Child Health And The Quality Of Medical Care

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Abstract: Health investments that promote development in early life have the potential to affect physical functioning, particularly in low- and middle-income countries where infectious illnesses amenable to care contribute significantly to ill health. We evaluate whether high quality prenatal and child healthcare promote child growth. We conclude that children who live in communities with high quality care are healthier compared with children who live in areas with poor quality care. These results support the shift health service delivery investments away from expanding access to improving the quality of care in existing health facilities.

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1. Introduction

The number of deaths among children worldwide has decreased over the past 20 years from fifteen to eleven million annually –a remarkable achievement considering the increase in the absolute number of births over the same period (UNICEF, 2000). This realization is due in part to health investments during the 1970s and 1980s that greatly expanded access to basic interventions (Rutstein, 2000). Yet, the vast majority of deaths among children under five in low-income settings is still attributable to a handful of causes treatable with medical care of of reasonable quality: acute respiratory infections, diarrhea, measles, malaria, malnutrition, and low birth weight (Gove, 1997). Moreover, recent evidence demonstrates that access to providers of poor quality actually *contributes* to child morbidity and mortality (Nolan *et al* 2000; Scofield and Ashworth, 1996; Sodemann *et al* 1997). As a result, many health policy makers are debating shifting the focus of health service delivery investments away from expanding access to improving the quality of care in existing health facilities. However, these shifts involve massive budgetary reallocations in the public health care systems that dominate low and middle-income countries. Moreover, such reallocations could be contraversial in countries where portions of the population, especially the poor, are located far from existing heatlh care facilities.

In this paper, we investigate whether children who live in communities with high quality care are healthier than those who live in areas with poor quality care. Drawing attention to the difficult task of measuring quality, we distinguish between structural and process quality (Donabedian, 1980). Structural quality assessments measure infrastructure, staff, services, or drug availability. Process quality, or technical clinical practice, measures the extent to which a practitioner appropriately applies his/her medical knowledge and resources to improve health.

The majority of previous studies in this area have employed structural quality measures to evaluate health interventions, such as the presence of medical doctors (Thomas *et al* 1996), nurses (Thomas *et al* 1996; Thomas and Strauss, 1992), hospital beds (Thomas *et al* 1996), drug supply (Strauss 1990), and village midwives (Frankenberg and Thomas, 2001)[1]. The underlying assumption in employing structural measures is that the availability of such tangible assets leads to high technical quality with no variation in provider practice. Yet the existence of a facility or clinician is not synonomous with high quality care. Research conducted in the U.S. and internationally has demonstrated not only enormous variation in provider practice but also that such variation can be linked to adverse health events (Nolan *et al* 2000; Schuster *et al* 1998).

We advance this literature by using process quality measures that accurately represent the provider's ability to respond to a range of conditions that promote poor human growth in low- and middle-income settings. Our measure employs clinical case scenarios that offer an objective method of evaluating what occurs during the encounter between a client and provider, and whether provider performance accorded with established standards of care. The specific case scenarios constructed measure the process quality of prenatal and child healthcare. These services were chosen because they address conditions of high prevalence, are associated poor long-term outcomes with significant functional impact, and have demonstrated efficacy in the clinical intervention (Tarlov *et al* 1989).

The primary outcome measure in this paper is child growth. Poor child growth in resource-poor countries, like mortality, rarely results from a single disease but an accumulation of insults at critical periods of development during the prenatal period and the first two years of life (Martorell, 1999; Morris *et al* 1998; Gould, 1989). One-third of children younger than five years

[1] An exception is Peabody, Gertler, and Liebowitz (1998), who showed a positive association between the process quality of prenatal care available in a community and birth weight in a Jamaican population.

in developing countries – approximately 182 million individuals – are stunted in growth (de Onis *et al* 2000). Such failure to reach full growth potential is associated in later life with impaired immuno-competence (Barros *et al* 1992; Martorell and Habicht, 1986), and poor cognitive skills and educational attainment (Behrman, 1996; Brown and Pollitt, 1996).

We analyze data from the 1993 Indonesian Family Life Survey (IFLS1), distinct in its collection of a broad array of current and retrospective socio-economic and health information among individuals, households, and communities[2]. The selection of households is representative of 83% of the Indonesian population, thus capturing the cultural and economic diversity among Indonesia's regional populations. An important part of the accompanying facility survey was a series of written clinical case scenarios, enabling an assessment of the quality of provider care processes that controls for variation in illness severity for comparison across facilities.

We find that the process measures of the quality of the prenatal and child care processes are positively and significantly associated with child growth. Structural quality and access variables, however, are not associated with child growth. These findings suggest that investments in improving prenatal and child care process quality in existing facilities in Indonesia may be an effective way to address conditions that result in a child's inability to reach full physical potential.

This paper is organized in four sections. We first present our model for analysis and its assumptions. Second, we describe our data in some detail and pay special attention to the development of the process indices for measuring quality. We subsequently present the results and conclusions.

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[2] See Frankenberg, E., Karoly, L, et al.., November, 1995 for a description of the 1993 IFLS.

2. Conceptual framework

2.1. The Biological Pathways From Quality to Human Growth

Human growth is a measure of the physiological processes associated with birth weight, genetics, and environment. Poor environmental factors, including inadequate health care and nutrition can prevent the attainment of one's full growth potential (Martorell, 1999; Pelletier, 1994; Monckeberg 1992). Health care providers that practice high quality prenatal and child healthcare can directly influence the efficacy of the production of child health inasmuch as their practices have an empirical basis. The major assumption, therefore, is that the pathways of influence have a strong empirical foundation, i.e., that good technical quality care during both pre- and post-natal periods has the potential to address the main causal factors for child stunting.

The major factors that prevent children from attaining their genetic growth potential can be divided into three types: insults *in utero*, infection, and the synergistic effect of infection and malnutrition. The evidence that specific events *in utero* affect long-term health is well established –consider, for example, rubella, thalidomide, smoking, and alcohol and drug abuse. The long-term effects of such insults ultimately depend on a range of interrelated factors, including maternal health status and the timing of the insult itself (Hall and Peckham, 1997).

Persistent untreated illness early and throughout the pregnancy can result in a reduction of placental blood flow, with proportionate reduction in skeletal and soft tissue growth during the peak in the fetal length growth curve (Villar & Belizan, 1982; Kramer 1987a, 1987b). The result is proportionate reduction in brain and body size as measured by a symmetrically small or "short" infant. Proportionately growth retarded infants are less likely to catch-up in growth, and suffer impaired immuno-competence and thus high rates of infectious illnesses throughout life compared with infants of normal size at birth (Martorell and Habicht, 1986; Gould, 1989; Barros *et al* 1992). Proportionate intrauterine growth retardation in full term infants accounts for the vast majority of low birth weight infants in less developed countries, due in part to the high prevalence of infectious diseases and conditions known to promote chronic stunting *in utero* and are amenable to care, such as malaria, helminth infections, and anemia (Kramer, 2000; Villar and Belizan, 1982).

Full term infants that are *disproportionately* small at birth, however, may be the result of short-term insults in the third trimester, for example, that promote weight and muscle loss but spare brain and body length (Gould, 1989). These infants may have the ability to catch up in growth where the environment fulfills health and nutritional needs (Adair, 1999). In industrialized countries, access to intensive care technology influence an infant's long-term prognosis (Dashe *et al* 2000), although such technology is not available to the majority of Indonesian women.

Post-natal infections not only occur more frequently in children stunted *in utero* but also promote stunting post-natally in young children, particularly in low- and middle-income settings where a high prevalence of infectious illnesses combines with poor sanitation to facilitate fecal-oral transmission of diarrheal and parasitic illnesses (Grantham-McGregor *et al* 1999b). Such settings promote repeated infections that may prevent a child from completely restoring weight lost during illnesses, thereby resulting in a drop in the growth trajectory over the long term (Martorell *et al* 1975; Rowland and McCollum, 1977). Both short-term and chronic infections may result in micronutrient deficiencies via decreased food intake, impaired absorption, or direct micronutrient losses (Duggan *et al* 1980; Stephensen, 1999).

Interventions addressing specific micronutrient deficits may be of limited use, particularly within environments where concurrent pathogens contribute to poor nutrition.[3] Indeed, significant associations between child mortality and nutritional deficiencies emphasize the

[3] In Indonesia during the late 1970s, a national child growth program was initiated under which some 2 million children underwent routine growth monitoring and food supplementation, under the assumption that inadequate dietary intake was the

synergism between poor nutrition and infection, which results in a magnified decrease in the frequency of child growth and/or a decrease in its velocity (Pelletier, 1994; Pelletier, Low, Johnson, Msukwa, 1994). Within the first two years in particular, growth rates are higher than in later life and the immune system is developing. Such ongoing development in early childhood implies both high nutritional requirements during a critical period of development and high susceptibility to illness (Martorell, 1999).

In summary, strengthening clinical case management of common infectious illnesses among children in low- and middle-income countries has potential, therefore, in promoting child growth during the critical first few years of life (Gove, 1997).

2.2. A Behavioral framework

We employ a behavioral framework based on the model of health capital developed by Grossman (1972) and Mosley and Chen's (1984) model of the proximate determinates of health. We begin by characterizing the child health production function, which is a biomedical process that converts specific investments into health.

The production function characterizes health as a form of human capital, where current health status is a function of choices and shocks over the individual's lifetime. Specifically, an individual's health capital, such as height, is the result of a set of factors, including previous health status, medical care, personal behaviors, and environment –some of which are observed, i.e., altitude, whereas others are not. Some of the determinants are chosen, such as nutritional intake, medical care, and time spent in seeking care. Others, such as environmental health, are only partially determined by a household's choices of sanitation, waste disposal, and water source. Yet some inputs are fully exogenous to the household, such as the portion of the disease environment determined by public health and sanitation infrastructure. An important

major cause of poor growth. Mosley (1984) noted that the design of the program itself might have been flawed because the primary cause of malnutrition was recurrent infection rather than inadequate diet.

issue for our analysis is that the quality of medical care received is a choice variable, whereby households choose whether to obtain care and from which provider.

