Socioeconomic Indicators of Underweight Children During Indonesia's Economic Crisis: A Case-Control Study of Children Aged 2-5 Years in Pisangan Baru, East Jakarta

by

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Background

Statement of the research problem

During the summer of 1997, the Republic of Indonesia rapidly fell into a financial crisis that swept across many countries in Asia. The rupiah (Indonesia's national currency) depreciated to 15 percent of its early 1997 value, inflation rocketed to 68 percent during 1998, the economy shrank by 14 percent, and the country entered a deep recession.[1] By the beginning of 1998, these critical macroeconomic trends began their severe impact at the local household level; millions of people lost their jobs and the cost of food and the Consumer Price Index nearly tripled. While more politically stable countries such as Korea and Thailand made structural reforms that brought about a relatively rapid economic recovery, Indonesia's recession provoked long brewing socio-political tensions to erupt resulting in massive protests and rioting which in turn brought about the resignation of the corrupt military dictator President Soeharto. As political and social turmoil set in, the prognosis for economic recovery was bleak and remains so to this day.

As 1998 wore on, cases of severe malnutrition, virtually unheard-of during the previous ten years, started receiving national attention. The Helen Keller Institute (HKI), an international non-governmental organization based in Jakarta, found through their nutritional data from Java that there was an increasing incidence of iron and vitamin A deficiencies, particularly in urban areas.[2] Vitamin A deficiency due to malnutrition, as detected by HKI, can lead to blindness and immune system damage. In early 1999, HKI had already documented cases of night blindness, an early indicator of vitamin A deficiency, among women and children in Central Java province. Iron deficiency, also detected by HKI in Central Java, is the leading cause of anemia worldwide, impairs the immune system, reduces physical and cognitive capacity, can impair intellectual development and stunt growth. Both HKI and Indonesia's popular press lamented the emergence of a "lost generation" of children due to this widespread child malnutrition epidemic throughout Indonesia.[2]

While the assumption was made in the popular press that the economic crisis was the ultimate cause of this epidemic, a number of recent studies summarized by Gardner and Amaliah from the Population Council in Jakarta have presented conflicting evidence about the crisis effects on the nutritional health of Indonesia's children.[3] Similar to HKI's findings, the Indonesian Family Life Survey (IFLS), conducted in late 1997 and then again in late 1998, concluded that there was a significant increase in anthropometric measures falling below two standard deviations from the average. The National Social and Economic Survey (SUSENAS) concluded that the increasing prevalence of underweight urban children was not a recent trend, but instead had been increasing since 1992 thereby ruling out the economic crisis as a primary causative factor. Recent analysis of the SUSENAS data by Atmarita, et al. suggests that while the prevalence of severely malnourished children has increased slightly, the aggregate nutritional status of Indonesian pre-school children has improved steadily during the past ten years, including the crisis years.[4] Within a more specific period of time, the 100 Village Survey (SSD), found an *increase* in the proportion of children under-five with "good nutritional status" between August and December of 1998. Most studies are in agreement, however, that urban children have fared worse than rural children since the onset of the economic crisis.[3]

My project in Pisangan Baru, a neighborhood in East Jakarta, represents a localized effort to examine which factors may be contributing to the current supposed epidemic of malnutrition among Indonesia's children. Specifically, I'm testing the three following hypotheses:

1. The effects of the Indonesian economic crisis in the household have a negative association with the weight-for-age status[1] of children aged two to five years in Pisangan Baru.
2. Health knowledge of Pisangan Baru mothers has a positive association with the weight-for-age status of their children aged two to five years.
3. The involvement of a paternal figure in making health care decisions in a Pisangan Baru household has a positive association with the weight-for-age status of children aged two to five years.

The first hypothesis reflects my primary interest with this study. Although numerous studies in the past have demonstrated an association between nutritional status and poverty, no recent localized studies have looked for associations between Indonesia's economic crisis and the current child malnutrition epidemic.[5-9] Similarly, there is an extensive literature that cites a mother's education as one of the strong indicators of her child's nutritional health. Even in the absence of formal education, it has been demonstrated that basic community health education courses yield significantly better health outcomes.[10-12] This evidence bodes well for my second hypothesis above, and it is hoped that knowledgeable mothers would have a positive counteracting effect upon the hypothesized negative effects of the economic crisis. The third hypothesis is a

[1] "Age-weight status" is used as a proxy indicator for nutritional status in this study. An explanation of and justification for this measure is provided in the Methods section.

relevant question for local health authorities in Indonesia to consider since recent Department of Health education campaigns have been heavily directed toward male participation in family health decision-making.

