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Effects of Malnutrition on Economic Productivity in China As Estimated by PROFILES[1]

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Objective To calculate the effects of malnutrition on economic productivity in China. **Methods** PROFILES was used to quantify the function consequences of malnutrition in term of protein energy malnutrition, iron deficiency and iodine deficiency. **Results** Productivity gained due to improved iodine nutrition. The reduction in the TGR in 1992 to 2001 increased the net present value of further economic productivity by ¥142 billion. Reduction of the TGR rate to 5% over next 10 years would result in future productivity gains with value of ¥40 billion. Productivity gain due to reductions in child stunting would result in future economic productivity gains with the value of ¥101 billion. Reducing stunting further over the next 10 years would gain ¥20 billion. Productivity gain due to reduction of iron deficiency anemia reduced by 30% over the next 10 years would gain worth ¥107 billion and if childhood anemia reduced by 30% over next 10 years would gain ¥348 billion. **Conclusion** These interventions have huge economic payoff. That is likely to exceed their costs many times over.

Key words: PROFILES; Malnutrition; Economic productivity; Iodine nutrition; Iron deficiency

INTRODUCTION

Malnutrition is a relatively abstract concept in the spectrum of public health problems. It is not well understood by non-nutritionists for a number of reasons. Firstly, it is not a highly visible problem. Although extreme forms may attract attention, these mask a problem of mild to moderate malnutrition that is neither visible nor appreciated. Secondly, the consequences of malnutrition are similarly unappreciated. These include developmental problems, cognitive impairment, and reduced immunity, leading to reduced human capacity, sickness and death. One result of this lacks of appreciation of the true magnitude of malnutrition and its consequences are that the public policy response is typically insufficient. Among the least visible and least appreciated effects of malnutrition is its impact on human capacity. This has implications for the ability to think, learn, and work, all of which affect economic productivity. In turn, there are consequences for household welfare and for community and national development.

Although many nutritional problems impair human development, the three most prevalent and damaging are protein energy malnutrition, iron deficiency and iodine deficiency, all of

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which continue to be problems in China. The purpose of the analysis reported here was to estimate the consequences of these problems in terms of economic productivity in the workplace. By quantifying these consequences in economic terms, and by drawing attention to the direct links between malnutrition and national development goals, there will be more appropriate levels of investment in nutrition interventions. PROFILES is both a process and a set of software tools designed to estimate the functional consequences of malnutrition in terms that are important to policy makers (morbidity, mortality, economic productivity, etc.) and to communicate these consequences to inform decision making. The software tools consist of spreadsheet workbooks with a series of user entry sheets that accept nutrition prevalence, demographic data, model coefficients, and economic information. Another series of sheets performs the calculations based upon relationships described in the nutrition literature, estimating functional consequences of malnutrition over a period from the present to some future years. Alternative scenarios can be described, representing different degrees of improvement in nutritional status, providing estimates of both the consequences of malnutrition if there is no improvement and the benefits of improving nutrition in line with specified targets. This paper describes the model assumptions, methods used for this purpose and the results for selected nutrition problems and consequences.

The period for the projections reported here is from 2001 through 2010. Additional analysis of the period from 1992 to 2001 provided estimates of the benefits of recent reductions in stunting on future productivity. Despite rapid improvements in overall health, nutrition and economic conditions in China, large disparities remain between urban and rural area and among provinces. The national government has identified 11 provinces and 1 municipality as disadvantaged and eligible for special development assistance programs, they are: Inner Mongolia, Guangxi, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang and one municipality, Chongqing, together comprising about 28% of the Chinese population. Additional separate estimates were made for this subset of provinces and municipality to illustrate the potential benefits of geographically targeted actions to improve nutrition there. This region is collectively referred to in this report as "the west" or "the western provinces" or "12 provinces" shortly.

The calculations rely on demographic projections based on current United Nations estimates of the population in 1995 by age and sex, and projected life expectancies and fertility rates[1]. The total population obtained for the year 2000 using these methods was 1.293 billion whereas the current State Statistical Bureau population estimate is 1.266 billion. All estimates were therefore proportionally adjusted by a factor of 1.266/1.293 or 0.979. Similar procedures were used to derive demographic estimates for the 1992 model, using 1990 as the base year for projections. With the benefit of hindsight, the 1992 model was modified to reflect the observed trends in population, infant and child mortality, wages, and employment rates to bring its "projections" into line with the 2001 model.

