented in Table 2. We estimate negative values of EI for both stunting and severe stunting, meaning that the distribution of both outcomes is more concentrated among the poor. The last column indicates that there was a significant decrease in the inequality for stunting (0.07 points reduction) but not for severe stunting. For reasons of space, we proceed only with a decomposition of the significant change in the next section.²

Decomposition of socioeconomic inequalities of stunting and their change over time

An OLS estimated Linear Probability Model (LPM) is used to assess the association between stunting and its determinants since the decomposition only holds exactly for linear models. For comparison, we

² We also performed the same decomposition for non-severe stunting measure. The results in terms of relative contributions of determinants were very similar to those for severe stunting (results available in supplementary material).

Table 1
Summary statistics for analysis sample.

Variable	2007	2014	Change
Outcomes			
HAZ Score	-1.438 (0.024)	-1.412 (0.021)	0.026 (0.036)
Stunting	0.354 (0.007)	0.342 (0.007)	-0.013 (0.011)
Severe Stunting	0.137 (0.005)	0.112 (0.005)	-0.025*** (0.008)
Underlying Determinants			
Care and Feeding Practice			
Age-appropriate feeding	0.679 (0.007)	0.568 (0.007)	-0.111*** (0.011)
Health Care Services			
Full immunization	0.33 (0.007)	0.308 (0.007)	-0.022* (0.011)
Full immunization (Age 12–23 months)	0.389 (0.016)	0.445 (0.016)	0.056** (0.026)
4 + ANC	0.899 (0.005)	0.936 (0.004)	0.037*** (0.007)
Institutional delivery	0.591 (0.008)	0.803 (0.006)	0.211*** (0.011)
Posyandu participation	0.454 (0.008)	0.495 (0.007)	0.041*** (0.012)
Healthy Environment			
Safe drinking water	0.934 (0.004)	0.938 (0.004)	0.004 (0.006)
Improved sanitation	0.636 (0.007)	0.736 (0.006)	0.1*** (0.011)
Clean HH environment	0.941 (0.004)	0.918 (0.004)	-0.023*** (0.006)
>1 smoker in HH	0.106 (0.005)	0.109 (0.005)	0.003 (0.008)
Intrahousehold food competition			
Birth order and interval			
First born	0.053 (0.003)	0.034 (0.003)	-0.03*** (0.01)
Short birth interval (<24 month)	0.320 (0.007)	0.369 (0.007)	-0.019*** (0.004)
Long birth interval (≥24 month)	0.053 (0.003)	0.034 (0.003)	0.049*** (0.01)
Number of HH member >4	0.476 (0.008)	0.458 (0.007)	-0.018 (0.012)
Basic Determinants			
Household and Parental Factors			
Household wealth			
Poorest third	0.357 (0.007)	0.339 (0.007)	-0.018 (0.011)
Middle third	0.311 (0.007)	0.324 (0.007)	0.013 (0.012)
Richest third	0.332 (0.007)	0.337 (0.007)	0.005 (0.012)
Electricity	0.963 (0.003)	0.993 (0.001)	0.03*** (0.004)
Mother's education min. Junior High School	0.607 (0.007)	0.714 (0.007)	0.108*** (0.011)
Mother's age at birth <20 years	0.132 (0.005)	0.129 (0.005)	-0.003 (0.008)
Male HH head	0.902 (0.005)	0.886 (0.005)	-0.016** (0.008)
Non-modifiable factors			
Male Child			
Male Child	0.508 (0.008)	0.507 (0.007)	-0.002 (0.012)
Child's age			
0–5 months	0.101 (0.005)	0.106 (0.004)	0.004 (0.007)
6–11 months	0.1 (0.005)	0.103 (0.004)	0.003 (0.007)
12–23 months	0.206 (0.006)	0.196 (0.006)	-0.01 (0.009)
≥>=24 months	0.593 (0.008)	0.595 (0.007)	0.003 (0.011)
Mother short stature (<145 cm)	0.103 (0.005)	0.104 (0.004)	0.001 (0.007)
Regional Factors			
Urban			

(continued on next page)

Table 1 (continued)

