

The Cost of Hunger

Social and Economic Impact of Child Undernutrition
in the Plurinational State of Bolivia, Ecuador,
Paraguay and Peru



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**The cost of hunger: Social and
economic impact of child
undernutrition in the Plurinational
State of Bolivia, Ecuador,
Paraguay and Peru**

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This document has been developed within the framework of the agreement between ECLAC and the World Food Programme: "Analysis of the social and economic impact of hunger in Latin America" (WFP/03/080), coordinated by Rodrigo Martínez, of ECLAC Division for Social Development, and by Judith Thimke, Carlos Acosta Bermúdez and Francisco Espejo of the Regional Office for Latin America and the Caribbean of the World Food Programme (WFP).

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Foreword

The economic costs of child undernutrition are extremely high. Child undernutrition is one of the principal problems confronting any society. Given that it is entirely preventable today, not only does it cause unacceptable human suffering, but it also imposes inadmissible costs.

This study on the economic costs of child undernutrition follows on the heels of the study carried out by the authors in Central America in 2007, and confirms that the Andean subregion is also paying very high costs for a situation that is completely preventable: the millions¹ of growing boys and girls who do not have the necessary nutrients to develop and achieve their rich genetic potential. Indeed, nearly nine million girls and boys under the age of five suffer from stunting in the region (regional average: 15.4%, taking into account the growth standards of the National Centre for Health Statistics (NCHS),² or 20.1%³ considering the new World Health Organization (WHO) standards).

Child undernutrition is a recognized cause of mortality and morbidity. What is less widely recognized is the fact that it also leaves permanent mental and physical sequelae that have serious consequences, both human and economic.

Children with undernutrition are more vulnerable to infections, which in turn increase undernutrition and lead to greater risks of premature death. In addition, undernutrition interferes with proper physical and brain development. Inadequate brain development manifests itself not only in reduced cognitive and learning abilities but also in the limited capacity of many other brain functions that are necessary to lead a healthy and productive life.

The first two to three years of life are critical for building individuals' future capacities. Low birth weight and child undernutrition rob boys and girls of the potential they are born with. This creates an unacceptable ethical situation, especially when we realize that it has a much greater impact on families who have little or nothing. In fact, child undernutrition deprives persons of the abilities they need the most to break the cycle of extreme poverty which, along with a low educational level, indigenous origins and rural living conditions, characterizes the most vulnerable families in this part of the world.

¹ Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, Mathers C, Rivera J; Maternal and Child Undernutrition Study Group. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet*. 2008, Jan 19; 371(9608):243-60.

² National Center for Health Statistics Growth Curves.

³ WHO, 2008. Desnutrición en infantes y niños pequeños en América Latina y el Caribe: alcanzando los ODMs.

Knowing the economic costs of undernutrition is essential for achieving an adequate understanding of the problem, of the burden it imposes on society and of the priority it should be given. Child undernutrition involves costs that can be measured in terms of not only illnesses and lives but also money, and it has just as great an impact on those who suffer from this scourge as on the productive capacity of society as a whole.

The Economic Commission for Latin America and the Caribbean (ECLAC), in conjunction with the World Food Programme (WFP) and recognized experts in the region, developed a methodology that draws on secondary data to estimate the opportunity cost of undernutrition. The methodology has been applied successfully in Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua and Panama, where it was estimated that undernutrition cost US\$ 6.658 billion in 2004.

This study covers four South American countries: Ecuador, Paraguay, Peru and the Plurinational State of Bolivia. The results indicate that the cost of undernutrition in these countries reached US\$ 4.331 billion in 2005, equivalent to 3.3% of the countries' combined GDP.

The findings make it abundantly clear that child undernutrition is more than just a health problem or an unacceptable ethical situation; considering the enormous social costs and the loss of opportunities for the national economy, it is a national problem.

It is more urgent today than ever that the region treats child nutrition as a priority, because the global crises that have occurred are exerting strong pressure on public, community and family social protection systems. Governments have fewer resources for social programmes, and families are seeing a decline in the income they can earn directly as well as that derived from foreign remittances.

The pressures are myriad and the constraints grow ever tighter, which is why now is the time to stand firm in maintaining the essential priorities. Child undernutrition is one of them. This study shows that failing to invest in solutions today will bring a heavy price tomorrow.

We hope that the findings of this research will provide society and governments with the arguments necessary to justify implementing all the interventions that will lead to the speedy eradication of child undernutrition in the Andean subregion, honouring the commitment to "continue considering food and nutrition security to be a 'national, regional and universal emergency'",⁴ as expressed by 33 government representatives at the Conference on the Eradication of Child Undernutrition in Latin America and the Caribbean held in Santiago, Chile in May 2008.

Pedro Medrano
Regional Director
Latin America and the Caribbean
World Food Programme

Alicia Bárcena
Executive Secretary
Economic Commission
for Latin America and the Caribbean

⁴ Regional Conference on the Eradication of Child Undernutrition in Latin America and the Caribbean, Santiago, Chile, 5 and 6 May, 2008. Santiago Declaration, page 3.

Executive summary

There is a consensus in the region today on the urgent need to eradicate the scourge of hunger and undernutrition. As the Secretary General of the United Nations stated when the study of the cost of hunger in Central America and the Dominican Republic (Panama, 2007) was published, “hunger among boys and girls is a moral issue. But as this study demonstrates, it is also a critical economic concern”.

In view of the social and economic importance of the problem of hunger and child undernutrition in the region, in 2005 the World Food Programme (WFP) and the Economic Commission for Latin America and the Caribbean (ECLAC) agreed to carry out a joint project for the “Analysis of the economic and social impact of hunger in Latin America”. In 2007 the results for Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama and the Dominican Republic were presented. This document presents the estimates for four South American countries: the Plurinational State of Bolivia, Ecuador, Paraguay and Peru, based on data from 2005.

The results show that the economic impact in these countries amounts to between 2.0% and 5.9% of GDP. Up to 95% of the costs are attributed to losses in productivity due to higher mortality rate and lower education levels. Once again, then, it has been shown that not only is the eradication of undernutrition an ethical imperative, but it would also yield benefits. Therefore, any programmes that succeed in reducing the prevalence of undernutrition would have a major impact on the quality of life enjoyed by inhabitants and result in significant savings for society. The greater the problem, the greater the challenge, but also the greater the benefits, especially in terms of countries’ production capacity.

A. Theoretical-methodological principles

The main factors associated with the emergence of undernutrition as a public health problem can be categorized as: environmental (from natural or human causes), socio-cultural-economic (associated with the problems of poverty and inequality), and political-institutional, which combine to increase or decrease biomedical and productivity vulnerabilities. In turn, these vulnerabilities determine the amount, quality, and absorption capacity of food consumption, all of which are factors in undernutrition.

Each of these factors acts to increase or decrease the probability that an individual will suffer from undernutrition. Thus, each person’s weight depends on the phase in the demographic

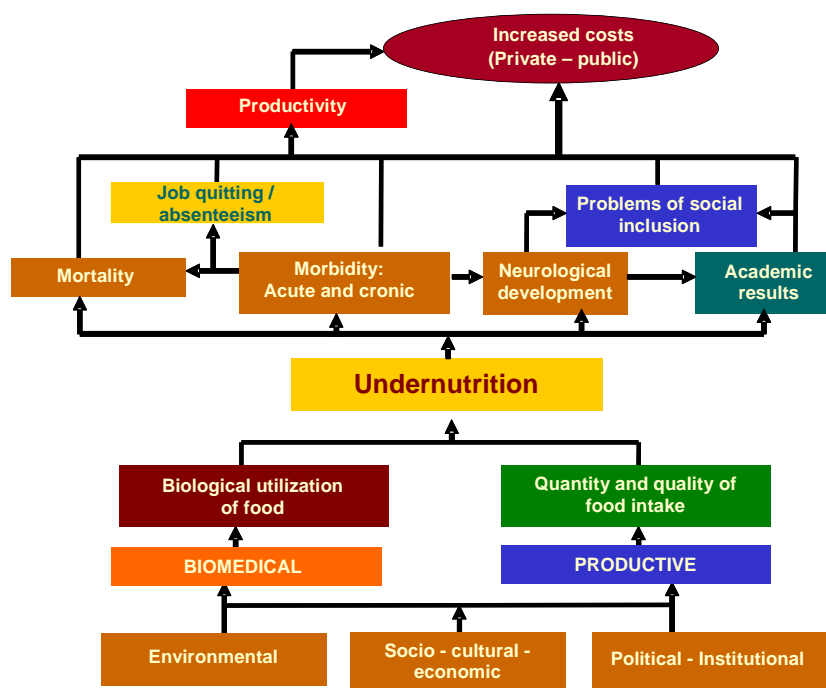
and epidemiological transition through which the country is going and where the person is in the life cycle. Together, these aspects determine how vulnerable the individual is.

Moreover, undernutrition has negative effects on different dimensions of people's lives, most notably health, education and the economy (public and private costs and expenditure, and lower productivity). Consequently, these effects generate more problems for social inclusion and exacerbate or deepen the scourge of poverty and indigence in the population. Thus, the vicious cycle is reproduced as vulnerability to undernutrition grows.

These impacts are seen as increases in probability, and they may appear immediately or throughout a lifetime. They then create a greater risk of undernutrition later in life among those who have suffered in the initial stages of development, and increase the likelihood of other consequences.

Thus, problems of intrauterine undernutrition can cause problems from birth through adulthood.

FIGURE 1
CAUSES AND CONSEQUENCES OF UNDERNUTRITION



Source: Authors' compilation.

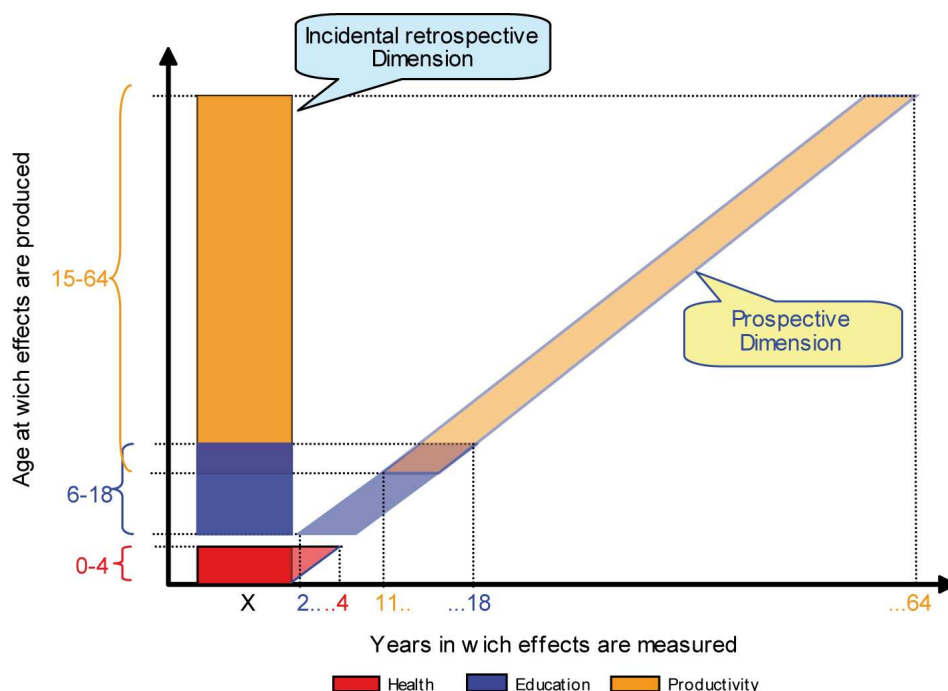
In order to conduct a comprehensive analysis of the phenomenon of undernutrition in the region, the model developed by ECLAC for this type of study (Martínez and Fernández, 2006) first requires that each of the aforementioned consequences (health, education and productivity) be studied and then translated into costs. Two dimensions of analysis are considered for this purpose:

- *Incidental retrospective dimension* Allows for an estimate of the cost for a given year of the undernutrition that has affected a country's population. Thus, the health costs for pre-schoolers who suffer from undernutrition during the year of analysis are estimated, as are the education costs resulting from the undernutrition suffered during

the first five years of the lives of children now in school, and the economic costs resulting from the loss of productivity by working-age persons who were exposed to undernutrition during the first five years of life.

- *Prospective, or potential savings dimension.* This dimension allows for the projection of present and future losses incurred as a result of medical treatment, repeated grades and lower productivity caused by undernutrition in children under five in each country, in a given year. Based on that, it is possible to estimate potential savings from the implementation of actions needed to achieve nutritional objectives (for example the one defined in Millennium Development Goal 1, cutting undernutrition in half by 2015).

FIGURE 2
DIMENSIONS OF ANALYSIS BY POPULATION AGE AND YEAR WHEN EFFECTS OCCUR



Source: Authors' compilation.

As shown in the figure 2, the incidental retrospective dimension includes the social and economic consequences of undernutrition in a specific year (X) for several cohorts that have been affected (aged 0 to four years for health, six to 18 years for education and 15 to 64 years for productivity). The prospective dimension, in contrast, projects the future effects and costs of undernutrition existing in a specific year (X) in a cohort of boys and girls under five (between years X and X+4 for health, from X+2 to X+18 for education and X+11 to X+64 for productivity).

B. Socioeconomic and nutritional background

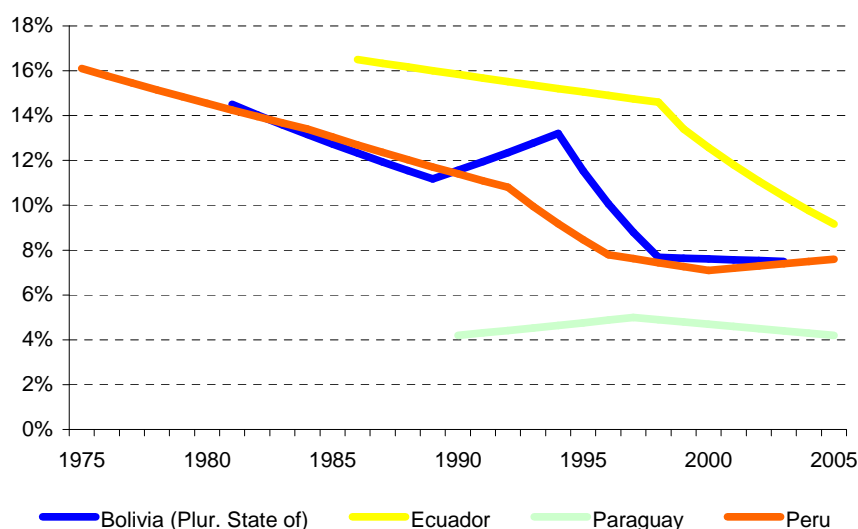
The Latin American and Caribbean Demographic Centre (CELADE-Population Division) estimates that in 2005 the total population of the four southamerican countries analyzed was 57 million inhabitants, of whom 28 million were Peruvian, 13 million Ecuatorian, nine million

Bolivian and six million Paraguayan. Approximately 33% of these inhabitants live in rural areas, and between 11% and 14% were boys and girls aged 0 to 59 months.

According to UNDP estimations (2004), the country with the largest indigenous population relative to the total population is the Plurinational State of Bolivia, where estimates range from 56% to 76%. It is followed by Peru (estimated at 37% to 50% indigenous), Ecuador (23% to 46%) and Paraguay (2% to 3%).

Looking at the nutritional profile of these countries, the latest available figures indicate that the prevalence of underweight is 1.7 to 3.4 times the normal rate.⁵ Ecuador has the highest prevalence (8.6%), followed by Peru (7.6%) and the Plurinational State of Bolivia (7.5%). Paraguay, in contrast, has the lowest prevalence (4.2%).

FIGURE 3
UNDERNUTRITION TRENDS IN THE COUNTRIES, 1975-2005



Source: Authors' compilation, based on Demographic and Health Surveys (DHS) of the Plurinational State of Bolivia, and Peru, household surveys in Paraguay and Life conditions Survey in Ecuador.

Although each country is undergoing its own nutritional transition process, on three countries a major progress was seen. However, in the last 10 to 15 years the trend has slowed and even reversed in some cases. This is true of Peru, which began taking national measurements between five and 15 years earlier than the other countries, and the Plurinational State of Bolivia. One specific characteristic of the Plurinational State of Bolivia is that major fluctuations were seen during the first half of the 1990s. Ecuador is the only country that has seen a decline in undernutrition in the last decade. In fact, its greatest progress was seen in the last two measurements, taken in 1998 and 2005. Finally, Paraguay, with prevalences around 5% and 4.5% showed the longest period of stagnation, it is at the same time the country with the shorter history of undernutrition measurements.

As has been noted in other studies, the problem of undernutrition is concentrated in the preschool years. Nevertheless, low birth weight (LBW) is also a significant factor. Ecuador and

⁵ A normal prevalence is considered to be 2.5%, corresponding to -2 standard deviations from the mean, taking the National Centre of Health Statistics (NCHS) distribution as a comparison pattern.

Paraguay have the most severe problem in this regard, with between 29 and 26 live births per thousand showing evidence of low birth weight with intrauterine growth restriction (LBW_{IUGR}).

Finally, it should be emphasized that the recent rise in food prices in our region as well as the rest of the world has created a complex situation in which the poorest population has become even more vulnerable. ECLAC estimates that “a 15% increase in the price of food raises the incidence of indigence nearly three points, from 12.7% to 15.6%. Therefore, a change in prices would propel 15.7 million more Latin Americans into indigence. As for poverty, the increases are similar, in that the same number of people would become poor”. Thus, considering that data for the countries in the region indicate that extreme poverty accounts for half the prevalence of undernourishment and undernutrition, the region’s food vulnerability can certainly be expected to increase.

C. Effects and costs of underweight

1. The situation in 2005

The estimates made for each of the four countries analysed in this study indicate that the cost of the underweight prevalence seen in the last six decades as of 2005 was nearly US\$ 4.331 million, equivalent to 3.3% of the aggregate GDP of these countries in 2005.

Peru accounts for 55% of that amount, though it had 45% of the population under five and a proportion around this value of those suffering from undernutrition during that period. It is followed by Ecuador, with 29% of the total cost, with similar proportions of its population in the under-five cohort and suffering from undernutrition (22% and 25%), and the Plurinational State of Bolivia, with 13% of the total cost, 20% of the population, and 20% of the total number suffering from undernutrition. At the opposite end of the spectrum is Paraguay, with 3% of the cost, with 8% of its population suffering from undernutrition during the period, it has the lowest unit costs of all the countries analysed.

With respect to GDP, given the weight of productivity in total costs, the distribution is similar to that described above for each country. When the amounts indicated above are compared with each country’s public social expenditure, the average is 36%, with a high of 53% in Ecuador and a low of 25% in Paraguay.

TABLE 1
ESTIMATED TOTAL COST OF UNDERWEIGHT, 2005

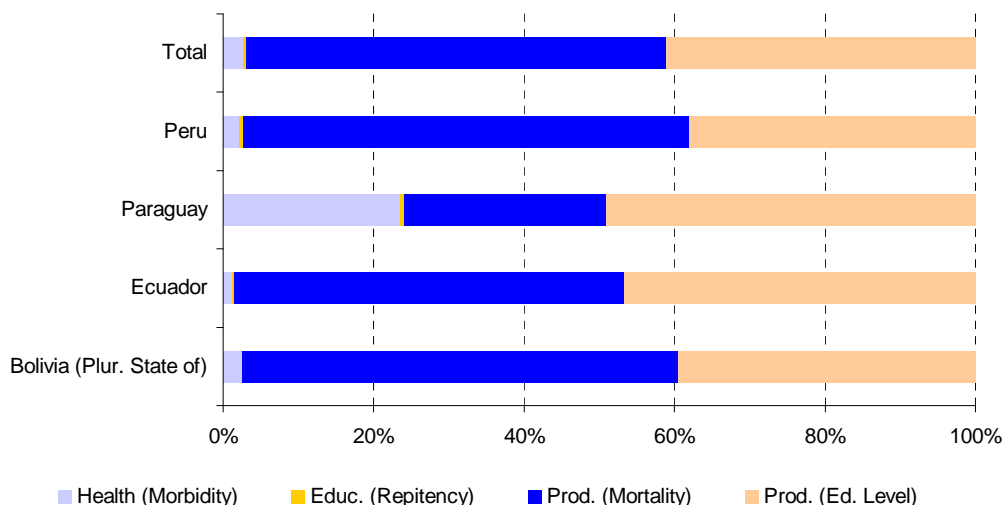
	Country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Total (Millions of dollars)	552	1 236.5	149.2	2 393.4	4 331.1
Total (Millions of PPP dollars)	1 514	1 947	579	5 096	
Percentage of GDP	5.8	3.4	2.0	3.0	3.3
Public Social Expenditure	31.8	53.2	24.6	34.1	

Source: Authors’ compilation, based on official data from the countries and ECLAC: Social Expenditure database.

When the costs are broken down, productivity costs as a whole account for 97%, with mortality representing 56% and lower education levels representing 41% within that category.

Health costs are only 2.7% of the total, and education costs less than 1%. These proportions vary from one country to another, but in general the distribution patterns remain constant, with the exception of Paraguay. In that country, losses due to mortality are significantly lower, whereas health and productivity costs due to lower education levels are relatively greater.

FIGURE 4
DISTRIBUTION OF UNDERWEIGHT COSTS IN THE COUNTRIES
(INCIDENTAL RETROSPECTIVE DIMENSION, 2005)
(In percentages)



Source: Authors' compilation.

Thus, it can be concluded with respect to the four countries analyzed that if we know the size of the population under five with low weight for their age and the correlations between undernutrition and the two dimensions of productivity, we can estimate more than 90% of the costs incurred in a given country.

2. Projections for children under five years of age in 2005

The costs of underweight for the cohort of boys and girls under the age of five in 2005 in the four countries analysed can be projected at a present value of US\$ 733 billion, 71% of which will be generated in Peru and Ecuador, and 29%, is distributed equally among the other two countries.

In terms of purchasing power parity (PPP), the equivalent value is significantly lower in the Plurinational State of Bolivia and Ecuador, thus the impact in the population is more relevant in Paraguay and Peru.

The equivalent annual cost for the 65-year period over which the various estimated values are distributed is nearly \$59 million. On average, this cost represents 0.5% of public social expenditure and 0.04% of GDP in 2005. These proportions are the highest in Paraguay, at 1.4% of social expenditure and 0.11 GDP points.

The most noteworthy result is that the loss of productivity is the principal source of underweight costs, accounting for more than 70% at the subregional level. The situation is even more marked in the Plurinational State of Bolivia and Ecuador, where the loss of productivity generates about 80% of these costs. In contrast, it accounts for about half the total costs in Paraguay.

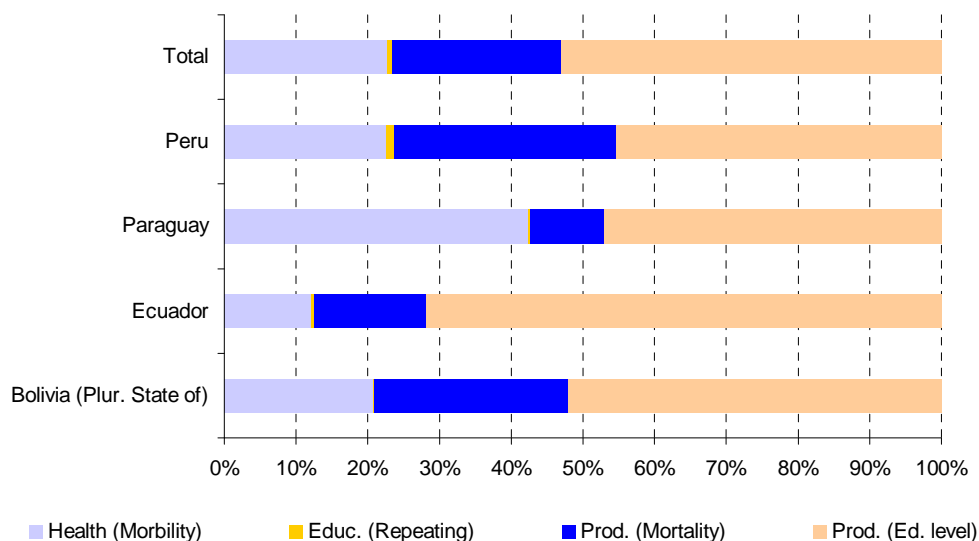
Health costs exceed 23% of the total, and in Paraguay they represent more than 40%. On the other hand, the cost associated with repeated grades in school is less than 1% of the total, though it is higher in Peru.

TABLE 2
PROJECTED COST OF UNDERWEIGHT IN CHILDREN UNDER THE AGE OF FIVE, 2005

	Estimate per country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Present value (Millions of dollars)	103	178	108	346	733
Present value (Millions of PPP dollars)	281	279	417	736	
EAC (Millions of dollars)	8.3	14.3	8.7	27.8	59.1
% of Public Social Expenditure	0.5	0.6	1.4	0.4	0.5
% of GDP	0.09	0.04	0.11	0.04	0.04

Source: Authors' compilation, based on official data from the countries and ECLAC: Public Social Expenditure database.

