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OTHER ORIGINAL PAPERS

Weight-for-age malnutrition in Indonesian children, 1992–1999

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Background This article measures changes over time in Indonesia in the prevalence of moderate and severe child malnutrition, and examines the factors associated with these changes. A child with a weight-for-age Z-score below −2.0 is classified as underweight and either moderately or severely malnourished.

Methods A pooled cross-sectional dataset of 163 986 children <5 years of age from the 1992, 1995, 1998, and 1999 Indonesia Socioeconomic Household Surveys was analysed using multivariate logistic regression, and by running separate pooled regressions to calculate the effect of the each of the principal independent variables separately for each year. Robust regression techniques corrected for non-constant variance resulting from multilevel modelling.

Results The overall percentage of children <5 years that are underweight decreased from 37.7% in 1992 to 28.5% in 1999. Nearly all of the gains occurred in children over one year of age. Child nutritional status improved for all major social groups in Indonesia. There was no measurable general effect of the 1997–1999 East Asian economic crisis on levels of underweight children.

Conclusions Disparities among social and economic groups have narrowed over time in Indonesia; the relatively high risk of male children compared with females has also decreased. Maternal education and economic status—as measured by quintile of adjusted per-capita household expenditures—have continued to be very strong predictors of children's nutritional outcomes.

Keywords Child malnutrition, underweight, economics and health, pooled cross-sectional analysis, Indonesia

Indonesia has realized impressive public health gains in recent decades. Life expectancy at birth increased from 48 to 64 years in just 20 years, from 1975 to 1995. This article looks in detail at the improvements made in child malnutrition, measured as the percentage of children who are underweight, during the time period 1992–1999. The article teases apart factors at the individual and household levels that influence children's nutritional status—in order to determine which factors have been the most important in influencing this substantial decline in malnutrition.

Household-level variables that have been found to be important predictors of children's weight-for-age nutritional status include family income, mothers' education, and source of water.[1,2] Earlier studies in Indonesia have shown an important relationship between mothers' employment status and child malnutrition. In Surabaya, children of non-working mothers were found to better nourished than children whose mothers worked—children of mothers working in the informal employment sector were found to be at particularly high risk for malnutrition.[3]

Analysis of the 1989 national Indonesia Socio-Economic Household Survey (SUSENAS) has shown that the level of mothers' education is an important predictor of child nutrition levels in Indonesia, especially for boys.[4] A separate study in West Java in Indonesia found that community-level factors—including vaccination programmes, child care services, and

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environmental sanitation and latrines—are strongly associated with children's growth.[5]

Methods

In this article, a pooled cross-sectional dataset from the 1992, 1995, 1998, and 1999 Indonesia SUSENAS is used to measure the prevalence of underweight children <5 years of age. The analysis identifies the major individual- and household-level factors influencing children's nutritional status, and assesses how these relationships have changed over time. The SUSENAS is a large, nationally representative household survey conducted annually by the Indonesian Government Central Bureau of Statistics. Conducted annually, the survey focuses on economic factors, including detailed household expenditures, labour force participation, education, and health. The SUSENAS has a sample size of approximately 200 000 households in most years. Households are identified using stratified random sampling techniques. Annual household response rates are in the range 85–90%.[6] There are 163 986 children <5 years of age in our pooled dataset.

Each year the survey contains a core individual-level questionnaire including demographic and education information on all household members, supplemented by modules covering about 60 000 households that are rotated over time and include health care and nutrition, household income and expenditure, and work force experience. Child anthropometric indicators, generally included every 3 years, are in the 1992, 1995, and 1998 surveys. Child anthropometric measures were also added to the 1999 survey in order to be able to measure the effects of the 1997–1999 East Asian economic crisis on child malnutrition.