Anthropometry

Most malnutrition assessment studies at the population level rely on quick and easy anthropometric measurements. The three most commonly used (and least invasive) indices include: weight-for-height, height-for-age, and weight-for-age. When used alone, each index has its own strengths and weaknesses. Height-for-age, for example, serves as a useful index for stunting, short stature, or linear growth retardation, conditions which may indicate chronic malnutrition or disease due to poor economic conditions over the long term. Weight-for-height is perhaps the best index of wasting or thinness, reflecting a failure to gain weight or a loss of weight perhaps due to acute malnutrition or infection. Weight-for-age, however, is the most commonly used index because it is the easiest to measure. Although this measure fails to distinguish between short children of adequate body weight and tall, thin children, in many situations it is useful for following a child over time to identify downward trends and acute changes associated with wasting.[13, 14]

The Indonesian Department of Health uses weight-for-age as the primary indicator of malnutrition for children under the age of five years. Every month in urban neighborhoods and villages across the country, mothers bring their under-fives to Integrated Health Service Posts (hereafter referred to by its Indonesian acronym, POSYANDU) where their children are weighed and their weights are graphed against age on the child's health card. The graph shows the child's weight relative to the national standardized average weight for each month. In this way, families and communities keep track of the nutritional health of their children under five. With this existing institution to draw upon, I was able to easily identify cases and controls for my study by observing children being weighed at the POSYANDU held in the neighborhoods of Pisangan Baru in East Jakarta. Since I proposed to look for acute weight changes brought about by the economic crisis, weight-for-age was the easiest and most appropriate indicator of children who are *more likely* to be undernourished if they fall beneath a certain cutoff point.

Brief literature review

In a brief review of other community-based nutritional status assessments, most study designs were cross-sectional, presumably because that is all that was necessary to get a snapshot of current nutritional conditions along with other indicators in the community. Sampling methods varied considerably depending on the area under study, the resources available to the researchers, and research question under study. For example, government civil servants Paul Matulessy from the Indonesian Department of Health and his research team had direct access to health records at the Jakarta municipal health clinics to make their assessment of the nutritional situation in all of metropolitan Jakarta during the late 1980s.[5] Geefhuysen and Soetrisno, under sponsorship from Gadjah Mada University's Department of Social Pediatrics and using rural and urban comparison communities near and in Yogyakarta, Central Java, sampled all the families with children under five by inspecting the growth charts at the home and then cross-referenced them against the records of the community health clinics in their effort to assess nutritional status and the effectiveness of the POSYANDU program.[15] These two studies had the distinct advantage of being carried out under Indonesian government sponsorship, thus facilitating access to both the subject communities and the medical records at the government health clinics. Perhaps most similar to my own sampling methodology (see Methods below), Kathryn Dewey sampled a few of the smaller communities in a large rural agricultural village in Tobasco, Mexico and then went door to door to conduct household interviews for her cross-sectional study.[16]

Study site

Entry into the Pisangan Baru community and their POSYANDU was facilitated by my sponsoring organization, the Kusuma Buana Foundation (YKB), a Jakarta-based non-profit organization operating five reproductive health clinics throughout the city. While other representative Jakarta communities certainly exist, I only had access to the communities where YKB had their clinics. Of these five, Pisangan Baru was one of the two clinics close to the YKB main office (where I was staying); the other clinic was situated in a relatively affluent area of Central Jakarta and was therefore not considered representative of the populations with children most likely to be nutritionally affected by the economic crisis.

The district of Pisangan Baru in East Jakarta covers 67.51 hectares and is divided into 15 administrative "neighborhood" units. At the time of data collection in July and August 1999 there were a total of 42,330 inhabitants living in 12,343 households, and 9700 were children under five years of age.[17] Pisangan Baru is considered by many Jakarta residents to be a "typical" densely populated mixed middle and lower class (mostly lower) community in the nation's capital. The neighborhoods of East Jakarta are home to mostly stable, long-term city dwellers as opposed to the coastal North Jakarta neighborhoods, home to more itinerant sea-faring immigrant communities. For these reasons and other practical reasons mentioned above, Pisangan Baru was the ideal "representative" Jakarta community in which to do this study.

Methods

The staff of the YKB clinic in Pisangan Baru facilitated my introduction to the local volunteers and officials from the government health clinic in charge of running the monthly POSYANDU in each of Pisangan Baru's 15 neighborhoods. By attending POSYANDU and examining the growth chart of each child being weighed I was able to identify my cases and controls. At that time, cases were defined as children aged two to five years of age whose weight in June or July of 1999 fell at least three standard deviations below the average for their age. Controls, also two to five years of age, were those whose weight in June or July of 1999 was higher than three standard deviations below the average weight for their age. The weight-for-age index as an indicator of underweight status is consistent with the Indonesian government's method for assessing the children's health at the population level; it was also the easiest and least invasive method given the limited time and resources to identify the subjects for this study.

There are several reasons why subjects were all between the age of two and five years. If we assume that the household effects of the economic crisis began in early 1998, then even the youngest in the sample, those close to two years of age, will have had at least six months of their infancy to display healthy weight-for-age measurements. This allows a comparison of the weight-for-age index over time before and during the economic crisis for all subjects. Also, the only severely underweight children who qualified to receive nutritional supplements from the (IMF-sponsored) government social safety net relief program during this crisis were those under the age of two. Severely underweight children aged five and above in elementary school also received nutritional supplements at school, thus leaving children between the ages of two and five least likely to benefit from any government assistance programs during the crisis.

Using the original definition mentioned above for the identification of cases and controls, 108 cases and controls (56 cases and 52 controls) were identified at six neighborhood POSYANDU in Pisangan Baru in June and July 1999. With this step completed, four women among the staff of the YKB clinic were hired to carry out blinded interviews in the homes of the mothers of each of these children. The interviewers were familiar and respected faces in Pisangan Baru because of their YKB affiliation, but didn't have an imposing or intimidating presence in the home as a government health official or foreigner might have had. Interviews were preceded by an informed consent administered orally. The questionnaire gathered information on the following variables:

- Ethnicity/religion of mother
- Migrant status in Jakarta
- Household size
- Household income
- Formal education of mother
- Current occupation of mother
- Health knowledge of mother
- Birth order of child
- Illness history of child
- Utilization of health services by mother
- Examination of the child's health card
- Presence of paternal figure in household
- Current occupation of paternal figure
- Paternal involvement in health care decisions
- Household diet
- Changes in household diet since economic crisis
- other crisis effects (job loss, etc.)