Formally, individual *i*'s health status at the end of period *t* is:

$$h_t = H\left(h_0, x_{ht}, x_{h0}, \widetilde{u}_{ft}, u_{f0}, \widetilde{u}_{ct}, \widetilde{u}_{c0}, \widetilde{z}_t, \widetilde{z}_0, \varepsilon_t, \varepsilon_0\right) \qquad [1]$$

The vector of chosen inputs consumed during period *t* is represented by x_{ht}. Choices at the individual level include those motivated by health considerations such as nutrition and the decision to utilize care or deliver in hospital. Behavioral choices may not be motivated by health considerations but have health impacts, such as smoking or alcohol abuse. The proximate determinants in this model refer to the specific health choices of obtaining prenatal and curative child healh care. Other behaviorally chosen proximate determinants that influence fetal growth during pregnancy are nutritional intake, physical activity, and tobacco and alcohol use.

The rest of the arguments in the production function include $\widetilde{u}_{ft}$, which is a vector of individual and household (family) characteristics, $\widetilde{u}_{ct}$, which is a vector of community characteristics including environment, public infrastructure, z_t, which is the quality of medical care, and ε_t, which combines unobserved individual, household and community shocks to health. High technical quality can directly influence the efficacy of the health production function inasmuch as the activities conducted have an empirical basis. Structural quality may facilitate high quality technical processes as well as its cultural and financial appropriateness.

Note that the health production function includes both current and lagged values in recognition of health as both a stock and a flow, with different dimensions of health responding differently to change. Height, for example, is a cumulative measure reflecting the physiological processes associated with genetics in addition to birth weight and environment –and as such, prenatal and early childhood investments (Gould 1986). Whereas maximum height is determined genetically, poor environmental factors, health care, and nutrition can prevent the attainment of one's full height potential (Martorell, 1999; Pelletier, 1994; Monckeberg 1992). Weight, however, assesses fluctuations in body proportionality; it provides, therefore, an indicator of short-term deficiencies in weight from illness, decrease in food intake, or some combination of the two.[4]

The effect that each factor has on health varies by individual biology and socioeconomics, i.e., age, gender, genetic endowments, and knowledge or education. Better-educated households, for example, may attain enhanced health improvements from medical services because they have greater ability than poorly educated ones to comply with treatment recommendations.

However, it is important to distinguish between characteristics that affect the productivity of medical care, such as age and education, and those that only affect health through their influence on which and what type of medical care to obtain. Factors such as medical care prices, travel time to providers, and the household's economic resources, for example, may affect health indirectly through their influence on nutrition and medical decisions, but do not otherwise directly affect health. These latter characteristics do not enter the production function.

Even though the child health production function captures critical information, estimation of its parameters is difficult in practice, given that it would require detailed information about the choice of each input. Such estimation would require an identifying instrument, such as a price, for each input included in the production function (Rosenzweig and Schultz, 1983). Furthermore, these choices are simultaneously determined with the outcome, are thus endogenous and likely to be correlated with the error term.

In particular, the quality of care received is a choice variable. Individuals choose whether and where to obtain care based on factors such as quality (expected efficacy of treatment),

[4] Weight for height most accurately reflects short-term deficiencies, whereas weight for age –the outcome in these

price of available providers, the type and severity of illness, and budget constraints. Individuals are not randomly assigned quality, and those that choose a high quality care provider might be more severely ill. Selection bias based on unobserved severity of illness may confound the estimated relationship between quality received and health outcomes.

Consequently, we estimate the reduced-form determinants of health that relate measures of health status to long-term constraints. The reduced-form is obtained by substituting the determinants of the chosen health behaviors into equation (1) for the x_{ht}. To derive the determinants of the x_{ht}, we make the standard assumption that households make decisions by maximizing their overall welfare as they define it; given their household resources, the available information, their beliefs, and the underlying health and sanitation environment. However, household allocation decisions are constrained by available time and resources, by the health production function, and the price and quality of all *available* medical services. Therefore, the health behavior demands in period *t* are:

$$x_t = H\left(w_t, \mu_{ft}, \mu_{ct}, z_t, p_t, h_{t-1}, \varepsilon_t\right) \qquad [2]$$

where w_t is household resources at time *t*, μ_c represents endogenous environmental factors, z_t and p_t are the quality and price of all *available* medical care options.

We obtain the reduced form health production function by substituting [2] into [1] and solving recursively:

$$h_t = H\left(h_0, w_0, \mu_f, \mu_c, z, p, \varepsilon\right) \qquad [3]$$

where the subscript, *0*, refers to the initial endowments, and μ_f is a vector of family-level and individual level constraints, μ_c is a set of constraints at the community-level, and *z* and *p* are the quality and price of all available medical care. A key implication of this conceptualization is that

analyses—is a measure of both short- and long-term insults to health.

health stock is a function of past as well as current values of the constraints. Thus, the reduced-form relates current health to current and past constraints.

The reduced-form model does not distinguish the pathways through which quality of care affects health. However, the reduced form equation captures the combined direct and indirect benefits of quality care rather than solely their influences on behavioral choices. The direct effects are the consequences of actual care use; the indirect effects are the ways in which quality influences the decision where and when to seek care. Indeed, poor quality care contributes to low utilization (Akin and Hutchinson, 1999); low primary care utilization, in turn, can result in avoidable complications. Health education that typically occurs during prenatal care, such as the knowledge of danger signs for an obstetric emergency, may also be used in subsequent pregnancies or benefit other women in the household and community. Mothers that seek prenatal care may be more likely to obtain preventive services for their infants (Shiono and Behrman, 1995). In a less developed country, in particular, prenatal care may represent an adult woman's first contact with the health system and influence future visits. Treatment of tuberculosis or malaria during and after pregnancy –a time during which women are particularly vulnerable to these illnesses (Connolly and Nunn, 1996) –not only benefits the individual but also prevents transmission to others.

2.3. Empirical specification

The empirical specification employs the following equation:

$$H_{ij} = \alpha + \beta Q_j + \Sigma \lambda_k X_{ik} + \varepsilon_i \qquad (4)$$

where H_{ij} is the health outcome of individual *i* in community *j*. Physiological processes are often used to represent health where those processes are empirically linked to health outcomes. In these analyses, we employ child anthropometric measures that represent unobserved nutrients and processes at the cellular level (Pelletier, 1994). Q_j is the quality of prenatal and child medical care *available* in community *j*. We assume that technical quality changes slowly and the values of quality and other covariates remained stable.

The *X's* are a set of individual, household, and community control variables (Figure 1). Community controls encompass environmental factors known to affect intrauterine growth, such as sanitation and disease environment, proxied by province identification codes. Average food prices in the district for a selected basket of items common across different regions control for nutrition availability; prices and travel time to health care providers are also included. Household level controls represent family economic resources.

Three key maternal factors are age, parity, and height. These maternal characteristics are proxies for the initial health endowment. The cut-off points for age and parity represent physiologic risk given that early and late pregnancies may carry increased biological risks of negative outcome (PHS, 1989; Kiely *et al* 1993; Fraser, 1995; DuPlessis *et al* 1997; IOM 1985; Kline, 1989). The number of previous pregnancies, particularly if closely spaced, may increase in blood volume and placental iron requirements, which could contribute to anemia concurrent with co-existing micronutrient deficiencies in iron, folate, vitamin B12, and illness such as malaria and helminth infection.

Maternal height is determined by three factors: genetics, skeletal maturity, and the combined impact of environmental influences on maturity (Kramer, 1987). Short maternal stature could result from either genetic potential or prior stunting during the mother's development. Regardless of the cause, any deficiency in maternal stature can impose physical limitations on the growth of the uterus, placenta, and fetus (Gluckman and Harding, 1992).

Clearly, height and weight are also a function of age and sex; male infants consistently tend toward higher mean birth weights compared with females although this does not correspond to a specific pathology (Kramer 1987; Wilcox and Russell, 1983). We control for age and sex semi-parametically through a series of dummy variables.

3. Data and Measurement

Our research setting is Indonesia. The diversity of its environment and population of over 207 million people creates a dynamic milieu under which we can study how policies influence health. The country has undergone remarkable socioeconomic developments during the past thirty years: in 1970, GNP per capita was estimated at U.S. $230 per person; before the economic crisis in 1996, it was U.S. $1080 (World Bank, 2000). The Government in Indonesia views health interventions as integral to overall welfare and poverty alleviation goals and invested in large-scale infrastructure and equipment for improving access to basic services.

Such health investments were curtailed, however, in response to international budget crises in the 1980s, declining oil prices, and increasing debt payments (World Bank 1991). Despite the Indonesian Ministry of Health's efforts to improve the allocation of limited public resources for vulnerable populations that bear a disproportionate burden of ill health, the infant mortality rate is currently estimated at 52 per 1000 live births –75% of which were attributable to acute respiratory infections, perinatal complications, and diarrhea (UNICEF, 2000). While the government has expanded access to basic interventions, particularly for the poor, it has only recently emphasized high quality comprehensive care, skilled providers, and responsive health systems.

3.1 Data Source.

The Indonesian Family Life Survey is a unique household and community survey, distinct in its extensive array of current and retrospective socio-economic and health information to evaluate programs and policies systematically and comprehensively. The IFLS used a sampling scheme that stratified on 13 provinces[5] and randomly sampled 7730 households from 321 enumeration areas chosen from a nationally representative sample used in the 1993 SUSENAS National

[5] North Sumatra, West Sumatra, South Sumatra, Lampung, DKI Jakarta, West Java, Central Java, Yogyakarta, East Java, Bali, West Nusa Tenggara, South Kalimantan and South Sulawesi

Socio-Demographic Survey.[6] Over-sampling in urban and small province EAs allows for comparisons between urban and rural areas, and Javanese and non-Javanese ethnicities, enabling a representation of 83% of the Indonesian population. The survey is thus designed to capture the cultural and economic diversity among Indonesia's regional populations, in addition to the varying effects of decentralized government social policies and economic shocks. In these analyses, we use data from the first wave conducted in 1993-4 (IFLS1); the household response rate was 93%.