The terms 'underweight children' and 'weight-for-age malnutrition' are used interchangeably in this article. They both refer to children with standardized normal weight-for-age Z-scores (WAZ scores) below −2.0, a condition also known as 'undernutrition'. Underweight children are those who have a WAZ score that is more than two standard deviations below the mean for a well-nourished population. Weight-for-age measures were converted to WAZ scores using the reference growth curves developed by the US National Center for Health Statistics (NCHS) and recommended for international use by WHO.[7] Severe malnutrition is defined as less than three standard deviations below the international standard. WAZ values >6.0 or <−6.0 were considered to be extreme values and are deleted from the analysis—these values accounted for less than 1% of the full 4-year sample. Epi Info 2002 software, developed by the Centers for Disease Control (CDC), was used to compare the WAZ score of each child with international standards for children of the same age and sex.[8]

Since malnutrition measured in this manner is a dichotomous 0/1 outcome, the pooled regression analyses were estimated using multivariate logistic regression. The survey year (1992, 1995, 1998, or 1999) was included as a separate variable in the regression. Separate regression equations were modelled to test for the effect of selected variables by year by using interaction terms between these variables and a dummy variable for year. We then separately calculated the corresponding odds ratio (OR) for these variables for each survey year. Stata statistical software, Version 7, was used to perform the multivariate logistic regression analysis.[9]

At the individual level, the child's sex, age, and birth order within the family can feasibly influence feeding patterns, health care, and nutritional status. At the household level, variables potentially affecting children's nutritional status include the household's expenditure quintile; the main source of household income; the parents' education level; the number of children under age 5 and total household size; whether or not the head of the household is female; and the region and area (urban-rural) of residence. The household's physical environment is represented by variables for water supply and the type of flooring material.

The level of per-capita household expenditures is the principal measure of households' economic status. All types of household expenditures are included in this measure, and not just those on health care. The level of expenditures is generally recognized as a better measure of economic status than income, since income does not reflect permanent wealth and can be seasonally variable. Households were placed in expenditure quintiles based on their level of overall expenditures per household member; children <5 years of age count as one-half of a household member for these calculations. The first quintile contains the 20% of households with the lowest per-capita expenditures on a nationwide basis; the fifth quintile has the most expenditures. For the multiyear regression analysis, household expenditures were standardized across years using the official Indonesian consumer price index.

There is a clear potential in this study for heteroskedasticity—or non-constant variance—resulting from multiple level analysis, since there are variables from the individual, household, and regional levels in the same equation. Because explanatory variables are correlated across observations, the regression residual will also be correlated. Correlated residual values across observations cause biased and inconsistent results in non-linear regression analyses, including logistic regression.[10,11] The Huber-White 'sandwich' variance estimator was used to correct for correlated residual values. The estimator is based on the variance of the scores, using the fact that the variance of the sum of the scores is equal to the sum of the variances of the independent scores plus all the covariances between pairs of scores that are not independent. This correction treats clusters as 'super observations,' and allows for any type of variance correlation within clusters. It therefore accommodates for clusters that have sub-clusters within them, as is the case in this study.[12]

Results

The percentage of children under age 5 who are underweight in Indonesia decreased from 37.7% in 1992 to 28.5% in 1999. Table 1 shows the estimated prevalence of weight-for-age malnutrition measured by the SUSENAS survey in the years 1992, 1995, 1998, and 1999, together with the corresponding 95% CI and sample size (N) of children in each of the survey years. The overall improvement in the prevalence of underweight children between each survey is statistically significant as there is no overlap in the 95% CI.

The risk of being underweight declined during this time period for female children from 33.9% to 26.7%, and even more dramatically for males—from 41.5% in 1992 to 30.1% in 1999. All of these decreases are statistically significant, except

Table 1 Improvements in child malnutrition, 1992–1999, measured as per cent underweight under age 5 years

	Child's sex		
Year	Female	Male	**Total**
1992			
n (<5)	17 326	17 805	35 131
Point estimate (%)	33.9	41.5	37.7
95% CI	33.2, 34.6	40.8, 42.2	37.2, 38.2
1995			
n (<5)	12 900	13 110	26 010
Point estimate (%)	30.3	34.9	32.6
95% CI	29.5, 31.1	34.1, 35.7	32.0, 33.2
1998			
n (<5)	12 029	12 521	24 550
Point estimate (%)	27.2	32.3	29.8
95% CI	26.4, 28.0	31.5, 33.1	29.2, 30.4
1999			
n (<5)	38 264	40 031	78 295
Point estimate (%)	26.7	30.1	28.5
95% CI	26.2, 27.2	29.6, 30.6	28.2, 28.8

for the decline in the prevalence of underweight female children from 1998 to 1999, where there is overlap in the CI (Table 1).