FIGURE 5
DISTRIBUTION OF UNDERWEIGHT COSTS IN THE COUNTRIES
(PROSPECTIVE DIMENSION, 2005)
(In percentages)



Source: Authors' compilation.

When this distribution is compared with that found in the incidental retrospective dimension, a significant difference can be seen; in both cases, however, the greatest costs are seen in productivity. Whereas in the incidental retrospective dimension, mortality and education levels have a similar weight, in the projective analysis the latter has a weight nearly seven times higher

than the former in cases such as Ecuador and Paraguay. When the relative weight of health-care costs is examined, the countries can be divided into two groups: in Paraguay these costs represent between 40% of the total, and in the Plurinational State of Bolivia, Ecuador and Peru the amount represent between 10% and 25%.

3. Analysis of scenarios

Based on the estimate of the costs to be borne by the four countries analysed as a consequence of the current rate of undernutrition in the population under the age of five in 2005, three alternative scenarios for 2015 are considered:

- The undernutrition rate of 2005 is maintained.
- Target 2 of the Millennium Development Goals (MDG) is achieved, that is, underweight levels are cut in half from 1990.
- Underweight is eradicated in the country (prevalence of 2.5%).

In scenario 1, factoring in the countries' population growth, the cost in 2015 would be about 1% lower than in 2005. The reduction is the result of lower fertility and mortality rates in the countries' populations, which is primarily true of Peru. This country represent a significant proportion of the total cost. Paraguay, in contrast, is the only country where costs rise in this scenario, as a result of the growth of the population aged 0 to four years.

Should the countries achieve target 2 of the MDG, the cost in 2015 would be 21% less than in scenario 1, and Paraguay accounts the mayor reduction of costs.

Finally, the cost of underweight in 2015 if a prevalence of 2.5% is achieved would be 61% less than in scenario 1. Nearly US\$ 211 million of this reduction would be seen in Peru, where the equivalent cost would be less than 40% of the scenario 1 cost without any changes in the prevalence. The Plurinational State of Bolivia follows with a 35% decrease.

TABLE 3
ESTIMATED COST OF UNDERWEIGHT FOR THE BASE YEAR AND THREE SCENARIOS
(Present value in millions of dollars; 2005 and 2015)

	Country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay ^a	Peru	
2005	103	178	108	346	733
No change in prevalence	102	172	116	338	729
MDG achieved (50% of 1990)	88	160	65	266	579
Eradication (2.5%)	36	56	65	127	284

Source: Authors' compilation.

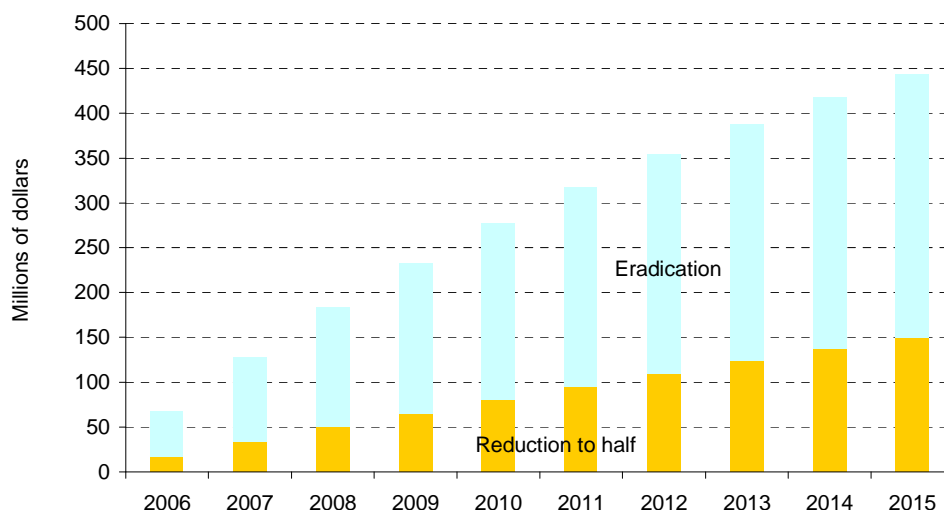
^a Given that the MDG target for Paraguay entails an undernutrition prevalence that is less than the value considered to be eradication, these scenarios are deemed to be the same.

Based on the cost trends shown, it is possible to estimate potential savings that would be generated as soon as actions aimed at achieving the targets are initiated.

Figure 6 shows a gradual increase in the potential savings resulting from a year-to-year comparison of scenarios 2 and 3 with scenario 1. The savings generated in 2006, in yearly

adjusted dollars, would be more than four times greater by 2015 in scenario 2, rising from US\$ 16 million to US\$ 69 million.

FIGURE 6
ESTIMATED YEARLY SAVINGS IN TWO UNDERNUTRITION SCENARIOS
IN THE FOUR COUNTRIES, 2006-2015
(Millions of current dollars for each year)



Source: Authors' compilation.

If eradication is achieved, the growth rate is somewhat smaller, just over three times, but savings would total US\$ 206 million by the end of the period. Both scenarios would continue yielding savings, but at declining growth rates. Future benefits from the eradication of undernutrition can be expected to stabilize.

As of 2005, the present value of yearly savings during the period under study for the four countries would be US\$ 1.708 million if eradication were achieved. According to each country's share of the cost, 48% of the savings would come from Peru, which would have generated 40% of the total by 2010. If MDG1 target 2 is achieved, the resultant savings would be US\$ 516 million, of which Peru would account for 48%. By 2010, 36% of the savings would already have been realized.

These savings do not cease in 2015, but continue accumulating. Thus, if appropriate policies remain in place, the projected benefits would continue accruing beyond 2015.

The above is a reflection of the economic benefits to be gained from advancing towards the eradication of undernutrition in these countries. Any programme that manages to reduce the prevalence of undernutrition will not only have an impact on people's quality of life but will also yield major savings for society.

TABLE 4
ESTIMATED SAVINGS ACCORDING TO SCENARIOS, 2005 TO 2015
(Present value in millions of dollars)

	Country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay ^a	Peru	
MDG achieved (50% of 1990)	50	42	179	245	516
Eradication (2.5%)	254	460	179	814	1 708

Source: Authors' compilation.

^a Given that in Paraguay the costs of both scenarios are the same (see note to table 3), the savings are also the same.

4. Conclusions

The model of analysis developed by ECLAC for estimating the effects and costs of undernutrition is being applied for the second time in this study, thus demonstrating once again the feasibility of implementing this type of experience with reliable results in the region.

Nevertheless, as shown in the study on the cost of hunger in Central America (ECLAC-WFP, 2007), important challenges remain with respect to methodology and information quality. These challenges must be overcome in order to improve this type of estimate and thereby enhance the reliability of risk projections and include complementary dimensions, such as deficiencies in micronutrients and other associated impacts.

The characteristics of the nutritional, epidemiological and demographic profile of the countries analyzed mean that the estimated costs are lower in relation to their population size than those estimated for the Central American countries. However, they amount to approximately US\$ 4.300 million, equivalent to 3.3 points of aggregate GDP. This is a very high opportunity cost for their economies that restricts their productivity potential and limits their growth, thereby adding a new dimension to the need to place undernutrition at the first level of priority on the political agenda. This is especially true in view of the fact that this scourge is completely preventable.

Thus, the countries' stated commitment to eradicating hunger and undernutrition will involve major social impacts and yield significant economic savings. Most notably, since all of society will benefit, the challenge is shared by all.

This point is even more important in view of the impact in social and economic vulnerability in the current context, where food prices were rising steadily until the middle of 2008, diminishing later, but increasing the risk due to financial and economic crisis, which threatens to exacerbate more the situation.

Finally, the international experience suggests that it is cheaper to invest in eradicating child undernutrition in the region than to suffer the social and economic consequences. To achieve this requires resources, technically well-defined policies and management models that maximize impact and efficiency. Moreover, all sectors of society must be committed and must participate actively.

I. Introduction

At present, Latin America is in a paradox, as the effects of both extremes of poor nutrition (obesity and undernutrition) are present simultaneously in a region where the food supply is much greater than it has been historically and in most cases exceeds the population's dietary energy requirements.

The prevalence of poor nutrition is not a mere accident in the region, but a reflection of huge disparities in income and the lack of priority given to food and nutrition issues on the countries' political agendas.

As we have indicated previously, aside from the ethical imperative and the goals the countries set for themselves in the Millennium Declaration, it is necessary to analyse more carefully the economic consequences in order to support decision-making and allocate the resources needed to eradicate this scourge.

In view of the social and economic importance of the problem of hunger and child undernutrition in the region, in 2005 WFP and ECLAC agreed to carry out a joint project for the "Analysis of the economic and social impact of hunger in Latin America". The first product of the project was published in 2007, when the results of this analysis were presented for the Central American countries and the Dominican Republic.

In this document the results of the comparative analyses for the Plurinational State of Bolivia, Ecuador, Paraguay and Peru are presented on the basis of the methodology developed especially by ECLAC. Technical teams from every country participated actively in the endeavour, from gathering information to processing and analysing it.

The document contains a brief description of the theoretical-methodological principles on which the study is based, and the estimates are presented at the subregional level. The four countries are described and analysed comparatively, both in relation to their social, economic and nutritional backgrounds and with respect to their results in the incidental retrospective and prospective dimensions and the projection of scenarios to the year 2015.

The estimates undertaken in this study are based on official data on health care, educational results, productivity and costs for 2005. Given the intertemporal nature of the study, however, these estimates are based on records from 1941 to 2005 and contain projections up to 2069.

II. Model of analysis

Hunger is associated with food and nutritional insecurity, which occurs when part of the population does not have assured physical, social and economic access to safe and nutritional food to satisfy people's dietary needs and preferences for a healthy and active lifestyle.

Thus, there are people with food vulnerability when there is “the probability of an acute decline in food access, or consumption, often in reference to some critical value that defines minimum levels of human well-being” (WPF, 2002).⁶

One of the first things that must be considered in the analysis is that hunger is related to vulnerability, which is the result of a combination of a high risk of having limited access to food (due to social, environmental or economic problems) and little response capacity (individual and collective) to contend with that limitation. Moreover, the direct consequence of this combination is undernutrition, the clearest manifestation of which is boys and girls with low birth weight, underweight and/or lower than normal height for their age.

Another element of the analysis to take into consideration is demographic, epidemiological and nutritional transitions, which can be used to obtain more reliable assessments of the scenarios in each country and hence the consequences that can be foreseen for the population's nutritional situation.

A third element to bear in mind is the fact that a person's nutritional situation is part of a process that is expressed differently depending on the stage of the life cycle: intrauterine and neonatal life, infancy and pre-school, school years, or adult life. This is because the nutrient requirements and the needs are different for each stage.

Below is a discussion of the central elements considered in the model of analysis developed to estimate the effects and costs of child undernutrition, with a brief description of the causes and consequences, as well as the dimensions of analysis and the principal methodological aspects that must be taken into account in order to correctly interpret the results presented later on.⁷

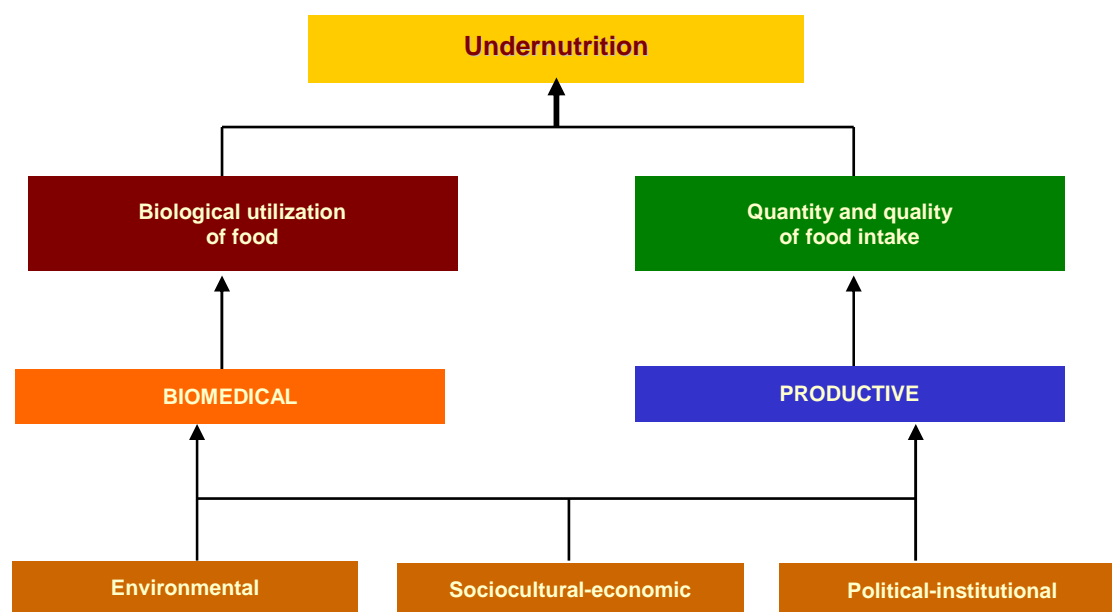
⁶ VAM Standard Analytical Framework. World Food Programme 2002.

⁷ A summarized version of the theoretical background and the basic characteristics considered in the model of analysis is presented here. For a more detailed discussion of the model, see Martínez and Fernández, (ECLAC-WFP 2006), “Modelo de análisis del impacto social y económico de la desnutrición infantil en América Latina”. *Serie Manuales* N° 52.

A. Causes of undernutrition

The main factors associated with the emergence of undernutrition as a public health problem can be grouped as follows: environmental (from natural or entropic causes), sociocultural-economic (associated with the problems of poverty and inequality), and political-institutional. Together, they increase or decrease biomedical and productivity vulnerabilities, through which they determine the quantity and quality of dietary intake and the absorption capacity that are elements of undernutrition.

FIGURE II.1
FACTORS ASSOCIATED WITH THE DEVELOPMENT OF UNDERNUTRITION



Source: Authors' compilation.

Each of these factors helps increase or decrease the likelihood that a person will suffer from undernutrition. Thus, the importance of each of these factors depends on where the country is in the demographic and epidemiological transition and the person's current stage in the life cycle, which together determine the intensity of the resulting vulnerability.

Environmental factors define the surroundings in which the subject and his or her family live, including the risks stemming from the natural environment itself and its cycles (from floods, droughts, frosts, earthquakes, and other phenomena), and those produced by humans themselves (such as the contamination of water, air, and food, the expansion of agriculture into new territories, etc.).

The socio-cultural-economic determinants include elements associated with poverty and equality, education and cultural norms, employment and wages, access to social security, and coverage of aid programmes.

The political-institutional factors encompass government policies and programmes aimed specifically at solving the population's food and nutritional problems.

Production factors include those directly associated with the production of food, as well as the access that the at-risk population has to them. The availability and autonomy of each country's dietary energy supply depend directly on the characteristics of production processes, the degree to which they utilize natural resources, and the extent to which these processes mitigate or aggravate environmental risks.

And finally, biomedical factors take into account the individual's susceptibility to undernutrition, insofar as deficiencies in certain elements limit the capacity to make biological use of the food consumed (regardless of quantity and quality).

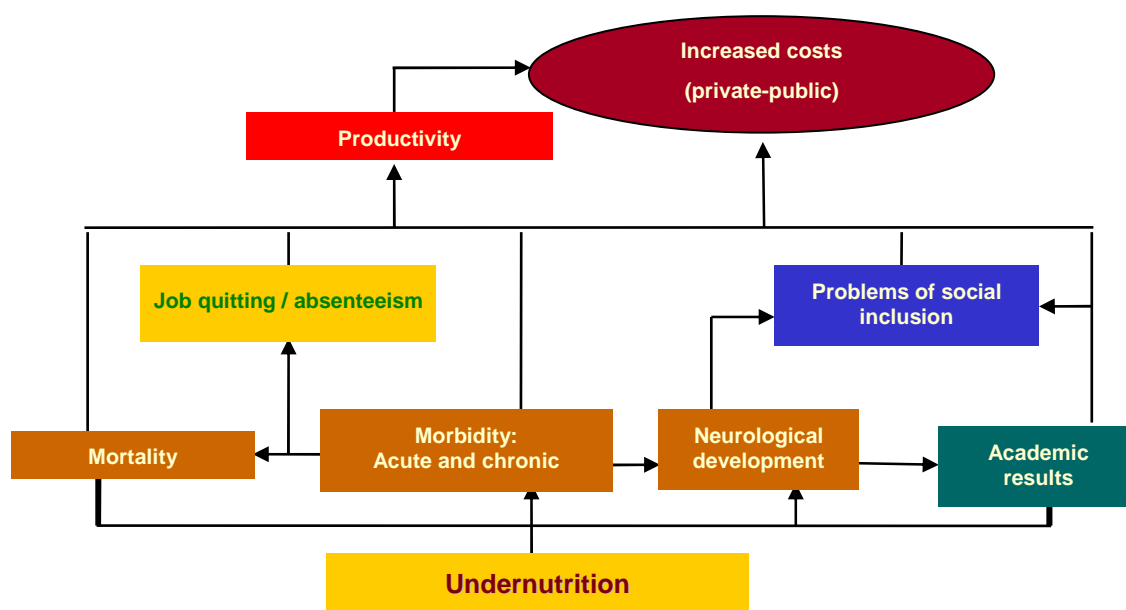
B. Consequences of undernutrition

Undernutrition has negative effects on various aspects of people's lives, most notably health, education, and the economy (costs and expenditures in the public and private sectors, and lower productivity). Consequently, these effects exacerbate problems with social integration and increase or intensify the poverty and indigence that plague the population. The vicious cycle is then perpetuated as vulnerability to undernutrition grows.

These effects may appear immediately or throughout a person's lifetime, and they increase the chances of later undernutrition in those who have already suffered it during the early years of the life cycle. Other consequences are more likely to ensue as well. Thus, intrauterine undernutrition can create difficulties from birth to adulthood.

Various health studies have shown that undernutrition makes certain pathologies more likely to appear and/or intensify, and it increases the chances of death in different stages of the life cycle. How these consequences materialize depends on the epidemiological profile of each country.

FIGURE II.2
CONSEQUENCES OF UNDERNUTRITION



Source: Autor's compilation.

With respect to education, undernutrition affects student performance because of disease-related deficits and the limited learning capacity associated with deficient cognitive development. This translates into greater probabilities of starting school at a later age, repeating grades, dropping out of school, and ultimately a lower level of education.

Undernutrition and its effects on health and education also translate into heavy costs for society at large. Thus, the total cost of undernutrition (TC^U) is a function of higher health-care expenditure (HC^U), inefficiencies in education (EC^U) and lower productivity (PC^U). Thus, to account for the total cost (TC^U), the function can be summed up as:

$$TC^U = f(HC^U, EC^U, PC^U)$$

In the area of health, the higher probability resulting from the epidemiological profile of individuals suffering from undernutrition proportionally increases costs in the health-care sector (HSC^U), which at the aggregate level is equal to the sum of the interactions between the probability of undernutrition in each human group, the probability that this group will suffer each of the diseases because of that undernutrition, and the costs of treating the pathology (diagnosis, treatment, and control). To this are added the costs paid by individuals and their families as a result of lost time and quality of life (IHC^U). Thus, to study the variables associated with the health cost (HC^U), the formula is:

$$HC^U = f(HSC^U, IHC^U)$$

In education, the reduced attention and learning capacity of those who have suffered from child undernutrition increases costs to the educational system (ESC^U). Repeating one or more grades commensurately increases the demand that the educational system must meet, with the resulting extra costs in infrastructure, equipment, human resources and educational inputs. To these costs are added the private ones (incurred by students and their families) derived from the larger quantity of inputs, external educational supplementation, and more time devoted to solving or mitigating low performance problems (IEC^U). Thus, in the case of the education cost (EC^U), the formula is:

$$EC^U = f(ESC^U, IEC^U)$$

Undernutrition's cost to productivity is equal to the loss in human capital (HK) suffered by a society, stemming from the lower educational level achieved by individuals with undernutrition (ELC^U) and the loss of productive capacity resulting from the higher number of deaths caused by undernutrition (MMC^U). Thus:

$$PC^U = f(ELC^U, MMC^U)$$

To carry out a comprehensive analysis of the phenomenon of undernutrition in the countries, the model first undertakes to study each of the consequences indicated (health, education and productivity) and then translates them into costs.

C. Dimensions of analysis

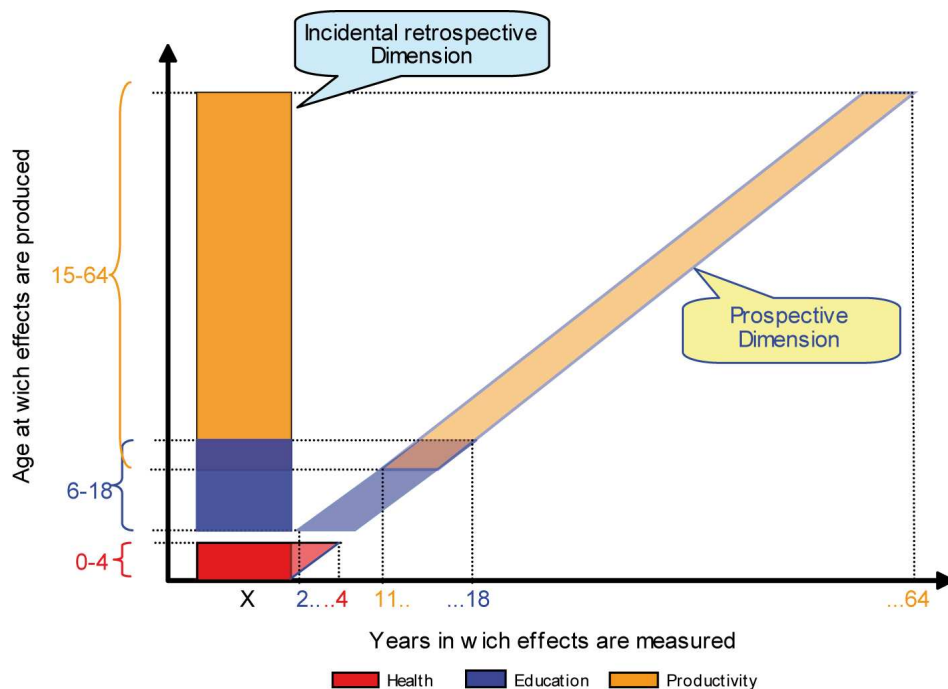
Considering that a country's undernutrition situation and the consequences thereof reflect a specific epidemiological and nutritional transition process, a comprehensive analysis of the matter involves making estimates of the current situation by extrapolating from previous transitional stages, as well as estimates of the future, predicting potential cost and savings scenarios based on the prospects for intervening to control or eradicate the problem.

On this basis, a two-dimensional analysis model has been developed for estimating the costs arising from the consequences of child undernutrition in health, education and productivity:

1. *Incidental retrospective dimension.* Makes possible an estimate of the cost of undernutrition in a country's population for a given year. Thus, it is possible to estimate the health costs of pre-school boys and girls who suffer from undernutrition during the year of analysis, the education costs stemming from the undernutrition children now in school suffered during the first five years of life, and the economic costs due to lost productivity by working-age individuals who were exposed to undernutrition before the age of five.
2. *Prospective, or potential savings dimension.* This dimension makes it possible to project the present and future losses incurred as a result of medical treatment, repetition of grades in school, and lower productivity caused by undernutrition among children under the age of five in each country, in a specific year. Based on that, potential savings derived from actions taken to achieve nutritional objectives can be estimated (for example, to attain MDG1, reducing undernutrition by half by 2015).

As the following figure shows, the incidental retrospective dimension includes the social and economic consequences of undernutrition in a specific year (X) for different cohorts that have been affected (0 to four years of age for health, six to 18 years for education, and 15 to 64 years for productivity). The prospective dimension, on the other hand, projects future effects and costs of the undernutrition that exists in a specific year (X) in a cohort of children less than five years old (between years X and X+4 for health, X+2 to X+18 for education, and X+11a to X+64 for productivity).

FIGURE II.3
DIMENSIONS OF ANALYSIS BY POPULATION AGE AND YEAR WHEN EFFECTS OCCUR



Source: Authors' compilation.

D. Methodological aspects

The analysis focuses on the initial stages of the cycle and its consequences throughout life. This limits the study of undernutrition and health to the foetus, the infant, and the pre-schooler (those aged 0 to 59 months).⁸ The effects on education and productivity are analysed in the other demographic groups.

The universe of children suffering from undernutrition has been divided into sub-cohorts (0 to 28 days, one to 11 months, 12 to 23 months, and 24 to 59 months) in order to highlight the specificity of certain effects during each stage of the life cycle.

The undernutrition indicators used in this study depend on the stage in the life cycle. For intrauterine undernutrition, what is estimated is low birth weight (LBW) due to intrauterine growth restriction (IUGR, defined as a weight below the tenth percentile for gestational age). For the pre-school stage, the concepts of moderate and severe underweight (weight-for-age score below -2 standard deviations) are used, taking the National Center of Health Statistics (NCHS) distribution as a comparison pattern.⁹

Estimates of the impacts of undernutrition on health, education, and productivity are based on the concept of the relative (or differential) risk run by individuals who suffer from undernutrition during the first stages of life. This is valid both for the incidental-retrospective analysis and for the prospective-savings analysis. However, its operationalization has specific characteristics in each case, so they are detailed separately in the document.