The only pre-crisis data collected in this questionnaire was the number of times the child was weighed at the POSYANDU prior to December 1997 and the number of times he/she fell below three standard deviations from the mean weight-for-age. All other variables reflect post-crisis household data. Most questions were closed response for easy statistical analysis, but a few open-ended questions were included to get more information about mother's perception of a healthy diet for her child and for experiential stories about how the economic crisis has affected their lives.

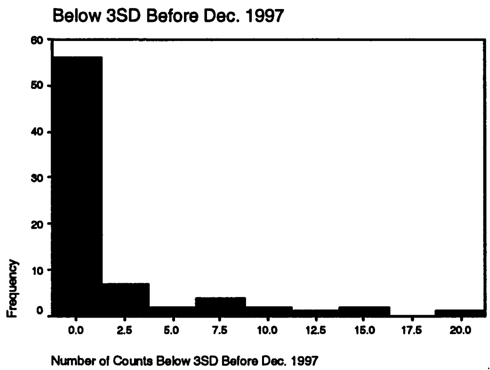
After coding and entering the data from each questionnaire, the preliminary analysis comparing the cases and controls against various indicators yielded no significant results. The original designation of cases and controls, based on whether or not they fell below three standard deviations of the average weight-for-age, captures each child's status at one point of time only and does not reflect longitudinal trends prior to and during the economic crisis. This realization lead me to embark on two separate types of analysis that better capture the temporal aspects of the longitudinal data. In each questionnaire, there are the following four useful variables: number of times weighed before December 1997 (BEFDECTO), number of times falling below three standard deviations before December 1997 (BEFDECLO), number of times weighed after December 1997 (AFTDECTO), and the number of times falling below three standard deviations after December 1997 (AFTDECLO). These data could be used to look retrospectively at how much children's weight-for-age were affected by the crisis, using December of 1997 as the point in time at which the crisis began to have its severe effects in the homes of middle and lower class Indonesians. The next two sections describe the two types of analysis undertaken using this data:

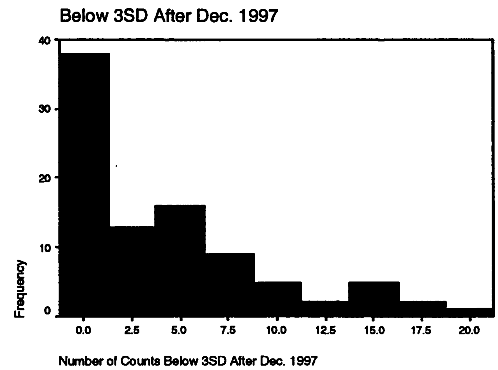
Logistic Regression Analysis

Using the variables BEFDECLO and AFTDECLO, cases and controls were re-designated in the following way: controls were those kids who never fell below three standard deviations both before and after December 1997 while cases were those who never fell below prior to December 1997, but then fell below three standard deviations at least once after December 1997. Children who were below three standard deviations at least once before December 1997 were not included in this analysis. Using SPSS, controls (=0) and cases (=1) were the dichotomous outcomes in a series of logistic regression analyses modeling different variables to determine the significance of their odds ratios (see Results below). Due to such a small sample size, most odds ratios are presented with 90 percent confidence rather than the standard 95 percent in order to capture emerging patterns and trends in the data. These odds ratios will tell us which risk factors are associated with the likelihood of normal weight-for-age children before December of 1997 becoming underweight-for-age some time after December of 1997.

Poisson Regression Analysis

A drawback of using the case-control analysis with logistic regression is the significant loss in sample size (due to strict case and control definitions) and the absence of a sense of the proportion of time each child spends below three standard deviations from the average weight-for-age both before and after December 1997. Poisson regression analysis in SAS offers some useful solutions to this problem. Poisson distributions are counts of non-negative integers with a skewed distribution. Distributions are skewed (a departure from normal symmetry) when the skewness is more than twice its own standard error. The counts of children falling below three standard deviations of their weight-for-age are distributed precisely in this manner:





Statistics

		Below 3SD Before Dec. 1997	Below 3SD After Dec. 1997
N	Valid	75	91
	Missing	28	12
Mean		1.92	4.18
Median		.00	2.00
Variance		17.51	24.57
Skewness		2.704	1.314
S.E. of Skewness		.277	.253

Table 1: Demonstration of Pisangan Baru weight counts < 3SD fitting the exact definition of a Poisson distribution

Unlike normally distributed data where the variance is constant regardless of the mean, Poisson distributions allow for variance to increase equally with the mean. In many cases, a Poisson distribution is "overdispersed" (the variance exceeds the mean), but a standard correction coefficient can be calculated to compensate for overdispersion (this is done automatically in SAS when conducting a Poisson regression analysis).