Variable	2007	2014	Change
	0.454 (0.008)	0.501 (0.007)	0.048*** (0.012)
Island			
Sumatra	0.21 (0.006)	0.188 (0.006)	-0.023*** (0.008)
Java	0.669 (0.007)	0.692 (0.007)	0.023** (0.009)
Kalimantan	0.05 (0.003)	0.049 (0.003)	-0.001 (0.003)
Bali and Nusa Tenggara	0.035 (0.003)	0.038 (0.003)	0.004 (0.003)
Sulawesi	0.036 (0.003)	0.034 (0.003)	-0.003 (0.003)
Observations	4247	4723	

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

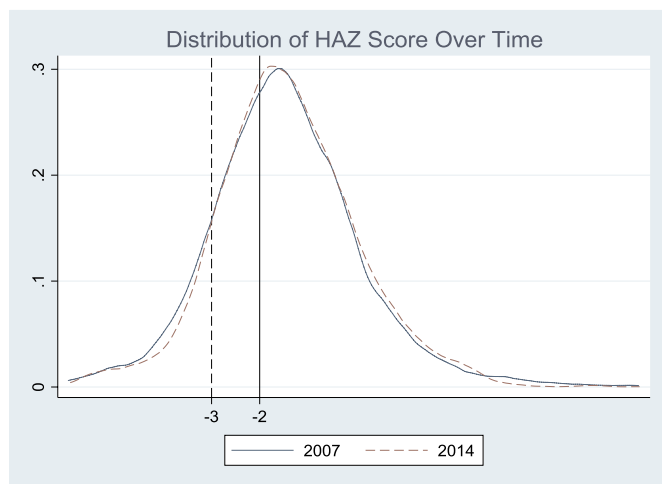


Fig. 2. Density distribution of HAZ score of under-five children, 2007 and 2014.

also show the marginal effects obtained from logistic regression. It can be seen that both the magnitude and significance of the point estimates are quite similar to those obtained from the LPM (see Table 3).

We can see that child’s age and maternal stature show a significant

positive association with stunting in both periods while child’s sex does not. As for intra-household food competition, compared to first-borns, subsequent children are more likely to be stunted, this association is higher for those who have short birth interval. Of the health care utilization variables, complete immunization, at least four ANC visits during pregnancy, and being born in any type of health facility are all negatively associated with stunting, but only full immunization shows a statistically significant coefficient in both years.

Safe drinking water and the availability of electricity in the household are associated with a lower stunting risk while the opposite is true for the presence of cigarette smokers in the household. Improved household sanitation and a clean household environment show a negative association with stunting (albeit only significant in 2014 for the former and only in 2007 for the latter). At household and parental level, wealth, maternal education, and older mother all show a significant protective effect against stunting (except for wealth in 2014 and mother’s age in 2007). Lastly, children living in urban areas and in Java island are on average less likely to be stunted.

Next, Table 4 shows – for each determinant – its contribution to the EI of stunting as the product of its (partial) effect on stunting (β) and its distribution by wealth (EI). In both years, the strongest driver of inequalities is household wealth itself, followed by maternal education and institutional delivery. In 2007, household wealth contributed 44% of total inequality while in 2014 this was to only 5%. Institutional delivery also showed much lower contribution in the second period (from 11% to only 5%). On the other hand, maternal education became slightly more important in 2014 with the contribution going from 8% to 13%. Mother’s stature, maternal age at birth, and household sanitation also showed a similar trend. Living in the urban area had a moderate role with 6% and 12% contribution in 2007 and 2014 respectively while

Table 2

Change in socioeconomic-related inequality in under-five stunting and severe stunting.

Population	2007	2014	Change over Time
	N=4247	N=4723	
Stunting	-0.172*** (0.018)	-0.099*** (0.018)	0.073*** (0.025)
Severe Stunting	-0.062*** (0.013)	-0.043*** (0.012)	0.018 (0.018)

Notes: Robust standard error in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All indices were computed for restricted sample using *conindex* command (O’Donnell et al., 2016).