To estimate the costs, in the first case the values occurring in the year of analysis are totaled, and estimates are made of the process undergone in the different cohorts of the population. In the second case, on the other hand, a future cost flow is estimated and updated (to present value), and for purposes of comparison with public social expenditure (PSE) and gross domestic product (GDP), it is translated into an equivalent annual cost.

The countries analysed are the Plurinational State of Bolivia, Ecuador, Paraguay and Peru, taking the year 2005 as a reference, with estimates of costs and potential savings based on different scenarios through 2015.

The study relied on data available between May 2006 and April 2008 from official sources in the respective countries, and from international organizations' databases.¹⁰

⁸ In the original design, the idea of analysing direct information on the nutritional and health situation of pregnant women was considered, but the lack of reliable information on the incidence of undernutrition and the gestation times led to its exclusion from the analysis.

⁹ Standard of the National Center of Health Statistics, United States.

¹⁰ See Annex.

III. Sub-regional situation: comparative analysis

A. Socioeconomic and nutritional background

The reality of each country's nutritional situation and therefore the effects and costs of undernutrition are a reflection of the different stages of demographic, epidemiological and nutritional transition that it has reached, together with its population's socioeconomic situation and social vulnerability. Accordingly, without attempting to describe the social panorama exhaustively in this document, we present here some of the social, economic and demographic elements and characteristics of the four countries that are necessary for putting the analyses in context.

1. Countries' populations and underweight statistics

In 2005, the total population of the four countries studied was 57 million. Near a half of the habitants live in Peru, and just over one fourth in Ecuador, follow by the Plurinational State of Bolivia.

TABLE III.1
TOTAL POPULATION AND POPULATION UNDER FIVE, 2005

Country	Total population		Under five years of age	
	Millions	Percentages	Millions	Percentages
Bolivia (Plurinational State of)	9.4	17	1.3	19
Ecuador	13.2	23	1.4	22
Paraguay	6.2	11	0.8	13
Peru	27.9	49	3.0	46
Total	56.8	100	6.5	100

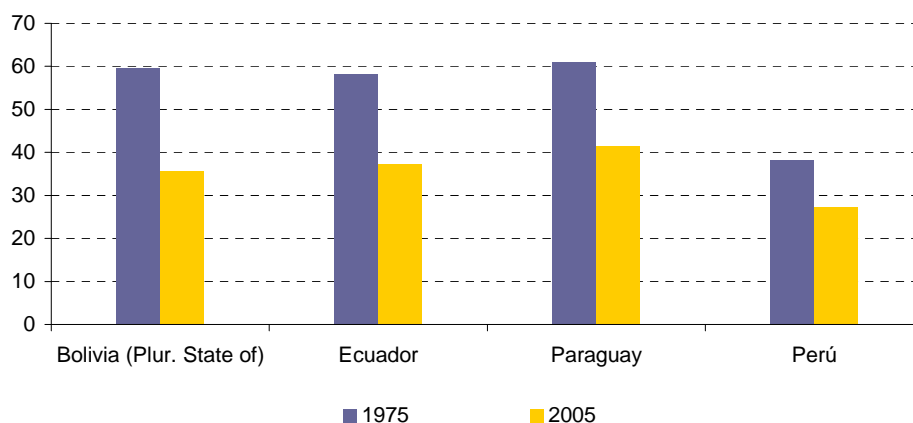
Source: CELADE.

Between 10% and 14% of the population in the countries of the region are aged 0 to 59 months. The Plurinational State of Bolivia has the highest proportion of children in that age group, while Ecuador has the smallest.

The countries each have distinctive characteristics in terms of ethnicity and rural residence, but the countries analysed as a whole have larger ethnic and rural populations than the rest of the region. In 2005, according to CELADE estimates, rural residents in the subregion accounted for approximately 33% of the total population, which represents a decline of 16 percentage points in the past 30 years. Paraguay, Ecuador and the Plurinational State of Bolivia have the largest proportion of rural inhabitants (between 36% and 41%).

According to UNDP estimates (2004), the country with the largest indigenous population relative to the total population is the Plurinational State of Bolivia, where estimates range from 56% to 76%. It is followed by Peru (estimated at 37% to 50% indigenous), Ecuador (23% to 46%) and Paraguay (2% to 3%).

FIGURE III.1
RURAL POPULATION IN THE COUNTRIES, 1975 AND 2005
(In percentages)



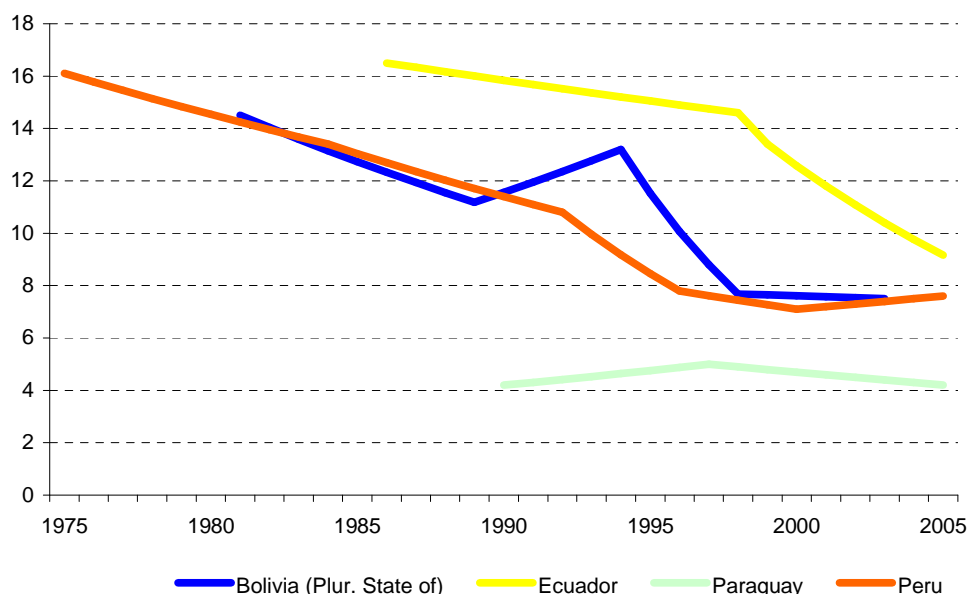
Source: CELADE.

Finally, looking at the nutritional profile of these countries, the latest available figures indicate that the prevalence of underweight is 1.7 to 3.4 times the normal rate.¹¹ Ecuador is the country with the highest prevalence (8.6%), followed by Peru (7.6%) and the Plurinational State of Bolivia (7.5%). Paraguay, in contrast, has the lowest prevalence (4.2%).

Consistent with the unique characteristics of their transition processes, the historical trend in undernutrition is also specific to each country. Nonetheless, figure III.2 shows that in every case, in the second half of the twentieth century significant reductions were achieved, whereas in the last 10 to 15 years the trend has slowed down and even reversed in some cases. This is true of Peru, which began taking national measurements between five and 15 years earlier than the other countries, and of the Plurinational State of Bolivia as well. One specific characteristic of the Plurinational State of Bolivia is that major fluctuations were seen during the first half of the 1990s. Ecuador is the only country that has maintained a downward trend in the last decade. In fact, its greatest advances were reported between 1998 and 2005. Finally, Paraguay, with prevalences around 5% and 4.5% has had the longest period of stagnation, at the same time is the country with the shorter history of undernutrition measurements.

¹¹ A normal prevalence is considered to be 2.5%, corresponding to -2 standard deviations from the mean, taking the NCHS distribution as a comparison pattern.

FIGURE III.2
UNDERNUTRITION TRENDS IN THE COUNTRIES, 1965-2005



Source: Authors' compilation, based on Demographic and Health Surveys (DHS) of the Plurinational State of Bolivia, and Peru, household surveys in Paraguay and Life Conditions Survey Ecuador.

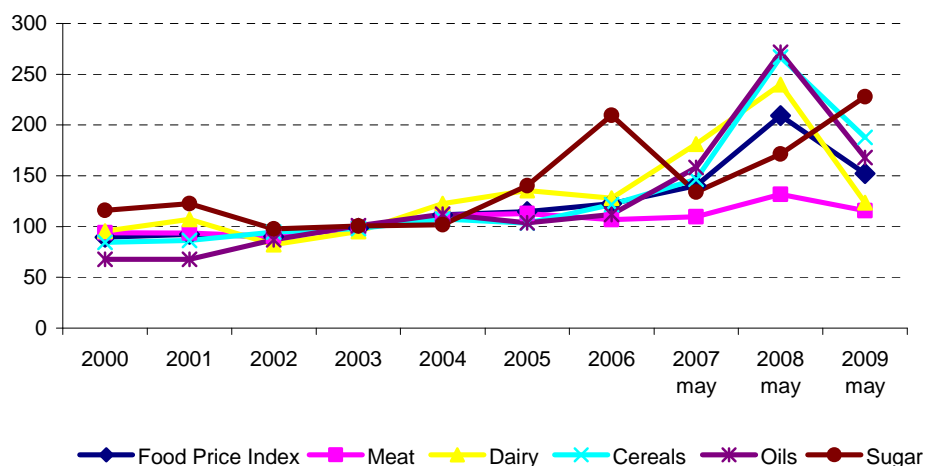
As has been noted in other studies, the problem of undernutrition is concentrated in the preschool years. However, low birth weight (LBW) is also significant, particularly considering the chain of causality presented in the life cycle in these initial stages. Ecuador and Paraguay have the most severe problem in this regard, with between 29 and 26 live births per thousand showing evidence of low birth weight with intrauterine growth restriction (LBW_{IUGR}). In contrast, Peru and the Plurinational State of Bolivia have 18 and 12 live births per thousand showing evidence of LBW_{IUGR} .

2. Food prices, poverty and food security

The rise in food prices and the recent economic crisis in our region as well as the rest of the world have created a complex situation in which the poorest population has become even more vulnerable. ECLAC estimates that “a 15% increase in the price of food raises the incidence of indigence nearly three points, from 12.7% to 15.6%. This would propel 15.7 million more Latin Americans into indigence. As for poverty, the increases are similar, in that the same number of people would become poor”. Thus, considering the previous projections, the population living in extreme poverty could reach nearly 85 million persons, and the total poor population could amount to more than 205 million.

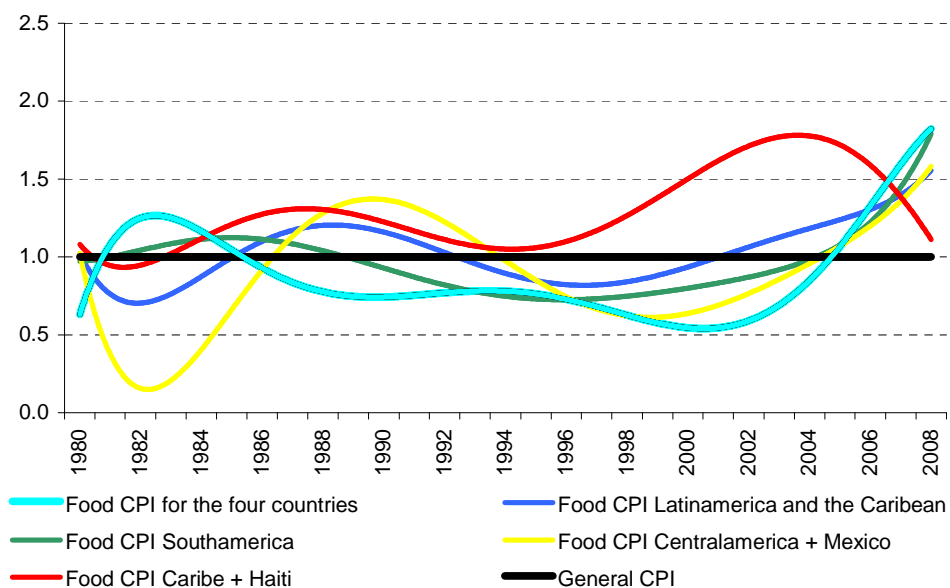
According to FAO estimates, between March 2007 and March 2008, food prices rose an average of 57%. Prices of oils and fats climbed by as much as 106%, grains by 88%, dairy products 48%, sugar 26% and meat 10% (see figure III.3). Except for those of dairy products and meats, these increases are similar to or greater than those reported for the period between 2000 and March 2007. Food prices showed a decrease during the first semester of 2009 close to 2007 prices. However, the positive impact of this decrease on the more vulnerable population, specially the undernourished group was reduced by the economic crisis that affected the region and.

FIGURE III.3
WORLD PRICE VARIATIONS FOR SOME FOODS, 2000-2008
(FAO price index)



Source: FAO Crop Prospects and Food Situation - N°. 2, July 2009.

FIGURE III.4
LATIN AMERICA AND THE CARIBBEAN (24 COUNTRIES): RELATIONSHIP
BETWEEN VARIATIONS IN FOOD CPI AND GENERAL CPI, 1981-2007
(Simple averages)



Source: Authors' compilation based on ECLAC, Statistical Yearbook for Latin America and the Caribbean 2007.

ECLAC data indicate that during this decade, the region has seen food prices rise steadily, at a much higher rate than the general inflation indices in these countries. As the figure

III.4 shows, this situation has been seen before, but what is different about 2007 is that the food CPI is more than 50% higher than the general CPI.

For the time being, the price trend is not clear, some prices are increasing (for example the international price of sugar) while other prices keep the tendency to decrease. This volatility generates a scenario which poses even more challenges for social policy. To be sure, as the Secretary General of the United Nations has pointed out, significant resources must be brought to bear in addressing this problem, but innovative management alternatives must also be identified so that the effectiveness and efficiency of countries' social expenditure can be enhanced.

3. Undernutrition and associated diseases

In the countries studied, the pathologies most affected by undernutrition in the first 59 months of life are Acute Diarrheal Disease (ADD), Acute Respiratory Infections (ARI) and iron-deficiency anemia. In addition, there are the pathologies specific to critical nutritional deficiencies in calories and proteins, such as marasmus and kwashiorkor.

According to official information and the reports from the national Demographic and Health Surveys (DHS), the prevalence of pathologies associated with undernutrition in children under five varies significantly from one country to another. Thus, whereas there is more undernutrition in Ecuador and Peru, the prevalence of ADD is higher in the Plurinational State of Bolivia and Peru. Official data indicate that the greatest prevalences of iron-deficiency anemia are in the Plurinational State of Bolivia, with significantly higher prevalences than those reported by the other countries. Reported cases of marasmus and kwashiorkor, in turn, are considerably more numerous in the Plurinational State of Bolivia. Because records in the Plurinational State of Bolivia are not sufficiently reliable, the number of cases is estimated based on the probability associated with reported cases of severe undernutrition.

This situation can be seen in the table III.2.

TABLE III.2
PREVALENCE OF UNDERWEIGHT AND ASSOCIATED DISEASES, PER COUNTRY, 2005

Pathology	Prevalence by country			
	Bolivia (Plurinational State of) ^a	Ecuador	Paraguay	Peru
Underweight (in %)	7.5	8.6	4.2	7.6
Anemia (in %)	10.1	0.7	0.2	0.0
ADD (in %)	11.4	0.5	...	8.1
ARI (in %)	0.4	7.1	...	8.9
Kwashiorkor (N)	4 630 ^a	83	77	266
Marasmus (N)		14	24	478

Source: Authors' compilation, based on the latest DHS available and official statistics reported by each country.

^a For the Plurinational State of Bolivia, no breakdown can be made for kwashiorkor and marasmus, as the data represent an estimate by the country for both pathologies together.

4. Relevant education factors

According to data from UNESCO 2005,¹² basic education coverage is quite high in the countries of the region: 94% (Paraguay), 95% (Plurinational State of Bolivia), 96% (Peru) and 97% (Ecuador). However, the situation is different at the secondary school level; coverage fluctuates between 55% (Ecuador) and 73% (Plurinational State of Bolivia).

Accordingly, the proportion of persons in the working-age population (WAP) who have completed primary and secondary education¹³ is less than 30%, with Peru reporting the most favourable situation. The Plurinational State of Bolivia and Paraguay have the lowest rates of school completion.

TABLE III.3
PERSONS IN WAP WHO HAVE COMPLETED SECONDARY
EDUCATION, BY AGE, 2003-2005

Age range	Percentage of school completion, by country			
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru
25 to 64	14	21	15	30
25 to 34	23	29	22	41
45 to 54	10	17	9	25
Variation in 20 years (%)	134	71	128	64

Source: Authors' compilation, latest household survey available for each country.

As shown in table III.3, the situation is not stagnant, as important advances can be seen when comparing cohorts 20 years apart. The most noteworthy cases are the Plurinational State of Bolivia and Paraguay, which nearly doubled the proportion of adults who have completed secondary education during those years. As indicated in the previous paragraph, however, they are still far behind the other countries.

5. Social expenditure

In response to the problems mentioned here, in 2005 the countries of the region allocated an average of 8.8% of GDP to public social expenditure (PSE), with an average of 3% earmarked for education and 2% for health.¹⁴ The Plurinational State of Bolivia reported the highest amount of public social expenditure (19% of GDP). In contrast, Ecuador and Paraguay spent only 6% and 8% of GDP, respectively, followed by Peru (9%). Unlike Central America, where the countries with the highest undernutrition prevalences have the lowest PSE per capita, in the four countries studied here there is no correlation. The Plurinational State of Bolivia has high prevalences and high public expenditure figures, whereas Ecuador has both the highest prevalence and the lowest PSE.

This assertion is reinforced by analysing per capita PSE, which averages US\$ 177 in current dollars for the countries as a whole, equivalent to US\$ 424 in 2005 purchasing power

¹² <http://stats.uis.unesco.org/unesco>.

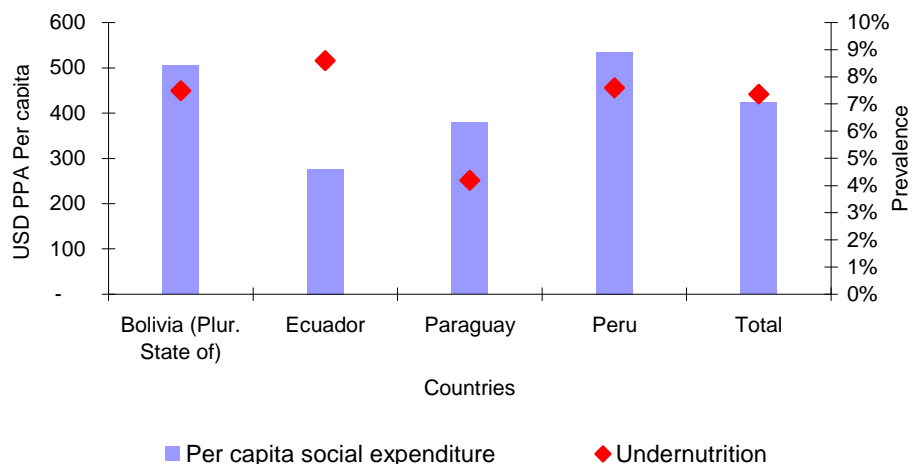
¹³ Peru requires 11 years of schooling; the other countries require 12.

¹⁴ In some countries health expenditure is recorded together with nutrition figures.

parity (PPP). Ecuador has the lowest PSE figure at less than US\$ PPP 300 as well as the highest undernutrition prevalence, while Peru spends US\$ PPP 537 per capita.¹⁵

This occurs in a scenario in which most of the countries in the region devote less than 1% of PSE to financing food programmes (ECLAC-WFP, 2005b).

FIGURE III.5
UNDERNUTRITION AND PER CAPITA PUBLIC SOCIAL EXPENDITURE, 2005



Source: Authors' compilation, ECLAC Social Expenditure Database and latest national nutrition survey available for each country.

It should be noted that if the current level of social expenditure appears insufficient for addressing historical conditions, scenarios of greater economic vulnerability for the population require even greater efforts to eradicate child undernutrition.

B. Effects and costs of underweight in 2005: analysis of the incidental retrospective dimension

As indicated in the methodology developed for these studies, this dimension is used to estimate and analyse the effects and costs on education, health and productivity incurred as a result of undernutrition in a specific year, in this case 2005.

Thus, the consequences analysed focus on:

- health*, caused by undernutrition in the cohort of boys and girls aged 0 to 59 months who suffered from undernutrition in 2005;
- education*, for children between six and 18 years of age who in 2005 were in primary or secondary school and who had suffered from undernutrition between 0 and 59 months of age;

¹⁵ The cost comparisons are made in 2005 PPP dollars. The conversion factors of that year have the greatest impact on the estimates in current currency of Paraguay and the Plurinational State of Bolivia (0.26 and 0.36 respectively), while in Peru the ratio is 0.47, and Ecuador with 0.64.

- c. *productivity*, involving young people and adults who in 2005 were aged 15 to 64 and had suffered from undernutrition in the first five years of life.

1. Undernutrition and health

The health effects of undernutrition are measured based on the differences in the incidence of mortality and morbidity prevalences that can be found between persons without undernutrition and those who have suffered from undernutrition at some point before turning five years old. The value of these differences is specific to each pathology and age group; it depends on the extent of the undernutrition, and in general it varies by location, region and country.

In some countries in the region, it is not easy to identify differential morbidity and mortality indicators according to the nutritional state. On the one hand, there is the problem of underreporting in official statistics, which are biased by the coverage of the health-care system, particularly among the most vulnerable groups in the population. On the other hand, the records do not identify the concomitant presence of different pathologies, so there is no segmentation of the universe between those who suffer from undernutrition and those who do not.

To fill these information gaps, this study relies on estimates based on some longitudinal studies, external sources and the Pan-American Health Organization (PAHO) and World Health Organization (WHO) estimates of morbidities, as well as the mortality statistics of the Latin American and Caribbean Demographic Centre (CELADE-Population Division). For some diseases, the absence of data has required the use of differential prevalences estimated for all of the countries in the study as a whole.

1.1 Effects on health

1.1.1 Morbidity

The numbers of boys and girls under the age of five who contract different diseases as a result of undernutrition are quite variable. They depend on the population size and the differences in prevalence (DP) that apply to each case. As shown in table III.4, however, the general trend is for iron-deficiency anemia to be the most prevalent, amounting to an additional 37,000 persons in the subregion suffering from these pathologies because of undernutrition. Added to that are 26,000 cases of ADDs and 21,000 cases ARIs.¹⁶

According to the latest information available, the proportion of the population under the age of five years in each country is similar to the weight of the number of children suffering from undernutrition in each country. Thus, for example, Peru had more than one half of the population under the age of five in 2005 and also had a similar number of children suffering from undernutrition (47.3%). The country with the largest differences in distribution is Paraguay, where the cases of undernutrition amount to two thirds of the weight its child population represents among the countries as a whole. In contrast, the distributions of pathologies associated with undernutrition vary considerably. The Plurinational State of Bolivia has a high concentration of cases of kwashiorkor and marasmus, whereas Peru has relatively high prevalences of ARI and anemia.

¹⁶ The effect of deficits in micronutrients such as zinc, iodine and Vitamin A are also important in the subregion. To date, however, no reliable methodological procedure has been identified to make it possible to incorporate them into the cost estimate.

TABLE III.4
NUMBER AND DISTRIBUTION OF CASES OF DISEASES ASSOCIATED
WITH UNDERWEIGHT, 2005

Pathology	Distribution by country (in percentages)				Total (N)
	Bolivia (Plurinational State of) ^a	Ecuador	Paraguay	Peru	
Underweight	19.6	25.0	8.1	47.3	510 921
Anemia	36.9	11.8	0.3	51.0	37 020
ADD	37.3	25.7	...	36.9	26 653
ARI	3.0	23.6	...	73.4	21 242
Kwashiorkor	84.5 ^a	3.0	2.8	9.7	2 741
Marasmus	81.8 ^a	0.49	0.8	16.9	2 831
Population aged 0 to 59 months	19.5	22.0	12.7	45.7	6 553 195

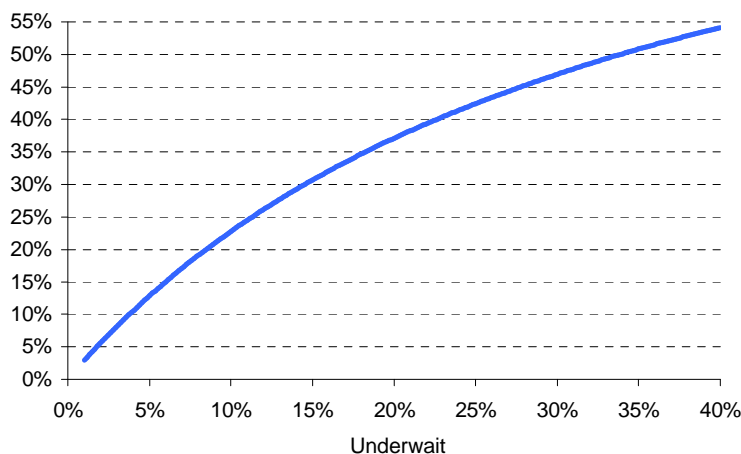
Source: Authors' compilation, based on the latest national nutrition survey available in each country and official data on cases of disease in each country.