Since the count variables BEFDECLO and AFTDECLO are meaningful only when relative to the total number of times weighed before and after December 1997 (BEFDECTO and AFTDECTO), we have to present the counts in the Poisson regression equation as proportions (i.e. BEFDECLO/BEFDECTO and AFTDECLO/AFTDECTO). In order to isolate the dependent counts on the left side of the regression equation, but also maintain the proportions, we take a log of the proportion as follows:

1. *log (N times below 3SD / N times measured) = function (predictors) + k*

2. *log (N times below 3SD) – log (N times measured) = function (predictors) + k*

3. *log (N times below 3SD) = log (N times measured) + function (predictors) + k*

In SAS, a GENMOD procedure can be run to model a regression using this Poisson distribution, with the "log (N times measured)" on the right side of the equation acting as an "offset" (control variable) to the dependent count we're interested in on the left side.

The resulting coefficients from a Poisson model have a different interpretation than the odds ratios that are taken from logistic model coefficients. Exponentiating the coefficient yields a count multiplier rather than an odds ratio. In the models fitted to this data from Pisangan Baru, we interpret the exponentiated coefficient as a multiplier upon the proportion of weight measurements that a child falls below three standard deviations from the average weight-for-age for every unit increase of the predictor.

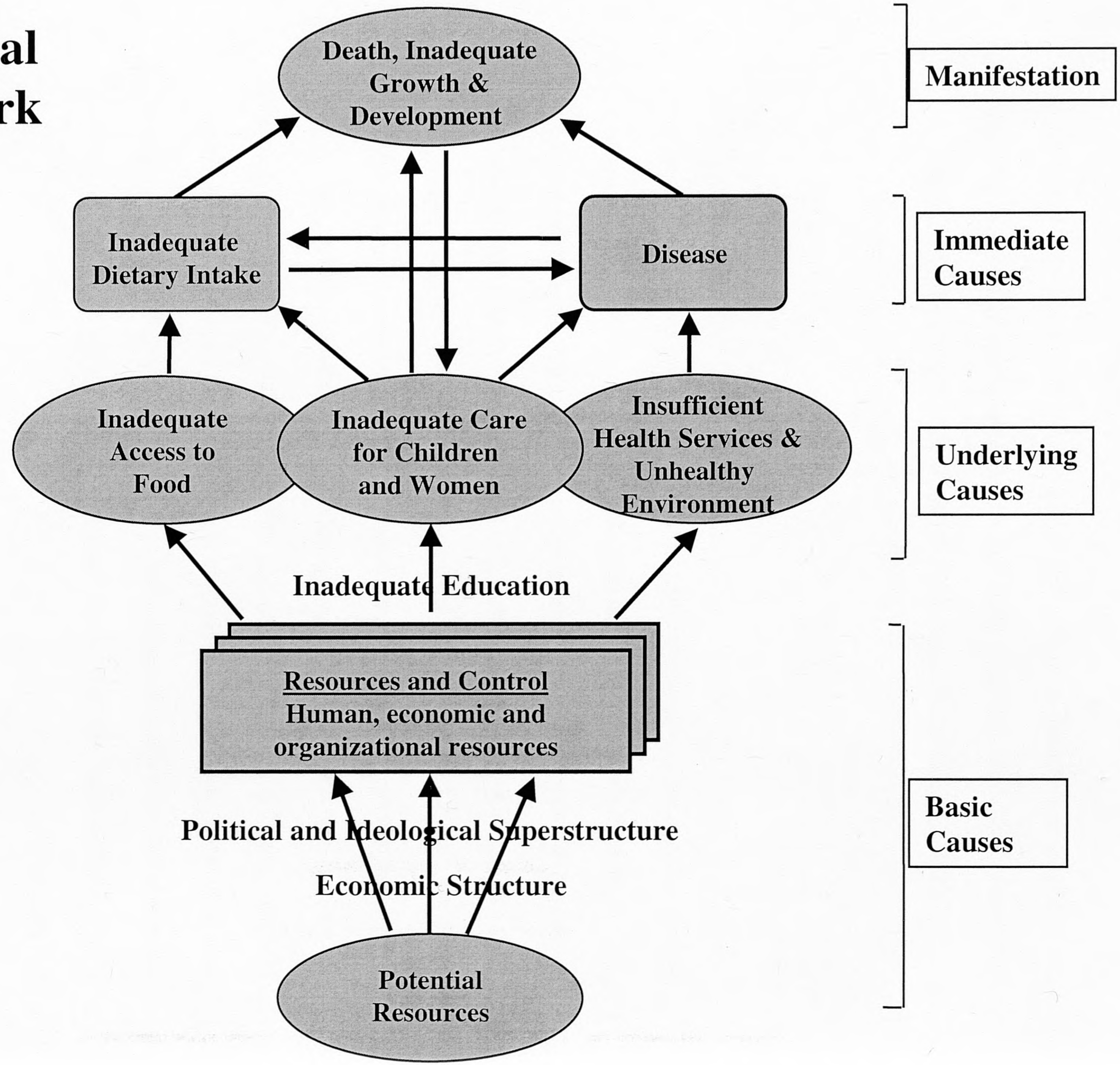
While the interpretation may be less intuitive or tangible than an odds ratio, the benefits of using a Poisson analysis for this data set outweigh this shortcoming for the following reasons: 1. As mentioned above, the Poisson analysis for skewed non-zero counts is perfect for this crucial component of the data which captures a temporal effect of the economic crisis on the weight of the study subjects. 2. Poisson regression allows all subjects without missing values into the analysis, thereby providing a much-needed boost in the sample size relative to the sample-limiting logistic analysis described above. 3. The logistic analysis flattens out the number of times children fall below three standard deviations by employing an "ever or never-below" case-control definition, but the Poisson analysis allows the proportion of each child's total measures falling below the line into the equation; along with the increased sample size, this added dimension to the analysis also helps boost the statistical power of the results and thus enable them to be presented with 95 percent confidence intervals.