Demographic data for the West were derived in the same manner as for China as a whole but the base year (1995) population pyramid was taken from the 1995 Chinese 1% sample survey, which provides population estimates by age and sex for each province. The fertility estimates were assumed to be the same as for China as a whole and the life expectancy as for China as a whole 5 years earlier.

METHODS

The analysis reported here used PROFILES, a computer-based process designed to estimate the functional consequences of malnutrition in terms that are important to policy makers[2]. Spreadsheet model were used to project these consequences over time under different assumed sets of conditions or scenarios. A companion article described the use of these methods to estimate to consequences of PEM and vitamin A deficiency for child survival in China[3].

This analysis dealed with two kinds of productivity losses due to malnutrition:

1) Future losses as a result of permanent damage in early life and

2) Current losses due to the temporary effects of current malnutrition.

Future losses were estimated as a consequence of iodine deficiency during pregnancy and its effects on the unborn fetus, stunting during the first 3 years of life and anemia throughout childhood. Current losses were taken as a consequence of anemia among the present adult workforce.

Permanent damage in early life caused by malnutrition may result in a lifetime of reduced wages. To estimate the monetary value of this loss, the model discounted the future lost wages back to the year of the disabling event, and was adjusted for normal mortality. A "lifetime discounting factor" was defined for each type of disability that is a function of 1) the age of the disabling event, 2) the ages of entry to and exit from the labor force, 3) the annual discount rate, and 4) the probability of surviving to each future wage earning year. The lifetime discounting factor could be interpreted as the number of years of earning at the current wage that future productivity was presently worth, adjusting for survival and the discount rate, assuming (at this stage) full employment.

The age of the "disabling event" in these models was assumed to be birth in the case of iodine deficiency, 3 years in the case of stunting, and was spread over ages 0 to 14 in the case of iron deficiency. The ages of entry to and exit from the labor force were 15 and 65 respectively. An annual discount rate of 3% was used, following the example of the 1993 World Development Report[4]. The adjustment for survival used a standard survival function that reflects the current estimates for China of life expectancy at birth and the rates of infant and under 5 mortality.

The present net monetary value of the discounted lifetime of future lost wages in the year the disability occurred was obtained by multiplying the lifetime discounting factor by the average annual agricultural wage, the effective employment rate (defined as the total number of employed as a proportion of the total working age population), and the proportional loss in productivity due to the disability. No assumptions or adjustments were made at any stage about growth in real wages.

The future productivity benefits for the 1992 model were calculated in real 2001 terms so that they could be compared with other economic estimates, also calculated as net present value in 2001. For the 1992 model this required two modifications to the net present value calculations in the 2001 models:

1) Discounting future productivity back only to 2001 rather than 1992, and

2) Adjusting for inflation (182.6% over the period from 1992 to 2000, the last year for which the consumer price index was calculated).

In the case of iron deficiency anemia in adults, the effects were current so there was no need to discount future losses. Productivity losses were calculated by multiplying the average annual agricultural wage by the employment rate by the proportional loss in productivity due to the deficiency. Population-wide estimates were then obtained by multiplying by the working age population. Using sex-specific data on anemia, employment and population, separate estimates were made for men and women.

The benefits from the proposed intervention (or a reduction in malnutrition) were computed by the model as the difference in productivity losses between a "status quo" scenario, in which prevalence were projected to remain constant at base year levels over the course of the ten-year projection, and an "improved" scenario, in which prevalence were assumed to decline linearly over the ten years according to specified targets. These targets reflected consensus among the China PROFILES working group on what was feasible rather than official government goals.

RESULTS

Productivity Gains Due to Improved Iodine Nutrition

Iodine deficiency during pregnancy is known to hinder the development of the fetus and to result in the birth of cretins and infants with severe mental impairment. From analysis of information from seven Asian countries, the rate of cretinism and severe mental retardation at birth appeared to be 3.4% and 10.3%, respectively, of the total goiter rate (TGR)[5]. The reduction in productivity associated with these disabilities was assumed to be 100% for cretins and 25% for the mentally retarded[6]. For the purposes of the calculations here, we conservatively assume that another 86.3% of the TGR were mildly impaired and that these infants would experience an average reduction in their future productivity of 5.4%[7]. In iodine-deficient environments there was a community-wide average reduction of 13.5 IQ points[8], equal to almost a full standard deviation in the distribution of normal IQ. Considering that we applied our estimate only to children born to mothers with palpable goiters, the 5% reduction was likely a conservative estimate of the total impact of iodine deficiency on the productivity children in affected communities. In sum, the proportion of infants affected was assumed to be equal to the TGR and the average reduction in future productivity that they would experience, given all the above assumptions, was 10.7%.