^a For the Plurinational State of Bolivia it is not possible to break down cases of kwashiorkor and marasmus, since the official estimate considers the two pathologies together.

1.1.2 Mortality

Based on the relative risk results obtained by Fishman et al (2004), the effects of undernutrition on the mortality of children under five have been estimated for the four countries studied. Figure III.6 shows how mortality rises along with underweight in the range of 1% to 40%.

FIGURE III.6
MORTALITY OF CHILDREN UNDER FIVE ASSOCIATED WITH UNDERWEIGHT
(In percentages)



Source: Authors' compilation based on official health statistics, latest national survey available in each country, CELADE mortality estimates and estimates of differential relative risks (DP) by Fishman et al.

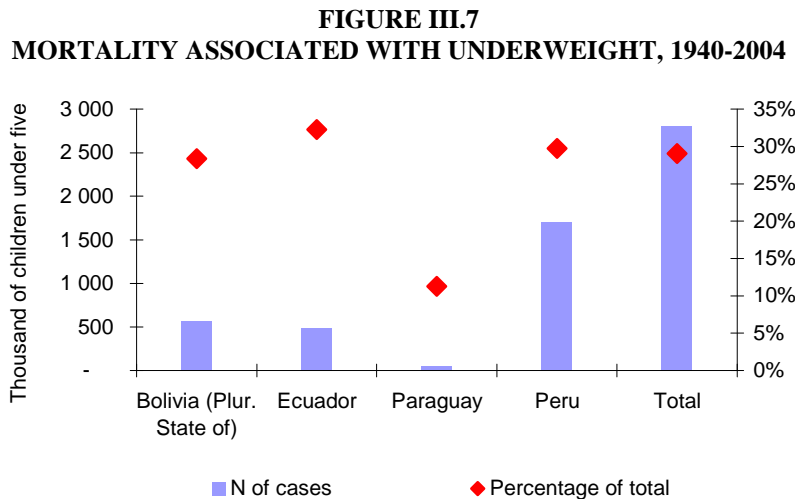
Considering the specific data for each country analysed, the number of deaths associated with undernutrition in children under five in 2005 has been estimated at just under 69 thousand, equivalent to about 18% of the total mortality for the cohort. This indicator, like others, varies from one country to another in the study. In Paraguay there were 4,000 cases (11% of the total), compared to 38,000 in Peru (18% of the national total).

When these values are contrasted with the number of live births in the cohort for each country, mortality rates associated with underweight average 52 per 1,000 live births (63 in the Plurinational State of Bolivia, 62 in Peru, 34 in Ecuador, and 26 in Paraguay).

From a historical perspective, between 1941 and 2005 (64 years) it is estimated that there were just over 2.8 million deaths associated with undernutrition in these countries, which represents 29% of all cases of mortality in the cohort for that period.

As figure III.7 shows, Peru had the largest absolute number and proportion of deaths associated with underweight during the period under study, with 1.7 million cases (61% of the total number of deaths of children under five nationally), followed by the Plurinational State of Bolivia with 560,000 and Ecuador with nearly 500,000 deaths (20% and 18% of the national total, respectively). These figures decreased 14% average if they are adjusted by the survival rate.

In keeping with its smaller population and lower prevalences of undernutrition, Paraguay is at the opposite end of the scale, with about 47 thousand cases. At the same time, however, deaths associated with underweight account for a relatively large share of total deaths in the cohort, more than 11%.



Source: Authors' compilation based on official health statistics, latest national survey available in each country, CELADE population and mortality estimates and estimates of differential relative risks (DP) by Fishman et al.

1.2 Health costs

The institutional costs (those incurred by the health-care system) and private health costs incurred as a result of treatment sought for pathologies associated with undernutrition¹⁷ in children under five amount to US\$ 116.5 million, equivalent to US\$ 228 for each child suffering from undernutrition.

¹⁷ In the case of public costs, indicators were estimated based on information reported by various agencies of the health ministries. Private costs were estimated using the official minimum wage and urban public transportation fares.

The costs are concentrated among children aged 24 to 59 months (48%), even though that group represents a higher percentage of the population, thus, it derives a lower unitary cost than the cost of undernutrition among children aged 0 to 23 months. It is followed by children between one and two years of age (31%) and those aged one to 11 months (10% to 11%). This distribution is valid only for the countries as a group. Within each country, the distribution varies considerably, reflecting the particular epidemiological characteristics as well as the operating costs of the country's health-care system and those borne by its citizens.¹⁸

When the countries are compared, it can be seen that in terms of purchasing power parity (PPP), there are significant differences in health costs. These may reflect the differences in the amount of resources each country devotes to combating undernutrition. Thus, for example, the estimated cost for Paraguay is six times higher than that of Ecuador and four times higher than the Plurinational State of Bolivia's, whereas the number of underweight boys and girls under five is one third times than that reported in Ecuador and 2/5 times higher than the Plurinational State of Bolivia's.

The highest unit cost in PPP dollars is found in Paraguay, where it is nearly 21 times greater than the equivalent cost in Ecuador and nine times higher than in the Plurinational State of Bolivia. Thus, although Paraguay has one of the lowest prevalences and reports the smallest number of cases of all the countries, it has the highest adjusted unit cost.

TABLE III.5
HEALTH COSTS OF UNDERWEIGHT, PER COUNTRY, 2005

Age group	Country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Total (Millions of dollars)	13.8	14.8	35.1	52.8	116.5
Total (Millions of PPP dollars)	37.9	23.3	136.0	112.3	
Newborn	0.4	16	27	2	11
1 to 11 months	17	15	6	9	10
12 to 23 months	50	40	20	32	31
24 to 59 months	33	29	47	57	48
Cost per child suffering from undernutrition (dollars)	144	119	1 004	236	241
Cost per child suffering from undernutrition (PPP dollars)	405	188	3 893	493	
Percentage of public expenditure on health	4.3	3.4	41.2	4.4	5.7
Percentage of GDP	0.15	0.04	0.5	0.07	0.09

Source: Authors' compilation, based on official morbidity data and health costs recorded in each country; Public Social Expenditure, ECLAC database.

In 2005, the health cost in the four countries analysed reached an average of 0.09% of GDP and 5.7% of public expenditure on health, and the highest figures were reported in Paraguay. Thus, not only is the equivalent value in those countries higher, but it represents a

¹⁸ The system costs include consultation, treatment (procedures and medications), hospitalization and use of the infrastructure. Private costs include the travel and time involved. In other words, the administration of the health-care system is not taken into account, given the difficulty of attributing specific administrative costs to certain pathologies. Therefore, the costs reflected here underestimate the costs to the system.

larger share of national resources and of those allocated to the sector, though the costs are not as high as in some Central American countries.

In looking at the origins of these costs, we see that on average, public costs amount to 46.1% of the total. According to official data, private costs are significantly higher in Peru, where they account for 82.2% of total health-care costs. Paraguay is in second place, with high proportions even though they are relatively smaller, at 45.7%. Private costs in the other countries represent a relatively smaller share, between 5.1% and 16.4%.

2. Undernutrition and education

Boys and girls suffering from undernutrition face a greater risk of falling ill and a lag in their ability to learn, associated with limited cognitive development. This increases the likelihood that they will start school late, miss classes, perform poorly, repeat grades and drop out. Thus, child undernutrition leads to lasting educational disadvantages that are exacerbated when access to food continues to be limited during the school-age years. These disadvantages also bear a strong correlation to micronutrient deficiency.

The effects and costs resulting from underweight in the specific cases of the Plurinational State of Bolivia, Ecuador, Paraguay and Peru were analysed using information from official statistics and household surveys in each country, along with data from the United Nations Educational, Scientific and Cultural Organization (UNESCO) and CELADE population data.

2.1 Effects on education

Applying special processing techniques to longitudinal data on the vulnerable population (ECLAC, 2006), it has been possible to estimate the effects of undernutrition on educational outcomes.

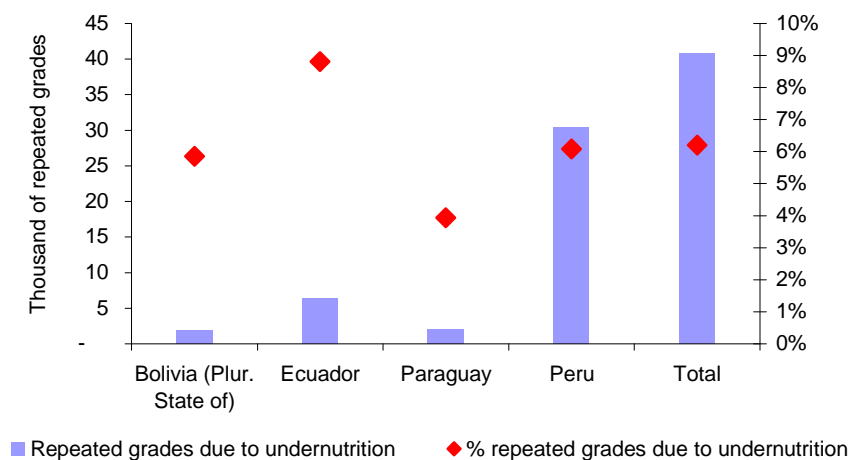
Among the countries studied, the population not suffering from undernutrition repeats grades at an average rate of 1.9% in primary education and 2.9% in secondary education. Of children who did suffer from undernutrition, an average of 3.2% of those attending primary school fail grades at that level, and 4.8% of those who attend secondary education fail grades. In both groups, Peru has the highest proportions of repeated grades in primary education (over 50% above the average), and at the secondary level (around twice the average).

The total number of children repeating grades for reasons associated with undernutrition was 40.816 in 2005 (two thirds occurring in primary school). Figure III.8 shows that this represents 6.2% of the total number of repeated grades in the countries educational systems that year. Ecuador has the largest proportion of such cases, with nearly 9% of those repeating grades having suffered from undernutrition. It is followed by Peru and the Plurinational State of Bolivia, which have about 6%.

As a result of the different population sizes, undernutrition rates, and education coverages and outcomes, 75 of every 100 students repeating grades in the four countries are Peruvian and 16 are ecuatorian, only five are Bolivian and Paraguayan.

As for dropout rates, for the countries as a whole, 59% of students who have not suffered from undernutrition will fail to complete primary school, and 57% of those in the same category who enter secondary school will drop out. Among those who have suffered from undernutrition, these percentages are markedly higher: 77% for primary education (above 50% in the four countries) and 81% for secondary education. In Ecuador and Paraguay, the latter figure is above 90%.

FIGURE III.8
GRADE REPETITION ASSOCIATED WITH UNDERWEIGHT, BY COUNTRY, 2005



Source: Authors' compilation, based on official data from the countries.

From a historical perspective, it is estimated that just over two million citizens of the southamerican countries analysed who were part of the WAP in 2005 had dropped out of school as a consequence of underweight, which translates into an education gap that amounts to 2.4 years of school¹⁹ compared to students who did not suffer from undernutrition. Thus, the latter average 6.8 to 7.7 years of schooling, while the population suffering from undernutrition averages between 4.0 and 5.1 years of education.

2.2 Education costs

Education costs have been estimated on the basis of the private and public values reported for this sector in each country. Among them, costs derived from additional education activities made necessary by repeated grades figure prominently.

Estimates for private costs are derived from the average per-student cost of inputs not provided by the school system, at values prevailing in the public materials provision programme, and from the transportation costs required to go to school,²⁰ based on current urban rates in each country.

Estimates for the public system are derived from records reflecting the operation of the system per student per academic year.²¹ Among these costs, the use of the infrastructure and equipment of the establishments making up the country's education system is taken into consideration whether the ultimate provider is public or private.

Considering the values indicated, the fact that nearly 41.000 additional students were in school in 2005 because of the differential rates of grade repetition produced by undernutrition in the four countries translates into US\$ 15.6 million in current dollars. This total amounts to 0.36% of public expenditure on education and 0.01% of the aggregate GDP for that year. Peru has the highest number of repeated grades, and thus bears the highest cost (US\$ 10 million). In terms of

¹⁹ This gap takes into account only the primary and secondary levels of education.

²⁰ Two trips per day are assumed for each student, whether the student traveled alone or with an accompanying adult.

²¹ This cost includes subcategories of costs by grade and education level.

purchasing power parity, also Peru has the highest costs (US\$ PPP 21.6 million), followed by Ecuador with less than half of the total cost.

TABLE III.6
EDUCATION COSTS OF UNDERWEIGHT, PER COUNTRY, 2005

	Country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Total (Millions of dollars)	0.4	4.2	0.8	10.1	15.6
Total (Millions of PPP dollars)	1.1	6.6	3.2	21.6	
Percentage of cost in primary education	44	60	96	60	62
Percentage of cost in secondary education	56	40	4	40	38
Percentage of public expenditure on education	0.06	0.44	0.28	0.42	0.36
Percentage of GDP	0.00	0.01	0.01	0.01	0.01

Source: Authors' compilation, based on official data and education costs recorded in each country; Schooling, household survey in each country; Public Social Expenditure, ECLAC database.

As showed in table III.6, the highest cost is seen in primary education (62%). The figures for Ecuador and Peru are consistent with this average, but not those of Paraguay, where 96% of education costs are in primary education. Furthermore, in the Plurinational State of Bolivia the figure is just 44%.

Comparing these results with the educational coverage rates published by UNESCO, this situation could just be a reflection of the low coverage of secondary education in these countries, where the average is only a little more than half that of primary education. While all the countries together report official coverage figures of 94% to 97%, the two countries with the highest secondary school coverage are the Plurinational State of Bolivia and Peru (73% and 70%, respectively).

3. Productivity

3.1 Effects on productivity

As indicated in the conceptual model used for this study, one effect of undernutrition is the loss of human capital. The countries' labour force may lose productivity because of the lower skill level attained by the population surviving child undernutrition, the greater probability that this population will drop out of school, or the higher incidence of mortality due to pathologies associated with undernutrition.

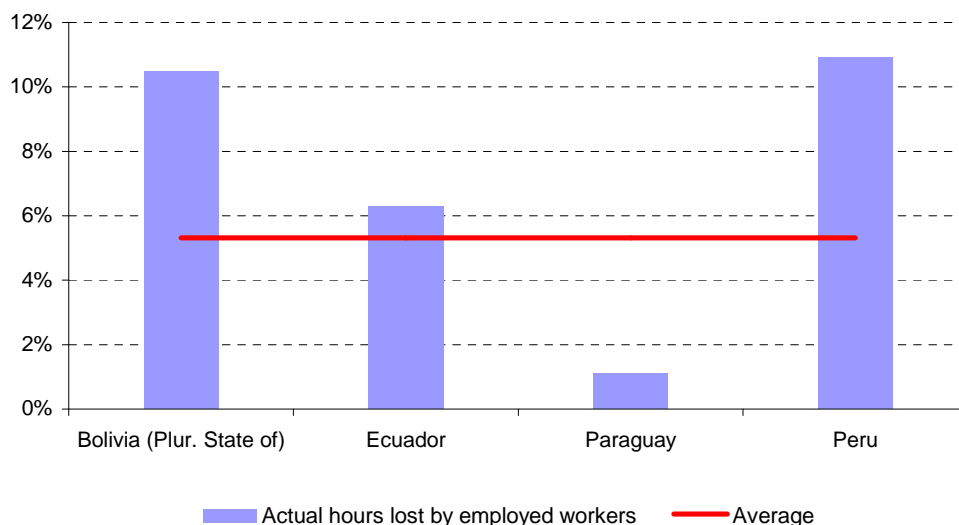
Poor school performance by boys and girls affected by undernutrition at an early age, compared with those not suffering from it, leads to higher attrition rates. Consequently, there is an average education gap of between 1.9 and 2.8 years in the countries analysed, which limits the production capacity of these individuals and reduces their potential earnings.

Mortality associated with undernutrition, on the other hand, causes a direct economic loss to society, because that boy or girl will fail to reach working age. Based on the analysis presented in point 1.1.2, of a total of 2.8 million deaths due to undernutrition, it is estimated that two million persons would today belong to the working age population (WAP) if not for

undernutrition, as they would be between 15 and 64 years of age in 2005. This total represents 5.9% of the WAP in the subregion in that year.

As can be seen in figure III.9, in keeping with the magnitude of its nutrition problem, Peru has suffered the greatest impact on its production capacity (10.9%), followed closely by the Plurinational State of Bolivia (10.5%). At the opposite end of the spectrum is Paraguay with only 1.1%, while Ecuador is in the middle with a loss equivalent to 6.3% of its productivity capacity.

FIGURE III.9
EFFECT OF UNDERNUTRITION ON THE EAP OF EACH COUNTRY, 2005



Source: Authors' compilation, based on the latest household survey available for each country.

Considering the effective employment rate of the WAP and the average number of hours worked by employed persons²² in each country, it is estimated that the four countries lost a total of 3.1 billion hours of labour in 2005, equivalent to 5.3% of the total hours worked by the economically active population (EAP)²³ in the subregion.

3.2 Productivity costs

The highest productivity costs arising out of undernutrition are derived from the economic value of the working hours lost due to mortality and lower levels of education.

Based on the data presented above, in the four countries analysed the loss of productivity due to mortality associated with undernutrition is valued at US\$ 4.199 billion, of which US\$ 1.781 billion corresponds to lost productivity due to fewer years of education and US\$ 2.418 billion to mortality-caused productivity losses. In other words, for every US\$ 10 of productivity lost due to undernutrition, US\$ 6 corresponds to that caused by mortality and US\$ 4 to that caused by education deficiencies. As table II.7 shows, these averages are borne out in three countries analysed; only Paraguay shows a different distribution.

²² Declared in household surveys.

²³ All men and women aged 15 to 64 years who work or are looking for work are considered to be in the EAP.

When the cost is compared from one country to another, Peru has the highest productivity cost associated with undernutrition, with 55.5%; it accounts for 47.3% of the cases. The Plurinational State of Bolivia, in contrast, has 19.6% of the cases but represents 12.8% of the aggregate cost.

TABLE III.7
ESTIMATED PRODUCTIVITY COST OF UNDERWEIGHT, 2005

	Country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Total (Millions of dollars)	537.8	1 217.5	113.3	2 330.5	4 199.1
Total (Millions of PPP dollars)	1 474.8	1 916.7	439.4	4 961.7	
Cost due to lower levels of education	219	578	73	910	1 781
Cost due to mortality	319	640	40	1 419	2 418
Percentage of GDP	5.7	3.3	1.6	2.9	3.2

Source: Authors' compilation, based on official data and education costs recorded in each country; Income and schooling, from household surveys in each country.

The cost of lost productivity is equivalent to 3.2 points of the cumulative GDP of all four countries in 2005. When the proportions are analysed by country, three different categories can be identified: the highest percentage is seen in the Plurinational State of Bolivia, with nearly 6%, followed by Ecuador and Peru, where the cost amounts to about 3% of GDP, and in the third category is Paraguay, with 1.6%.

4. Summary of effects and costs

Combining all the estimates for each of the four countries analysed in this study, the total cost of underweight in 2005, as a result of the undernutrition that has prevailed in the last six decades, amounts to nearly US\$ 4.331 billion, equivalent to 3.3% of the aggregate GDP of these countries in 2005.

Peru accounts for 55% of that amount, even though it had 45% of the population under five and of those suffering from undernutrition during that period. Ecuador, in second place, accounts for 29% of the total cost, with 22% of its population in the under-five cohort and 25% suffering from undernutrition. It is followed very closely by the Plurinational State of Bolivia, with 13% of the total cost, 20% of the population and of the total number suffering from undernutrition. At the opposite end of the spectrum is Paraguay, with 3% of the cost. With 8% of its population suffering from undernutrition during the period, it has the lowest unit costs of all the countries analysed.

With respect to each country's GDP, given the weight of productivity in total costs, the distribution is similar to that described above for each country.

And finally, when the amounts indicated above are compared with each country's public social expenditure, the average is 36%, with a high of 53% in Ecuador and a low of 25% in Paraguay.

When the costs are broken down, productivity costs as a whole account for 97%, with mortality representing 56% and lower education levels representing 41% within that category.

Health costs are only 2.7% of the total, and education costs less than 1%. These proportions vary from one country to another, but in general the distribution patterns remain constant, with the exception of Paraguay. In that country, losses due to mortality are significantly lower, whereas health and productivity costs due to lower education levels are relatively greater.

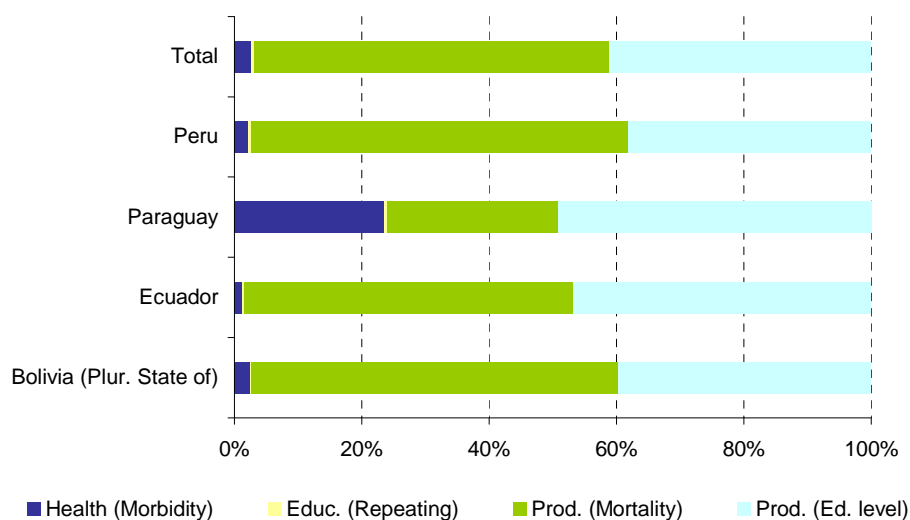
TABLE III.8
ESTIMATED TOTAL COST OF UNDERWEIGHT, 2005

	Country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Total (Millions of dollars)	552.0	1 236.5	149.2	2 393.4	4 331.1
Total (Millions of PPP dollars)	1 514	1 947	579	5 096	
Percentage of GDP	5.8	3.4	2.0	3.0	3.3
Public Social Expenditure	31.8	53.2	24.6	34.1	

Source: Authors' compilation, based on official data from the countries and ECLAC: Social Expenditure database.

Thus, for three of the four countries analysed, it can be concluded that if we know the size of the population under five with low weight for their age and the correlations between undernutrition and the two dimensions of productivity, we can estimate more than 95% of the costs incurred in a given country. This estimation is not representative for Paraguay, which present the lowest prevalence of underweight.

FIGURE III.10
DISTRIBUTION OF UNDERWEIGHT COSTS IN THE COUNTRIES
(INCIDENTAL RETROSPECTIVE DIMENSION, 2005)
(In percentages)



Source: Authors' compilation.

C. Effects and costs in the cohort aged 0-59 months in 2005: analysis of the prospective dimension

1. Health effects and costs

Based on the population census data for each country, it is possible to estimate that in the cohort aged 0 to 59 months in 2005, just over 52,000 deaths associated with underweight will occur, with 21,039 cases (41%) in 2005.²⁴

Given the greater incidence of undernutrition in Peruvian boys and girls compared to their counterparts in the other countries, just over one half of the associated deaths can be expected to occur among them; one in four of these cases will be in the Plurinational State of Bolivia. In contrast, only 5% of the cases correspond to Paraguayan children.

Considering the total number of cases in the four countries, 17% of the deaths can be expected to occur before the first birthday, although the figure rises to 24% in Ecuador and Paraguay, around 21% in the Plurinational State of Bolivia and 13% in Peru. Thus, although undernutrition is at its most lethal during the first year of life, 83% of all cases occur in the remaining four years of the cohort.

The estimated impact on the morbidity of underweight children under five in 2005 amounts to nearly 138,000 cases, nearly 66% of which are expected to occur in 2005 and the rest between 2006 and 2009. This does not take into account the direct impact on treatments required for children with undernutrition to recover, which is 26,000 due to LBW_{IUGR} and 756 thousand due to underweight.

TABLE III.9
MORTALITY ASSOCIATED WITH UNDERWEIGHT IN CHILDREN UNDER FIVE, 2005-2009

	Country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Total	12 438	5 743	2 824	30 749	51 754
0 to 11 months	2 558	1 405	691	4 004	16.7
12 to 59 months	9 880	4 338	2 133	26 745	83.3
%	24	11	5	59	100

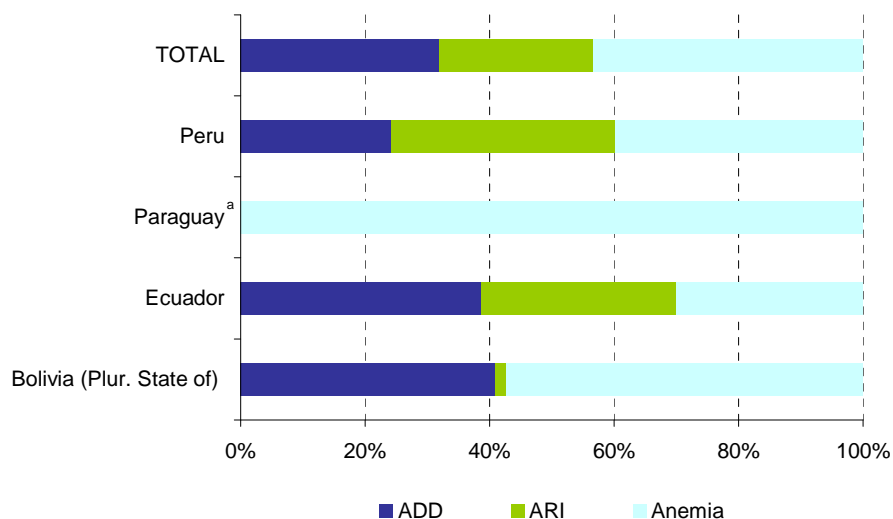
Source: Authors' compilation, based on CELADE population and mortality statistics, relative risks reported by Fishman et al, and the prevalence of undernutrition according to the latest national nutrition survey available for each country.