The community and facility survey was conducted in the same 321 enumeration areas as the household survey. Inasmuch as no existing sampling frame included both public and private primary level providers, the facility survey frame was generated from locations identified by community leaders, and reported knowledge and utilization patterns of household members. Questions referred specifically to facilities *ever used* to avoid potential seasonal and socioeconomic biases associated with studying only those facilities used by members that were recently ill. The sample, therefore, is representative both of public and private providers regardless of a given facility's administrative boundaries. Facilities interviewed were based on a random probability sample of public and private facilities from this frame. These analyses employ data from 2300 public and private facilities –approximately 95% of modern primary level facilities surveyed –that completed a clinical case scenario for prenatal and/or child care (Figures 2 and 3).

3.2. Child Anthropometrics

Within the household survey, a health worker accompanied the interviewers and collected anthropometric data, the basis of our key health outcomes. In these analyses, child height is expressed both in centimeters and as standard deviation units, or z-scores scores, for gender and age; weight is also expressed by z-scores given gender and age. Z-scores are derived by

[6] The Survei Sosial Ekonomi Nasional (SUSENAS) includes more than 60,000 households. The Indonesian Demographic

subtracting each child's height from the National Center for Health Statistics median reference standard and dividing by the standard deviation of the reference distribution for a given age and gender (WHO 1993). The use of a standard growth curve establishes the potential upper mean limit, thereby illustrating the strength of environmental factors that prevent full growth potential. Height for age captures long-term insults to growth, whereas weight for age represents both short- and long-term events.

Anthropometric indices were calculated using the EPI6 program from the Centers for Disease Control. All births from 1990 to 1993 listed both in the pregnancy history and in the anthropometric register were included, given plausible values for height, weight, and age. A total of 1608 children from 1359 households were included in the analyses using height and height-for age analyses; and 1785 children from 1509 households were used for the weight for age regressions. The difference in numbers of children reflects the greater availability and accuracy of weight values compared with height.

To determine whether the excluded children had different socioeconomic characteristics than those included in this analysis, we estimated a random effects logistic regression predicting the availability of height- and weight-for age information among singleton births that occurred from 1990 to 1993 and were alive at the time of the survey (Figure 4). An increase in the number of years of maternal education were significantly associated with the odds of height for age information being available, and the other explanatory variables were not significant at the 90% level. Turning to weight for age, the availability of this information in our dataset was more likely to be available among children from households with higher levels of per capita household consumption, and less likely for mothers under 20 years of age or less or those with five or more prior children. Given the established associations between low socioeconomic status and poor

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and Health Surveys similarly randomly select EAs from the SUSENAS sampling frame, based on the census.

health outcomes in Indonesia (Gwatkin *et al* 2001), these omissions suggest that our estimates may be conservative.

Figure 5 illustrate the prevalence of stunting and being underweight in our sample of Indonesian children.[7] Substantial heterogeneity exists among age groups and sex, yet the standard deviation units are uniformly negative for each six-month age group with the scores at zero to six months closest to the median reference values. Consistent with previous studies, the first few months after birth are characterized by relatively positive health (Martorell, 1999) although the effects of insults *in utero* may manifest themselves over time. Particularly striking is the period between 0 to 6 months and 13 to 18 months characterized by a 7.5-fold decrease in height for age z-scores. The dramatic decline in z-scores after six to 18 months until two years demonstrates this period of vulnerability (Figure 5). The slight increase after 24 months should be interpreted with caution given the measurement error in the growth reference standard itself (Pelletier 1991).[8] The relative fluctuations in average z-scores are less dramatic after 36 and 42 months, albeit children remain unable to catch up in stature. By 43 months, the average height for age z-score is below negative 2, the standard cut-off point for moderate and severe stunted growth.

Turning to weight-for-age, infants in the 0 to 6 months age group average -.13 standard deviations from the reference median weight for age. Between six and 18 months, however, a greater than 14-fold decline in weight for age z-scores occurs. Similar to stunting, the relative fluctuations in weight for age z-scores after 24 months represent neither a worsening condition nor the ability to catch-up. By 43 months, the average weight for age z-score is –1.81. The

[7] See Frankenberg et al 1996 for a detailed discussion of nutritional status using these data.

[8] The World Health Organization Expert Committee that recommended the continued use of the international growth standards also recognized its major limitation: different populations and methods of height measurement were used for children younger than 24 months and older than 24 months (de Onis and Habicht, 1996). An analysis across this disjunction at 24 months where two separate populations are combined requires some caution, particularly for height. In multivariate analyses, we control for this error by including dummy variables for by each three-month age group by sex.

total proportion of children considered underweight is less than the proportion stunted, indicating the relative severity of chronic health needs.

For sex, the mean height- and weight- for age z-scores for males is less than females; male height for age, for example, averages –1.63 compared with –1.47 for females. This finding is consistent with a 35-country review of health status measures for children under five years (Hill and Upchurch, 1995). Those authors attributed this finding to less physical activity among female children and / or decreased exposure to disease episodes.[9] Rural children have much lower child height and weight scores compared with urban infants: height for age z-scores for children in this sample averaged -1.72 in rural areas compared with –1.18 in urban areas.

The striking declines both in height-for-age and weight-for-age within the first 18 months of life suggest periods of tremendous vulnerability with lasting effects on subsequent well-being. Whether the decline is due to prenatal insults, post-natal influences, or some combination of both, the environment is unable to compensate for the drop in the growth trajectory. Such a decline reinforces the importance of promoting health during critical periods of development *in utero* until two years of life, in particular, when growth rates are higher than in later life and the immune system is developing (Martorell, 1999).

3.2. Quality of care

To measure the quality of care, we distinguish between the care process and structure (Donabedian, 1980). The facility survey provides comprehensive information about the structural elements of care, i.e., prices, range of services, drugs, and equipment. Structural quality measures, however, are necessary but insufficient indicators of care provision. We employ data that assess the interaction between provider and client, or process quality, through clinical case scenarios. Upon presentation of the scenario, the clinician responds to a series of

[9] Given that medical care plays an important role in maintaining good health between the ages of one to four, sex specific variability in nutrition and health care is also a possibility, although no evidence exists of male gender discrimination in Indonesia (Hill and Upchurch, 1995).

questions about patient diagnosis and management (Figures 2 and 3). These identical written case simulations recreate a patient visit and provide an objective method of assessing the quality of technical processes that controls for case-mix, or variation in illness severity, for comparison across facilities and providers. The vignettes are scored against a gold standard constructed from evidence-based criteria and expressed as a percentage of key criteria mentioned (Dresselhaus *et al* 2000).

The case scenario approach has been validated against actual clinical practice in rigorous prospective trials and consistently predicted actual clinical practice more accurately than medical record abstraction (Dresselhaus *et al* 2000; Luck *et al* 2000). By presenting identical scenarios, vignettes control for variation in illness severity, thereby allowing for comparison across individuals, locations, and time. Although several previous international socioeconomic and health surveys employed the case scenario methodology, the health quality assessments used in the IFLS were notable in several respects. The scenarios were extensively pilot-tested before implementation; substantial field experience was gained and adaptations made through the earlier use of the methodology. During the Indonesia Family Life Survey pilots, direct observation in ten facilities for ten patients each ensured that the instruments were reliable and accurate. Indonesian physicians worded the scenarios and responses, and all instruments were first written in Indonesian with back-translation into English for clarity and conciseness in language and minimal measurement error.

We developed process indices based on these case scenarios to evaluate the quality of care for 2300 public and primary level providers that completed a case scenario for prenatal care (1745 facilities), child care (2012 facilities), or both (72.5% of the facilities). The selection of variables for the process indices was based on established evidence of health impact within the resource limitations of a low- to middle-income country (Villar *et al* 2001; Carroli *et al* 2001; WHO, 1998; Rooney, 1992; WHO 1994; Kiely *et al* 1993; UNICEF 1999; World Bank 1993;

Gove 1997). Using this evidence-based criteria and data availability, we identified six sets of activities that have positive health impact within the process of a prenatal examination: checking for hypertensive disorders of pregnancy, conducting a thorough physical examination, asking about preexisting medical conditions, performing key preventive activities, and establishing a system of case management (Figure 2). The sets of activities were then aggregated into one 20-item index. The 12-item child care process index was based on information within the case scenario developed by Indonesian medical practitioners for the presentation of a child with diarrhea (Figure 3). The score for each prenatal and child care provider was expressed as a percentage of key criteria spontaneously mentioned, similar to previous analyses utilizing the case scenario approach (Luck *et al* 2000).

Subsequently, we controlled for structural inputs, selected to the extent that those elements facilitate the provision of the given technical processes. Structural quality variables include the presence of a medical doctor, an internal water source, the price of a prenatal care visit, and an index measuring structure and perceptions. The structure-perceptions index aims to capture both perceptions and the extent to which basic structural quality exists across facilities regardless of provider specialization or public/ private sector. It is comprised of nine variables: three types of basic equipment (blood pressure cuff, gloves, and an infusion kit), observation of a clean examination room, the availability of curtains for privacy, whether the head of the facility had worked there for more than three years, and the availability of three services: delivery, family planning, and tuberculosis treatment.

The selection of each variable in this index relates to process quality. Monitoring blood pressure in pregnant women is currently the most sensitive test for diagnosing hypertensive disorders of pregnancy when done in conjunction with urine protein (Rooney, 1992). The availability of an infusion kit to restore fluids in response to an obstetric emergency or severe dehydration allows a skilled primary level provider to provide first aid and stabilize, thereby influencing maternal and infant health outcomes at the referral hospital level (Maine and Rosenfield, 1999). Sterile gloves can protect both mother and provider from infection. A recent study about patient satisfaction in Indonesia provides some justification in the use of curtains to assess privacy and clean floors to evaluate cleanliness (Bernhart *et al*, 1999). The study found that Indonesian women undergoing prenatal care examinations mentioned the importance of privacy; it also noted that women prefer clean surroundings more than men do. Whether the head of the facility had been posted there for more than three years provides some indication of the facility's familiarity with the community and its needs. A study conducted in Indonesia noted that pregnant women were not taking the iron supplements received from health center because of poor understanding of its benefits, uncomfortable side effects, and local food and drug taboos during pregnancy (WHO 1997). This underscores the importance of trust between provider and client to ensure compliance –also a critical factor in appropriately managing childhood illnesses at home (Gove, 1997).