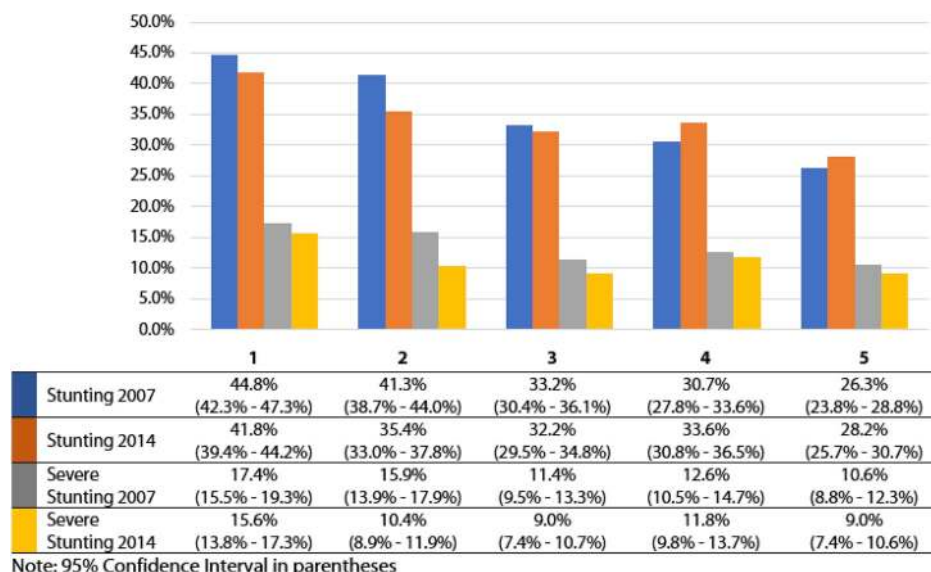


Fig. 3. The estimated prevalence of under-five stunting and severe stunting across different quintile of socioeconomic status in 2007 and 2014.

Table 3
OLS estimated coefficients of LPM and Average Marginal Effects from Logistic Regression for determinants of under-five stunting.

Determinants	LPM		Average Marginal Effect	
	2007	2014	2007	2014
Care and Feeding Practice				
Age-appropriate feeding	-0.016 (0.018)	-0.027* (0.016)	-0.016 (0.017)	-0.027* (0.016)
Health care services				
Full immunization	-0.043** (0.018)	-0.031* (0.018)	-0.042** (0.018)	-0.029* (0.018)
4 + ANC visits	-0.008 (0.029)	-0.015 (0.034)	-0.007 (0.027)	-0.014 (0.033)
Institutional delivery	-0.042** (0.020)	-0.021 (0.022)	-0.040** (0.019)	-0.019 (0.021)
Posyandu participation	0.015 (0.017)	-0.012 (0.017)	0.015 (0.017)	-0.011 (0.017)
Healthy environment				
Safe drinking water	-0.066** (0.032)	-0.014 (0.035)	-0.060** (0.029)	-0.011 (0.033)
Improved sanitation	-0.015 (0.019)	-0.036* (0.020)	-0.014 (0.018)	-0.035* (0.019)
Clean HH environment	-0.075** (0.036)	-0.027 (0.031)	-0.069** (0.033)	-0.026 (0.029)
>1 smoker in HH	0.022 (0.028)	0.041 (0.027)	0.022 (0.027)	0.041 (0.026)
Intrahousehold food competition				
Birth order and interval				
First-born	Reference			
Short birth interval	0.084** (0.036)	0.119*** (0.041)	0.082** (0.033)	0.116*** (0.038)
Long birth interval	0.007 (0.018)	0.057*** (0.017)	0.007 (0.018)	0.056*** (0.017)
Number of HH members >4	0.006 (0.017)	-0.018 (0.017)	0.006 (0.017)	-0.019 (0.017)
Household and parental factor				
Household wealth				
Poorest third	Reference			
Middle third	-0.054** (0.022)	-0.026 (0.022)	-0.050** (0.021)	-0.026 (0.021)
Richest third	-0.083*** (0.025)	-0.007 (0.024)	-0.082*** (0.025)	-0.006 (0.023)
Electricity	-0.020 (0.049)	-0.080 (0.083)	-0.017 (0.044)	-0.076 (0.078)
Mother's education min. Junior High School	-0.041** (0.019)	-0.054*** (0.020)	-0.040** (0.018)	-0.052*** (0.019)
Mother's age at birth <20 years	0.028 (0.024)	0.085*** (0.026)	0.028 (0.023)	0.081*** (0.024)
Male HH head	0.020 (0.027)	-0.018 (0.026)	0.020 (0.027)	-0.017 (0.025)
Non-modifiable factors				
Male Child				
Male Child	0.020 (0.016)	0.012 (0.015)	0.020 (0.015)	0.012 (0.015)
Child's age				
0-5 months	Reference			
6-11 months	0.004 (0.035)	0.031 (0.033)	0.006 (0.039)	0.041 (0.040)
12-23 months	0.158*** (0.030)	0.239*** (0.030)	0.160*** (0.032)	0.248*** (0.034)
≥24 months	0.103*** (0.027)	0.158*** (0.026)	0.106*** (0.029)	0.173*** (0.032)
Mother short stature (<145 cm)	0.170*** (0.028)	0.229*** (0.027)	0.157*** (0.025)	0.209*** (0.023)
Regional factors				
Urban				
Urban	-0.024 (0.018)	-0.035* (0.018)	-0.025 (0.018)	-0.034* (0.018)
Island				
Java				
Sumatra	-0.015 (0.023)	-0.020 (0.021)	-0.013 (0.022)	-0.020 (0.021)
Kalimantan	0.050** (0.025)	0.074*** (0.025)	0.048** (0.024)	0.072*** (0.024)
Bali and Nusa Tenggara	-0.010 (0.040)	0.025 (0.037)	-0.010 (0.038)	0.024 (0.035)
Sulawesi				