As can be seen in figure III.11, most of the additional cases of disease correspond to anemia, reaching a total of 43% for all countries and 57% in the Plurinational State of Bolivia. ADDs amounts to 32% of the total, and in the Plurinational State of Bolivia, where it is more prevalent, the figure is 41%. ARIs represent 25% of all associated diseases, with the greatest relative presence in Peru and Ecuador (36% and 31%, respectively).

²⁴ All estimates for the cohort aged 0-four years in 2005 will gradually decrease through 2009 as a result of the members moving up into higher age groups.

In light of the information compiled, it is not possible to identify patterns in the morbidity consequences in the different countries. Therefore, each case needs to be followed up specifically to minimize the adverse impacts of undernutrition.

FIGURE III.11
DISTRIBUTION OF ADDITIONAL CASES OF DISEASE DUE TO UNDERWEIGHT, 2005-2009



Source: Authors' compilation based on official health statistics, CELADE population estimates, latest national nutrition survey available in each country, and estimates of differences in prevalence (DP).

^a For Paraguay, only information on anemia is available.

In general, the distribution pattern of morbidity is similar to that of undernutrition. The bear due to morbidity is higher in Peru with 51% which is consistent with the number of undernourished Peruvian's children on the estimation.

When analysing the distribution of disease cases by age group, it can be seen that more than 58% are found among children aged 24 to 59 months, within countries, Peru and the Plurinational State of Bolivia have more cases older than 24 months, while Ecuador and Paraguay concentrate cases among children aged 0 to 23 months.

TABLE III.10
MORBIDITY CASES ASSOCIATED WITH UNDERWEIGHT, 2005-2009

	Estimate per country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Total (N)	46 142	24 148	295	67 207	137 793
0 to 11 months (in %)	6	20	16	8	10
12 to 23 months (in %)	36	28	37	31	32
24 to 59 months (in %)	57	52	48	61	58
%	33.5	17.5	0.2	48.8	100

Source: Authors' compilation based on official health statistics, CELADE population estimates, latest national nutrition survey available in each country, and estimates of differences in prevalence (DP).

The cost to the health sector of the added burden of diseases caused by undernutrition in 2005 is estimated at a present net value (PNV) of US\$ 166 million,²⁵ which includes both diseases associated with undernutrition and the recovery of individuals suffering from undernutrition. This is particularly important in the cases associated with intrauterine growth restriction in countries with lower levels of undernutrition, such as Paraguay.

Accordingly with its population size and the undernutrition prevalence, nearly half of the aforementioned costs are incurred in Peru. Thus, while undernutrition in that country represents 47% of the total for all the countries and associated diseases account for 49% of the total, the resulting costs are equivalent to 47%.

The above-mentioned values are based on an equivalent annual cost (EAC)²⁶ of nearly US\$ 50 million for the 2005-2009 period for the four countries combined, which represents one eighth of public expenditure on health in 2005 and 0.04% of GDP for that year. These proportions are significantly higher in Paraguay.

TABLE III.11
ESTIMATED COST OF MORBIDITY ASSOCIATED WITH UNDERWEIGHT, 2005-2009

	Estimate per country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Perú	
Present value (millions of dollars)	21.3	21.1	45.6	78.2	166
Total (Millions of PPP dollars)	58.3	33.2	176.9	166.6	
EAC (Millions of dollars)	6.4	6.4	13.8	23.6	50.2
% of public expenditure on health	2.0	1.4	16.2	2.0	2.4
% of GDP	0.07	0.02	0.17	0.03	0.04

Source: Authors' compilation, based on official morbidity data and health costs recorded in each country; Public Social Expenditure, ECLAC database.

2. Education effects and costs

By projecting the characteristics of the educational process may have for boys and girls in the four countries analyzed under the age of five in 2005,²⁷ it is possible to estimate the number of students who may have to repeat grades in the future due to underweight and its associated costs. For this purpose, the differential probability estimates of scholastic achievement, described in the preceding chapter, are used.

Among the four countries analysed, it is predicted that between 2008 and 2023 there will be over 25 thousand additional cases of repeated grades, about 83% of which will be in primary school. In the specific case of the Plurinational State of Bolivia, 44% of the population that suffers from undernutrition repeated grades in primary, while 56% in secondary school. Based on official information, in Paraguay the cases of repeated grades in both populations (suffering from undernutrition and not suffering) in primary school is 99%.

²⁵ With an annual discount rate of 8%.

²⁶ Ibid.

²⁷ This projection is based on education coverages of the school-age population and educational levels achieved by the cohort aged 20 to 24 as of the latest household survey for each country.

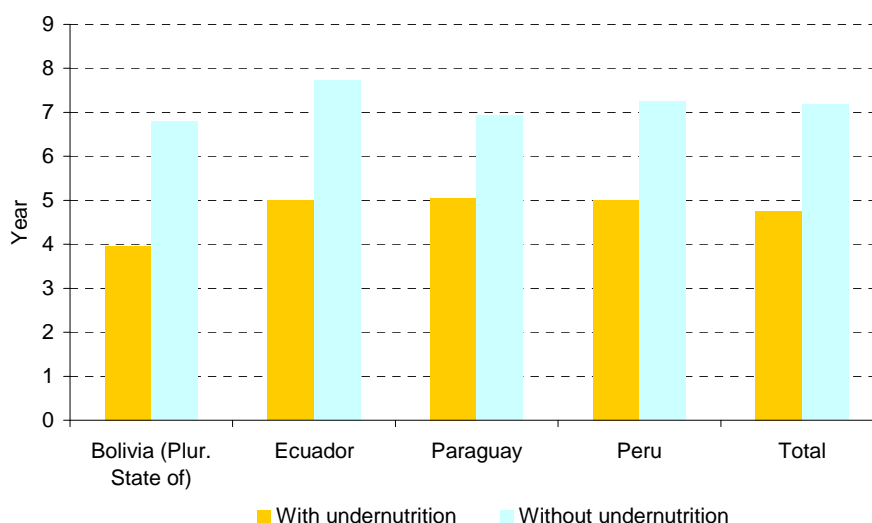
Given the different combinations of undernutrition, education coverage and school completion rates, in three of the four countries between 960 and 2,600 cases are projected, amounting to 20% of all cases. Peru accounts for 80% of the cases.

TABLE III.12
REPEATED GRADES AND ATTRITION ASSOCIATED WITH UNDERWEIGHT, 2005-2009

	Estimate per country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Total repeaters	1 482	2 590	964	20 371	25 408
%	5,8	10,2	3,8	80,2	100.0
Total dropouts	22 732	64 766	13 127	32 771	133 396
%	17,0	48,6	9,8	24,6	100.0

Source: Authors' compilation, based on official education data and household surveys in each country.

FIGURE III.12
**AVERAGE LEVEL OF EDUCATION ESTIMATED FOR THE COHORT
AGED 0-59 MONTHS IN 2005, WITH AND WITHOUT UNDERWEIGHT**



Source: Authors' compilation, based on household surveys in each country.

As we can observe in table III.13, it is estimated that nearly 133 thousand future students will drop out of school early as a consequence of the undernutrition affecting them in 2005, which suggests an average difference of two years in the schooling of those suffering from undernutrition and those who are not, in the 11 or 12 years that make up the countries' school requirements. The range is from 1.3 years in Peru to approximately 2.3 years in Ecuador.

TABLE III.13
ESTIMATED COST OF GRADE REPETITION ASSOCIATED
WITH UNDERWEIGHT, 2005-2009

	Estimate per country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Present value (Millions of dollars)	0.13	0.89	0.24	3.30	4.6
Present value (Millions of PPP dollars)	0.35	1.40	0.93	7.02	
EAC (Millions of dollars)	0.01	0.10	0.03	0.39	0.5
% of public expenditure on education	0.00	0.01	0.01	0.02	0.01

Source: Authors' compilation, based on official data and education costs recorded in each country; Schooling, household survey in each country; Public Social Expenditure, ECLAC database.

As a result of the additional repeated grades estimated for the cohort, education costs expressed in present value (at a discount rate of 8%) are estimated at US\$ 4.6 million in 2005 dollars. The equivalent annual cost (EAC) for the period of 15 to 16 years during which the cohort under study would be of school age (2007-2022), would be US\$ 0.5 million in 2005 dollars, which would represent 0.01% of the public expenditure allocated to education in the countries of the region in 2005.

3. Productivity effects and costs

As it was mentioned above, one direct consequence of the schooling gap caused by undernutrition in the first years of life can be seen in workers' productivity. Their reduced human capital affects their individual well-being as well as the economic capacity of society as a whole.

In addition, taking into account the 51.754 young people who will die as a result of undernutrition in the southamerican countries analysed between 2005 and 2009, it is possible to estimate a potential loss of 4.816 million hours of work in what would have been their working life (between 2015 and 2069).

The impact of the underweight prevailing in 2005 on the productive population of the countries analysed is estimated at losses equivalent to US\$ 388 million due to the education gap and US\$ 173 million due to mortality, at present 2005 values. Thus, the productivity losses in the cohort would amount to US\$ 562 million.

Considering the entire period in which these values would be produced (2015-2069), the equivalent annual cost is approximately US\$ 46 million. Of that total, US\$ 32 million corresponds to losses due to lower levels of education and US\$ 14 million represents mortality costs.

As shown in table III.14, the loss of productivity is equivalent to 0.03% of the four countries' GDP in 2005. There are significant differences among the countries, ranging from 0.02% in Ecuador to 0.06% in Paraguay.

Furthermore, these figures represent 0.4% of total public social expenditure in 2005. Whereas in Peru and the Plurinational State of Bolivia this cost amounts to about 0.3%, in Paraguay it is around 0.8%.

TABLE III.14
ESTIMATED PRODUCTIVITY COST OF UNDERWEIGHT, 2005-2009

	Estimate per country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Present value (Millions of dollars)	81.2	155.5	61.8	264.1	562.6
Present value (Millions of PPP dollars)	222.6	244.8	239.6	562.3	
EAC (Millions of dollars)	6.6	12.6	5.0	21.4	45,7
% of Public Social Expenditure	0.4	0.5	0.8	0.3	0.4
% of GDP	0.07	0.03	0.06	0.03	0.03

Source: Authors' compilation, based on official data and education costs recorded in each country; Income and schooling, Public Social Expenditure and household surveys in each country.

4. Summary of effects and costs

The costs of underweight for the cohort of boys and girls under the age of five in 2005 in the four countries analysed can be projected at a present value of US\$ 733 million, 71% of which will be generated in Peru and Ecuador, 29% is distributed equally among the other two countries analyzed.

In terms of purchasing power parity (PPP), the equivalent value is significantly lower in the Plurinational State of Bolivia and Ecuador.

The equivalent annual cost for the 65-year period over which the various estimated values are distributed is nearly US\$59 million. On average, this cost represents 0.5% of public social expenditure and 0.04% of GDP in 2005. These proportions are the highest in Paraguay, at 1.4% of social expenditure and 0.11 GDP points.

TABLE III.15
PROJECTED COST OF UNDERWEIGHT IN CHILDREN UNDER THE AGE OF FIVE IN 2005

	Estimate per country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
Present value (Millions of dollars)	103	178	108	346	733
Present value (Millions of PPP dollars)	281	279	417	736	
EAC (Millions of dollars)	8.3	14.3	8.7	27.8	59.1
% of Public Social Expenditure	0.5	0.6	1.4	0.4	0.5
% of GDP	0.09	0.04	0.11	0.04	0.04

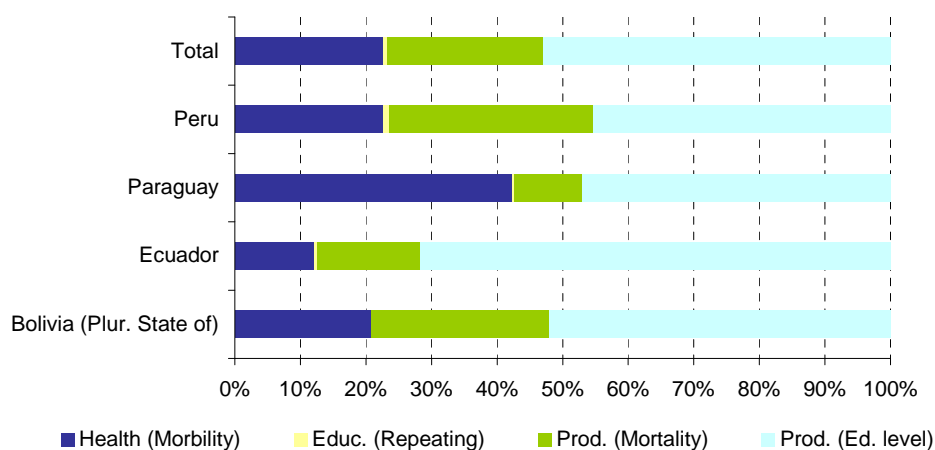
Source: Authors' compilation, based on official data from the countries and ECLAC: Public Social Expenditure database.

The breakdown of costs reveals that the loss of productivity is the principal source of costs derived from underweight, accounting for over 70% of them at the subregional level. The situation is even more marked in the Plurinational State of Bolivia, Ecuador and Peru, where the loss of

productivity represents about 80% of these costs. In Paraguay represented around one half of the total cost.

The cost associated with repeated grades in school is less than 1% of the total, though it is higher in Peru. In contrast, health costs exceed 23% of the total, reaching over 40% in Paraguay.

FIGURE III.13
DISTRIBUTION OF UNDERWEIGHT COSTS IN THE COUNTRIES
(PROSPECTIVE DIMENSION, 2005)



Source: Authors' compilation.

When this distribution is compared with that found in the incidental retrospective dimension, a significant difference can be seen; in both cases, however, the greatest costs are seen in productivity. Whereas in the incidental retrospective dimension, mortality and education levels have a similar weight, in the projective analysis the latter has a weight nearly seven times higher than the former in cases such as Ecuador and Paraguay.

5. Analysis of scenarios: costs and savings

Relying on the databases and procedures used to estimate the effects and costs with the prospective dimension of analysis in the four countries, a number of different scenarios can be projected. Below are the results of the simulations corresponding to three undernutrition scenarios and their effects on costs for 2015:

1. The latest figures available on the prevalence of underweight used in this study remain the same in 2015.
2. The Target established in the Millennium Development Goals for reducing underweight in each country to half the 1990 figure is attained in 2015.
3. Underweight is eradicated in the country by 2015, which for purposes of this analysis means achieving a prevalence of 2.5%, the "normal" proportion of cases according to the measurement parameters published by the National Centre of Health Statistics (NCHS).

Table III.16 shows the estimated costs for the three scenarios, considering not only the prevalence of undernutrition but also the effect of the variation in population size of the cohort and mortality projections²⁸, with all other variables remaining constant.

TABLE III.16
ESTIMATED COST OF UNDERWEIGHT FOR THE BASE YEAR AND THREE SCENARIOS
(Present value in millions of dollars; 2005 and 2015)

	Country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay ^a	Peru	
2005	103	178	108	346	733
No change in prevalence	102	172	116	338	729
MDG achieved (50% of 1990)	88	160	65	266	579
Eradication (2.5%)	36	56	65	127	284

Source: Authors' compilation.

^a Given that the MDG target calculated for Paraguay implies an undernutrition prevalence that is less than the value considered to be eradication, the costs for that scenario have been estimated as equivalent to those of the third scenario.

In scenario 1, the cost in 2015 would be about 1% lower than in 2005. The reduction is the result of lower fertility and mortality rates in the countries' populations, which is primarily true of Peru, which has a significant proportion of the total cost. Paraguay, in contrast, is the only country where costs rise in this scenario, as a result of the growth of the population aged 0 to four years.

Should the countries achieve target 2 of the MDG, the cost in 2015 would be 21% less than in scenario 1. The major decrease in costs would be generated in Paraguay (44%) and the minor in Ecuador (7%). The wide range of the reduction of costs within countries reflects the differences related to demographic and epidemiological transition.

Finally, the cost of underweight in 2015 if a prevalence of 2.5% is achieved would be 61% less than in scenario 1. Nearly US\$ 211 million of this reduction would be seen in Peru, where the equivalent cost would be less than 63% of the scenario 1 cost without any changes in the prevalence. The Plurinational State of Bolivia would follow with a 65% decrease.

Based on the cost trends shown, it is possible to estimate potential savings that would be generated as soon as actions aimed at achieving the targets are initiated.

As indicated in figure III.14, the potential savings resulting from a year-to-year comparison between scenarios 2 and 3 and scenario 1 rise steadily over time. The savings generated in 2006, in yearly adjusted dollars, would be more than four times greater by 2015 in scenario 2, rising from US\$ 16 million to US\$ 69 million.

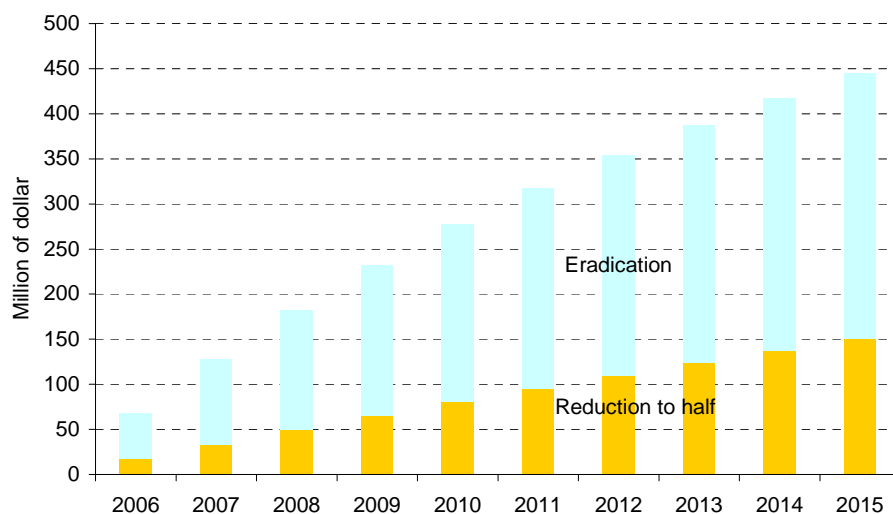
If eradication is achieved, the growth rate is somewhat smaller, just over three times, but savings would total US\$ 206 million by the end of the period. Both scenarios would continue yielding savings, but at declining growth rates. Future benefits from the eradication of undernutrition can be expected to stabilize.

As of 2005, the present value of yearly savings during the period under study for the four countries would be US\$ 1,708 million if eradication were achieved. According to each country's

²⁸ According to CELADE estimates.

share of the cost, 48% of the savings would come from Peru, which would have generated 40% of the total saving by 2010.

FIGURE III.14
ESTIMATED YEARLY SAVINGS IN TWO UNDERNUTRITION SCENARIOS
IN ANDEAN COUNTRIES AND PARAGUAY, 2006-2015
(Millions of current dollars for each year)



Source: Authors' compilation.

If MDG1 target 2 is achieved, the resultant savings would be US\$ 516 million, of which Peru would account for 48%. By 2010 36% of the savings would already have been realized.

This implies that not only could costs be significantly lower in 2015, but major savings could be achieved throughout the process of attaining the proposed targets. In turn, if appropriate policies remain in place, the projected benefits could continue to accumulate beyond 2015.

The above is a reflection of the economic benefits to be gained from advancing towards the eradication of undernutrition in these countries. Any programme that manages to reduce the prevalence of undernutrition will not only have an impact on people's quality of life but will also yield major savings for society.

TABLE III.17
ESTIMATED SAVINGS ACCORDING TO SCENARIOS, 2005 TO 2015
(Present value in millions of dollars)

	Country				Total
	Bolivia (Plurinational State of)	Ecuador	Paraguay	Peru	
MDG achieved (50% of 1990)	50	42	179	245	516
Eradication (2.5%)	254	459	179	814	1 708

Source: Authors' compilation.

D. Conclusions and final comments

The model of analysis developed by ECLAC for estimating the effects and costs of undernutrition is being applied for the second time in this study, thus demonstrating once again the feasibility of implementing this type of experience with reliable results in the region.

Nevertheless, as shown in the study on the cost of hunger in Central America (ECLAC-WFP, 2007), important challenges remain with respect to methodology and information quality. These challenges must be overcome in order to improve this type of estimate and thereby enhance the reliability of risk projections and include complementary dimensions, such as deficiencies in micronutrients and other associated impacts.

The characteristics of the nutritional, epidemiological and demographic profile of the four countries analyzed mean that the estimated costs are lower in relation to their population size than those estimated for the Central American countries. However, they amount to approximately US\$4,300 million, equivalent to 3.3 points of aggregate GDP. This is a very high opportunity cost for their economies that restricts their productivity potential and limits their growth, thereby adding a new dimension to the need to place undernutrition at the first level of priority on the political agenda. This is especially true in view of the fact that this scourge is completely preventable.

Thus, the countries' stated commitment to eradicating hunger and undernutrition will involve major social impacts and yield significant economic savings. Most notably, since all of society will benefit, the challenge is shared by all.

This point is even more important in view of the current context, in which food prices are rising steadily and threaten to exacerbate the situation further. This point is even more important in view of the impact in social and economic vulnerability in the current context, where food prices were rising steadily until the middle of 2008, diminishing later, but increasing the risk due to financial and economic crisis, which threatens to exacerbate more the situation.

The international experience suggests that it is cheaper to invest in eradicating child undernutrition in the region than to suffer the social and economic consequences. To achieve this requires resources, technically well-defined policies and management models that maximize impact and efficiency. Moreover, all sectors of society must be committed and must participate actively.

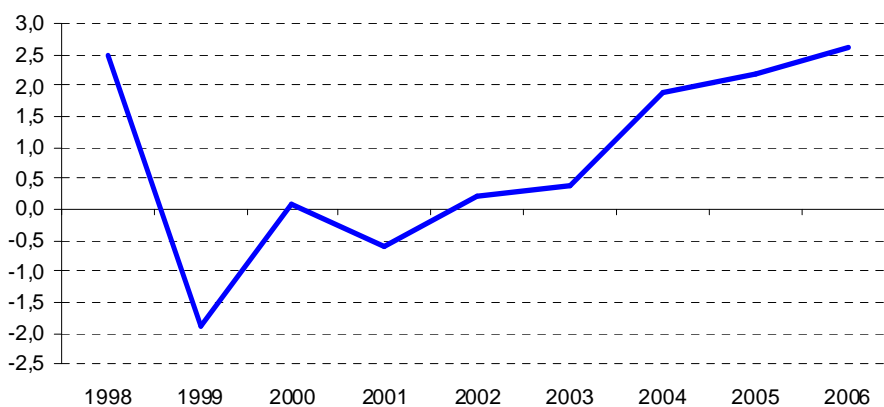
Finally, as it was outlined in the study of the Cost of the Hunger in Central America and Dominican Republic "The challenge the region faces next is to identify specific interventions that will allow it to maximize the impact and efficiency in each country and each region, while also strengthening systems to oversee management and evaluate impacts. This will mean that it can minimize risks and eradicate the scourge of hunger as soon as possible. This is not a short process, but a long-term endeavour that requires stable institutions, government policies and financing, with the involvement of all sectors. All of that requires all actors affected by this social problem, that is, all of society, to commit themselves fully."

IV. Results of study in the Plurinational State of Bolivia

A. Socioeconomic and nutritional background

In the year 2005 the internal gross product of the State Plurinacional of Bolivia reached to 9,441 million dollars, which in the light of nine million inhabitants they suppose 1,001 dollars per capita (equivalent approximately to 1,025 dollars of 2000). About the year 2006 the growth of the GDP overcome in 1.7% points the rate of growth of the decade, rising this way also the GDP per capita in 2.5%. From the year 2000 the rate of growth of the country has gone in rise, after the negative effects that the international crisis had in the period 1999 to 2001 in which it came to negative rates of growth (-1,9).

FIGURE IV.1
PLURINATIONAL STATE OF BOLIVIA: TRENDS IN PERCAPITA GDP, 1998-2006
(In percentages)



Source: Author's compilations base on Economic Study for Latinamerica and the Caribbean, 2008.

Regarding other economic indicators, the unemployment rate in the Plurinational State of Bolivia has been relatively constant between the year 2000 and 2006, in which it came to 8%. On the other hand, the consumer prices index has not showed an important variation in the last three years. The price increase that affected the country from 2001, was due in its first stage to the devaluation of the boliviano with regard to the dollar, in 2003 it was caused by the reduce of supply generated by the crisis, whereas in the year 2004 it would be consequence of the rise of prices of fuels and supply decrease of diesel (ECLAC, 2003b, 2005b, 2007b).