Multivariate logistic regression analysis of the pooled dataset shows that males were 1.27 times more likely to be underweight than females ($P < 0.001$) over the time period covered by the surveys (Table 2). After accounting for the effects of the other variables in the model, children in 1995 were 0.92 as likely as those in 1992 to be underweight ($P < 0.1$). Children in 1998 and 1999 were 0.82 and 0.75 times as likely to be underweight, respectively, as children in 1992 ($P < 0.001$ for both). There were also clear secular improvements over time—indicator variables for survey year have a statistically significant impact on the probability that children are underweight.

Nearly all of the gains in children's nutritional status occurred for children between the ages of 12 and 60 months. For those less than a year old, there was little or no improvement—but this age group also has much lower rates of underweight children in general (Figure 1). Weight-for-age malnutrition rates begin to increase substantially at the age that children are no longer exclusively breastfed. Weaning increases exposure to infectious agents and increases the likelihood of episodes of diarrhoea that detract from a child's weight gain. In multivariate logistic regression analysis of the pooled dataset, age group has a highly significant ($P < 0.001$) association with malnutrition for all age groups. Exposure to malnutrition peaks for the 30–35 months age group, with an OR of 3.57 compared with infants aged ⩽5 months. The OR decreases slightly for older age groups, and is consistent across the 4-year time period (Table 2).

The birth order of the child is also a significant ($P < 0.001$) risk factor for being underweight. The OR associated with an increase of one in the birth order is 1.07 in the analysis of the pooled dataset, which controls for the number of children in the household, socioeconomic status, and other variables. This effect is consistent across years. First-born children have a slight but strongly significant advantage over later born children.

Mothers' education has very strong protective effects. In 1999, the prevalence of weight-for-age malnutrition among children of mothers who had not completed primary education was 34%, compared with 23% for children of mothers with a secondary or higher education (Figure 2). This effect is also apparent in the multiyear regression analysis, where the OR associated with secondary level maternal education compared with less than primary level is 0.72 ($P < 0.001$) (Table 2).

The differential effect of maternal education has diminished over time as the nutritional status of children in less-educated families improved. The prevalence of weight-for-age malnutrition for children of mothers with secondary education did not change substantially. Among children whose mothers have less than primary education, the percentage underweight meanwhile decreased from 42.4% in 1992 to 33.6% in 1999 (95% CI: 41.4%, 43.5% for 1992; 32.8%, 34.4% for 1999).

Multivariate logistic regression analysis of the pooled dataset, with separate regressions for each independent variable interacted with each survey year, shows a similar pattern. Secondary or higher maternal education had a strongly protective baseline (1992) effect on weight-for-age malnutrition—an OR of 0.63 in comparison with mothers with less than primary education (Table 3). The equivalent OR for secondary or higher maternal education in 1995, 1998, and 1999 were 0.77, 0.72, and 0.79 respectively (all significant at $P < 0.05$). The impact of lower secondary maternal education compared with less than primary education likewise decreased over time.

Improvements in children's nutritional status occurred among all economic groups, as measured by quintile of adjusted per-capita expenditure. Among the poorest (first) quintile, the prevalence of children who were underweight decreased from 44.9% in 1992 to 32.8% in 1999 (95% CI: 43.7%, 46.2% for 1992; 32.2%, 33.5% for 1999). For the wealthiest quintile, it declined from 27.6% to 21.6% (95% CI: 26.4%, 28.8% for 1992; 20.8%, 22.4% for 1999). In analysis of the pooled dataset, children in households in the wealthiest quintile had an OR of 0.75 compared with the least well-off quintile—a strong protective effect associated with the economic level of the family (Table 2).

But as with maternal education, the advantage of the wealthiest expenditure quintile has narrowed over time—from an OR of 0.65 in 1992 to 0.73 in 1999. These patterns are somewhat different in urban and rural areas. In Indonesia's cities, differences in child weight-for-age malnutrition rates by expenditure quintile narrowed substantially between 1992 and 1999—as the prevalence among the poorest quintile in urban areas fell from 42.6% to 29.7% (95% CI: 39.3%, 45.9% for 1992; 27.7%, 31.7% for 1998).

Overall, the advantage of urban children in nutritional status disappeared after 1992 after controlling for other factors. In the regression analysis isolating the effect of the principal variables by year, urban residence showed an OR of 0.83 compared with rural residence in 1992 ($P < 0.001$). This protective effect was nullified in the subsequent years, as shown by insignificant OR for urban residence in 1995, 1998, and 1999 of 1.04, 0.99, and 1.04, respectively (Table 3).