As there was no national data of TGR for 1992, we made a conservative estimate of TGR in 1992 as 20.3%.

Other assumptions and results of the calculation of the monetary value of discounted lost future wages due to iodine deficiency in China are presented in Table 1.

TABLE 1

Monetary Value of Discounted Lost Future Wages Due to Iodine Deficiency in China: Assumptions and Results. 1992 Results Were Expressed in Real 2001 Terms

Variable	1992	2001	West
Live Births in Base Year (Millions)	21.008	18.789	5.559
TGR* in Base Year (%)	20.3	8.3	15.1
Ten-year Target TGR (%)	8.3	5.0	5.0
Annual Wage (All Sectors)	4951	9371	8196
Effective Employment Rate (%)	83.8	80.1	75
Lifetime Discounting Factor (at Birth)	18.9	15.8	13.2
Productivity Losses Due to IDD** Over 10 Years if No Improvement (Billion ¥)	448.6	198.8	70.9
Productivity Gains From Reducing IDD Over 10 Years (Billion ¥)	141.6	40.1	23.7

Note. *TGR: Total goiter rate. **IDD: Iodine deficiency disorders

The reduction in the TGR from 20.3% in 1992 to the current level of 8.3% increased the net present value of future economic productivity by ¥142 billion.

If the total goiter rate remained at the current level (8.3%) the cognitive damage to the fetus caused by iodine deficiency during pregnancy would result in future productivity losses over the next ten years with a net present value of ¥199 billion.

Reduction of the total goiter rate to 5% over the next ten years would result in future productivity gains with a net present value of ¥40 billion.

Of these gains, ¥24 billion would be in the western provinces alone, assuming that the TGR there was also reduced to 5% (from the current 15.1%).

Productivity Gains Due to Reductions in Child Stunting

The relationship between childhood stunting (low height-for-age) and future labor productivity was based on two scientific results. First, studies showed that stunting generally developed over the first two years of life and remained throughout his (her) life. Although it might be possible to partially reverse stunting with proper feeding and care, this rarely happened. For example, a long-term longitudinal study of Guatemalan children found that children who were stunted at 22 months of age remained stunted into adulthood[9]. Pinstrup-Andersen *et al.*[10] showed that the approximate height deficits of mild, moderate, and severe stunting in two year olds were 5 cm, 7 cm, and 10 cm, which translated into percentage adult height deficits of 3.125%, 4.375% and 6.25% respectively.

The second scientific result addressed the productivity of adults as a function of their size. It is important to note that it was not shortness *per se* that was considered to influence productivity but stunting. Reduced stature due to stunting is a proxy indicator of a host of nutritional and other insults that cumulatively affect physical and mental development in ways that, although quantified, are still poorly understood. Reviews by Behrman[11] and Pinstrup-Andersen *et al.*[10] concluded that several methodologically sound studies have found a significant relationship between physical size and labor productivity in adults. One of these studies[12] in the Philippines concluded that for every 1% increment in height, the productivity of agricultural workers increased by 1.38%. The relationship between stunting and future productivity modeled here applied only to manual labor so the effective employment rate was taken as the number employed only in "blue collar" sectors (farming, forestry, animal husbandry, fishing, mining, manufacturing and construction) as a proportion of the total population. Stunting was also associated with cognitive deficits and reduced school performance[13] and was therefore likely to affect productivity in other sectors but these effects were difficult to quantify. Limiting the effects only to manual labor sectors therefore would underestimate the full impact of stunting on future productivity.

The calculation of the lifetime discounting factor for stunting assumed that stunting became permanent at three years of age. This was the age at which stunting rates in China appeared to plateau and remained stable. Therefore the prevalence we used in the models was the prevalence of stunting among children 36-47 months old. In reporting our findings, we referred to the more commonly reported and recognized prevalence of stunting among children under five, although the specific value used in the model was the slightly greater prevalence among children in the 1-year age group from 36-47 months.