TABLE IV.1
PLURINATIONAL STATE OF BOLIVIA: TRENDS IN SOME
ECONOMIC INDICATORS, 2000-2006

	2000	2001	2002	2003	2004	2005	2006
Variation of the GDP	2.5	1.7	2.5	2.7	4.2	4.4	4.8
Private Consumption (% var.)	2.3	1.3	2.0	1.9	2.9	3.3	4.1
Change on net investment	-7.4	-17.5	17.9	-12.8	-11.8	26.9	-5.1
Total Exports (% var.)	15.0	8.4	5.7	12.2	16.6	8.3	11.3
Unemployment rate	7.5	8.5	8.7	9.2	6.2	8.1	8.0
Change on price index	3.4	0.9	2.5	3.9	4.6	4.9	4.9

Source: Author's compilations base on Economic Study for Latinamerica and the Caribbean, 2009.

The Plurinational State of Bolivia is a country with great ratios of poverty and indigence (ECLAC, 2005). According to household survey 2004 the incidence of the poverty reach 63.9% of the population, while in rural zones was higher (80.6%). Additionally, indigence reached 34.7 coming to 59% in rural zones.

According to the latest available estimates, based on the 2003 Demographic and Health Survey (known by its Spanish acronym ENDSA 2003),²⁹ 7.5% of the Bolivian children from one to 59 months of age was suffering form underweight –weight/age– in the moderate and severe categories.³⁰ In spite of significant progress made in relation to previous measurements, the country still exhibits a persistent vulnerability in the undernutrition issue.

The low weight for age affects almost five out of every 100 children under five years old, while sand 0.01 out of every 100 present intrauterine growth restriction.

Although there are still considerable levels of under-recording of information, pregnant women also suffers from serious undernutrition problems. In consequence, it can be said that the undernutrition cycle starts at the intrauterine life.

Regarding the risk of suffering from undernutrition in the early years of life, as highlighted by previous studies done in the region, in the Plurinational State of Bolivia the risk is greater over the first 24 months of life, with a subsequent decline and stabilization on the pre-school stage.

It should be highlighted that the most vulnerable population is represented by indigenous children living in rural areas. However, such problem does not appear only in those scattered areas, but in peri-urban areas as well.

²⁹ National Statistics Institute - Instituto Nacional de Estadísticas (INE), 2004

³⁰ To allow comparisons with other countries participating in the ECLAC and WFP Regional Initiative, the use of the weight/age indicator for child undernutrition was agreed upon.

TABLE IV.2
PLURINATIONAL STATE OF BOLIVIA: POPULATION AND UNDERWEIGHT

Age groups	Population size (2005)	Population affected (2005)	Undernutrition prevalence ^b (2003)
Newborn (intrauterine growth retardation - IUGR) ^a	264 311	3 144	1.2% ^c
0 to 11 months	264 311	10 282	3.9%
12 to 23 months	259 007	35 743	13.8%
24 to 59 months	755 960	50 725	6.7%
Total	1 279 278	99 893	

Source: Prepared in-house based on information from the Ministry of Health and Sports (MSD) of the Plurinational State of Bolivia, the ENDSA surveys and estimates of the Latin American and Caribbean Demographic Center (CELADE).

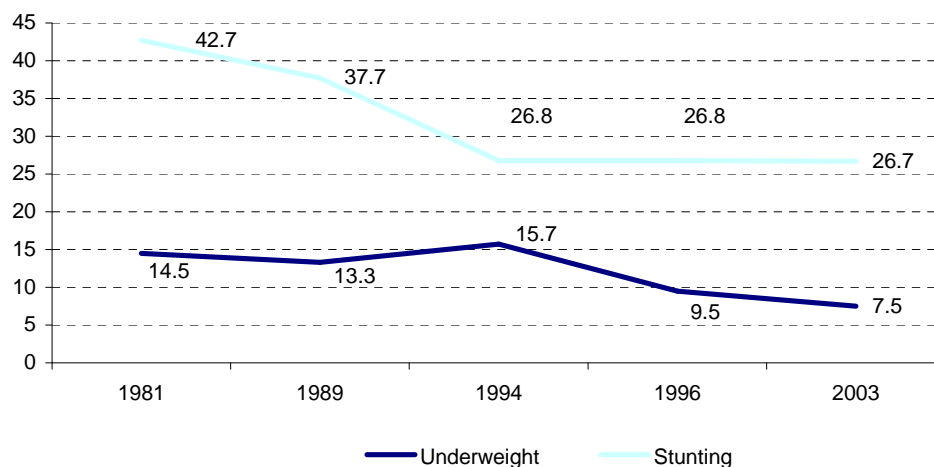
^a In a given year, the newborn population is the same as the 0-11 month's age group.

^b Data estimated from the most recent undernutrition prevalence figure available.

^c Estimated on the basis of the equation of De Onis et al, 2003.

As it is shown in figure IV.2, over a 14-year period, the undernutrition rate in Plurinational State of Bolivia has followed a sustained decrease, with higher intensity as of 1994, and staying relatively stable –above 7.5%– since 1998.

FIGURE IV.2
PLURINATIONAL STATE OF BOLIVIA: ESTIMATED UNDERNUTRITION TRENDS IN CHILDREN UNDER FIVE, 1981-2003^a

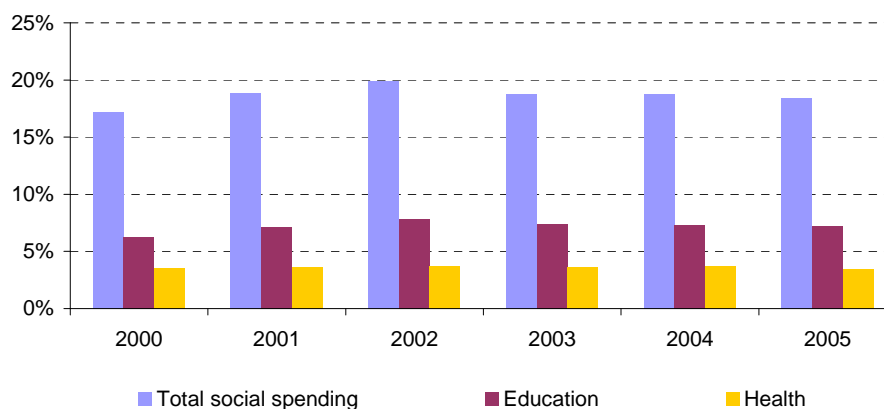


Source: Prepared in-house based on information from the MSD, National Institute of Food and Nutrition - INAN (1982), and the 1989, 1994, 1998 and 2003 ENDSA surveys.

^a Standards of the National Council Health Survey (NCHS).

In response to the problems of malnutrition, between the year 2000 and 2005 the Plurinational State of Bolivia devoted around 18.6% of GDP to the social public expenditure, with an average of 7.2% in education and 3.6% in health, representing both 58% of the whole. In relation to the GDP of every year, from 1990 the social total public expenditure increased in 48.2% (36% in education and 8% in health).

FIGURE IV.3
PLURINATIONAL STATE OF BOLIVIA: PUBLIC SOCIAL
EXPENDITURE BY SECTOR, 2000-2005
(As percentage of GDP)



Source: ECLAC, social expenditure database.

Within the framework of institutionalization of the nutrition and food policy in the Plurinational State of Bolivia, it is possible to highlight important advances made in the implementation of national actions to combat undernutrition during the most recent years.

In this sense, the National Council for Food and Nutrition (Spanish acronym: CONAN) was created on May 8th, 2003 by Supreme Decree 27029. Such body is in charge of promoting and coordinating inter-institutional and inter-sector participation for the formulation and follow up of national policies on food and nutrition.

Initially, CONAN was made up by representatives of several institutions, under the coordination of the First Lady Office.

In spite of its commitment with nutritional issues, such structure was not operational. For this reason, on the 5th of April 2006, by Supreme Decree 28667, the CONAN was repositioned with the following new objectives: to promote and coordinate the participation of public sector institutions and civil society in the formulation, dissemination and follow up of national policies on food and nutrition; and to promote the development of a national policy on food and nutritional security, aimed at the promotion of the human right of receiving appropriate nourishment and the eradication of undernutrition in the country.

CONAN is chaired by the President of the Republic of the Plurinational State of Bolivia and its members are the following ministers: Presidency; Development Planning; Finances; Health and Sports; Rural and Agricultural Development and Environment; Education and Culture; Production and Micro-businesses; Water; and Justice. Representatives of civil society participate as well. Nowadays, it is in process the approval of a new project of Supreme Decree that will include the Ministry of Work and Public Works, doing a whole of 11 departments.

The main attributions of CONAN, as the Supreme decree establish are:

- Promote the elaboration and implementation of the National Policy of sovereignty and Nutritional Food Security.
- To stimulate and coordinate the inter-institutional and inter-sector participation.

- To manage resources that are needed for the implementation and follow up to flow up of national policies on food and nutrition.
- To follow-up, monitoring and evaluation of the execution of the National Plan of Sovereignty and Food Nutritional Security.
- To propose other political strategies, programs and inter-sectorial, national and regional projects, in coordination with local authorities orientated to the achievement of the aims of the National Plan of Sovereignty and Food Nutritional Security.
- To instruct the conformation of technical commissions for the treatment of specific topics of sovereignty and food safety.

Structurally, CONAN has a Technical Secretariat under the responsibility of the MSD, and a Multi-Sector Technical Committee (CT-CONAN), composed of delegates from the nine abovementioned ministries, which are in charge of the elaboration and follow up of the policies defined by the CONAN.

At the departmental scale, the multi-sector instance for CONAN is the Departmental Council for Food and Nutrition (CODAN). Such council is chaired by the department's Prefect and composed by representatives of the different sector departmental services under the prefectures, representatives of civil organizations, social organizations, private enterprise, churches and universities, among other institutions. Each CODAN has also a Technical Secretariat managed by the Departmental Health Service (SEDES).

At the municipal context, the Municipal Council for Food and Nutrition (COMAN) is in charge of managing actions among sectors. Each COMAN is chaired by the municipality mayor and composed of representatives of social organizations, civil organizations, public and private institutions, private enterprise and churches part of the municipality. One of the main attributions of the COMAN is to promote and coordinate inter-sector, inter-institutional and civil society participation in the municipal context, in order to execute actions and optimize the resources of the programs and projects being developed at the municipalities.³¹

B. Effects and costs of underweight in 2005: analysis of the incidental retrospective dimension

As indicated in the methodology developed for these Studies, this dimension makes it possible to estimate and analyze the education, health and productivity effects and costs generated by undernutrition in a specific year, in this case 2005.

1. Undernutrition and health

1.1 Effects on health

Undernutrition at an early age predispose people to a higher risk for morbidities as well as mortality, which can be analyzed through probability differentials.

To estimate these effects, we have consulted data from epidemiological follow-up studies and official health statistics for the country, complemented by information gathered through interviews with national specialists.

³¹ CT-CONAN, 2008a.

1.2 Morbidity

In the Plurinational State of Bolivia, the effects of undernutrition on the morbidity rates of different associated pathologies –ADDs, ARIs and anemia, mainly– involved about 24 thousand cases out of the diseases registered during 2005; almost 10 thousand cases of ADDs, 643 ARIs and a little more than 13 thousand cases of iron deficiency anemia.³² Such a situation is derived from the prevalence differences.³³

Data referred to pathologies correspondent to critical nutritional deficiencies in calories and proteins, such as severe emaciation or marasmus and edema undernutrition or Kwashiorkor, reached in 2005 4,630 cases. The State Plurinacional of Bolivia is the second country of the region with the major quantity of reported cases.

1.3 Mortality

There are several pathologies through which undernutrition affects mortality, most notably diarrhea, pneumonia, malaria and measles. In order to limit errors derived from the inaccuracy and poor quality of the data obtained from official records on causes of death in the Plurinational State of Bolivia, the estimation of undernutrition impact was done considering the estimates from Fishman et al. (in *World Health Organization – WHO, 2004*) which define differential relative risks for all death causes in children younger than five years of age, together with mortality rates estimated by CELADE.

TABLE IV.3
PLURINATIONAL STATE OF BOLIVIA: MORTALITY OF CHILDREN UNDER FIVE
ASSOCIATED WITH UNDERWEIGHT, ADJUSTED TO THE SURVIVAL RATE, 1941-2005

Period	Number of dead children
1941-1950	69 268
1951-1960	79 973
1961-1970	90 611
1971-1980	94 763
1981-1990	66 441
1991-2000	45 614
2001-2005	15 855
Total	462 525

Source: ECLAC on the basis of CELADE`s population and mortality statistics, and relative risks estimated by Fishman et al.

On the basis of such estimates, it was found that in the Plurinational State of Bolivia, in a 64-year period (1941-2005), close to half million of children under five years of age died due to causes associated with undernutrition (table IV.3). Taking into account survival rates for the different cohorts under study, it was detected that more than 82% of children of that age group of the population would still have been alive in the year 2005 if they had not suffered from

³² In this study, estimates of effects and costs correspond to averages and are subject to the margins of error of the original data sources.

³³ Probability differences are the higher probabilities the malnourished have of presenting a given pathology as a consequence of their malnutrition.

underweight and, thus, they would have been part of the current working age population (WAP).³⁴ Likewise, it was estimated that out of the total of deaths occurred in population younger than five years old, in 2005, almost 16 thousand cases (18%) were associated with underweight.

In addition, between 1941 and 1990 undernutrition was responsible for the deaths of 401 thousand children under five who would be between 15 and 64 years of age in 2005, and therefore would be part of the working age population (WAP).³⁵ As indicated in section 3 of this chapter, this has a major impact on productivity in the country.

1.4 Health costs

Institutional –public system– and private health-related costs,³⁶ stemming from increases in the treatment of pathologies associated with undernutrition in children of less than five years of age, in 2005, were higher for the age group of children from 12 to 23 months of age (table IV.5): 35% of the population affected by undernutrition and 50% of the total health cost for that cohort. Nevertheless, the highest unitary costs are those of the newborn children with restriction of intrauterine growth (BPN_{RCIU}) due to the fact that the protocols of attention in this group of age are more expensive.

As shown in table IV.4, during 2005, the public and private health-related costs were 13.8 million U.S. dollars, which accounted for 0.15% of the Bolivian GNP and to 4.3% of the national public expenditure in health. The analysis of the origin of both costs shows that 95% corresponded to the public sector and 5% to the private sector. For the private sector, the greatest cost corresponds to the time and transportation required to get medical care.

Near 128 thousand cases require health care for diseases associated with malnutrition, shown in table IV.4, include 99 thousand children needing direct care just because they are underweight.

TABLE IV.4
PLURINATIONAL STATE OF BOLIVIA: HEALTH COST OF UNDERWEIGHT, 2005

Age groups	Number of cases	Millions of U.S. dollars
Newborns (IUGR)	3 144	0.1
0 to 11 months	13 274	2.3
12 to 23 months	45 095	6.9
24 to 59 months	67 264	4.6
Total	128 777 ^a	13.9

Source: ECLAC.

^a Cases include 99 direct treatments provided to affected children only due to the fact of having low weight.

³⁴ With the aim of comparing cost estimates, the working-age population is defined in this study as the population between 15 to 64 years of age.

³⁵ For purposes of comparing the cost estimates, in this study the WAP is defined as the population between 15 and 64 years of age.

³⁶ In the case of public cost, indicators were estimated from information reported by the different branches of the MSD. For the private cost estimate, the minimum official salary in Bolivia was taken, as well as the urban transportation rates and inputs not covered by the public health system.

2. Undernutrition and education

2.1 Effects on education

In 2005 in the Plurinational State of Bolivia, educational coverage registered in official statistics was high for primary education (95%) and low for secondary education (73%) (UNESCO, 2004).³⁷

According to 2005 Household Survey, the average education level of the adult population was eight years, revealing a progressive increase in schooling. Thus, among people from 55 to 64 years of age, the schooling average was five years less than that of the population of 20 to 24 years of age, but maintained a high deficit in the coverage and relatively low academic success: only 35% of the people had finished the secondary education level.

In the primary and secondary education levels, the Bolivian population suffering from undernutrition showed an average schooling differential 2.8 years lower compared to that of non-malnourished students. This can be explained, partly, because a good proportion of people that suffered from undernutrition in their pre-school stage did not even attained first-grade primary education.

The population suffering from underweight has a significantly lower number of students completing secondary, 2.9, compared to 22.4 of those who have not had suffering form underweight. On the other hand, it has been found out that among the population with some degree of schooling, 91% of malnourished children only attended to the primary education level, while for those non-malnourished the figure was 55%. This relation is progressively inverted in secondary education that is why only 3.3% of those with undernutrition achieved 12 years of schooling, while 25.3% of those without undernutrition completed such education level. These differences are very important indicators at the moment of considering gaps in labor opportunities and income during working life in the country.

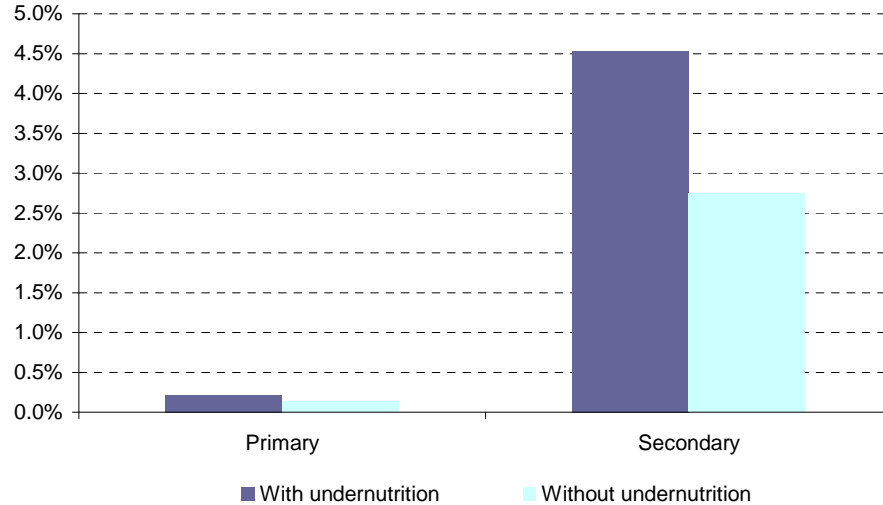
Certainly, during 2005, underweight in the Bolivian school population generated 1,936 additional repeated school years –44% of these cases corresponding to the primary level–³⁸ a figure that increased costs in the education sector.

It should be noted that the group of children that suffered from undernutrition before five years of age, showed a greater concentration of cases of repeating the primary school level, compared with those that did not have undernutrition. As can be seen in figure IV.4, in both population groups, rates of repetition were higher at the secondary school level, maintaining a gap with greater disadvantages for students who were affected by undernutrition during their first years of life.

³⁷ <http://stats.uis.unesco.org>.

³⁸ To estimate educational gaps generated by malnutrition, estimates of a longitudinal study undertaken in Chile between 1987 and 1998 (Ivanovic, 2005), were adapted. According to these estimates in populations similar in the socio economic aspect, persons with malnutrition during preschool stage present higher risk of repeating any year at school, equivalent to 1.65 times more than non-malnourished students. In the absence of estimators and considering characteristics of the educational systems, in order to have comparable estimates among Andean countries, such relative risk was applied to repetition and one differential of 1.4 for dropout during the educational cycle.

FIGURE IV.4
PLURINATIONAL STATE OF BOLIVIA: EFFECTS OF UNDERWEIGHT
ON GRADE REPETITION, 2005
(In percentages)



Source: ECLAC, base on data from Ministry of Education and Culture (2005), estimated population CELADE (2005).

2.1.1 Education costs

The additional burden of repeated grades by those who have suffered from undernutrition is a central issue in the cost of operating the education system. Consequently, in 2005, the 1,936 additional students originated by the differential repetition probability, meant more than 50 thousand dollars, 0.06% of the public expenditure in education and 0.004% of the GDP for that year.

TABLE IV.5
PLURINATIONAL STATE OF BOLIVIA: COSTS OF DIFFERENCE
IN GRADE REPETITION DUE TO UNDERWEIGHT, 2005

	Primary	Secondary
Annual cost per student (Bs. 2005)	1 710	1 745
Additional annual cost (Bs. 2005)	1 459 495	1 889 985
Additional annual cost (USD 2005)	180 943	234 313
		415 256
% Social expenditure on education		0.06
% GDP		0.004

Source: ECLAC, based on official education statistics of Ministry of Education and Culture (2005).

3. Productivity

3.1 Effects on productivity

As indicated previously, undernutrition has an adverse impact on a country's production capacity as a result of the higher prevalence of mortality among children under the age of five caused by pathologies associated with undernutrition and the lower education levels achieved by those suffering from undernutrition.

Table IV.6 depicts the magnitude of the productivity losses as a consequence of the deaths of more than 400 thousand children under five. Considering occupation rates in the country by age cohorts, the cost resulting from this loss is equivalent to more than 583 million of hours worked; meaning 10.5% of hours worked by the economically active population (EAP).

TABLE IV.6
PLURINATIONAL STATE OF BOLIVIA: PRODUCTIVITY EFFECTS
OF MORTALITY DUE TO UNDERWEIGHT

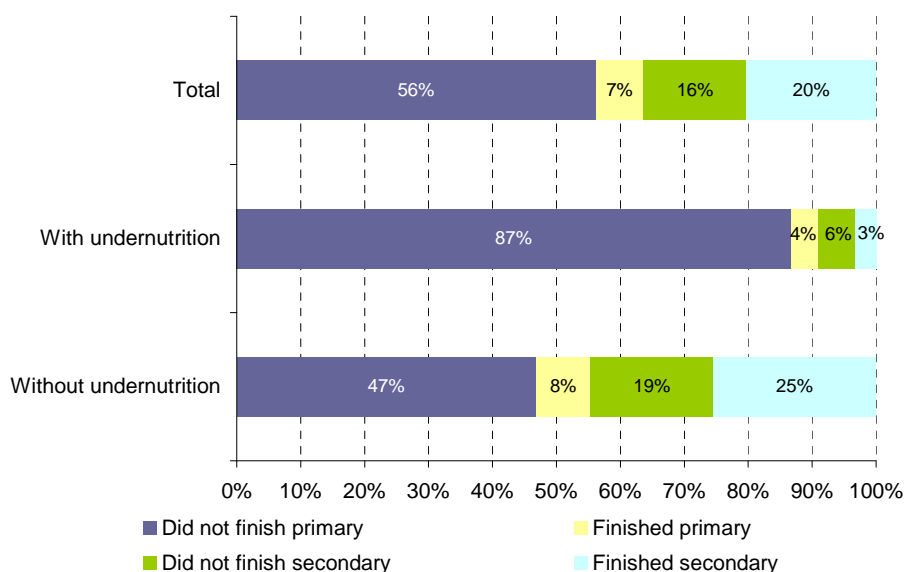
Age group	Mortality due to undernutrition (N, 1941-1990)	Lost work hours (2005)
15 to 24 years	66 441	46 130 939
25 to 34 years	94 763	151 470 561
35 to 44 years	90 611	156 839 994
45 to 54 years	79 973	129 909 973
55 to 64 years	69 268	99 114 734
Total	401 056	583 466 200
% hours lost as a function of EAP		10.5

Source: ECLAC, based on CELADE population and mortality statistics, relative risks estimated by Fishman et al, and UDAPE.

If labour potential is considered to be 2,400 hours of work per year, these deaths associated to undernutrition result in a loss estimated to be 962.5 million hours, equivalent to 17.3% of the EAP.

Regarding diminished productivity due to the schooling gap, this arises from differences in school years at the primary and secondary levels of people that had underweight compared to those that did not. In this respect, figure IV.5 shows the educational level attained by the population that could register at school.

FIGURE IV.5
PLURINATIONAL STATE OF BOLIVIA: EFFECTS OF UNDERWEIGHT ON
EDUCATION LEVEL DISTRIBUTION (POPULATION AGED 25 TO 64), 2005
(In percentages)



Source: ECLAC, based on Household surveys (2005), DHS (2003) and CELADE population estimated (2005).

3.2. Productivity costs

The higher productivity costs reflect the economic value into which the aforementioned effects translate. For 2005, it is estimated that lower levels of education caused losses amounting US\$219 million, which is equivalent to 12.6% of the social expenditure on education for that year, 32.1% of the public expenditure in education and around 2.3% of the GDP for that year.

In addition, it was estimated that for 2005 productivity loss was of 319 million U.S. dollars –accounting to 3.4% of the GNP–, due to the effect of deaths caused by undernutrition experienced by people that in that year could have been part of the working-age population group. Thus, if not for the levels of undernutrition suffered by the country in recent decades, productivity would have been 5.8% higher in 2005.

4. Summary of effects and costs

To sum up, underweight in the different cohorts of the population in 2005 cost approximately 4,453 million Bolivianos, equivalent to 552 million U.S. dollars. This represents 5.8% of the GNP and 31.8% of the total social expenditure in the country for that year.