Table 2 Odds ratios for weight-for-age malnutrition, pooled multiyear logistic regression

Variable	Odds ratio
Time variables	
Year (base = 1992)	
1995	0.92*
1998	0.82***
1999	0.75***
Individual	
Male child	1.27***
Age (base = 0–5 months):	
6–11 months	2.09***
12–17 months	3.29***
18–23 months	3.49***
24–29 months	3.52***
30–35 months	3.57***
36–41 months	2.87***
42–47 months	3.24***
48–53 months	2.93***
54–59 months	3.40***
Birth order of child	1.07***
Household variables	
Consumption quintile (base = poorest):	
Second	0.96
Third	0.92**
Fourth	0.90**
Fifth (richest)	0.75***
Source of income (base = agriculture):	
Mining	1.01
Industry	0.92**
Electricity, gas, water	0.90
Construction	0.89**
Trading	0.93
Transportation	0.95
Financial, insurance	0.93*
Community groups	0.90***
Other	0.98
Urban residence	0.99
Female-headed household	0.96
Water supply (base = rain water):	
Bottled water	
Tap water	0.92
Pump	0.95
Covered well	0.96
Uncovered well	0.93
Covered spring	0.88
Uncovered spring	0.94
River	1.07
Other	0.89
Mother's education (base = below primary)	
Primary	0.89**
Lower secondary	0.84**
Secondary or higher	0.72***
Father's education (base = below primary)	
Primary	0.98
Lower secondary	0.93*
Secondary or higher	0.91**
Number of HH members	0.94***
Number of under 5's in HH	1.18***
Type of floor (base = earth floor):	
Marble, ceramic	0.96**
Tile	0.91**
Cement, brick	0.96
Wood	1.08
Bamboo	1.30***
Other	1.22
Region (base = Java-Bali)	
Sumatra	1.16*
Kalimantan	1.22*
Sulawesi	1.11*
Other Islands	1.29***

* Statistically significant ($P < 0.1$).

** Statistically significant ($P < 0.01$).

*** Statistically significant ($P < 0.001$).

Pseudo $R^2 = 0.038$.

Note: For analysis by region, Indonesia's provinces are grouped into five natural regions:

- *Java-Bali Region*: DKI Jakarta; West Java; Central Java; DI Yogyakarta; East Java; and Bali.
- *Sumatra*: DI Aceh; North Sumatra; West Sumatra; South Sumatra; Lampung; Riau; Jambi; and Bengkulu.
- *Sulawesi*: North Sulawesi; South Sulawesi; Central Sulawesi; and Southeast Sulawesi.
- *Kalimantan*: West Kalimantan; South Kalimantan; Central Kalimantan; and East Kalimantan.
- *Other provinces (Eastern Islands)*: Provinces of West Nusa Tenggara; East Nusa Tenggara; East Timor; Maluku; and Irian Jaya.

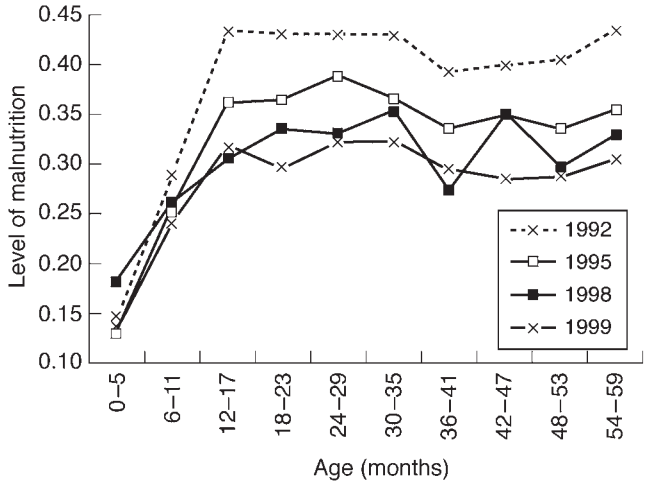

Figure 1 Percentage of underweight children by age group and year

Discussion

Overall levels of underweight children declined substantially from 1992 to 1999 in Indonesia, from 37.7% to 28.5%. These figures combine children who suffer from moderate and severe weight-for-age malnutrition. Disparities in children's nutritional status among social and economic groups also decreased. The advantage that the wealthiest expenditure quintile has over the poorest has narrowed from an OR of 0.65 in 1992 to 0.73 in 1999; the advantage of mothers' secondary education has likewise narrowed from an OR of 0.63 in 1992 to 0.79 in 1999.