Table 3 (continued)

Determinants	LPM		Average Marginal Effect	
	2007	2014	2007	2014
	0.074** (0.038)	0.051 (0.039)	0.068** (0.035)	0.051 (0.037)
Constant	0.490*** (0.076)	0.421*** (0.101)		
Observations	4247	4723	4247	4723
Adjusted R ²	0.055	0.066		

Note: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

regional differences as captured by the island fixed effects only show a limited contribution to total inequality. Lastly, there are no other covariates with a substantial role in lowering the disparities between these years.

How did these developments in determinants over time contribute to the observed decline in stunting inequality? From the Oaxaca-like decomposition of change (shown in column "Equation (4)" of Table 4), we derive the total contribution of each determinant from two components: (1) its contribution through the change in its inequality by wealth (EI) weighted by its partial effect (β) in 2007, and (2) its contribution from the change in coefficients weighted by its inequality (EI) in 2014.

In general, household wealth and institutional delivery stand out as the two most important drivers of the reduction of stunting inequality. Household wealth contributes to +93% of the change and this derives mostly from the smaller regression coefficient (which dropped from -0.083 to -0.007). This suggests that stunting differences between children in the richest third relative to the poorest third were much smaller in 2014 than in 2007. Meanwhile, the contribution of institutional delivery (19%) mainly results from its lower inequality in the second period (EI fell from 0.450 to 0.242). Full immunization, safe drinking water source, and clean household environment also show positive contributions of 4%, 9%, and 4% respectively. The share of full immunization is mostly due to its more equal distribution in 2007 while the other factor contribution changes mainly stem from their lower partial effects. We also observe a considerable inequality reduction in maternal education and antenatal care, but that effect is neutralized by their larger coefficients (in absolute terms) in the second period.

On the other hand, there are no major negative contributors to the fall of stunting inequality. By far the largest share comes from child's age (-8%), improved sanitation (-7%) and maternal age at birth (-5%). The contribution of older children and younger maternal age at birth is explained by its greater 'harmful effect' in the second period - since its inequality did not change substantially. As for improved household sanitation, the fall in its inequality did not translate into lower stunting inequality because its 'protective effect' against stunting also grew (from -0.015 to -0.036). Other environmental factors such as the presence of smokers in the household, a clean household environment, and safe drinking water all show positive contributions to the inequality reduction, mostly due to their smaller association with stunting in 2014.

Discussion

Our analysis has led to a number of relevant findings with respect to changes in the unequal distribution of childhood stunting in Indonesia. First, both the prevalence of under-five stunting and severe stunting declined between 2007 and 2014. However, this drop was modest, and only statistically significant for severe stunting. The mean level of stunting is still considered (too) high and the reductions were small compared to the drops observed in similar periods in neighboring countries such as Cambodia (from 41.6% to 33.9% in 2005-2014) and Vietnam (from 36.7% to 22.7% in 2000-2011) (Kien et al., 2016; Zanello, Srinivasan, & Shankar, 2016). Secondly, we find that the presence of under-five stunting in Indonesia is more concentrated in

Table 4
Decomposition of Erreygers Concentration Index (EI) in 2007, 2014, and of its change.