In order to estimate the effect of the crisis on the underweight status of Pisangan Baru children between the ages of two and five, each subject has a repeated measure: the proportion of measures a child falls below 3SD both before and after December 1997. For this particular analysis, we employ a clustered Poisson model, also known as a generalized estimating equation (GEE). A clustered model correlates the measures before December 1997 (crisis=0) with the measures after December 1997 (crisis=1). The GEE is analogous to a repeated measures ANOVA analysis when dealing with normal distributions.[18]

Conceptual Model

While the small sample size of the data may not sustain a statistical analysis with more than one predictor (particularly in the logistic analysis), I will attempt to fit multivariate models that control for possible confounders by using an oft-used conceptual framework of the determinants of nutritional status put forth by Jonsson in 1993.[19] The inserted diagram on the following page summarizes this conceptual framework by showing the proximate and distal factors that affect inadequate growth due to disease and/or poor dietary intake. In my analysis, the crisis represents the prevailing economic structure (basic cause), and mother's education (underlying cause) ideally has a protective effect on the impact of the crisis. Education in turn may have an effect on food intake (represented by monthly expenditure on food / N members of the family) and a host of other underlying causes that ultimately affect the underweight status of children in the household.

Conceptual Framework



Results

103 interviews were conducted (95.4% participation). Of the five non-participants, four were due to the mothers being out of town during the three-week period when the interviews were conducted. The fifth subject refused to participate.

Logistic Analysis

Using the new case and control definitions, the original sample of 103 subjects was reduced to 53 due to questionnaires with missing values and not including children who were below 3SD weight-for-age both before and during the crisis. There were 21 controls (39.6%) and 32 cases (60.4%), 34 boys (64.2%) and 19 girls (35.8%). Although sex was not a significant predictor, 68.4% of all girls were cases (dropped from consistently normal weight-for-age before the crisis to underweight-for-age at least once during the crisis) while only 55.9% of all boys were cases, suggesting that girls possibly fared worse than boys during the crisis. The Poisson analysis in the following section reveals a more complex situation between boys and girls before and during the crisis.

The following table shows the significant results of a series of single variable logistic regressions where the dependent outcome is defined as controls=0 and cases=1.

Variable	Parameter Estimate	Standard Error	Odds Ratio	90% C.I.
Mother's Formal Education	-.592	.345	.55	.31 - .98
Monthly Food Expenditure / Rp100,000 / family size	-1.496	.677	.22	.07 - .68
Monthly Food Expenditure / Rp100,000 / family size (top quartile versus lowest quartile)	-2.328	1.173	.097	.01 - .67
Child's Age (in years)	-.549	.325	.58	.34 - .99

Table 2: Significant single predictors in a case-control logistic regression analysis.

Mother's Formal Education (EDUMOM) is a categorized variable (where 0=illiterate, 1=primary education, 2=middle school, 3=high school, 4=higher education) but analyzed continuously in order to conserve statistical power. A continuous analysis is partially justified by the trend of decreased parameter estimates with each higher level of education. Thus for each increased level of mother's education, normal weight-for-age children prior to December 1997 were .55 times less likely to be underweight-for-age during the crisis. In addition to EDUMOM, the questionnaire asked a series of nutritional knowledge and attitude questions in order to generate a nutritional knowledge score. Unfortunately, this didn't yield any significant results at the .1 level; nevertheless mothers who got every question correct were .4 times as likely to have underweight-for-age children during the crisis compared with mothers who got one or more question wrong (p=.126, 90% C.I. = .15 - 1.07), a trend worth reporting.

The food expenditure variable shows the strongest association, but requires some explanation. In this sample, families spent between Rp0 and Rp1,220,000 each month for food (during the summer of 1999, US$1 was roughly equal to Rp8500). In order to make a logistic analysis more meaningful, food expenditure was divided by Rp100,000 and then divided by family size (mother, father, plus their children) in order to take family size into account. After dividing by family size, monthly food expenditure ranged from Rp0 to Rp305,000 per person. Thus, for every increase in Rp100,000 per person for monthly food expenditure, children were .22 times as likely to become underweight-for-age during the crisis. When this variable is divided into quartiles and analyzed categorically, only the top quartile in comparison to the lowest quartile yielded a significant odds ratio: families in the highest quartile of monthly food expenditure per person (>Rp127,500/month) were .097 times as likely to have their child become underweight-for-age during the crisis compared to families in the lowest quartile (<Rp63,630/month).

Older kids during the crisis are less likely to be underweight-for-age. As age increases by one year, normal weight-for-age children are .58 times as likely to have become underweight-for-age during the crisis. This interpretation is tenuous because age is not a constant variable over time and young children of different ages can experience undernutrition differentially. The Poisson analysis elucidates the age question further.