Other assumptions and results related to the effects of stunting on economic productivity are presented in Table 2.

The reduction in the prevalence of child stunting (from 32.7% to 14.4%) since 1992 resulted in future economic productivity gains with a net present (2001) value of ¥101 billion.

If current stunting levels remained unchanged over the next ten years, the net present value of future productivity lost would be ¥159 billion.

Reducing stunting further over the next 10 years (from 14.4% to 11%), would gain ¥20 billion.

A 40% reduction of stunting in the West during the same period (from 22.7 %) would result in future productivity gains with a net present value of ¥10 billion.

TABLE 2

Data and Results Related to the Effects of Stunting on Economic Productivity

Variable	1992	2001	West
Population Aged 36-47 Months (Millions)	20.580	19.110	5.572
Prevalence of HAZ <–2 to –3 SDs (36-47 Months)	17.4	10.7	15.6
Prevalence of HAZ <–3 SDs (36-47 Months)	17.1	5.6	10.0
Target Prevalence in Ten Years:			
HAZ <–2 to –3 SDs (36-47 Months)	10.7	8.0	9.4
HAZ <–3 SDs (36-47 Months)	5.6	4.2	6.0
Annual Wage (Manual Sectors) (¥)	3795	8353	6114
Effective Employment Rate in Manual Sectors (%)	60.7	51.3	56.7
Lifetime Discounting Factor (at Age 3)	21.83	17.96	14.78
Productivity Losses Due to Stunting Over 10 Years if No Improvement (Billion ¥)	338.3	159.4	50.1
Productivity Gains From Reducing Stunting Over 10 Years (Billion ¥)	101.4	19.7	9.9

Productivity Gains Due to Reduction of Iron Deficiency Anemia

Iron is a component of hemoglobin, the oxygen-carrying protein of the blood. Low hemoglobin is therefore an indicator of both poor iron status and low oxygen carrying capacity. Iron is important for brain development and neurotransmission in rat models and is also a risk factor for poor cognitive development in children. Although the mechanisms are not fully understood, iron deficiency anemia therefore affects survival, health, and performance in ways that can now be quantified. Here we looked only at the effect of anemia on current labor productivity of adults and on the future productivity of children via its effects on cognitive development.

The estimates presented here should be considered conservative for several reasons. Firstly, there is convincing evidence that the effects of iron deficiency on productivity are not limited to anemic individuals. The rapid and substantial increase in physical capacity following short term supplementation without an increase in hemoglobin[14] and the improvements in physical capacity following replenishment of iron stores in non-anemic individuals[15] suggest that the productivity benefits due to an improvement in iron status would extend beyond the anemic populations. Secondly, benefits seen in less physically demanding light work[16,17] suggest that the benefits may extend beyond manual labor. Finally, economic productivity as captured by wages and employment rates tends to underestimate the true economic value of production because although these statistics were intended to also represent domestic, subsistence and informal economic activities, much of this production was not represented in current labor statistics.

a) Current Productivity of Adults

The model assumed a direct relationship between the level of anemia and adult manual labor productivity. Levin *et al.*[6] reported that workers with iron deficiency anemia were less productive in physical tasks than non-anemic workers, producing 1.5% less output for every 1.0% their hemoglobin was below standard. This conclusion was based primarily on a study in Indonesia by Basta *et al.*[18] but was supported by an extensive literature[6]. Ross and Horton[19] estimated that iron therapy in anemic adults resulted in a 5% increase in "blue collar" labor productivity and an additional 12% increase in heavy manual labor productivity.

The calculation of lost productivity due to iron deficiency anemia in adults used these estimates, together with the information in Table 3 and the demographic data to calculate the productivity losses, also shown in Table 3. The anemia rates for women at the national level were from a 1998 survey and were adjusted for altitude[20]. For men, the only data available were from the 1992 National Nutrition Survey[21]. No estimates of the consequences of iron deficiency in the 1992 model were reported because there was no evidence that anemia had been reduced in the last ten years.

If adult anemia remained at current levels (women: 35.6%; men: 13.7%) the value of lost productivity over the next ten years would be total ¥702 billion.

The majority (69%) of these losses would be among women.

Reducing anemia by 30% over the next ten years would result in productivity gains worth ¥107 billion, including ¥30 billion in the western provinces.