The three services in the structure-perceptions index are delivery, choice of family planning methods, and tuberculosis. The availability of delivery services alongside prenatal care may promote delivery with a trained attendant, which influences maternal and infant outcomes. Family planning services post-delivery can influence spacing between births. The key quality measure in family planning is choice (Askew, 1993); we measure choice by identifying those providers that offer any brand of three different methods: pill, injectible and IUD insertion. Lastly, tuberculosis is the single greatest infectious cause of death in women worldwide and an important cause of female morbidity, particularly for those in their reproductive years (Connolly and Nunn, 1996).

We omit drug availability for two reasons. Similar to other studies, the availability of drugs suffers from endogeneity because high quality facilities may deplete their stocks more quickly than low quality facilities (Mwabu *et al* 1993). Furthermore, key drugs such as anti-malarials reflect the distribution of supplies to malaria endemic areas. Given that malaria during pregnancy represents a major cause of poor intrauterine and post-natal growth and is amenable to high quality care, controlling for these areas via the availability of antimalarials would remove precisely the effect we are trying to capture.

Figure 6 describes the structural and process indicators for prenatal and child care providers, expressed as a proportion of criteria mentioned. The process quality indices averaged .53 for prenatal care providers and .65 for childcare providers. Therefore, a representative sample of prenatal care providers spontaneously mentioned, on average, 53% of the 20 criteria in the prenatal case scenario (Figure 2). Childcare providers scored slightly higher, mentioning 65% of the 12 criteria in the scenario for a child presenting with diarrhea (Figure 3). A larger proportion of private nurses and physicians offered curative child care compared with prenatal care, and fewer midwives did so.

The facility and household level datasets were combined by collapsing the prenatal and child care indices into mean values for each community. To ensure a representative sample, we applied the facility weights developed from a series of questions in the household survey about facilities ever visited by any family member. The indices measuring process quality in the multivariate analyses, therefore, represent the average level of care quality available in the community from a representative sample of prenatal and child care providers.

The community quality averages are listed at the bottom of Figure 7. The prenatal care quality index averaged .52. Given evidence that such case scenarios may reflect actual practice (Luck *et al* 2000), this figure implies that prenatal care providers in a given community practiced, on average, 52% of efficacious procedures during a prenatal care examination. The average level of child care quality available in a community was higher at .65. While one would expect the prenatal and child care indices to be correlated, the pairwise correlation coefficient is .44. This may reflect the generally fragmented nature of services in many low- and middle-income countries, with verticalized funding of specific public sector programs resulting in different levels of quality between essential services.

Previous studies have employed structural indicators to proxy overall health care quality. Care quality experts believe, however, that structural quality is indeed an important facilitating factor in high quality care provision –but that structure alone is insufficient for ensuring high quality technical processes (Donabedian, 1980). We exploit the availability of both process and structural quality information in the facility dataset and explore the extent to which structural quality explains or limits process quality (Figure 8). Two regressions are estimated, with the dependent variables as the process quality indices for providers of prenatal care and child healthcare.

In the first regression, we focus on primary level facilities that provided prenatal care. All three structural quality measures –the structure-perceptions index, an internal water source, and the availability of a medical doctor –are positively associated with prenatal care processes. Privately practicing nurses are associated with lower prenatal care quality compared with private clinics. In the second analysis among child healthcare providers, the structure-perceptions index and availability of a medical doctor are also significantly and positively associated with process quality, although an internal water source is not. Privately practicing physicians are associated with higher quality curative child healthcare compared with private clinics.

In these regressions, three additional variables control for socioeconomic status and health needs: average household expenditure by enumeration area, average maternal age, and whether the facility was located in a rural area. Dummy variables for each province are also included. The average level of household expenditure in the community and maternal age are not significant predictors of process quality in either regression. The variable identifying rural areas, however, is significantly and positively associated with an increase in child healthcare quality, an effect that could be attributed to strong promotion of government treatment protocols for the management of common childhood illnesses in peripheral areas. The F-test for the joint significant of the province dummy variables is also significant. The joint significance of the province variables may reflect the "uneven" quality of initial and continuing medical education (World Bank, 1994), such as sub-optimal residency or post-theoretical training, non-standardized in-service and continuing education programs across regions, and provincial differentials in technical support and dissemination systems. Overall, however, the R-squared indicates that structural factors explain 13% of the variation in prenatal care process quality and 20% of the variation in child care process quality.

3.3. Control variables

Because nutrition plays an important role in growth, we control for basket of food prices collected in the community survey to obtain price variation among a range of processed, unprocessed, and locally produced items aggregated by enumeration area. Socioeconomic characteristics were identified within the household survey from a roster for each household that included information about member composition, consumption, basic demographics, and household characteristics. Race and/or ethnicity are typically included in a health analysis to proxy an aspect of socioeconomic status, preferences, or ways of behaving; however, the Indonesian government's policy of "unity in diversity" precludes asking these questions. We take account of whether the interview with the mother was conducted in the Indonesian language to capture ethnicity and, possibly, barriers to care access. Additional socioeconomic controls are maternal education, any type of insurance coverage, and rural areas. Environmental risk factors that affect intrauterine growth are proxied by province identification codes, and the joint significance of the province identification variables are reported.

Maternal and infant characteristics were identified from a separate series of questions administered to all women younger than 50 years who had ever been married. From this book, we have detailed retrospective life histories about women of reproductive age who gave birth from 1990 to 1993. We include in these analyses key maternal and infant risk factors, namely, maternal age and parity at the time of birth, maternal and paternal height, sex of infant, and gestational age. For parity, women with no prior pregnancies and grandmultiparas are identified. For grandmultiparas, we employ a commonly used definition of five or more pregnancies. These factors not only represent biological risk but also control for selective program placement should resources be distributed to areas of health needs.

4. Endogeneity of Program Placement

In this section, we examine selective program placement –an important issue in health policy analyses because health interventions are often targeted towards populations of need. Structural quality measures may be particularly sensitive to endogeneity in program placement given that they reflect tangible resource allocations. We evaluate whether our measures of structure and process quality are associated with observable socioeconomic levels in a community (Figure 9).

One problem with an ordinary least squares analysis of cross-sectional data evaluating health services is selective government policies and program placement because resources are not randomly distributed (Gertler and Molyneaux, 2001; Pitt *et al* 1993; Rosenzweig 1988; Rosenzweig and Wolpin, 1986). Public health resources are normally targeted to areas based on specific socioeconomic factors, particularly in low- and middle-income countries where the government remains the primary financier and / or provider of health services, especially for the poor.

Indeed, previous studies using structural quality to evaluate health interventions have had conflicting results. Cross-sectional analyses using data from the Ivory Coast showed positive associations between the presence of medical doctors and child height (Thomas *et al* 1996); this study and others, however, found negative associations between child height and structural measures, such as the availability of nurses (Thomas *et al* 1996; Thomas and Strauss, 1992), hospital beds (Thomas *et al* 1996) and drugs (Strauss 1990). Frankenberg and Thomas (2001) use a quasi-experimental design and longitudinal data across Indonesian communities to control for program placement; they demonstrate positive associations between the presence of a trained health worker and the outcomes of maternal body mass index and birth weights.

The analyses in Figure 8 demonstrate that average household consumption levels do not predict process quality using facility level data. Using the average process quality measures merged with the household dataset, we cross-tabulate the average structural and process quality available by household expenditures levels, whereby “one” equals the lowest monthly quintile of real per capita household expenditure and “five” equals the highest quintile (Figure 9). The first three rows show the average availability of structural inputs, specifically an internal water source, presence of a medical doctor, and the structure-perceptions index measuring a range of services and client perceptions. The next three rows evaluate the three process quality indices, and the last two rows, travel time to the public health center, and price for a prenatal care visit. Significant differences are noted between the first and fifth quintile mean values for all three structural measures, travel time, and price.

Tests measuring differences in subpopulation means, however, demonstrate no significant differences between the first and fifth expenditure quintiles for the three indices measuring process quality. This suggests that process assessments may more accurately capture the influence of care quality in cross-sectional analyses, although future research using data from consecutive panels is required to control fully for selective program placement. To further control for placement of resources based on observable socioeconomic factors, we include in the multivariate analyses variables identifying rural areas, household consumption levels, maternal education, insurance coverage, language spoken during the interview, in addition to province identification codes and community prices.

5. Results

In this section, we report the main results of the paper focusing on the influence of care quality on three outcomes that reflect different aspects of child growth: height in centimeters, the proportion of children stunted, and the proportion of children underweight.

5.1 Height

The models described in Figure 10 report the random effects estimates of the influence of community quality on child height in centimeters, while controlling for other community factors, socioeconomic status, and maternal, paternal, and infant factors associated with biological risk. Model 1 first includes only structural quality and access variables, and none is significantly associated with height.

In Model 2, we add the process quality index for prenatal care, representing the average quality of prenatal care available in the community. An increase in the prenatal care process index is associated with a significant increase in height conditional on age and sex, and this association is independent of the range of services and basic equipment available as represented by the structure-perceptions index in addition to the presence of an internal water source. Recall that the process indices are calculated on scales of zero to one; thus, the corresponding elasticity is .02 for a 1% change in prenatal care process quality. The variables measuring price and distance to the health center are not significant.

In Model 3, we replace prenatal care with the child care process index derived from a different vignette assessing care quality for children with diarrhea (see Figure 3), while also including a variable measuring maternally reported small size at birth. This enables us to distinguish to some extent between the relative influence of postnatal rather than prenatal care quality. The child care process index, however, is not a significant predictor of height; nor are the other community variables representing structural quality and access.

In Model 4, we include both the prenatal and child care process quality indices. The coefficient representing prenatal care process quality remains significant at the 10% level.

Models 5, 6, and 7 represent the same analyses in Models 2,3, and 4, respectively, but omit the structural variables in view of the fact that structure explains some of the variation in process (Figure 7). The magnitude of the prenatal and child care process quality coefficients increase slightly with the omission of the structural quality measures in Models 5 and 6, and the prenatal process care coefficient remains significant in Models 5 and 7.