Clustered Poisson Analysis

The most significant result central to my primary hypothesis comes from a clustered Poisson model correlating each child's proportion of weight measurements falling below 3SD before and after December 1997, and then estimating the effects of the crisis on those proportions by using time (crisis = 0 = before Dec.1997; crisis = 1 = after Dec.1997) as a proxy crisis predictor:

Variable	Parameter Estimate	Standard Error	Multiplier Estimate	95% C.I.
Crisis	.8415	.1959	2.32	1.58 – 3.41

Table 3: Crude clustered Poisson regression using crisis as a single predictor.

With 95% certainty ($p<.0001$), this crude model predicts that the proportion of a child's weight measurements below 3SD weight-for-age before the crisis will increase 2.32 times during the crisis. This estimate remains highly significant ($p<.01$) after adjusting for variables such as sex, age, birth order, and mother's education in a multivariate model.

We can model predictors with a regular Poisson analysis either before or during the crisis, and compare the results with a combined cluster analysis to clarify any possible interaction effects between crisis and another predictor. Child's sex (where girls=0, boys=1) is an exemplary variable analyzed in this manner. The following table shows the results of sex as a single predictor before and during the crisis, and then shows the results of a clustered analysis with sex as a predictor, controlling for crisis:

Variable	Parameter Estimate	Standard Error	Multiplier Estimate	95% C.I.
Sex (when crisis = 0)	-1.4578	.0941	.23	.16 - .35
Sex (when crisis = 1)	-.3797	.1035	.68	.56 - .84
Sex (clustered)	-1.4278	.5037	.24	.09 - .64
Crisis (clustered)	.5171	.1962	1.68	1.14 – 2.46
Sex*Crisis (clustered)	1.0020	.4702	--	(p=.0331)

Table 4: Three Poisson models using sex as a predictor.

Before the crisis, the proportion of boys' weight measurements below 3SD is .23 times as much as girls', but during the crisis the differential is reduced to .68 times. Surprisingly, girls were differentially worse off than boys *before* the crisis. During the crisis, girls probably did not "catch up" to boys, but rather boys probably declined at a faster rate than girls and thus reduced the pre-existing gap. Either version of the analysis above tells us the same thing, but this simple example shows the fidelity of the analysis for anyone who is a novice to Poisson regression. Note that in the clustered model, we add the interaction term to the sex estimate during the crisis and the resulting estimate is very close to the "Sex (when crisis = 1)" estimate. This analysis also reveals more nuance in the relationship between sex and the crisis than the logistic analysis.

Poisson Regression Analysis also offers some clues about how age plays a role in a child's weight-for-age status before and during the crisis. The following table presents results using age as a predictor similar to the sex table above:

Variable	Parameter Estimate	Standard Error	Multiplier Estimate	95% C.I.
Age (when crisis = 0)	.3233	.1136	1.38	1.11 – 1.73
Age (when crisis = 1)	-.2447	.0659	.78	.69 - .89
Age (clustered)	.3124	.2976	1.37	.76 – 2.45
Crisis (clustered)	2.738	.9174	15.45	2.56 – 93.32
Age*Crisis (clustered)	-.498	.2402	--	(p =.0382)

Table 5: Three Poisson models using age as a predictor

The clustered analysis by itself shows that age is not a significant predictor after controlling for crisis effects, but the age-adjusted crisis effect is greatly pronounced compared to the crude crisis effect discussed above *and* there is a puzzling significant interaction term. Looking at the effect of age before and during the crisis shows that age is significant at both times, but with an opposite effect. It's important to remember that the 2 to 5 year-olds in the sample were at least 1.5 years younger before the crisis began, and there are nutritional stressors with differential effects on weight-for-age depending on age of the child. Since age is a continuous variable in years, the interpretation of the multipliers is the following: prior to the crisis when the sample is at the latest aged 0.5 to 3.5 years, a child's proportion of weight measurements are increased 1.38 times for each increasing year of age. During the crisis, when the sample is at the latest aged 2 to 5 years, a child's proportion of weight measurements are .78 times as much for each increasing year of age. This crisis-period result agrees with the logistic results above.

Why the reversal of age's effect? While it is an imperfect analysis since the analysis of this aging cohort of children is only divided into two time periods, there are some possibilities to consider. Before the crisis, the youngest children are more likely to still be breast-fed, which confers immune protection and optimal nutrition for growing infants. The older children before the crisis are more likely to have stopped breast-feeding, and without a fully developed immune response are thus more likely to be underweight. At the time of the crisis, the youngest children are now at the risky age when they're probably not breast-feeding anymore, but have less developed immune responses than their older peers closer to five years of age. Older children are also more likely to have developed health behaviors that reduce their risk of exposure to infectious pathogens.[20]

The following table presents the results of four models in which mother's education is the main predictor: the effect of mother's education before the crisis only, during the crisis only, a clustered model using mother's education and crisis, and a second clustered model without using the interaction term:

Variable	Parameter Estimate	Standard Error	Multiplier Estimate	95% C.I.
Mother's Education (when crisis = 0)	-.2522	.0849	.78	.66 - .92
Mother's Education (when crisis = 1)	-.2156	.0564	.81	.72 - .90
Mother's Education (clustered)	-.1640	.2374	.85	.53 – 1.35 (p=.490)
Crisis (clustered)	.9768	.4704	2.66	1.06 – 6.68
Mother's Education*Crisis (clustered)	.0633	.1962	--	(p =.747)
Mother's Education (clustered)	-.2160	.1259	.81	.63 – 1.03 (p=.0862)
Crisis (clustered)	.8510	.1936	2.34	1.60 – 3.42

Table 6: Four Poisson models exploring the predictor effect of mother's education

In each model there are nearly equal estimates for mother's education. The insignificance of the interaction term allows us to drop it from the equation and boost the power of mother's education in the two variable clustered model which controls for the crisis effect. Even though mother's education is not significant at the p=.05 level in this model, the estimate appears correct given the similar estimates for both before and during the crisis. We can conclude with reasonable certainty that after adjusting for the significant crisis effect, the proportion of a child's weight-for-age measurements falling below 3SD will decrease with each increasing level of a mother's education by .81 times.