Determinants	2007			2014			Change					
	β	EI	%	β	EI	%	$\Delta\beta$	ΔGCI	ΔEI_{2007}	Equation 4	%	
			Contr. ($\beta \cdot EI$)			Contr. ($\beta \cdot EI$)			Absolute Contr.		Contr.	
Age-appropriate feeding	-0.016	0.094	-0.002	1%	-0.027	0.087	-0.002	-0.011	0.000	-0.001	-0.001	-1%
Full immunization	-0.043	0.132	-0.006	3%	-0.031	0.081	-0.003	0.012	0.002	0.003	0.003	4%
4 + ANC	-0.008	0.168	-0.001	1%	-0.015	0.066	-0.001	-0.007	0.001	0.000	0.000	0%
Institutional delivery	-0.042	0.450	-0.019	11%	-0.021	0.242	-0.005	0.021	0.009	0.005	0.014	19%
Posyantri participation	0.015	0.099	0.001	-1%	-0.012	0.094	-0.001	-0.026	0.000	-0.002	-0.003	-3%
Safe drinking water	-0.066	0.118	-0.008	5%	-0.014	0.104	-0.001	0.053	0.001	0.006	0.006	9%
Improved sanitation	-0.015	0.463	-0.007	4%	-0.036	0.328	-0.012	-0.021	0.002	-0.007	-0.005	-7%
Clean environment	-0.075	0.078	-0.006	3%	-0.027	0.104	-0.003	0.048	-0.002	0.003	0.003	4%
>1 smoker in HH	0.022	-0.028	-0.001	0%	0.041	-0.041	-0.002	0.019	0.000	-0.001	-0.001	-2%
Short birth interval	0.084	-0.028	-0.002	1%	0.119	-0.016	-0.001	0.035	0.012	0.000	0.000	1%
Long birth interval	0.007	-0.036	0.000	0%	0.057	-0.046	0.000	0.049	-0.011	-0.002	-0.002	-3%
Large HH size	0.006	-0.036	0.000	0%	-0.018	-0.050	0.001	-0.024	0.000	0.001	0.001	2%
Middle third	-0.054	0.034	-0.002	1%	-0.026	-0.002	0.000	0.027	0.002	0.002	0.002	3%
Richest third	-0.083	0.884	-0.073	43%	-0.007	0.901	-0.005	0.076	-0.001	0.069	0.067	93%
Electricity	-0.020	0.101	-0.002	1%	-0.080	0.020	-0.002	-0.060	0.002	0.000	0.000	1%
Mother's education min. JHS	-0.041	0.347	-0.014	8%	-0.054	0.236	-0.013	-0.013	0.005	-0.003	0.002	2%
Mother's age at birth <20 years	0.028	-0.073	-0.002	1%	0.085	-0.069	-0.006	0.056	0.000	-0.004	-0.004	-5%
Male HH head	0.020	-0.012	0.000	0%	-0.018	-0.006	0.000	-0.038	0.000	0.000	0.000	0%
Male Child	0.020	-0.005	0.000	0%	0.012	-0.019	0.000	-0.008	0.000	0.000	0.000	0%
Child's age: 6-11 months	0.004	-0.009	0.000	0%	0.031	0.011	0.000	0.027	0.020	0.000	0.000	1%
Child's age: 12-23 months	0.158	0.016	0.003	-1%	0.239	-0.002	-0.001	0.081	-0.018	0.000	-0.003	-4%
Child's age: ≥24 months	0.103	-0.011	-0.001	1%	0.158	-0.029	-0.005	0.056	-0.018	-0.002	-0.003	-5%
Mother short	0.170	-0.072	-0.012	7%	0.229	-0.066	-0.015	0.059	0.006	0.001	-0.004	-4%
Urban	-0.024	0.418	-0.010	6%	-0.035	0.346	-0.012	-0.011	0.002	-0.004	-0.002	-3%
Island ^a			-0.001	1%			-0.001		0.000	0.000	0.000	0%
Residual			-0.006	3%			-0.012				-0.001	-1%
Total			-0.172	100%			-0.099				0.073	100%

^a Total aggregate contribution from all dummy island variables with Java as the reference category.

poorer households. However, we also observe a significant decline in its inequality by wealth over the seven years period, suggesting that more of the stunting reduction occurred in poorer households. This observation contrasts with recent findings for Vietnam (Kien et al., 2016) and Bangladesh (Huda et al., 2017): in both countries stunting inequality by wealth increased. In other words, in these countries, the (greater) improvements in stunting primarily benefited the better-off households.