Evaluating the socioeconomic and individual correlates of child growth, the significant covariates are in the expected directions and consistent with previous studies. Significant positive predictors of height include monthly per capita household expenditures, maternal education (years squared), maternal height, missing maternal height values, and paternal height. The slight increase in magnitude and significance of monthly household expenditures in Models 3 and 6 implies that household resources may be relatively more important during the postnatal period, given that we also included in these models a variable for small size at birth to distinguish between the influence of pre- and post-natal care. Short maternal stature could result either from genetic potential or prior stunting during the mother's development, either of which could physically constrain fetal growth. Values were coded missing if the mother's height was not measured during the household visit; the significance of this dummy variable in all seven models suggests that missing maternal height values proxy a working mother or an aspect of socioeconomic status. Similar to household expenditures, the magnitude of this coefficient is slightly higher in Models 3 and 6.

Significant negative predictors across all models were residence in a rural area, maternal age less than 20 years at the time of birth, preterm birth, and being small in relative size at birth (Models 3 and 6). As discussed previously, young maternal age can be a predictor of biological risk, particularly for adolescent mothers who are not physiologically mature (DuPlessis *et al*

1997; IOM 1985; Kline, 1989); the slightly stronger associations demonstrated in Models 3 and 6 suggest that young maternal age, similar to household resources, may be a factor in poor post-natal growth. The control variable for small in relative size is negative as expected. The three sets of F-tests evaluate the joint significance of community food prices, province location, and a series of three-month age dummy variables by sex. Fixed effects for food prices are not significant in these models; province location is significant in Model 3, and the age-sex fixed effects are significant in all models.

5.2 Stunting and Wasting

Figures 11 and 12 describe a series of random effects logistic regression models to explore the relationship between prenatal and child care quality and the proportion of children stunted and underweight. In the model examining stunting, “one” equals less than two standard deviations below the median reference population of height for age –the established international cut-off point typically used to define moderate and severe stunting (WHO, 1983). Figure 12 also uses an established cut-off point for being underweight, whereby “one” equals less than two standard deviations below the median reference value weight for age. In Figures 10, 11, and 12, we also report the joint significance of food prices, province fixed effects, and three-month age/sex fixed effects.

Figure 11 describes seven identical models that estimate the influence of care quality on the proportion of children stunted using the same quality constructs while controlling for socioeconomic status, maternal characteristics, and individual factors. In these models, we report the odds ratios associated with the probability of stunting, whereas “one” equals less than two standard deviations below the median reference population of height for age. Model 1 includes only the structural quality and access measures, none of which is significantly associated with the odds of stunting. Model 2 adds the variable measuring prenatal care process quality, which is significantly and negatively associated with the probability of stunting.

Similar to the previous explorations, Model 3 replaces the prenatal care variable with one measuring the quality of child care, while also including a variable to control for small size at birth. While child care process quality was not significant in predicting the distribution of height (Figure 10), an increase in child care quality is significantly associated with a decrease in the proportion of children in the tail end of the height for age z-score distribution. In Model 4, the child care index remains significantly and negatively associated with the probability of stunting, and the prenatal care index is no longer significant.

Similar to the previous set of analyses, Models 5, 6, and 7 include the process quality measures and omit the structural variables. Those process indices that were significant with the structural quality variables remain significant with their omission.

Among the variables predicting a positive outcome, monthly household expenditure and insurance coverage are both associated with a decrease in the odds of stunting. Maternal and paternal heights are strongly and negatively associated with stunting as expected. Conversely, the negative associations between young maternal age and poor child health outcomes persist in these analyses, in addition to nulliparity. Neither food prices nor province location are jointly significant in any of the models.

The third aspect of child health, weight for age, captures both long- and short-term insults to growth. In Figure 12, we employ a random effects logistic regression to evaluate the associations between process quality and the established cut-off point for underweight children, less than two standard deviations below the reference median weight for age. Similar to the previous sets of models, we first evaluate structure and access. In Model 1, the structure-perceptions index –representing a range of services, basic equipment, and perceptions –is a significant negative predictor of the odds of being underweight.

Adding prenatal care process quality in Model 2, the coefficient for the structure-perceptions index declines slightly but it remains significant, as is prenatal care quality. Child care process quality is not associated with low weight for age (Models 3 and 4). When both process indices are included in one model, prenatal care process quality remains significantly and negatively associated with the odds of being underweight (Model 4).

The consistent significant association between the structure-perceptions index and being underweight in Models 1, 2 and 4 may represent the importance of a functioning health system and range of facilities that can respond to the relatively more complex condition of low weight-for-age (compared with height for age) given that it captures both long and short-term conditions.

Models 5, 6, and 7 do not include the structural quality variables, and the prenatal care process quality index remains highly significant (Models 5 and 7). In Models 5 and 7, the price of a prenatal visit also becomes significant, suggesting that financial access may also be a factor in explaining low weight for age.

Interestingly, none of the socioeconomic factors is associated with the odds of being low weight for age. Other studies have demonstrated that different socioeconomic characteristics have varying influences on weight and height (Bertrand *et al* 1988). Some experts point to the potential effects of seasonality given that reductions in weight are the primary response to seasonal changes in the availability of nutrition and income among well-nourished children – who may have higher energy requirements –whereas height reflects insults over time (Pelletier 1991). The associations between socioeconomic factors and different anthropometric indicators, therefore, may differ given varying temporal reference points that cannot be captured in this analysis due to broad differences in agricultural practices and weather conditions. Furthermore, weight for age does not distinguish weight gain from edema, which may result from certain types of acute nutritional deficiencies.

Similar to the other models, maternal and paternal heights are negatively associated with low weight for age. The positive association persists between young maternal age and being underweight. The F-tests indicate that age/sex fixed effects are jointly significant. Food prices are not jointly significant in any of the models. The province fixed effects are significant in Model 7.

Overall, significant associations exist between the availability of high quality provider practice and healthy children. Furthermore, these analyses imply different relationships among the two types of care, the methods of measuring quality, and the three aspects of growth. Even though the two types of care are correlated, organizational factors in the Indonesian public health system, such as verticalized funding of specific public sector programs, may explain different levels of quality among different services.

5.3 Discussion

We demonstrate that prenatal care process quality is positively associated with the distribution of child height, and negatively associated with low weight for age and height for age. This congruent set of findings is consistent with literature a propos the relationship between child anthropometrics and mortality. A review of 28 community-based studies concluded that the majority of deaths associated with malnutrition is attributable to mild and moderate (rather than severe) malnutrition given the larger proportion of children affected (Pelletier *et al* 1994). Those authors argue that health strategies focusing only on the sickest children will not make a substantive impact on child mortality at a population level. Our findings similarly indicate that investments in improving the quality of health provider activities promoting positive prenatal development may result in a shift in the distribution of height. This is logical given that poor prenatal development is an underlying cause of childhood illnesses (Gove 1997). Such a shift in the distribution represents improved overall child health, which implies health benefits that extend throughout the life cycle (Behrman 1996).

An increase in quality child care is consistently associated with a decreased likelihood of being stunted, implying that the availability of high quality child care in a community may influence the probability of stunting via curative care that addresses common childhood illness at critical periods of growth.

5. Conclusions and policy implications

These data demonstrate associations between high quality prenatal and child care available in a community and height, height for age, and weight for age among Indonesian children. This research suggests that greater investments in improving the quality of prenatal and early childhood care may lessen the probability that a child will suffer from poor growth and its concomitant long-term sequelae on physical functioning and productivity.

Such investments would take the form both of structure and process: improving the structural elements of care in addition to reducing the wide variation in provider practice. Despite the fact that infrastructure and medical education programs are clearly important in promoting high quality care processes, we find that structural quality, the level of socioeconomic development, or even provincial differentials explained only a fraction of the total variation in process quality. Efforts to improve provider practice in other countries suggest a more complex problem that encompasses not only infrastructure and clinical training but also incentives that promote best practices (Shortell *et al* 1998) and household behavior (Langsten and Hill, 1995). Furthermore, given that user fees from health services are an important source of revenue for the district governments in Indonesia, quality of care improvements concurrent with user fee increases remain an important research area to inform policy.

Indeed, the decentralization policies currently underway present new opportunities for revitalizing the health sector, although the challenges and complexities should not be underestimated. More and better data about care quality will support the Ministry of Health's efforts in careful monitoring and feedback into policy development as it proceeds with modifications to the current fiscal decentralization laws. Programs supporting high quality child care, in particular, have been critical of the decentralization process, suggesting that it may effectively reduce technical support essential in maintaining high quality technical processes (Claeson and Waldman, 2000). This research proposes a method to systematically measure activities that are empirically linked to health outcomes, compare process quality across regions, and inform consumers about the importance of technical quality.

Clearly, the margins for improvement are great. Poor child growth in low-income settings is largely the result of factors amenable to intervention. Sound child health policies promote investments in improving the content and quality of prenatal and child care within a strong health system.