Nearly all of the gains in children's nutritional status have occurred for children between the ages of 12 and 60 months. For those less than a year old, there has been little or no improvement. For both males and females, the biggest increases in levels of underweight children correspond to the ages when

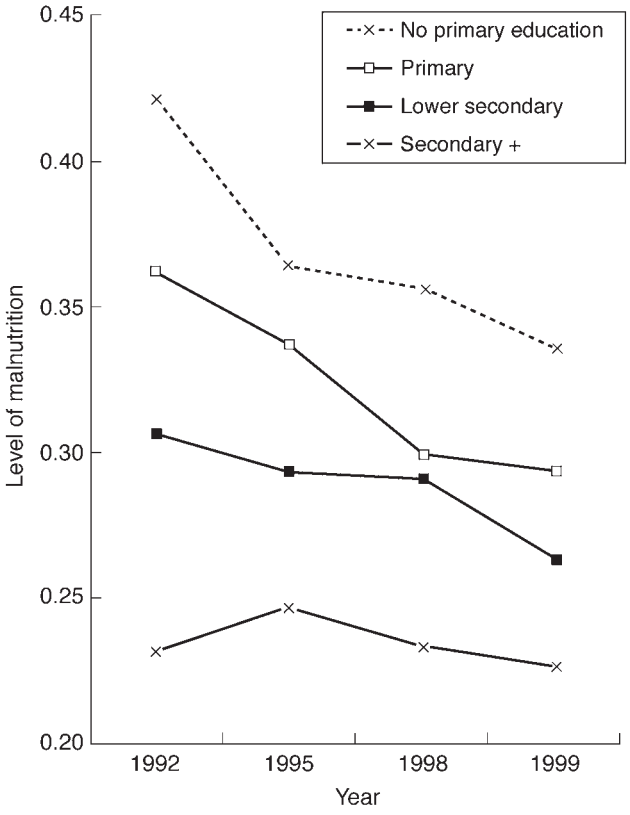

Figure 2 Proportion underweight by year and mother's education

children are being progressively weaned from breast milk and new foods and liquids are introduced into the diet. WHO recommends exclusive breastfeeding, without supplementary feeding or liquids, for the first 6 months of the child's life. Weight-for-age malnutrition levels increase dramatically from the 0–5 month age group to the 6–11 month group—a time when children should be receiving substantial additional foods and proteins. These findings emphasize the importance of correct weaning and infant feeding practices in Indonesia.

The effects of the 1997–1999 economic crisis

The economic crisis that struck East Asia in 1997 had particularly strong effects in Indonesia. From July 1997 to January 1998 Indonesia's currency, the Rupiah, lost 50% of its value against the US dollar.[13] Resulting inflation was high—and food prices increased by an estimated 80% over the course of 1998.[14] The poverty rate escalated from 11.3% in 1996 to an estimated 20% in 1999.[15] Unemployment also increased substantially, from 8% to 15% by mid-1998.[13,16]

Child malnutrition is an important indicator of the human effects of an economic crisis. The data for the 1998 SUSENAS survey were collected during the time period December 1997–January 1998. The economic crisis had already started by this time, but had not yet reached its peak. The 1999 data collection occurred while the crisis itself was easing, but the economic and social effects were still being acutely felt. Any effects on children's nutritional status should still have been in evidence. As a result, a comparison of the two surveys presents an estimation of the impact of the crisis on malnutrition levels.

There is no general effect of the crisis on the percentage of children who are underweight. Overall levels of underweight children <5 years of age in Indonesia continued their downward trend during this time period—from 29.8% in 1998 to 28.5% in 1999 (95% CI: 29.2%, 30.4% for 1998; 28.2%, 28.8% for 1999). Specific pockets of the population may have been adversely impacted by the crisis. Children's nutrition status slightly worsened for families gaining their living from the financial, insurance, and construction industries—from 27.0% to 27.5% underweight prevalence—but this effect is not statistically significant.