Third, our findings on the determinants of stunting are generally consistent with earlier evidence for Indonesia as reviewed by Beal et al. (2018, pp. 1–10). What our study adds to those is the potential risk of the presence of human and animal faeces around the residence as indicated by the clean household environment variable – apart from the adequacy of sanitation. This finding squares with results by Headey et al. (2017) and Penakalapati et al. (2017) who also document the association, particularly for animal faeces, with child health and nutritional status, possibly via its role in transmitting infectious diseases.

Fourth, regarding the contributing factors to the inequality reduction, our decomposition analysis suggests that household wealth plays the most important role. This was almost entirely due to the reduction in its partial association with stunting, and not to a reduction in wealth inequality, implying that the poor kids were relatively less likely to be stunted in the second period. But how can this be explained? One explanation might be that in the 2005 to 2015 period, Indonesia experienced quite a steady economic improvement with 5% average annual GDP growth, a significant decline in poverty rate from 19.1% to 11.2%. The substantial widening of the income gap over this period suggested by the growing Gini index from 0.36 to 0.41 estimated on National Socioeconomic Surveys (OECD Economic, 2016) is not confirmed in our analysis: the Gini estimate for the IFLS households included in this study fell from 0.353 in 2007 to 0.327 in 2014. Thus, living standards in general have improved and, at least in the IFLS sample, also the poorest households benefited from this growth. This can also be seen from the beneficial contributions of safer drinking water and cleaner environments (though not in improved sanitation).

Fifth, apart from household wealth and living standards, and more importantly from a health policy point of view, some proxy measures of health care access show some improvement. Various measures of health services use (like immunization rates) have improved but, perhaps surprisingly, the most significant contributor was delivery of births in health facilities. By 2014, birth deliveries in a facility have become less of a privilege of the richer households than in 2007. Research from Bangladesh (Heady et al., 2014) and Nepal (Headey & Hoddinott, 2015) also found that being born in hospital or in a health facility was significantly negatively associated with stunting. While the mechanism for such an effect maybe unclear, one possible explanation is that it might be a proxy for closeness to health care service in general and that it raises the exposure of mothers to professional health care providers, leading to better child health and nutrition awareness. Our finding that the level and distribution of maternal and child care were getting better is supported by a study on the trends in maternal health care utilization from 1986 to 2012 based on the Indonesian DHS (Demographic and Health Survey) data (Nababan et al., 2018). This trend is possibly related to the expansion of national health insurance for the poor program (*Jamkesmas*) since 2008 (previously named *Askeskin*). Several studies have documented a positive association of *Jamkesmas* with the use of antenatal care, skilled birth attendance, and delivery in a health facility in Indonesia (Brooks et al., 2017; Wang, Temsah, & Mallick, 2017). Another specific scheme for maternal care – known as *Jampersal* – was implemented for a brief period (2011–2013), but its impact was considered limited (Achadi et al., 2014).

Since 2007, Indonesia also started a Conditional Cash Transfer (CCT) scheme – the Family Hope Program (*Program Keluarga Harapan*, PKH) for poor households and *Generasi* for communities. It was steadily

expanded to reach more than 10 million households in 2018 (Cahyadi et al., 2018). Health indicators that were included as a conditionality for this program are 4 ANC visits, taking iron tablets during pregnancy, professionally-assisted birth, two postnatal visits, complete childhood immunization, adequate monthly weight increases for infants, vitamin A supplementation twice a year for under-five children, and routine weighing (Kusuma, McConnell, Berman, & Cohen, 2017). After 6 years of implementation, it was found that PKH had significantly reduced the stunting and severe stunting level among children aged 0–60 months (Cahyadi et al., 2018). Lastly, Indonesia also started to adopt the multisectoral framework of Scaling Up Nutrition (SUN) in 2012 in the form of a national movement of the first thousand days of life (*Gerakan 1000 Hari Pertama Kehidupan*). This program mainly aims to improve the coordination between stakeholders to ensure the sufficiency of nutritional needs of mothers and children (Bappenas, 2012). While we cannot in our seven-year change study attribute any of the observed changes specifically to any of these programs, it does seem likely that at least some of these have helped to improve the distribution of maternal and child health services in the relevant period.