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Figure 1. Definition of variables

Variables	Definition
Per capita real household expenditures	Sum of monthly household expenditure divided by the total number of household members. Includes purchased and self-produced food. Divided by deflator for each province and urban/ rural areas using Consumer Price Index.
Maternal education	The number of years of maternal education from 0 to 15 years, squared.
Insurance coverage	Any health insurance benefits through a householder's family or workplace or from a designated company clinic for hospital or outpatient coverage.
Mother non-Indonesian speaking	The woman did not speak Indonesian (official language) during the survey interview.
Food prices in district	Average of community -reported prices for fish, wheat, oil, and canned milk by each district; missing values replaced by average for each province.
Maternal and paternal height	Measured by individuals trained in collecting anthropometrics; height in centimeters. Missing values set to mean and variables generated to identify missing maternal and paternal height values.
Maternal age	Reported maternal age birth divided into </=20 yrs; 21 - 34 yrs; >34 yrs.
Parity	Total number of previous pregnancies, including living children those who died, stillbirths, and miscarriages: 0, 1-4, >/= 5.
Small at birth	Maternal response to "*In your opinion, compared with other infants, was … bigger, smaller, or similar in size*?" as much bigger, bigger, the same, smaller, or much smaller compared with other infants. "Small at birth" combines smaller and much smaller.
Prenatal care process index	Variables selected from the prenatal care case scenario (listed in Figure 1) summed and averaged for each prenatal care provider; average provider scores collapsed into a weighted mean for each community.
Child care process index	Variables selected from the child care case scenario (listed in Figure 2) summed and averaged for each child care provider; average provider scores collapsed into a weighted mean for each community.
Prenatal and child care process index	Each of the 32 variables from the prenatal and child care case scenarios and providers either of prenatal, child care, or both collapsed into a weighted mean for each community.
Structure-perceptions index	Proportion of criteria met for providers of prenatal, child care, or both collapsed into a weighted mean for each community: infusion set, gloves, sphygmomanometer, observed "clean" by interviewer, curtains on examination room, the head of the facility posted there for more than 3 years, delivery service available, a choice of three family planning methods, and tuberculosis services.
Internal H20	Health facilities that provide prenatal, child care or both have piped water. Average availability generated by collapsing weighted facility observations for each community.
Medical doctor available	Medical doctor works at facility that provides prenatal, child care, or both. Average availability generated by collapsing weighted facility observations for each community.
In real price for prenatal care	Natural log of price per PNC visit as reported by the facilities providing prenatal care. Public facilities include registration fee. Deflated using consumer price index.

Figure 2. Case scenario for the examination of a pregnant woman

I would like to understand the process by which you provide a pregnancy examination… from the arrival of the patient, waiting upon the patient until she goes home. I shall describe a pregnant mother, then I shall ask you to explain anything you regularly perform. Please state things in consecutive order. Mrs. Ani, a married woman, says she has not had her periods for 3 months. She has come to you for a pregnancy examination. This is her first visit. She appears to be in good health. Please recount everything you would do during Mrs. Ani's first visit… Mrs. Ani is at an advanced stage of pregnancy estimated to give birth in another 2 weeks. Mrs. Ani's condition so far has been good, and she is expected to give birth without complications. Now I would like to know the exact services Mrs. Ani has received up to this moment. [*]

Hypertensive disorders of pregnancy: Did the provider:

- Check blood pressure
- Check urine protein
- Ask about a history of high blood pressure
- Ask about smoking

Physical examination: Does the provider measure:

- Body height
- Body weight
- Abdominal examination
- IDs high risk pregnancy

Case management: Does the provider:

- Date the pregnancy
- Schedule the next visit
- Plan the delivery
- (Refer to a hospital) [‡]

Preexisting maternal medical conditions: Does the provider ask about:

- Diabetes
- Heart disease
- Hereditary disease

Preventive care: Does the provider:

- Check for tetanus toxoid coverage
- Check for STDs
- Give nutritional advice
- Supply iron folate
- Check hemoglobin levels

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[*] The original survey was divided into two separate parts evaluating the initial and final prenatal visit; these parts were combined into one. [‡] This variable was obtained from a question in the facility survey to the head of the facility, and was included for completeness in terms of establishing a case management system given the importance of a referral system for emergency obstetric care.

Figure 3. Case scenario for the examination of a child with vomiting and diarrhea

On this occasion, I would like to understand the process by which you examine a child suffering from diarrhea. I would like to know the steps you take from the moment the patient arrives, is waited upon, until he/ she leaves for home. After that, I request that you explain just what you usually do. Please make consecutive statements. Mrs. Nani came to the clinic together with her daughter Eli, an eight month old baby. She came with complaints about diarrhea for two days, with vomiting. Please tell me just what you did during the first examination.

History: Did the provider ask about:

- Duration of diarrhea
- Frequency of diarrhea
- Appearance of stools
- Blood in stools
- Presence of fever

Physical: Did the provider:

- Check alertness
- Take temperature
- Examine crown of head
- Check pulse
- Checked skin elasticity

Care: Did the provider

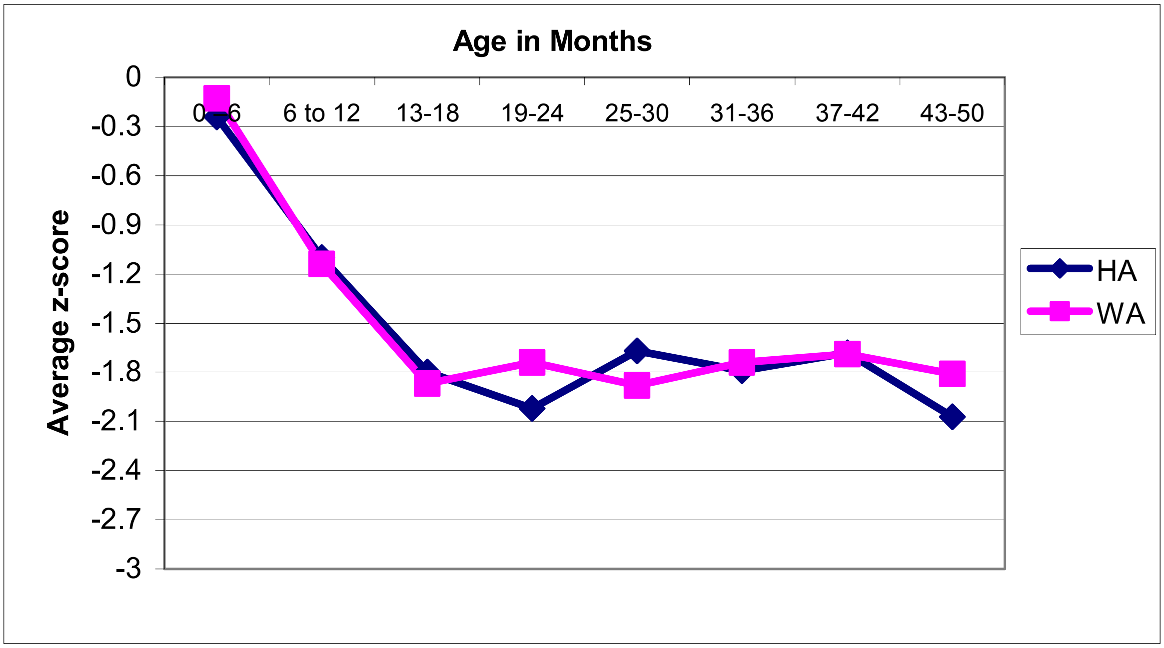
- Administer oral rehydration solution
- Instruct when to return if condition worsens

Figure 4. Odds Ratios from Random Effects Logistic Regression Models Explaining the availability of height-for-age and weight-for-age information*

Explanatory variables	Height for age	Weight for age
Ln (real mo. hshd expend per capita –rupiah)	1.15 (1.47)	1.25 (2.08)**
Number of years maternal education	1.05 (2.31)**	1.03 (1.50)
Mother non-Indonesian speaking (=1)	1.12 (0.76)	1.10 (0.57)
Rural (=1)	1.32 (1.49)	1.34 (1.41)
Maternal age (yrs) </= 20 yr (=1)	.93 (0.40)	.54 (3.05)***
Maternal age >35 yrs (=1)	.95 (0.27)	1.08 (0.35)
Parity 0 (=1)	.84 (1.10)	1.00 (0.00)
Parity 5+ (=1)	.90 (0.56)	.69 (1.87)*
Female sex (=1)	.90 (-0.92)	.91 (0.75)
# Observations	2179	2179
Log likelihood	-1157.64	-944.89

* Significance at *** 1%, ** 5%, and *10% levels. Odds ratios reported with z-values in parentheses. STATA random effects logistic regressions grouped on community identification codes.

Figure 5. Standardized measurements of stunting (height for age z-scores) and being underweight (weight for age z-scores) by age, gender, and location*



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* Tabulations and means done in STATA's survey (svy) program to account for strata, primary sampling unit, and respondent weights. Standard error in parentheses. The reference population standard employs data from the US National Center for Health Statistics.

Figure 6. Descriptive statistics for health facilities[*]

	Prenatal care providers		Child care providers	
	Mean	SD	Mean	SD
Quality indicators				
Process quality index	.53	.16	.65	.20
Structure-perceptions index	.65	.15	.62	.18
Internal water source (=1)	.71		.69	
MD available (=1)	.45		.49	
Socioeconomics: community averages				
Ln household expenditure	11.0	.56	11.0	.55
Maternal age	28.0	3.1	27.9	3.1
Rural community (=1)	.38		.40	
Type of staff				
Public health center	27.0		23.4	
Public auxiliary health center	19.5		18.9	
Privately practiving nurse	5.8		18.6	
Privately practicing midwife	30.4		14.1	
Privately practicing physician	14.3		21.9	
Private clinic	3.0		3.1	
# Observations	1745		2012	

[*] STATA survey regression identifies province strata, primary sampling unit, and facility weights.

Figure 7: Descriptive statistics[*]

Outcomes		Mean	SE
Average z-score for age and gender	Height for age (n=1608)	-1.55	.06
	Weight for age (n=1785)	-1.51	.05
% Below cut-off reference median for gender and age			
	Stunting: < -2 standard deviations height for age	.40	--
	Being underweight: < -2 standard deviations weight for age	.38	--
Socio-economic variables			
Ln (real mo. hshd expend per capita –rupiah)		10.69	.03
Number of years maternal education		5.44	.19
Any type of insurance coverage (=1)		.12	
Mother non-Indonesian speaking (=1)		.41	
Rural (=1)		.69	
Food prices in the district (rupiah):	Fish, kg	3178.31	88.59
	Wheat, kg	834.10	6.37
	Oil, kg	1281.45	13.11
	Canned milk	1623.55	9.37
Maternal, paternal and infant			
Maternal height (cm)		149.86	.20
Paternal height (cm)		161.15	.20
Maternal age	<21 years (=1)	.13	
	21-34 years (=1)	.73	
	>34 years (=1)	.14	
Parity	0 (=1)	.23	
	1-4 (=1)	.61	
	5 or more (=1)	.16	
Female infant (=1)		.48	
Small in relative size at birth (=1)		.15	
Community averages			
Prenatal care process quality index		.52	.01
Structure-perceptions index		.62	.01
Child care quality process index		.65	.01
Combined prenatal and child care process index		.57	.00
Internal water source		.66	.02
Medical doctor available		.42	.01
Real price per prenatal care visit (rupiah)		2514.63	70.92
Travel time to public health center (minutes)		21.68	1.21

[*] Tabulations and means done in STATA's survey (svy) program to account for strata, primary sampling unit, and respondent weights where applicable. Height for age values available for 1608 observations; weight for age values available for 1785 observations; mean values and their standard errors reported for height for age observations.