These clustered analyses with single predictors adjusted for the crisis effect help determine how to put them into a multivariate model. The table below shows the results of a multivariate model using crisis, sex, mother's education, and interaction terms for crisis*sex and crisis*age (in order to use the second interaction term, age must be included in the model as well, in spite of its insignificance). These final results are summarized in the discussion section below.

Variable	Parameter Estimate	Standard Error	Multiplier Estimate	95% C.I.
Intercept	-1.8525	.7410	--	(p=.0124)
Crisis	2.0545	.6913	7.80	2.01 – 30.25
Age	.1911	.1902	1.21	.83 – 1.76
Sex (1=males)	-2.3222	.4188	.098	.043 - .22
Mother's Education	-.2453	.1232	.78	.61- .99
Crisis*Sex	1.9917	.3850	--	(p<.0001)
Crisis*Age	-.4346	.2030	--	(p=.0323)

Table 7: Multivariate clustered Poisson model with interaction terms, incorporating results from univariate analyses above

Regular Poisson Regression Analysis During The Crisis

The following table presents the results of a multivariate model using regular Poisson regression (non-clustered). The analysis is based on weight measurements *during the crisis only* because the new variables in this model are unlikely to have been the same before the crisis. Predictors from the clustered model above are included as control variables.

Variable	Parameter Estimate	Standard Error	Multiplier Estimate	95% C.I.
Intercept	-.4390	.3539	--	(p=.215)
(Monthly Food Expenditure / Rp100,000) / Family Size	-.3506	.1165	.70	.56 - .88
Paternal Participation in Health Care Decision-making (0=none, 1=some or total)	.3193	.1094	1.38	1.11 – 1.71
Mother's Education	-.2230	.0654	.80	.70 - .91
Age	-.2162	.0684	.81	.70 - .92
Sex (0=females, 1=males)	.3175	.1122	1.37	1.10 – 1.71

Table 8: Multivariate Poisson model using crisis-period weight counts only.

The monthly food expenditure per family member variable, after controlling for paternal participation, mother's education, age and sex, agrees with the logistic analysis results; for every food expenditure increase of Rp100,000 per month per family member, the proportion of children's weight measurements below 3SD are 70% as much. Also, in families where fathers have some or total control in health-care decisions, the proportion of weight measurements below 3SD are 1.38 times greater than in families where only the mother makes health-care decisions, after controlling for monthly food expenditure, mother's education, age and sex.

A variable not included in the above model because of a very strong multicollinear association with monthly expenditure per person in the household is birth order. Defining birth order either continuously or dichotomously yields the following univariate results:

Variable	Parameter Estimate	Standard Error	Multiplier Estimate	95% C.I.
Birth Order	.0931	.0443	1.10	1.01 – 1.20
Dichotomized Birth Order (0=1st child, 1=not 1st child)	.4161	.1079	1.52	1.23 – 1.87

Table 9: Two univariate Poisson models showing the effect of birth order (not included in multivariate model due to multicollinearity).

As a child's birth order increases by one, the proportion of his/her weight measurements below 3SD increases by 1.1 times. The dichotomized birth order variable is easier to interpret and incorporates more meaningful magnitude into the result: the proportion of weight measurements below 3SD for children who are not the first-born child in their families are 1.52 times greater than the measurements for first-born children.

Discussion

Results Summary and Hypothesis Testing

The multivariate clustered Poisson model incorporating data before and during the crisis and the multivariate regular Poisson model during the crisis period provide enough information to answer the three hypotheses posed in the Background section. After controlling for age, sex, and mother's education, the proportion of a child's weight measurements falling below 3SD weight-for-age is likely to be 7.8 times higher during the crisis than prior to it. In this analysis of a single urban community during a brief time window immediately before and during the economic crisis, we can conclude that there has been a strong crisis effect on the weight-for-age status of under-five children in Pisangan Baru. As expected, mother's education has a protective effect on this crisis effect. Controlling for the crisis effect, age, and sex, the proportion of weight measurements falling below 3SD weight-for-age is decreased by .78 times for each increasing level of mother's education.

A surprising result that runs contrary to the expectations of the Indonesian Department of Health is the effect of paternal participation in health care decision-making in the household. Although it is not a strong association, the proportion of a child's weight measurements falling below 3SD weight-for-age (after controlling for monthly food expenditure, mother's education, age, and sex) is likely to be 1.38 times *higher* if the child's father has some or total say in household health care compared to households where only the mother decides. Along with the differential effect of sex on a child's underweight status, this result points to lingering gender inequities in Jakarta's urban slums. The government's aggressive campaign to improve fathers' participation in family health matters should be accompanied with an effort to educate fathers about family health priorities.