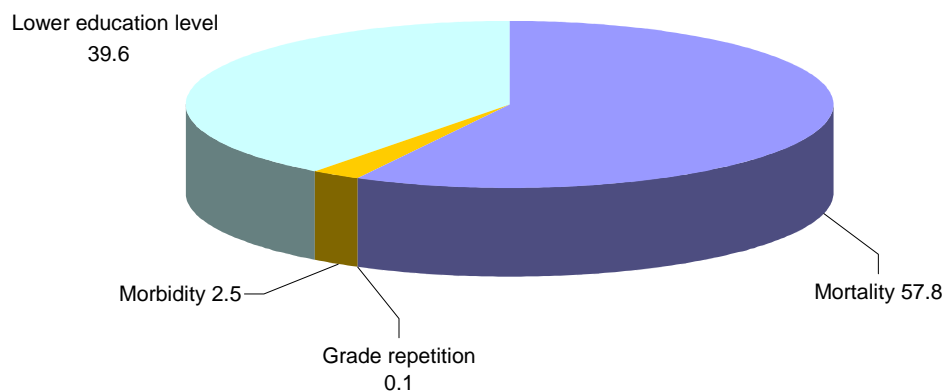
TABLE IV.7
PLURINATIONAL STATE OF BOLIVIA: SUMMARY OF RESULTS, EFFECTS AND COSTS
OF UNDERNUTRITION, 2005 (INCIDENTAL AND RETROSPECTIVE DIMENSION)

	Units	Millions of bolivianos	Millions of dollars
Health			
Additional cases of morbidity	128 777	111	14
Numer of additional deaths	401 056		
Education			
Additional repeated grades	1 936	3	0,4
Differential number of dropouts	343 853		
Productivity			
Hours lost due to mortality	583 466 200	2 573	319
Fewer years of schooling	2.8	1 765	219
Total		4 453	552.0
% of social expenditure			31.8
% GDP			5.8

Source: ECLAC.

As the figure below indicates, the costs of lost productivity due to mortality and lower education levels account for 97% of the total cost, whereas costs associated with morbidity caused by undernutrition represent 2.5%.

FIGURE IV.6
PLURINATIONAL STATE OF BOLIVIA: DISTRIBUTION OF UNDERWEIGHT COSTS
BY FACTORS (INCIDENTAL AND RETROSPECTIVE DIMENSION), 2005
(In percentages)



Source: ECLAC.

C. Effects and costs in the cohort aged 0-59 months in 2005 (analysis of the prospective dimension)

This model serves to estimate present and future losses (and potential savings) due to medical treatments, repeated grades and lower productivity stemming from the prevalence of underweight in the Plurinational State of Bolivia among children under five in 2005.

1. Health effects and costs

As demonstrated in the preceding chapter, undernutrition at an early age increases the risk of dying and of suffering from certain diseases.

From projections based on census data, it was estimated that 69,426 deaths would occur among the cohort of 0 to 59 months of age in 2005 before those children reach five years of age. Of these deaths, more than 12 thousand (41%) are associated with the prevalence of undernutrition with more than five thousand cases occurring in 2005³⁹ (table IV.8). On the other hand, while undernutrition affected almost 7.5% of the children, with the resulting mortality, this percentage increased to 41% due to the higher mortality risk among children affected by underweight.

TABLE IV.8
PLURINATIONAL STATE OF BOLIVIA: MORTALITY CASES ASSOCIATED
WITH UNDERWEIGHT IN CHILDREN UNDER FIVE, 2005-2009

Age	2005	2006	2007	2008	2009	Percentage
0 to 11 months	2 558					21
12 to 59 months	2 806	2 838	2 122	1 411	702	79
Total	5 365	2 838	2 122	1 411	702	12 438

Source: Author's compilation, base don CELADE population and mortality statistics, relative risks reported by Fishman et al, and ENDSA 2003.

Even if death incidence for the year 2005 was similar for the 0-11 months and 12-59 months groups of age, according to projection done in this study, the number of deaths follows a diminishing trend as children approach five years of age. It was estimated that almost 10 thousand children could die between their first and fourth year of life, due to causes associated to underweight.

Regarding morbidity, it was estimated that among children of the 0 to 59 months cohort for 2005, more than 46 thousand additional cases would occur due to ADDs, ARIs and anemia associated to underweight. Of these cases, 57% will be in the group aged 24 to 59 months.

It should be added to the above morbidity cases the health care demand derived from children suffering undernutrition; indeed, some 99 thousand treatments related to underweight per se are estimated for 2005, and 58 thousand health care treatments are projected between 2006 and 2009. Of these cases, about three thousand cases correspond to children with low weight at birth due to intrauterine growth retardation.

³⁹ All estimates for the 0-4 years cohort of 2005 have a progressive diminishing process up to 2009. This is due to the passing of its members to groups of older ages.

TABLE IV.9
PLURINATIONAL STATE OF BOLIVIA: MORBIDITY CASES ASSOCIATED
WITH UNDERWEIGHT IN CHILDREN UNDER FIVE, 2005-2009

Age	Estimated total cases of disease					Percentage
	2005	2006	2007	2008	2009	
0 to 11 months	2 993					6
12 to 23 months	9 352	7 335				36
24 to 59 months	16 539	5 670	3 358	753	143	57
Total	28 884	13 005	3 358	753	143	46 142

Source: ECLAC, based on CELADE population and mortality statistics, differences in prevalences, and ENDSA 2003.

The additional health cost resulting from the increased cases of disease caused by undernutrition amounts to US\$ 14 million in 2005 alone, with a present value of US\$ 11 million for the 2005-2009 period.

TABLE IV.10
PLURINATIONAL STATE OF BOLIVIA: COSTS OF MORBIDITY
ASSOCIATED WITH UNDERWEIGHT, 2005-2009
(Millions of 2005 US\$)

Age	2005	2006	2007	2008	2009
Newborn	0.1				
1 to 11 months	2.3				
12 to 23 months	6.9	5.4			
24 to 59 months	4.6	1.6	0.9	0.2	0.0
Total	13.8	7.0	0.9	0.2	0.0
PNV	21.3				

Source: Authors' compilation.

Values in the table IV.10 are translated into an annual cost equivalent to 6.4 million U.S. dollars in the period, at an annual discount rate of 8%. That amount corresponds to 2% of the public expenditure in health and to 0.07% of the 2005 GDP.

2. Education effects and costs

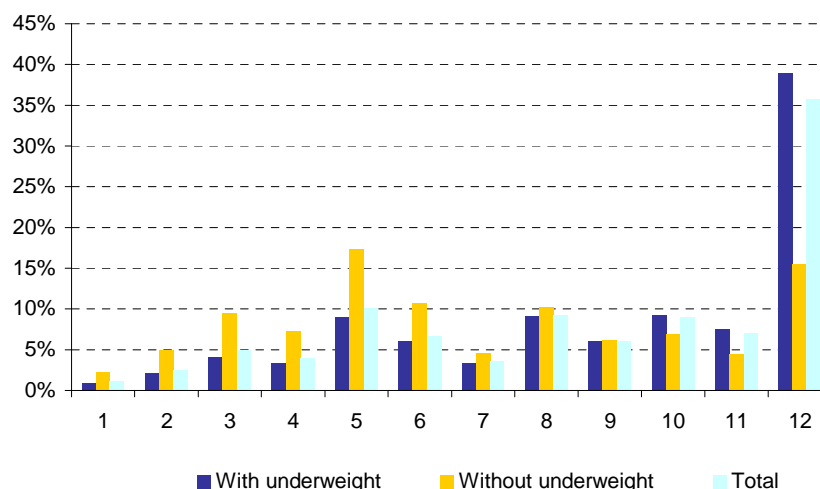
When the education figures for children under five in 2005 are projected, the probability differential for level of education can be estimated, along with the additional costs of the approximately 158,000 future students who now have undernutrition in Bolivia.

Using the official education information, it was calculated that between years 2007 and 2022 there would be 1,482 extra cases of school repetition. Of these cases, 44% correspond to the primary level and 56% to the secondary level. As a result of additional repetitions, costs in the area of education –expressed in present value at an annual discount rate of 8%– rise to 1.04 millions of Bolivianos, equivalent to 0.13 million of U.S. dollars.

Indeed, during the period of 16 years in which the analyzed cohort would reach school age (2007-2022), estimates of the total annual equivalent cost adds-up to US\$14 in 2005, a figure that represents a very low percentage of the social expenditure in education and that year's GDP.

Of these costs, 17% shall be covered by the students' families and 83% shall be covered by the national educational system.

FIGURE IV.7
PLURINATIONAL STATE OF BOLIVIA: ESTIMATED DISTRIBUTION OF GRADE COMPLETION FOR THE COHORT AGED 0-59 MONTHS IN 2005, WITH AND WITHOUT UNDERWEIGHT
(In percentages)



Source: Authors' compilation, base don Household Surveys (2005), ENDSA (2003) and CELADE population estimates.

Considering the higher dropout risk shown by children suffering from undernutrition, the projection under this study revealed that 22,732 students could abandon the educational process due to undernutrition. Consequently, a differential of two years of schooling can be estimated for children with and without undernutrition, with an average of about seven years of education for those with undernutrition.

Furthermore, for the entire cohort it is estimated that 16 out of every 100 children suffering from undernutrition will attain 12 years of education, compared to 39 out of every 100 children who have not had undernutrition.

3. Productivity effects and costs

The education differential discussed in the previous point translates into less cumulative human capital because of persons with undernutrition, and it has a direct negative effect on their productivity. In addition, 12,438 more deaths can be expected as a result of undernutrition in the cohort aged 0 to 59 months in the 2005-2009 period, leading to a potential productivity loss of more than 1,047 million hours of work during the cohort's working life (between 2015 and 2069).

On the basis of these data, it was estimated that economic losses associated with underweight affecting Bolivian population of less than five years of age, reached 655 million

Bolivianos in 2005, equivalent to US\$81 million of the same year. Of this amount, 53 millions are the result of a lower education level and 28 millions are due to the mortality differential.

Indeed, during 2015-2069 the total annual equivalent cost amounts to 53 million Bolivianos, equivalent to US\$ 6.6 million. Of this amount, US\$2.3 million corresponds to mortality costs and US\$4.3 million represent losses due to lower levels of education.

It should be noted that these productivity losses amounts to 0.1% of the Bolivian GDP and to 0.38% of the country's social expenditure.

4. Summary of effects and costs

When all the sources of costs associated with undernutrition are added together for the cohort of children under five in 2005, the present value was about 827 million Bolivianos, equivalent to US\$102.6 million.

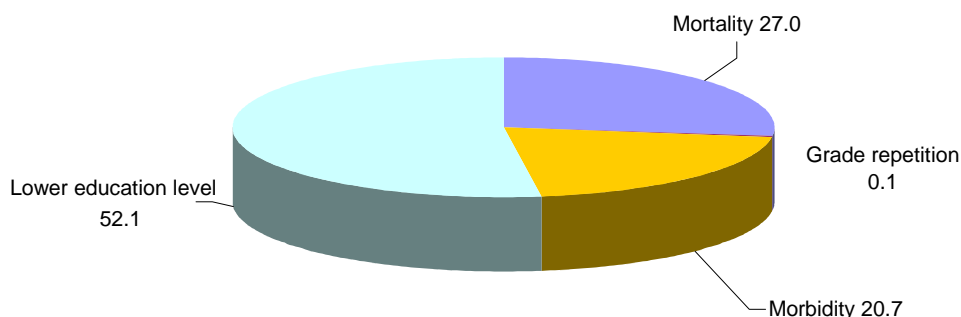
TABLE IV.11
PLURINATIONAL STATE OF BOLIVIA: SUMMARY OF RESULTS EFFECTS AND COSTS OF UNDERWEIGHT FOR THE COHORT AGED 0 TO 59 MONTHS IN 2005

	Units	Costs (Present value)	
		Millions of bolivianos	Millions of US\$
Health			
Additional cases of morbidity	204 504	177	21
Number of additional deaths	12 438		
Education			
Additional repeated grades	1 482	1.0	0.1
Differential Lumber of dropouts	22 732		
Productivity			
Hours lost due to mortality	1 047 249 164	224	28
Fewer years of schooling	2.1	431	53
Total		827	102.6

Source: Authors' compilation.

The loss of human resources due to lower educational achievement (52.1%) and due to greater costs in health care (20.7%) as a consequence of morbidity, account for most of the cost attributable to undernutrition.

FIGURE IV.8
PLURINATIONAL STATE OF BOLIVIA: ESTIMATED COST DISTRIBUTION OF
UNDERNUTRITION BY FACTOR (PROSPECTIVE DIMENSION), 2005
(In percentages)



Source: Authors' compilation.

D. Analysis of scenario: costs and savings

From the costs estimated as a consequence of underweight prevalence in the population of less than five years of age in 2005, it was possible to simulate three future scenarios for the Plurinational State of Bolivia. Below are the results of the simulations corresponding to two undernutrition scenarios and their effects on costs for 2015.

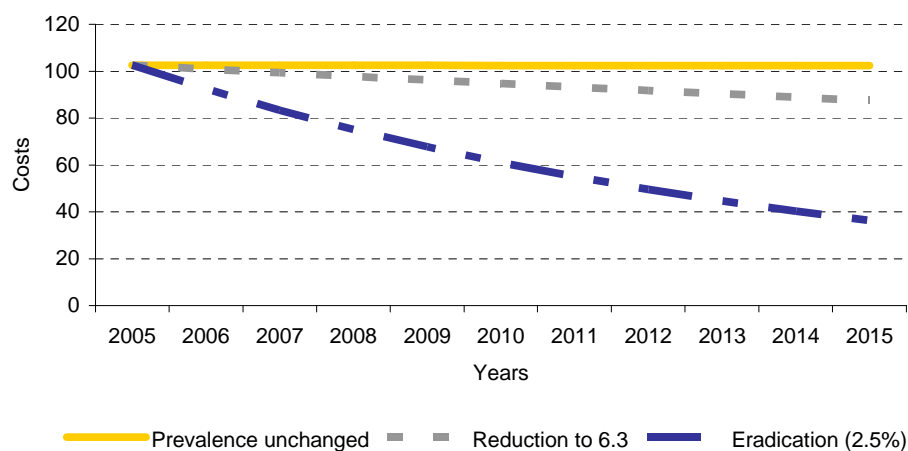
The scenarios considered are the following:

- The latest figures available on the prevalence of underweight used in this study remain stable in 2015 (see table IV.2).
- By 2015, the goal established in the MDG referring to decreasing underweight to half of the prevalence registered for 1990, is achieved. This would entail progressively lowering levels until reaching a rate of 6.35% for children under five years of age. That is, it is a reduction of around 2.7 percentage points annually, on average.
- Underweight is eradicated in the country by 2015. This is equal to a prevalence of 2.5% that represents the normal proportion of cases according to measurement parameters set up by the NCHS. In order to make this possible, a decrease of 5.8% points annually is required.

Figure IV.9 shows how progressive reduction in the prevalence of underweight also leads to a progressive reduction in associated costs. If the prevalence remains constant (scenario 1), by 2015 costs will have a slight variation (approximately 0.19%) in view of the fact that The Plurinational State of Bolivia shows a trend to slightly increase the size of the 0 to four years of age cohort (annual 0.3% in average) between 2005 and 2015. If the MDG is achieved (scenario 2), by

2015 the costs of underweight will decrease to 87.53 million U.S. dollars.⁴⁰ If eradication is achieved (scenario 3), the costs of underweight in 2015 will be US\$ 36.32 million.⁴¹

FIGURE IV.9
PLURINATIONAL STATE OF BOLIVIA: TREND IN ESTIMATED UNDERWEIGHT COSTS IN THREE SCENARIOS, 2005-2016
(Millions of US\$)



Source: Authors' compilation.

Table IV.12 shows a detailed comparison of costs estimated for 2005 with those projected to 2015 for each scenario. Data reveal that the greatest variation in costs is shown in the productivity and health areas.

TABLE IV.12
PLURINATIONAL STATE OF BOLIVIA: ESTIMATED TOTAL COST OF UNDERWEIGHT FOR THE BASE YEAR AND THREE SCENARIOS, 2005 AND 2015
(Millions of US\$ in present value)

	2005	Scenarios in 2015		
		Prevalence Unchanged	Reduction to half	Eradication (2.5%)
Health				
Additional cases of Morbidity	21.3	21.6	18.4	7.8
Education				
Additional years of repetition	0.1	0.1	0.1	0.05
Productivity				
Loss due to mortality	27.7	23.9	20.9	9.3
Fewer years of schooling	53.5	56.7	48.1	19.2
Total	102.6	102.4	87.5	36.3

Source: ECLAC.

⁴⁰ Value updated to 2015 at an annual discount rate of 8%.

⁴¹ Idem.

Based on cost trends shown, it is possible to estimate potential savings that would be generated as soon as actions aimed at achieving the target are initiated.

The distances between the trend lines in figure IV.9 –scenario 2 and 3 compared to scenario 1– illustrate the savings that would be generated year after year, accumulative up to 2015 as progress is made in reducing undernutrition. Such savings, expressed in present value for the year 2005⁴², are equal to almost US\$50 and US\$254 million for scenarios 2 and 3, respectively. Of these amounts, 3% and 40%, in each case, would occur with the impact generated during the first half of the process (2006-2010).

This implies that not only could be significantly lower in 2015, but major savings could be achieved throughout the process of attaining the proposed target. In turn, if appropriate policies remain in place, the projected benefits could continue to accumulate beyond 2015.

TABLE IV.13
PLURINATIONAL STATE OF BOLIVIA: ESTIMATED SAVINGS FOR SCENARIOS, 2015
(PV, in millions of US\$)

	Reduction to half (5.6%)	Eradication (2.5%)
Health	10.7	53.0
Education	0.1	0.3
Productivity		
Loss due to mortality	10.7	58.5
Fewer years of schooling	28.3	142.5
Total	49.7	254.4

Source: Authors' compilation.

The above results imply that costs in 2015 could not only be significantly less, but also important savings could be obtained from progress towards eradicating undernutrition. Any programme that is effective in this regard would have impacts on individuals' quality of life and would also yield major savings for society.

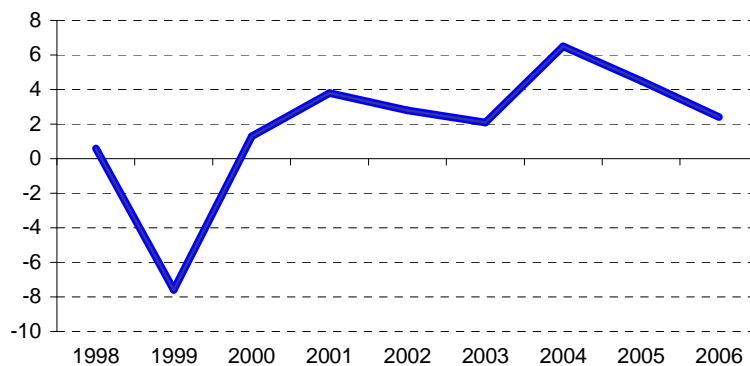
⁴² Value updated to 2004 at an annual discount rate of 8%.

V. Results of the study in Ecuador

A. Socio-economic and nutritional background

In 2005, Ecuador's gross domestic product reached US\$ 36.489 billion, which in a population of 13 million amounts to a per capita GDP of US\$ 2,762 (equivalent to US\$ 1,608 in 2000 dollars). Ecuador has reported positive growth of total GDP in the last few years, but behaviour has been variable. Since 2000, the highest growth rate was achieved in 2004, but it was followed by a decline until 2006. According to the Economic Survey of Latin America and the Caribbean (2006), the cause may be the slump in the petroleum sector.

FIGURE V.1
ECUADOR: TRENDS IN PER CAPITA GDP, 1998-2006



Source: Authors' compilation based on the Economic Survey of Latin America and the Caribbean, 2006 and 2009.

Ecuador's per capita GDP has grown rather sporadically, but the trendline has been positive despite the decline that has been seen since 2004. This contrasts with the end of the 1990s, when per capita GDP had negative growth, reaching -7.6 in 1999.

TABLE V.1
ECUADOR: TRENDS IN SOME ECONOMIC INDICATORS, 2000-2006

	2000	2001	2002	2003	2004	2005	2006
Rate of variation in total GDP	2.8	5.3	4.2	3.6	8.0	6.0	3.9
Rate of variation in private consumption	3.8	6.8	6.6	5.2	4.7	7.3	5.5
Rate of variation in gross domestic investment	12.1	23.5	18.9	-0.2	4.9	10.9	3.8
Rate of variation in exports of goods and services	-1.0	-0.8	-0.8	9.6	15.9	9.0	8.9
Rate of open unemployment	14.1	10.4	8.6	9.8	9.7	8.5	8.1
Variation in consumer prices	91.0	22.4	9.4	6.1	1.9	3.1	2.9

Source: Economic Survey of Latin America and the Caribbean, 2006, 2009.

When other economic indicators are analysed, it can be seen that Ecuador's unemployment rate has been declining steadily since 2000, reaching 8.1% of the population in 2006. Consumer prices, on the other hand, fluctuated sharply between 2000 and 2001. In 2000, the record 91% increase was the result of the delayed impact of currency issuance and the devaluation that occurred in 1999 (ECLAC, 2002b). The inflation of this period decreased in recent years, falling to single-digit variation rates.

In 2006, 43% of Ecuadorians were living in poverty, and of that group, 39.9% were in urban areas, compared to 49% in rural areas. However, there has been an annual decline in the poverty rate, thanks to the efforts that have been made to achieve the millennium goal of cutting poverty in half between 1990 and 2015. Moreover, 16.1% of the population is living in indigence, 12.8% of them in urban areas and 22.5% in rural areas.

With regard to undernutrition, Ecuador has the highest prevalence of underweight in South America, with nine out of every 100 boys and girls under five suffering a weight deficit.

According to the latest available estimate (Survey of Living Conditions, 2006), 8.6% of boys and girls aged 0 to 59 months suffer from undernutrition and are in the "moderate" and "severe" categories of low weight for their age. Although Ecuador has made significant progress compared to previous measures, it is still vulnerable.

In the case of newborns, just over seven of every 100 children have low birth weight and three of every 100 have intrauterine growth restriction. This places Ecuador among the high-incidence countries in this study.

Although the lack of representative data precludes an in-depth analysis of the nutritional situation of pregnant women, as in the case of Central American countries, unofficial data in Ecuador indicate that this group also has serious problems of undernutrition. Thus, the cycle of undernutrition is reflected from intrauterine life onward.

Various studies conducted in the region reveal that in Ecuador the risk of undernutrition during early childhood has grown significantly for children in the first 12 months of life (reaching nearly 16% in 2006), but then it declines and stabilizes during the rest of the preschool years.

It should be noted, in turn, that the most vulnerable population is indigenous children in rural areas. However, this increased risk should not draw attention away from the high levels of undernutrition in urban populations.

TABLE V.2
ECUADOR: POPULATIONS AND UNDERWEIGHT

Age	Population size (2005)	Population affected (2005) ^b	Prevalences (in percentages)			
			1986	1998	1999	2006
Newborn (IUGR) ^a	288 414	8 349	2.9 ^c
0 to 11 months	288 414	13 671	16.9	19.0	...	4.7
12 to 23 months	288 131	45 871	23.9	18.4	...	15.9
24 to 59 months	868 197	59 906	16.0	14.3	...	6.9
Total	1 444 742	127 796	16.5	14.6	13.4	8.6

Source: ECLAC, based on Surveys of Living Conditions and the Latin American and Caribbean Demographic Centre (CELADE).

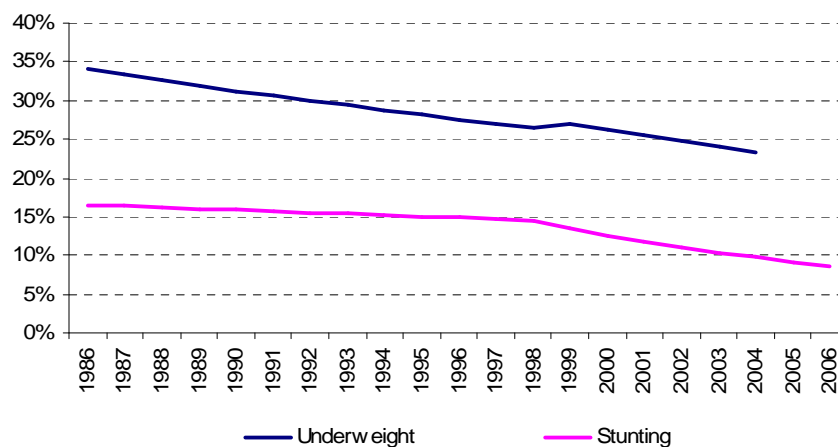
^a In a given year, the population of newborns is the same as that of children aged 0 to 11 months.

^b Estimated on the basis of the latest available prevalence figure.

^c Estimated on the basis of the equation of De Onis et al, 2003.

As figure V.2 shows, the incidence of underweight in Ecuador has fallen steadily over the 19-year period. The trendline drops more sharply after 1998.

FIGURE V.2
ECUADOR: ESTIMATED UNDERNUTRITION TRENDS IN CHILDREN UNDER FIVE



Source: ECLAC, on the basis of DANS 1986, Survey of Living Conditions 1998, 1999 and 2006.