Figure 8. Coefficients Explaining Facility Process Quality*

Explanatory variables	Prenatal care process quality index	Child care process quality index
Structural quality at the facility		
Structure-perceptions index	.12 (4.00)****	.09 (3.10)***
Internal water source (=1)	.03 (2.88)***	.00 (0.08)
MD available (=1)	.04 (2.81)***	.09 (4.54)****
Type of staff (=1)		
Public health center	.01 (0.50)	.01 (0.34)
Public auxiliary health center	-.02 (0.68)	-.01 (0.37)
Privately practiving nurse	-.06 (1.66)*	-.05 (1.62)
Privately practicing midwife	-.01 (0.28)	-.01 (0.37)
Privately practicing physician	-.01 (0.30)	.06 (2.16)**
Private clinic	(omitted)	(omitted)
Socioeconomics: community averages		
Ln household expenditure	.00 (0.29)	-.00 (0.42)
Maternal age	.00 (0.54)	.00 (1.43)
Rural community (=1)	.01 (0.81)	.02 (1.86)*
Constant	.37 (3.15)***	.48 (3.48)****
F-test: Province fixed effects	>.001	>.001
# Observations	1745	2012
R-squared	.13	.20

* Coefficients reported with t-values in parentheses. Level of significance * p<.10; ** p<.05; ***p<.01; ****p<.001 for two-tailed tests. STATA survey regression identifies province strata and primary sampling unit; facility weights applied.

Figure 9. Cross tabulation of average quality of care available in communities by household expenditure quintiles*

Average quality of care available in community health facilities	Range	Average quality available by household expenditure quintile from lowest (1) to highest (5)				
		1	**2**	**3**	**4**	**5**
Internal water*	0-1	.63 (.58-.69)	.65 (.60-.69)	.65 (.59-.70)	.70 (.66-.74)	.69 (.64-.74)
Medical doctor*	0-1	.37 (.33-.41)	.39 (.36-.42)	.40 (.38-.43)	.43 (.40-.46)	.44 (.40-.47)
Structure-perceptions index*	.37 - .85	.62 (.61-.64)	.63 (.61-.64)	.62 (.60-.64)	.63 (.62-.65)	.64 (.63-.65)
Prenatal process index	.29 - .85	.52 (.50-.55)	.53 (.51-.54)	.52 (.51-.54)	.53 (.52-.55)	.54 (.52-.56)
Child care process index	.39 - .92	.65 (.63-.68)	.65 (.63-.67)	.64 (.62-.66)	.65 (.64-.67)	.66 (.64-.69)
Combined prenatal and child care process index	.38 - .80	.57 (.55-.59)	.57 (.56-.59)	.57 (.55-.58)	.58 (.57-.59)	.59 (.57-.60)
Travel time to public health center (minutes)*	1- 240	26.9 (23.4 - 30.4)	23.5 (19.8 - 27.2)	21.5 (18.0 - 25.0)	15.9 (13.5 - 18.3)	15.2 (13.1 - 17.2)
Price for a PNC visit (rupiah)*	600 – 7162	2332 (2170-2494)	2490 (2294-2687)	2665 (2395-2894)	2629 (2425-2834)	2533 (2337-2729)

* STATA survey estimations identify province strata, control for clustering at community, and apply the household weights. 1509 households with weight and age information available for one or more children in the pregnancy register born from 1990 to 1993. Significant differences noted betweem quintile 1 and 5 subpopulation means (*p<.10); 95% confidence intervals in parentheses.

Figure 10. Coefficients from Random-Effects Generalized Least Squares Models Explaining Child Height in centimeters*

Explanatory variables	1	2	3	4	5	6	7
Community							
Child care process index	--	--	1.857 (1.23)	1.510 (0.95)	--	2.036 (1.42)	1.568 (1.03)
Prenatal care process index	--	3.201 (2.02)**	--	2.702 (1.63)*	3.278 (2.13)**	--	2.700 (1.66)*
Structure-perceptions index	1.561 (0.92)	1.135 (0.67)	1.397 (0.83)	0.930 (0.55)	--	--	--
Internal water source	-0.354 (0.56)	-0.450 (0.72)	-0.422 (0.69)	-0.430 (0.69)	--	--	--
MD available	0.270 (0.32)	0.090 (0.11)	0.016 (0.02)	-0.077 (0.09)	--	--	--
Ln travel time to health center	-0.082 (0.50)	-0.092 (0.57)	-0.097 (0.60)	-0.098 (0.61)	-0.078 (0.48)	-0.080 (0.49)	-0.087 (0.54)
Ln real price per PNC visit	-0.224 (0.61)	-0.267 (0.74)	-0.358 (1.00)	-0.269 (0.75)	-0.325 (0.93)	-0.414 (1.20)	-0.316 (0.91)
Socio-Economics							
Ln real hshd mo. expend per capita	0.348 (1.74)*	0.329 (1.65)*	0.390 (1.94)**	0.338 (1.69)*	0.336 (1.69)*	0.400 (2.00)**	0.344 (1.73)*
Maternal education (yrs squared)	0.014 (1.86)*	0.014 (1.85)*	0.013 (1.69)*	0.014 (1.82)*	0.014 (1.82)*	0.013 (1.67)*	0.013 (1.80)*
Maternal education (yrs)	-0.120 (1.17)	-0.115 (1.13)	-0.118 (1.14)	-0.112 (1.10)	-0.113 (1.11)	-0.117 (1.13)	-0.111 (1.09)
Any insurance coverage	0.462 (1.20)	0.481 (1.25)	0.557 (1.45)	0.483 1.26)	0.483 (1.26)	0.560 (1.46)	0.490 (1.28)
Mother non-Indonesian speaking	-0.218 (0.70)	-0.228 (0.73)	-0.229 (0.73)	-0.223 (0.71)	-0.215 (0.69)	-0.216 (0.70)	-0.209 (0.67)
Rural	-0.850 (2.57)***	-0.821 (2.51)***	-0.844 (2.61)***	-0.826 (2.54)***	-0.785 (2.56)***	-0.812 (2.68)***	-0.776 (2.54)***

* Significance at *** 1%, ** 5%, and *10% levels. STATA random effects generalized least squares model grouped on community identification codes. In addition to the variables reported in the table, all regressions include a series of dummy variables for each of 13 provinces, a series of dummy variables for sex interacted with each 3-month age group to control for non-parametric distributions of z-scores, and for dummy variables identifying missing values for weeks gestation, maternal height, and paternal height; missing values set to mean. Standard errors in parentheses.

Figure 10 Continued.

Explanatory variables	1	2	3	4	5	6	7
Maternal, paternal, infant							
Maternal height (cm)	0.118 (4.99)***	0.118 (5.01)***	0.125 (5.24)***	0.117 (4.97)***	0.118 (5.04)***	0.125 (5.25)***	0.117 (4.99)***
(Missing maternal height values=1)	1.727 (1.84)*	1.775 (1.89)*	1.888 (2.02)**	1.820 (1.94)**	1.781 (1.90)*	1.894 (2.03)**	1.818 (1.94)**
Paternal height (cm)	0.116 (5.02)***	0.116 (5.02)***	0.119 (5.10)***	0.116 (5.00)***	0.117 (5.10)***	0.120 (5.16)***	0.117 (5.06)***
Maternal age (yrs) </= 20 yr	-0.990 (2.29)**	-1.014 (2.35)**	-1.084 (2.49)***	-1.022 (2.37)**	-1.022 (2.37)**	-1.098 (2.53)***	-1.029 (2.39)**
Maternal age >35 yrs	-0.137 (0.35)	-0.174 (0.44)	-0.122 (0.31)	-0.187 (0.47)	-0.188 (0.48)	-0.139 (0.35)	-0.201 (0.51)
Parity 0	0.357 (1.03)	0.360 (1.03)	0.352 (1.00)	0.357 (1.02)	0.368 (1.06)	0.361 (1.03	0.360 (1.04)
Parity 5+	-0.272 (0.71)	-0.289 (0.75)	-0.352 (0.90)	-0.289 (0.75)	-0.282 (0.74)	-0.342 (0.88)	-0.284 (0.74)
Female sex	-1.446 (1.22)	-1.529 (1.29)	-1.227 (1.03)	-1.534 (1.30)	-1.584 (1.34)	-1.280 (1.08)	-1.587 (1.34)
Small in relative size at birth	--	--	-0.976 (2.82)***	--	--	-1.003 (2.90)***	--
F-tests							
Food prices	0.65	0.65	0.50	0.68	0.65	0.48	0.68
Province fixed effects	0.19	0.13	0.10	0.11	0.16	0.12	0.12
Age/sex fixed effects	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Constant	30.710 (2.22)**	28.239 (2.06)**	27.420 (1.94)**	25.634 (1.84)*	28.020 (2.07)**	27.467 (1.97)**	25.35 (1.85)*
# Observations	1608	1608	1563‡	1608	1608	1563	1608
Prob > chi2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
R-squared Within	.82	.82	.83	.83	.82	.83	.83
Between	.84	.84	.84	.84	.84	.84	.84
Overall	.82	.82	.82	.82	.82	.83	.82

‡ Missing relative size values included to estimate the influence of post-natal care account for fewer observations.