While not predicted in my hypotheses, monthly food expenditure per person in the household turned out to be one of the most significant predictors of underweight status. The logistic analysis showed that for every increase in Rp100,000 per person for monthly food expenses, children were .22 times as likely to become underweight-for-age during the economic crisis. The Poisson analysis showed that proportion of a child's weight measurements falling below 3SD weight-for-age is decreased .70 times for every increase in Rp100,000 monthly food expenditure per person after controlling for paternal participation in health decision-making, mother's education, age and sex. Using food expenditure as a crude proxy for either household income or household resource allocation, these results are not too surprising; families that have more money to direct toward food are more likely to absorb the unprecedented cost inflation of household staples which happened during the crisis.

Limitations and Lessons

There are several limitations in the study design worth mentioning that go beyond the small sample size and the limited time and resources available to design and implement this project. It is difficult to conduct a retrospective analysis studying the effects of the economic crisis when the only pre-crisis data available are the weight-for-age measurements. Unfortunately the questionnaire did not ask for important pre-crisis information about household expenditure, illness history, diet, health care utilization, occupation or household size. This would have been difficult to achieve in a single interview due to recall difficulties and would have required a longitudinal cohort study for more accurate comparative results. Sensitive predictors that have probably changed dramatically since the crisis, such as household food expenditure, require the Poisson analysis using weight measurements during the crisis only as the dependent variable due to the lack of pre-crisis expenditure data. Likewise the logistic analysis, focusing on how only normal weight-for-age children before the crisis were affected during the crisis by monthly food expenditure during the crisis, helps control for this shortcoming in the data, but imperfectly.

The questionnaire intended to measure mother's nutritional health knowledge instead of formal education as the major education-related predictor of her child's weight-for-age status. A series of questions which probed mother's nutritional knowledge, attitudes, and practice (KAP) were asked and then scored. However there wasn't enough variation in the score results to reveal any statistical differences. I believe the questions were too obvious and poorly conceived. Advance reading on how to collect KAP data would have proved useful. Pre-testing may have also revealed the shortcomings of the instrument, but time constraints prevented a thorough pre-testing. Pre-testing, advance KAP study design preparation, and some background on qualitative data analysis would have helped improve data collection on qualitative questions about changing diet patterns and personal accounts of how the economic crisis has affected the household.

As mentioned in the background section, weight-for-age fails to distinguish between average weight short children and tall underweight children; without a height measurement it is difficult to determine whether growth faltering is a result of inadequate weight gain or inadequate growth in height, or both. Weight-for-age is a useful tool for growth monitoring of individuals over time, because a velocity curve can show long term growth faltering or acute weight decline.[13] Comparison with a cutoff value can be misleading since each child may have different a different biological growth predisposition. Maternal anthropometry also affects her child's anthropometric measurements during early childhood (i.e. small mothers will have small children), so it is frequently misleading to compare a child's weight-for-age with a reference group without height or a longitudinal velocity curve.[21] Finally, at the population level, a high prevalence of underweight-for-age in the absence of height data does not fully describe the type of nutritional problem the population may be experiencing.[14] In the case of the children in Pisangan Baru, we make no diagnosis of malnutrition or even claim that any particular child is actually underweight. Nevertheless a crude description of the weight-for-age trends immediately before and then during the economic crisis has been a useful exercise to demonstrate that the crisis has had a significant effect on children's weight-for-age status.

There are at least two other biases in the study design that should be mentioned here. It is important to remember that the entire sample was recruited from mother's who bring their children to the POSYANDU (the monthly village weighing program), and not every mother brings their children every month. I call this the "POSYANDU bias," because the sample most likely includes the children who attend POSYANDU more regularly than those who do not and I suspect that this means the sample exclude wealthy families and the marginalized "poorest of the poor." A 1994 health practices study conducted in Jakarta by Kaye et al. showed that poor mothers were significantly more likely to report regular POSYANDU use than were wealthier mothers. Various ethnic Indonesians are also more likely to use POSYANDU than Chinese Indonesians, as were long-term residents as opposed to itinerant families. Regular POSYANDU users, regardless of economic class, were also more likely to be completely immunized than those who did not.[22] Kaye's results suggest that the sample in this study may not be entirely generalizable to all of Jakarta's urban population. Indeed, there were no Chinese Indonesians in my sample. Nor did any of the respondents claim to move around a lot, although four of the non-participants were out of town during the interview period, suggesting that there is an "itinerant bias" in the sample as well. One way to avoid this issue would have been to set a residency selection criteria as part of the sampling design.

In sum, this study serves as a useful pilot study of socioeconomic predictors, particularly Indonesia's economic crisis, and their association with the underweight status of children in Pisangan Baru, East Jakarta. The crisis had a negative association with children's weight, and mother's education had a protective effect. Surprisingly, paternal involvement in household health care decision-making had a negative association with children's weight. Finally, monthly household food expenditure per family member was also a positive predictor of a child's weight-for-age status. This study highlights the need for comprehensive longitudinal data (not just weight-for-age) for future studies like it, but it's unfortunate that the window of opportunity to examine the before-and-during effects of the crisis by means of a retrospective cohort study has largely passed. Future studies will have to rely on previously collected data, such as the Central Java data collected by the Helen Keller Institute, for comparison with current conditions as Indonesia continues to grapple with the social, political, and economic forces working against the overall health of its population, particularly the nation's "lost generation" of children.

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