TABLE 3

Data and Results Related to the Effects of Iron Deficiency Anemia on the Economic Productivity of Adults

Variable	China		West	
	Women	Men	Women	Men
Input Data				
Working Age Population in 2001 (Millions)	442.0	431.6	119.1	125.2
Anemia Prevalence in 2001 (%)	35.6	13.7	48.2	13.7
Target Prevalence in 2010 (%)	24.9	9.6	33.7	9.6
Annual Wage (Manual Sectors) (¥)	8353		6114	
Effective Employment Rate (%)	46.5	56.0	52.2	59.1
Results				
Productivity Lost Due to Anemia Over 10 Years (Billion ¥)	484	218	144	49
Gains From Reducing Anemia 30% by 2010 (Billion ¥)	74	33	22	7.6
Total Productivity Losses in 2001 (¥/capita)	51.6		50.7	
GDP (¥/capita)	7078		4687	
Lost Productivity as % GNP	0.73		1.08	

b) Future Productivity of Children

Observational studies of the relationship between iron deficiency anemia and mental test performance were remarkably consistent in finding that infants with moderate iron deficiency anemia had test scores that were 0.5 to 1.5 standard deviations lower than those of infants with sufficient iron stores[22,23]. Similarly, children with two years of age and older score about half a standard deviation lower on intelligence tests than did non-deficient controls[23]. Iron therapy corrected the IQ deficits, demonstrating that they were due to iron deficiency[24-26]. In one study that provided a quantitative estimate of the size of this effect, Seshadri and Gopaldas[25] suggested a reversible IQ deficit in anemic 5-6 year-old Indian boys of 8 points or half a standard deviation. This effect was similar in size to the difference in IQ between anemic and non-anemic children in observational studies.

The implications for educational performance and future productivity of such a deficit have been reviewed recently by Ross and Horton[19] who estimated that anemic children would suffer a 2.5% future productivity loss. Unlike the effect of anemia in adults, this loss was not restricted to manual labor but applied to any economic activity. It was assumed, further, that the effect of iron status on cognition was permanent and cumulative. More specifically, each year in which the child was anemic before age 15 "locks in" one-fifteenth of the value of the cognitive loss. The implication was that the lifetime discounting factor for all children under 15 in any given year could be calculated as the average lifetime discounting factor for all 1-year cohorts from 0 to 14.

Further assumptions and results of the application of this model in China are presented in Table 4.

TABLE 4

Data and Results Related to the Effects of Iron Deficiency Anemia on the Future Productivity of Children

Variable	China	West
Input Data		
Population 0-14 years (Millions)	305.392	89.391
Prevalence of Child Anemia in 2001	21.7	28.8
Target Prevalence in 2010	15.2	20.2
Effective Employment Rate (All Sectors)	80.1	75.0
Wage (All Sectors)	9371	8196
Mean Lifetime Discounting Factor (Age 1-15)	20.9	18.0
Results		
Net Present Value of Future Productivity Lost Over 10 Years Due to Childhood Anemia if No Improvement (Billion ¥)	2378.7	662.0
10-year Productivity Gains From Reducing Anemia (Billion ¥)	348.3	96.9
Total Productivity Losses in 2001 (¥/capita)	204	199
GNP (¥/capita)	7078	4687
Lost Productivity as % GNP	2.9	4.2

If the rate of anemia among children remained at its current level (21.7%) the value of lost productivity over the next ten years would be ¥2.4 trillion.

If childhood anemia was reduced by 30% over the next ten years (to 15.2%) the net present value of future productivity gained would be ¥348 billion.

As a proportion of GNP, losses in the West would be 45% greater than in China as a whole.

Summary of Productivity Consequences

The effects of malnutrition on economic productivity in 2001 alone are summarized in Table 5. The most striking results from this comparison were that the greatest productivity losses by far were due to anemia and that, of these, the greatest proportion was future productivity losses among currently anemic children. Anemia accounted for 90% of the total net present value of productivity losses and of these, 80% were due to childhood anemia. This suggests that although stunting and iodine deficiency are urgent problems that need to be addressed, in terms of the impact of malnutrition on economic productivity, there is a greater need to correct iron deficiency anemia, especially among children.