A separate data source, the Indonesia Family Life Survey (IFLS), reinforces the finding that there was no widespread impact of the economic crisis on child nutrition levels. The IFLS2 survey was conducted in late 1997, and a special follow-up survey, the IFLS2+, was implemented in a subsample of the IFLS survey design in July 1998—in order to monitor the effects of the crisis. These surveys do not show strong impacts of the crisis on child malnutrition. In the geographical areas covered by the IFLS2+, weight-for-age malnutrition among children actually decreased—from 50.7% in 1997 to 45.7% in 1998.[17]

The prevalence of adult malnutrition, measured by a body mass index <18, did increase slightly from 1997 to 1998—from 14.1% to 14.7%—with poor women particularly affected. Body mass index has been shown to be a health indicator that is sensitive to economic change.[18] These data could indicate that adults sought to protect the nutritional status of their children at their own expense.[19] A separate study of the health impact of the US economic embargo of Cuba found that the brunt of the impact, in nutritional terms, falls on adult men and the elderly.[20]

There are limitations in the interpretation of our analyses. Weight-for-age malnutrition combines elements of weight-for-height malnutrition (wasting) and height-for-age malnutrition (stunting). The prevalence of wasting among children would be a more sensitive indicator of the short-term effects of an economic crisis than the prevalence of weight-for-age malnutrition, but data on children's height are generally not collected in large-sample household surveys. The WAZ scores used internationally and in the Epi Info 2002 software are developed using reference growth curves from the US. Children's growth patterns may differ in Indonesia, where feeding and breastfeeding patterns vary from those in the US.

WHO has established international standards for child malnutrition prevalence, as measured by weight-for-age. Malnutrition prevalence of <10% is considered low, 10–20% medium, 20–30% high, and a prevalence of >30% is considered to be very high.[21,22] By these standards, weight-for-age malnutrition levels in Indonesia are still in the 'high' range. Indonesia's results are comparable with estimates from other Southeast Asian countries—including Thailand (25%), the Philippines (33%), Cambodia (40%), and Vietnam (40%).[23]

Despite the improvements documented in this article, poorer and rural Indonesians still suffer from high levels of child malnutrition as measured by weight-for-age. Earlier studies, including one from Indonesia, have shown clearly that

Table 3 The effect of selected independent variables on weight-for-age malnutrition, by year

	In year (*n* = no. of children <5 years)			
The effect of variable (odds ratios)	1992 (*n* = 35 131)	1995 (*n* = 26 010)	1998 (*n* = 24 550)	1999 (*n* = 78 295)
Expenditure quintile (base = poorest):				
Second	0.98	0.91†	0.89†	0.96
Third	0.86†	0.92†	0.89†	0.91
Fourth	0.85†	0.89†	0.92†	0.81†
Fifth (richest)	0.65†	0.70†	0.78†	0.73†
Male gender compared with female	1.38†	1.23†	1.26†	1.20†
Urban residence compared to rural	0.83†	1.04	0.99	1.04
Mother's education (base = below primary):				
Primary	0.89†	0.96	0.91†	0.88†
Lower secondary	0.75†	0.86†	0.88†	0.84†
Secondary or higher	0.63†	0.77†	0.72†	0.79†
Father's education (base = below primary):				
Primary	1.03	1.00	0.98	0.95†
Lower secondary	0.86†	1.03	0.94†	0.95†
Secondary or higher	0.91†	0.95†	0.90†	0.96
Region (base = Java-Bali)				
Sumatra	1.09	1.24†	1.18†	1.15†
Kalimantan	1.36†	1.19†		1.24†
Sulawesi	0.97	1.14†	1.08	1.17†
Other Islands	1.34†	1.35†	1.29†	1.23†

† Statistically significant ($P < 0.05$).

malnutrition is a strong contributor to child mortality.[24,25] Malnutrition makes children more susceptible to infectious diseases, and in turn worsens the effects of these diseases. Although greatly reduced through in the 1990s, child malnutrition remains a serious problem in Indonesia.

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KEY MESSAGES

- In Indonesia, the overall percentage of children <5 years of age that are underweight, as measured by a weight-for age Z-score below −2.0, decreased from 37.7% in 1992 to 28.5% in 1999.
- There was no measurable general effect of the 1997–1999 East Asian economic crisis on levels of underweight children in Indonesia.
- Disparities among social and economic groups in terms of the prevalence of underweight children have narrowed over time in Indonesia; the relatively high risk of male children compared with females has also decreased.
- Maternal education and economic status—as measured by quintile of adjusted per-capita household expenditures—have continued to be very strong predictors of children's nutritional outcomes.

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