Figure 11. Odds Ratios from Random Effects Logistic Regression Models Explaining Stunting[*]
Dependent Variable 1 = <2 Standard Deviations below the Reference Median Height for Age

Explanatory variables	1	2	3	4	5	6	7
Community							
Child care process index	--	--	.14 (2.31)**	.15 (2.14)**	--	.15 (2.35)**	.16 (2.20)**
Prenatal care process index	--	.20 (1.87)*	--	.38 (1.06)	.19 (1.97)**	--	.39 (1.06)
Structure-perceptions index	.63 (0.50)	.76 (0.29)	1.07 (0.07)	1.01 (0.01)	--	--	--
Internal water source	1.02 (0.06)	1.07 (0.20)	.96 (0.11)	1.03 (0.08)	--	--	--
MD available	.76 (0.60)	.83 (0.40)	1.11 (0.22)	1.02 (0.04)	--	--	--
Ln travel time to health center	1.03 (0.29)	1.03 (0.31)	1.04 (0.40)	1.03 (0.38)	1.02 (0.27)	1.04 (0.42)	1.03 (0.38)
Ln real price per PNC visit	.95 (0.27)	.97 (0.14)	1.01 (0.06)	.98 (0.09)	.99 (0.07)	1.01 (0.03)	.98 (0.09)
Socio-Economics							
Ln real hshd mo. expend per capita	.79 (2.27)**	.80 (2.17)**	.77 (2.49)***	.79 (2.23)**	.80 (2.18)**	.77 (2.48)***	.79 (2.23)**
Maternal education (yrs squared)	1.00 (0.52)	1.00 (0.50)	1.00 (0.16)	1.00 (0.49)	1.00 (0.49)	1.00 (0.17)	1.00 (0.49)
Maternal education (no. years)	1.03 (0.49)	1.02 (0.44)	1.01 (0.27)	1.02 (0.41)	1.02 (0.43)	1.02 (0.28)	1.02 (0.41)
Any insurance coverage	.68 (1.89)*	1.12 (0.68)	.65 (2.03)**	.68 (1.90)*	.68 (1.90)*	.65 (2.04)**	.68 (1.91)*
Mother non-Indonesian speaking	1.11 (0.66)	1.66 (2.83)***	1.06 (0.38)	1.11 (0.66)	1.12 (0.68)	1.07 (0.38)	1.11 (0.65)
Rural	1.70 (2.92)***	.67 (1.92)*	1.80 (3.21)***	1.67 (2.88)***	1.68 (3.06)***	1.80 (3.39)***	1.66 (3.03)***

[*] Odds ratios reported with z-values in parentheses. Significance at *** 1%, ** 5%, and *10% levels. STATA random effects logistic regressions grouped on community identification codes. In addition to the variables reported in the table, all regressions include a series of dummy variables for each of 13 provinces, a series of dummy variables for sex interacted with each 3-month age group to control for non-parametric distributions of z-scores, and for dummy variables identifying missing values for weeks gestation, maternal height and paternal height ; missing values set to mean. The reference population standard employs data from the US National Center for Health Statistics.

Figure 11 Continued

Explanatory variables	1	2	3	4	5	6	7
Maternal, paternal, infant							
Maternal height (cm)	.94	.94	.94	.94	.94	.94	.94
	(4.68)***	(4.66)***	(4.73)***	(4.62)***	(4.68)***	(4.73)***	(4.62)***
(Missing maternal height values=1)	.68	.67	.63	.65	.67	.64	.65
	(0.81)	(0.82)	(0.93)	(0.90)	(0.84)	(0.93)	(0.89)
Paternal height (cm)	.95	.95	.95	.95	.95	.95	.95
	(3.99)***	(3.99)***	(4.31)***	(3.96)***	(4.04)***	(4.31)***	(3.98)***
Maternal age (yrs) </= 20 yr	1.93	1.95	2.08	1.95	1.95	2.08	1.95
	(3.05)***	(3.09)***	(3.32)***	(3.09)***	(3.10)***	(3.33)***	(3.09)***
Maternal age >35 yrs	.91	.93	.90	.94	.93	.90	.94
	(0.44)	(0.38)	(0.48)	(0.29)	(0.37)	(0.48)	(0.29)
Parity 0	.69	.69	.73	.69	.69	.73	.69
	(2.02)**	(2.04)**	(1.70)*	(2.03)**	(2.06)**	(1.69)*	(2.03)**
Parity 5+	1.37	1.38	1.35	1.37	1.38	1.35	1.37
	(1.62)	(1.66)*	(1.50)	(1.63)*	(1.65)*	(1.50)	(1.62)*
Female sex	2.22	2.31	2.02	2.29	2.33	2.01	2.29
	(0.80)	(0.84)	(0.70)	(0.84)	(0.85)	(0.70)	(0.84)
Small in relative size at birth	--	--	1.73	--	--	1.73	--
			(3.14)***			(3.14)***	
F-tests							
Food prices	0.69	0.73	0.72	0.81	0.73	0.71	0.81
Province fixed effects	0.31	0.20	0.21	0.12	0.15	0.14	0.09
Age/sex fixed effects	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
# Observations	1608	1608	1563[±]	1608	1608	1563	1608
Log Likelihood	-878.047	-876.292	-841.924	-873.999	-876.427	-841.953	-874.004
Prob > Wald Chi2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

[±] To assess child care quality, we include a variable measuring relative size at birth; missing relative size values account for fewer observations.

Figure 12. Odds Ratios from Random Effects Logistic Regression Models Explaining Being Underweight[*]
Dependent Variable 1 = <2 Standard Deviations below the Reference Median Weight for Age

Explanatory variables	1	2	3	4	5	6	7
Community							
Child care process index	--	--	.51 (0.98)	.71 (0.48)	--	.36 (1.47)	.53 (0.93)
Prenatal care process index	--	.15 (2.74)**	--	.16 (2.45)***	.11 (3.02)***	--	.14 (2.65)***
Structure-perceptions index	.21 (2.00)**	.27 (1.79)*	.30 (1.62)	.28 (1.71)*	--	--	--
Internal water source	.78 (0.88)	.83 (0.68)	.79 (0.86)	.83 (0.69)	--	--	--
MD available	.65 (1.14)	.71 (0.95)	.70 (0.93)	.73 (0.83)	--	--	--
Ln travel time to health center	1.03 (0.44)	1.04 (0.59)	1.04 (0.58)	1.05 (0.60)	1.02 (0.32)	1.03 (0.35)	1.03 (0.44)
Ln real price PNC visit	1.22 (1.16)	1.25 (1.39)	1.28 (1.53)	1.25 (1.41)	1.27 (1.44)	1.29 (1.52)	1.27 (1.51)
Socio-Economics							
Ln real hshd mo. expend per capita	.88 (1.44)	.89 (1.26)	.89 (1.29)	.89 (1.27)	.88 (1.32)	.88 (1.34)	.89 (1.31)
Maternal education (yrs squared)	.99 (1.49)	.99 (1.47)	1.00 (1.21)	.99 (1.46)	.99 (1.45)	1.00 (1.21)	1.00 (1.43)
Maternal education (no. of years)	1.05 (0.97)	1.04 (0.88)	1.04 (0.80)	1.04 (0.87)	1.04 (0.86)	1.04 (0.79)	1.04 (0.81)
Any insurance coverage	1.01 (0.06)	1.01 (0.08)	1.04 (0.19)	1.02 (0.09)	1.01 (0.06)	1.03 (0.16)	1.02 (0.11)
Mother non-Indonesian speaking	.97 (0.22)	.97 (0.20)	.97 (0.24)	.97 (0.21)	.99 (0.08)	.98 (0.12)	.99 (0.08)
Rural	1.03 (0.18)	1.01 (0.07)	1.10 (0.63)	1.01 (0.09)	1.09 (0.62)	1.20 (1.23)	1.09 (0.65)

[*] Odds ratios reported with z-values in paretheses. Significance at *** 1%, ** 5%, and *10% levels. STATA random effects logistic regressions grouped on community identification codes. In addition to the variables reported in the table, all regressions include a series of dummy variables for each of 13 provinces, a series of dummy variables for sex interacted with each 3-month age group to control for non-parametric distributions of z-scores, and for dummy variables identifying missing values for weeks gestation, maternal height, and paternal height ; missing values set to mean. The reference population standard employs data from the US National Center for Health Statistics.

Figure 12 Continued

Explanatory variables	1	2	3	4	5	6	7
Maternal, paternal, infant							
Maternal height (cm)	.96	.96	.96	.96	.96	.96	.96
	(3.81)***	(3.89)***	(3.98)***	(3.87)***	(3.91)***	(3.95)***	(3.92)***
(Missing maternal height values=1)	1.06	1.01	1.02	1.00	.96	.97	.94
	(0.14)	(0.988)	(0.04)	(0.01)	(0.10)	(0.08)	(0.16)
Paternal height (cm)	.96	.96	.96	.96	.96	.96	.96
	(3.87)***	(3.88)***	(3.99)***	(3.89)***	(3.93)***	(4.04)***	(3.95)***
Maternal age (yrs) </= 20 yr	1.54	1.56	1.63	1.56	1.56	1.63	1.58
	(2.22)**	(2.32)**	(2.51)***	(2.32)**	(2.28)**	(2.48)***	(2.38)**
Maternal age >35 yrs	.93	.94	.87	.94	.95	.88	.94
	(0.41)	(0.35)	(0.76)	(0.34)	(0.30)	(0.69)	(0.33)
Parity 0	.94	.94	.93	.94	.94	.93	.93
	(0.36)	(0.40)	(0.47)	(0.40)	(0.38)	(0.43)	(0.43)
Parity 5+	1.24	1.27	1.29	1.26	1.24	1.27	1.26
	(1.24)	(1.39)	(1.46)	(1.37)	(1.26)	(1.33)	(1.34)
Female sex	.55	.59	.52	.58	.59	.52	.59
	(0.67)	(0.59)	(0.72)	(0.60)	(0.59	(0.72)	(0.58)
Small in relative size at birth	--	--	1.65	--	--	1.71	--
			(3.30)***			(3.50)***	
F-tests							
Food prices	0.87	0.84	0.69	0.83	0.84	0.67	0.79
Province fixed effects	0.37	0.14	0.26	0.13	0.11	0.17	0.06
Age/sex fixed effects	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
# Observations	1785	1785	1737‡	1785	1785	1737	1785
Log Likelihood	-1017.687	-1014.395	-981.332	-1014.280	-1016.576	-983.293	-1016.491
Prob> Wald Chi2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

‡ Missing relative size values account for fewer observations.