By considering only the effects of malnutrition on labor productivity here we seriously underestimated the full impact of malnutrition on the economy (see following section). Still, the net present value of losses in 2001 amounted to 4.0% of China's GDP and 6.1% of GDP in the western provinces.

TABLE 5

Summary of Productivity Losses Due to Malnutrition in 2001

Nutritional Problem	Net Present Value of Losses (2001)			
	China		West	
	¥ Billion	% of GDP*	¥Bbillion	% of GDP**
Stunting	16.6	0.22	5.2	0.43
Iodine Deficiency	19.8	0.18	7.3	0.31
Anemia (adults)	65.8	0.73	18.2	1.08
Anemia (children)	259.9	2.88	71.4	4.25
Total	362.1	4.01	102.1	6.07

Note. *China's 2001 GDP=¥9035 billion or ¥7078/capita. **West 2001 GDP=¥1682 billion or ¥4687/capita.

DISCUSSION

The costs of achieving the benefits of improved nutrition in each scenario are not known and we refrained at this stage from hazarding estimates that would permit the calculation of benefit-cost ratios. However, we know from the international literature that nutrition interventions can be remarkably cost-effective[4,27]. Based on the cost of iron fortification of wheat flour in Venezuela ($0.12 per person)[28], and information on the effectiveness of this strategy in reducing anemia[29], Ross and Horton[19] estimated that for 10 selected countries the median current productivity benefits among adults exceeded the cost of fortification by a factor of 6.3. When the discounted future productivity benefits attributable to cognitive improvements in children were included, the median benefit-cost ratio would rise to 35.7:1.

If local cost studies are used to develop benefit-cost ratios, it is important to point out that the estimates here do not adequately represent all the benefits of the proposed interventions. By restricting these analyses only to the increased labor productivity that results from anticipated improvements in nutritional status, we failed to account for the increased value of domestic production and the reduced costs to government in education costs and health care. In addition, there might be less tangible but perhaps equally important economic benefits that might be expected from a healthier, more capable and reliable workforce, such as lower absenteeism, increased innovation in individual tasks, or increased capacity for structural and technological change in the economy. Nor did we account for the human costs of mortality, illness and reduced physical and intellectual capacity, all of which would substantially reduce the quality of life in the absence of the proposed interventions. However, the purpose of these analyses was not to quantify all the potential benefits of improving nutrition, but to demonstrate that, using a common methodology and conservative assumptions, these interventions have huge economic payoffs that are likely to exceed their costs many times over.

Reduction in the prevalence of child stunting from 32.7% to 14.4% since 1992 has resulted in future economic productivity gains with a net present value (in 2001) estimated at ¥101 billion. However, not all nutritional deficiencies with implications for economic productivity have been reduced so markedly. In particular, anemia remains a sizable problem. The estimates presented here suggest that anemia among currently employed adults will reduce GDP by about 0.73%. Future productivity losses due to the cognitive impairment of children caused by anemia are even greater. It is estimated that the net present value of lost future productivity due to the cognitive effects of childhood anemia in 2001 was equal to 2.9% of GDP. Although only the economic productivity consequences of anemia have been estimated, these cognitive effects also have important implications for all aspects of human capacity and performance, including educational achievement.

The prevalence of nutritional deficiencies leading to economic productivity losses was greater in the west but because wages and employment rates were lower there, actual losses due to malnutrition comprised a smaller percentage (28%) of the national total. However, as a percentage of GDP these losses were 52% greater than in China as a whole (6.1% vs 4.0%).

The estimates presented here took no account of the impact of current malnutrition on long-term chronic disease. If this impact is as great as some experts predict, the additional economic cost will be huge. Apart from the consequences in terms of health, performance and survival, the costs of medical care and treatment for these conditions and the productivity losses due to illness and death will be enormous. These long-term economic consequences serve to underscore the urgency of the need to reduce the prevalence of early malnutrition, particularly stunting.

It is the large proportion of the population affected by mild malnutrition, rather than the severity of these conditions that makes these problems so significant. As mild malnutrition is difficult to detect, an obvious and important policy implication is that preventive measures are indicated. The proposed preventive solutions include: public heath education to improve infant feeding behaviors in the whole population, fortification of soy sauce or staple foods with iron, iron supplementation during pregnancy, and improved maternal nutrition both before and after conception.

The available evidence suggests that these strategies will not only pay for themselves but will be essential for the realization of China's development aspirations.

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