Limitations of the study

As the IFLS sample is representative of only about 83% of Indonesian population (excluding some eastern provinces), the generalizability of its findings is somewhat limited. Second, the use of the wealth index as a measure of socioeconomic status is sometimes questioned. However, we argue that its use for ranking households and individuals by wealth is defensible for a long term outcome like stunting, for which other socioeconomic indicators like income or consumption suffer from obvious disadvantages like seasonality, underreporting, etc (Houweling et al., 2003; O'Donnell, Van Doorslaer, Wagstaff, & Lindelow, 2008). Finally, a regression-based decomposition analysis as used in this study is limited by its inability to establish causal links for all required effects of determinants. As such, it mainly presents a sophisticated way of describing the main interactions between presumed determinants of an outcome and their unequal distributions.

Conclusion

While Indonesia's overall improvement in stunting levels was modest in the recent decade, the stunting distribution by wealth became somewhat less unequal. Our study suggests that, apart from general improvements in both the level and distribution of wealth, it may also have resulted from targeted efforts at improving the access of poorer mothers and children to effective health services. The hope is that the combination of these programs in the recent rollout of *Jaminan Kesehatan Nasional* (JKN) since 2014 will continue to improve the accessibility of essential mother and child health services to the poorer sections of the Indonesian population.

Conflicts of interest

The authors declare no conflict of interest.

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Appendix A. Operational Definition of Variables

Variable	Variable Type	Definition
Outcome		
HAZ Score	Continuous	Child height/length-for-age z-score, compared to WHO reference population.
Stunting	Binary	1 if child's HAZ score less than -2 SD from the reference population median.
Severe Stunting	Binary	1 if child's HAZ score less than -3 SD from the reference population median.
Underlying Determinants		
Feeding Practice		
Age-appropriate feeding	Binary	1 if children aged 0–5 months are exclusively breastfed; or if children aged 6–23 months still on breastfeeding and got minimum 4 types of foods in past day before the interview with minimum frequency of 2 times a day; or if children aged ≥24 months, they have already stopped breastfeeding, got minimum 4 types of foods in the past day before the interview with minimum frequency of 3 times a day.
Health care services		
Full immunization	Binary	1 if children aged ≥12 months already got minimum number of vaccination (1 measles, 1 BCG, 3 DPT, 3 Polio, and 3 Hepatitis B); children aged 0–11 months coded as 0 to keep them in the sample.
4 + ANC	Binary	1 if during the pregnancy mother received at least 4 times of antenatal care.
Institutional delivery	Binary	1 if a child was born in any healthcare facility.
Posyandu participation	Binary	1 if a child ever participated in <i>Posyandu</i> (a community program for child's growth monitoring) in past 4 weeks before the interview.
Healthy environment		
Safe drinking water	Binary	1 if household using boiled water from bottled water or either pipe water, well water, spring water, or rain water (WHO/UNICEF, 2006).
Improved sanitation	Binary	1 if household had private toilet with septic tank (WHO/UNICEF, 2006).
Clean HH environment	Binary	1 if interviewer did not observe any human or animal feces around the house where the child lived.
>1 smoker in Household	Binary	1 if there was more than 1 smoker in the household
Intrahousehold food competition		
Birth order and interval	Categorical	Categorized as: (1) "first-borns", (2) "Short birth interval" for subsequent children with less than 24 months of birth interval with their older siblings, and (3) "Long birth interval" if the birth interval is more than or equal to 24 months.
Large Household size	Binary	1 if household consisted of more than 4 members.
Non-modifiable factors		
Male Child	Binary	1 if a child is male
Child's age	Categorical	Child's age when interviewed, coded as 1 for children aged 0–5 months, 2 for 6–11 months, 3 for 12–23 months, and 4 for ≥24 months.
Mother's short stature	Binary	1 if mother's height is less than 145 cm
Basic determinants		
Household and parental factors		
Household Wealth	Categorical	Tertile of wealth index, grouped at household level observation. Coded as 1 for "Poorest third", 2 for "Middle third", and 3 for "Richest third".
Electricity	Binary	1 if household had any access to electricity
Mother's education: Min. Junior High Schl.	Binary	1 if child's mother had minimum of Junior High School Degree
Mother's age at birth: <20 years	Binary	1 if child's mother was a teenager (aged <20 years old) when giving birth. Mother's age at birth was calculated from the date of birth of the mother subtracted by the date of birth of the child.
Male HH head	Binary	1 if the gender of household head was male.
Regional factors		
Urban	Binary	1 if a child lived in urban area
Island	Categorical	Dummy variable for island where the child lived namely: Sumatra, Java, Kalimantan, Bali and Nusa Tenggara, and Sulawesi

Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2019.100469>.

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