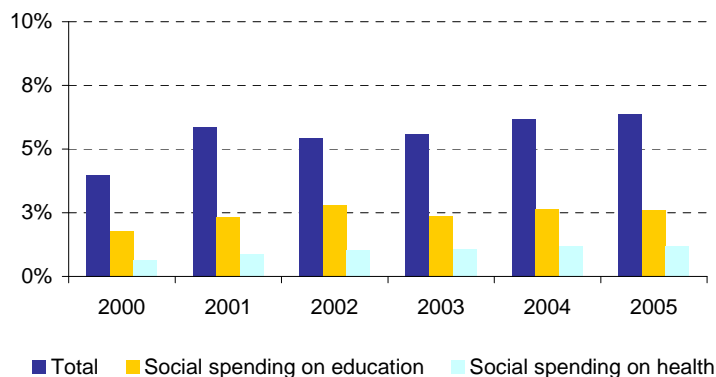
In response to the problems of undernutrition, between 2000 and 2005 Ecuador allocated approximately 6% of GDP to public social expenditure, with an average of 43.5% on education and 18% on health, that is, 62% of the total on these two categories. As a percentage of GDP, public social expenditure fell from 7.9% in 1990 to 6.3% in 2005, possibly due to the high growth rate of GDP compared to that of social expenditure.

It is worth noting that major advances in the institutionalization of food policy have been made during the past decade in Ecuador.

In 2003, Ecuador established the Integrated System of Food and Nutrition (SIAN) under the aegis of the National Food Commission, which in turn is made up of the Ministries of Public Health, Social Welfare, Education and Cultures, and Agriculture and Livestock plus the national

coordinators or directors of social programmes dealing with food and nutrition (ECLAC, 2005). Among other tasks, the Commission is responsible for defining the country's social policies on food and nutrition. One noteworthy characteristic of the implementation of these policies in Ecuador is centralization. The role of local officials is limited, as the centralized purchase of foodstuffs is given priority over the development of local experiences.

FIGURE V.3
ECUADOR: PUBLIC SOCIAL EXPENDITURE, BY SECTOR, 2002-2005
(In percentages of GDP)



Source: ECLAC, public social expenditure database.

Within the Public Health Ministry of Ecuador, the National Directorate of Nutrition oversees four programmes: the Integrated Micronutrients Programme (PIM), the Food and Nutrition Education Programme (PEAN), the Food and Nutrition Monitoring System (SISVAN) and the National Food and Nutrition Programme (PANN, 2000). The purpose of the PANN is to promote breastfeeding and proper nutrition for children and for pregnant and breastfeeding women. In addition, the School Food Programme (PAE) emerged in the 1990s. The breakfasts and lunches provided for school children under this programme are intended to nourish the poorest boys and girls aged five to 14 years in municipal, public and semi-public [fiscocomiccionales] schools.

B. Effects and costs of underweight in 2005: analysis of the incidental retrospective dimension

As indicated in the methodology developed for these studies, this dimension is used to estimate and analyse the effects and costs on education, health and productivity incurred as a result of undernutrition in a specific year, in this case 2005.

1. Undernutrition and health

1.1 Effects on health

Undernutrition at an early age predisposes people to a greater risk of morbidities as well as mortality, which can be analysed through probability differentials. To estimate these effects, data from epidemiological follow-ups and the country's official health statistics have been combined with information gathered in interviews with national specialists.

1.1.1 Morbidity

In Ecuador, the effects of undernutrition on morbidity rates for the various pathologies associated with it resulted in 16,000 additional cases in 2005. Among these, the most noteworthy are acute diarrheal diseases (ADD) with 6,800 cases, acute respiratory infections (ARI) with 5,000 cases, and iron-deficiency anemia with 4,300⁴³ cases. These figures are derived from the differences in prevalence (DP).⁴⁴

In addition, there are the pathologies specific to critical nutritional deficiencies in calories and proteins, such as marasmus and kwashiorkor. According to official data, they accounted for 97 cases in 2005.⁴⁵

1.1.2 Mortality

Undernutrition affects mortality through several different pathologies, the most significant of which are diarrhoea, pneumonia, malaria and measles. In order to limit the number of errors resulting from the poor quality of official records on cause of death, the estimates made by Fishman et al (WHO, 2004), which define relative differential risks for all causes of death among children under the age of five, were considered for each country together with the mortality rates estimated by the Latin American and Caribbean Demographic Centre (CELADE-Population Division).

On this basis, it is estimated that between 1941 and 2005, nearly 500,000 children under five died from causes associated with undernutrition. Considering the survival rates of the different cohorts throughout the period, just over 89% (435,000) would still be alive in 2005 if they had not suffered from underweight (see table V.3). In addition, it is estimated that of the total number of deaths that occurred in the population under five years of age in 2005, 10,000 (2%) were associated with underweight.

TABLE V.3
ECUADOR: MORTALITY OF CHILDREN UNDER FIVE ASSOCIATED WITH
UNDERWEIGHT, ADJUSTED BY SURVIVAL RATE, 1941-2005

Period	Number of deceased children
1941-1950	60 759
1951-1960	80 498
1961-1970	89 277
1971-1980	87 589
1981-1990	67 919
1991-2000	38 853
2001-2005	10 161
Total	435 055

Source: ECLAC, based on CELADE population and mortality statistics, relative risks estimated by Fishman et al, and the Survey of Living Conditions.

⁴³ The estimates of effects and costs presented in this report are averages and are subject to the margins of error specific to the original sources.

⁴⁴ DP represents the greater probability that those who have had undernutrition will present with a pathology (i) as a "consequence" of their undernutrition.

⁴⁵ Only the direct effects associated with underweight are considered, not those of deficiencies in micronutrients.

Furthermore, as shown in table V.3, between 1941 and 1990 undernutrition caused the deaths of 386,000 children under five, who would have been between 15 and 64 years of age in 2005 and therefore would have been part of the working-age population (WAP).⁴⁶ As demonstrated in section 3 of this chapter, this has had a major impact on productivity in the country.

1.2 Health costs

The institutional (public) and private health costs stemming from increases in the treatment of pathologies associated with undernutrition⁴⁷ among children under five are concentrated in the age range of 12 to 59 months: 83% of the population affected and 69% of total health costs for the cohort during the year in question. However, the highest unit costs are for newborns with intrauterine growth restriction (LBW-IUGR) because the treatment protocols for this age group are more expensive.

The public and private health cost estimated for Ecuador is equivalent to US\$ 14.8 million, 0.04% of GDP for that year and 3.4% of public expenditure on health for the same year.

When the origin of the expenditure categories is analysed, it is observed that 81.7% corresponds to the public sector and 18.3% to the private sector. The largest share of private sector expenditure is the time and transportation required for treatment. Medical inputs not covered by the public health system account for 27% of total private costs in Ecuador.

TABLE V.4
ECUADOR: HEALTH COST OF UNDERWEIGHT, 2005

Age	Number of cases	Millions of dollars
Newborn (IUGR)	8 349	2.4
0 to 11 months	18 564	2.2
12 to 23 months	49 709	5.9
24 to 59 months	67 517	4.3
Total	144 139	14.8

Source: Authors' compilation based on information from the Survey of Living Conditions 2006.

The 144,000 cases requiring health care due to illnesses associated with undernutrition, shown in table V.4, include 119,000 direct treatments of boys and girls solely for underweight.

2. Undernutrition and education

2.1 Effects on education

Net education coverage is high for primary education (97%) but low for secondary education (55%), according to Ecuador's official statistics.⁴⁸

According to the 2006 household survey, the average education level of the adult population (aged 20 to 64 years) is 7.1 years of schooling, reflecting a gradual increase in school

⁴⁶ For the purposes of comparing cost estimates in this study, the WAP is defined as the population between 15 and 64 years of age.

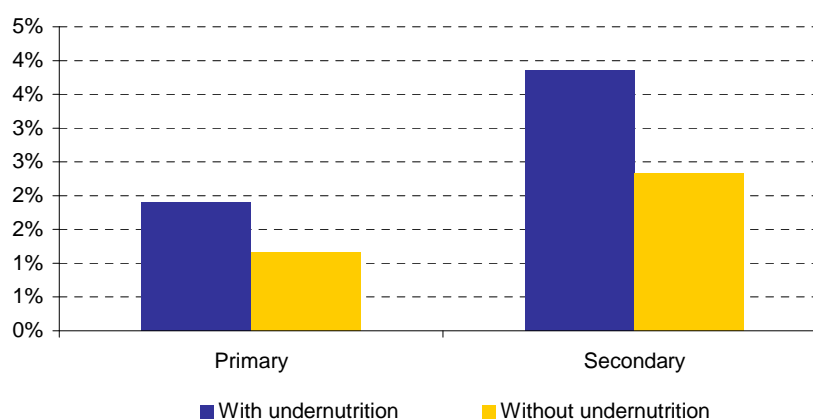
⁴⁷ In the case of public costs, indicators were estimated on the basis of information reported by different agencies of the Ministry of Health. For estimating private costs, the official minimum wage, urban public transport fares and inputs not covered by the public health-care system were considered.

⁴⁸ <http://stats.uis.unesco.org>.

attendance. Thus, among those aged 55 to 64, the average number of years of schooling is 3.5, less than the average for those aged 20 to 24. However, school completion rates are still low, and coverage is deficient, such that only 31.8% of the latter age group has finished secondary school.

The Ecuadorian population suffering from undernutrition has an average education differential that is three years less than the average for those without undernutrition, including both primary and secondary schooling. One reason for this may be that a larger percentage of those who suffered from undernutrition during their preschool years did not even complete the first grade of primary school.

FIGURE V.4
ECUADOR: EFFECTS OF UNDERWEIGHT ON GRADE REPETITION, 2005
(In percentage)



Source: ECLAC, based on data from SINEC 2003-2004 and SINEC 2004-2005 and on CELADE population estimates (2005).

The population suffering from undernutrition has a significantly lower number of students completing secondary school, 2.5%, compared to 29% of those who have not had undernutrition. When just the population with some schooling is considered, 88.3% of those who suffered from undernutrition attended just primary school, compared to 43% of those not suffering from undernutrition. This ratio is gradually reversed for secondary education, such that less than 3% of those with undernutrition attain 12 years of schooling, compared to 31% of those without undernutrition. These differences are very important indicators of the labour and income opportunity gaps between the two groups during their working years.

Underweight in Ecuador caused an additional 6,388 grade repetitions in 2005, which led to the corresponding incremental costs. Of those repetitions, 58.9% were in primary school.⁴⁹

One element worth mentioning is that children who have suffered from undernutrition have a greater concentration of repeated grades in the early years of primary school than

⁴⁹ To estimate education gaps caused by undernutrition, the estimates contained in a longitudinal study conducted in Chile between 1987 and 1998 (Ivanovic, 2005) were adapted. According to these estimates, in socio-economically similar populations, persons who have suffered from undernutrition during their preschool years have a risk of repeating one or another grade in school equivalent to 1.65 times the risk run by those who did not have undernutrition. In the absence of estimators, and considering the characteristics of the educational systems, this relative risk of grade repetition was used, along with a dropout differential of about 1.41 for the entire education cycle, to obtain comparable estimates among the different Andean countries.

“normal” children. However, as figure IV.4 shows, the rates for both groups are higher in secondary school, but those suffering from undernutrition still lag behind.

2.2 Education costs

The additional burden of repeated grades by those who have suffered from undernutrition is a central issue in the cost of operating the education system. The differential repetition probability means more than 6,000 additional students attending school in 2005, at a cost of US\$ 4.2 million, 0.44% of social expenditure on education and 0.012% of GDP for that year.

TABLE V.5
ECUADOR: COSTS OF DIFFERENCE IN GRADE REPETITION
DUE TO UNDERWEIGHT, 2005

	Primary	Secondary
Annual cost per student (US\$ 2005)	670	639
Additional annual cost (US\$ 2005)	2 521 533	1 677 993
		4 199 526
% of social expenditure on education		0.44%
% of GDP		0.01%

Source: ECLAC, based on official data from SINEC 2003-2004 and SINEC 2004-2005.

3. Productivity

3.1 Effects on productivity

As indicated previously, undernutrition has an adverse impact on a country's production capacity as a result of the higher prevalence of mortality among children under the age of five caused by pathologies associated with undernutrition and the lower education levels achieved by those suffering from undernutrition.

Table V.6 shows the loss of productivity that is a consequence of the 386,000 deaths associated with undernutrition in children under the age of five, as mentioned above. Considering the country's employment rates by cohort, the resultant cost is equivalent to more than 543 million hours of work, nearly 6.3% of the hours worked by the economically active population (EAP).

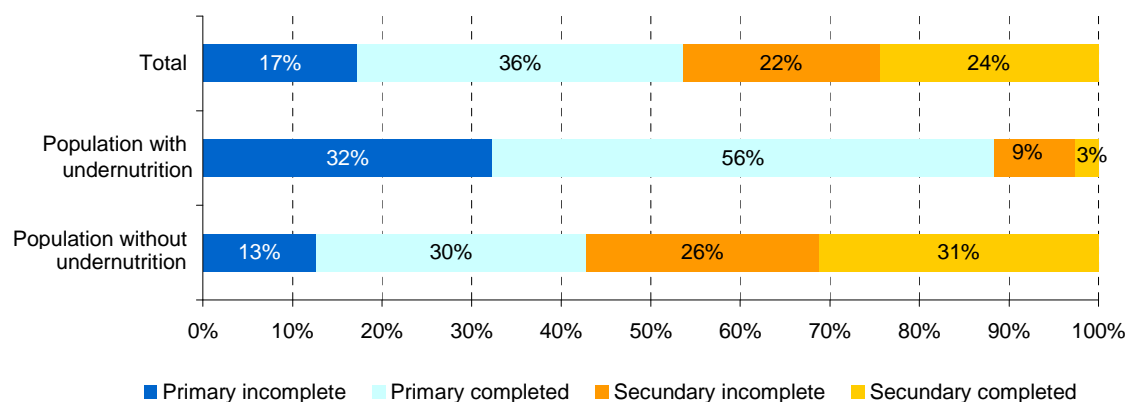
The effect of the schooling gap on productivity corresponds to the differences in the education level distribution of the population. Those who have suffered from undernutrition have lower rates of primary and secondary school completion than those not suffering from undernutrition, as depicted in figure V.5.

TABLE V.6
ECUADOR: PRODUCTIVITY EFFECTS OF MORTALITY DUE TO UNDERWEIGHT

Age group	Mortality caused by undernutrition (N, 1941-1990)	Lost work hours (2005)
15-24 years	67 919	53 593 801
25-34 years	87 589	135 894 461
35-44 years	89 277	145 520 268
45-54 years	80 498	126 731 640
55-64 years	60 759	81 559 053
Total	386 042	543 299 222
Hours lost in relation to EAP		6.3%

Source: ECLAC, based on CELADE population and mortality statistics, relative risks estimated by Fishman et al, and the 2005 Survey of Living Conditions.

FIGURE V.5
ECUADOR: EFFECTS OF UNDERWEIGHT ON EDUCATION LEVEL DISTRIBUTION, 2005 (POPULATION AGED 25 TO 64)



Source: ECLAC, based on Household Survey (2005) and CELADE population estimate (2005).

3.2 Productivity costs

The higher productivity costs are a function of the economic value resulting from the aforementioned effects. For 2005 it is estimated that lower levels of schooling led to losses totalling more than US\$ 577.7 million, equivalent to 25% of social expenditure for the year, 61% of public expenditure on education and approximately 1.6% of GDP.

Moreover, the loss of productivity due to deaths caused by undernutrition in the population that would have been of working age in 2005 is estimated at US\$ 639.7 million, approximately 1.8% of GDP. Thus, if not for the levels of undernutrition suffered by the country in recent decades, productivity would have been 3.3% higher in 2005.

4. Summary of costs

To sum up, underweight in the different cohorts of the population in 2005 cost approximately US\$ 1.237 billion. This represents 3.4% of GDP, twice the level of total social expenditure in the country that year.

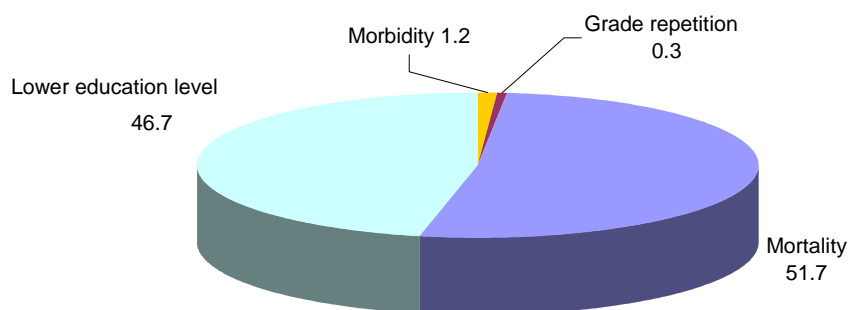
TABLE V.7
ECUADOR: SUMMARY OF RESULTS: EFFECTS AND COSTS OF UNDERNUTRITION, 2005
(INCIDENTAL RETROSPECTIVE DIMENSION)

	Units	Millions of dollars
Health		
More cases of morbidity	144 139	15
Number of additional deaths	386 042	
Education		
Additional repeated grades	6 388	4.2
Differential number of dropouts	1 080 648	
Productivity		
Loss of hours due to mortality	543 299 222	639.7
Fewer years of schooling	2.7	577.8
Total		1 237
Social expenditure		53.2%
GDP %		3.4%

Source: ECLAC.

As the figure V.6 indicates, the costs of lost productivity due to mortality and lower education levels account for 98.5% of the total cost, whereas costs associated with morbidity caused by undernutrition represent 1.2%.

FIGURE V.6
ECUADOR: DISTRIBUTION OF UNDERWEIGHT COSTS BY FACTOR, 2005
(INCIDENTAL RETROSPECTIVE DIMENSION)
(In percentages)



Source: ECLAC.

C. Effects and costs in the cohort aged 0-59 months in 2005: analysis of the prospective dimension

The present and future losses (and potential savings) stemming from medical treatment, grade repetition and lower productivity caused by the prevalence of underweight in Ecuador among those under the age of five in 2005 can be estimated through this dimension.

1. Health effects and costs

As demonstrated in the previous chapter, undernutrition at an early age increases the risk of dying and suffering from certain diseases.

Based on projections from census data, it is estimated that in the cohort aged 0 to 59 months in 2005, 27,000 deaths will occur before the fifth birthday. Of these deaths, nearly 6,000 (16%) are associated with the prevalence of undernutrition, with 2,705 cases in 2005.⁵⁰ Accordingly, whereas nearly 9% of children suffer from undernutrition, the resultant mortality figure increases to 21% because of the greater risk of death among those suffering from underweight.

Table V.8 shows that the highest incidence of death occurs before the first birthday, during which time the probability of death is 1.2 times greater than for the rest of the cohort. However, more than 4,000 children could also die from causes associated with underweight between one and four years of age.

TABLE V.8
ECUADOR: MORTALITY CASES ASSOCIATED WITH UNDERWEIGHT
IN CHILDREN UNDER FIVE, 2005-2009

Age	2005	2006	2007	2008	2009	Percentage
0 to 11 months	1 405					24
12 to 59 months	1 301	1 252	911	589	286	76
Total	2 705	1 252	911	589	286	5 743

Source: ECLAC, based on CELADE population and mortality statistics, relative risks estimated by Fishman et al, and the 2005 Survey of Living Conditions.

As for morbidity in Ecuador, it is estimated that in the cohort aged 0 to 59 months in 2005, a little more than 24,000 additional cases of diseases associated with underweight will occur before the fifth birthday, mainly anemia, ADD and ARI. Of these cases, 52% will be in the group aged 24 to 59 months.

In addition to the morbidity cases indicated in table V.9, the direct treatment of underweight boys and girls must be taken into consideration. They totalled 127,000 in 2005, and there were another 73,000 between 2006 and 2009, of which 8,300 were children with low birth weight due to intrauterine growth retardation (LBW-IUGR).

The added health costs resulting from additional cases of disease linked to undernutrition amounted to US\$ 14.8 million in 2005 alone, with a present value⁵¹ of US\$ 21.5 for the 2005-2009 period.

⁵⁰ All the estimates for the cohort aged 0-4 years in 2005 have gradually diminished in the years prior to 2009 as a result of the transition of the individuals in that cohort into higher age groups.

⁵¹ With a discount rate of 8% annually.

TABLE V.9
ECUADOR: MORBIDITY CASES ASSOCIATED WITH UNDERWEIGHT
IN CHILDREN UNDER FIVE, 2005-2009

Age	Total estimated cases of disease					Percentage
	2005	2006	2007	2008	2009	
0 to 11 months	4 893					20
12 to 23 months	3 838	2 980				28
24 to 59 months	7 612	2 726	1 654	374	71	52
Total	16 343	5 706	1 654	374	71	24 148

Source: ECLAC, based on CELADE population and mortality statistics, differences in prevalence and the 2005 Survey of Living Conditions.

TABLE V.10
ECUADOR: COSTS OF MORBIDITY ASSOCIATED WITH UNDERWEIGHT, 2005-2009
(Thousands of 2005 dollars)

Age	2005	2006	2007	2008	2009
Newborn	2 387				
1 to 11 months	2 159				
12 to 23 months	5 926	4 601			
24 to 59 months	4 334	1 552	942	213	40
Total	14 805	6 153	942	213	40
PNV	21 106				

Source: ECLAC.

The values indicated in table IV.10 translate into an equivalent annual cost (EAC)⁵² of US\$ 6.5 million for the period, amounting to about 1.4% of public expenditure on health and 0.02% of GDP.

2. Education effects and costs

When the education figures for children under five in 2005⁵³ are projected, the probability differential for level of education can be estimated, along with the additional costs of the approximately 225,000 future students who now have undernutrition in Ecuador.

Using official information, it can be estimated that between 2007 and 2022 there will be 2,590 additional cases of grade repetition. Of these repetitions, 76% will be in primary education and 24% in secondary, because there is greater coverage at the former level.

As a result of the extra grades, the education costs expressed in present value (at an 8% discount rate) will be US\$ 892,000 in 2005 dollars.

Converting these values to an equivalent annual value for the 16-year period during which the cohort in question will be of school age (2007-2022) results in a total of US\$ 100,000 in 2005 dollars, which represents 0.01% of social expenditure on education and 0.0003% of GDP for that year.

Of these costs, 17.5% would be paid by the children's families and 82.5% by the education system.

⁵² With a discount rate of 8% annually.

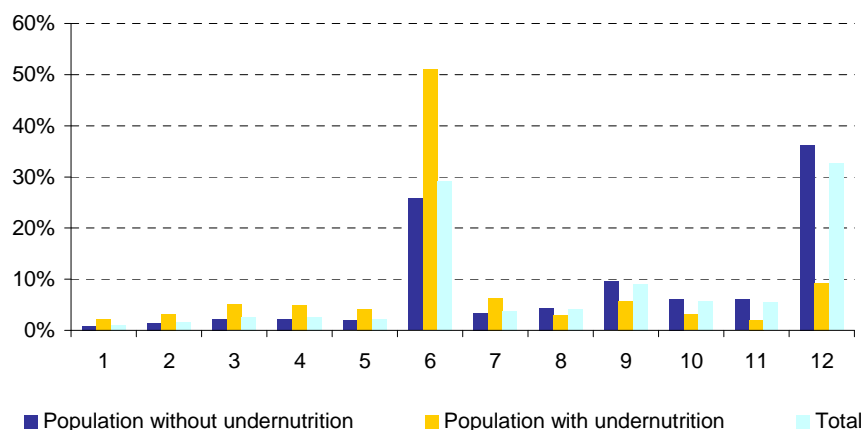
⁵³ This projection is based on the education coverage of the school-aged population and the education levels achieved by the cohort aged 20 to 24 years in the latest household survey (2005).

Moreover, the greater risk of school attrition among these children means that 64,766 students would drop out of school early due to undernutrition.

Consequently, a differential of 2.3 years of schooling can be estimated for children with and without undernutrition, with an average of about 6.4 years of education for those with undernutrition.

Furthermore, for the entire cohort it is estimated that 9 out of every 100 children suffering from undernutrition will attain 12 years of education, compared to 35 out of every 100 children who have not had undernutrition.

FIGURE V.7
ECUADOR: ESTIMATED DISTRIBUTION OF GRADE COMPLETION FOR THE COHORT
AGED 0-59 MONTHS IN 2005, WITH AND WITHOUT UNDERWEIGHT
(In percentage)



Source: ECLAC, based on Household Survey (2006) and CELADE population estimates.

3. Productivity effects and costs

The education differential discussed in the previous point translates into less cumulative human capital because of persons with undernutrition, and it has a direct negative effect on their productivity.

In addition, 5,743 more deaths can be expected as a result of undernutrition in the cohort aged 0 to 59 months in the 2005-2009 period, leading to a potential productivity loss of more than 566 million hours of work during the cohort's working life (between 2015 and 2069).

Against this backdrop, it is estimated that productivity losses associated with underweight in children under five in Ecuador in 2005 will total US\$ 156 million. Of that amount, US\$ 127.8 million is a consequence of lower education levels and US\$ 27.8 million of differential mortality.

Considering the entire period in which these values would be produced (2015-2069), the equivalent annual cost is US\$ 12.6 million. Of that total, US\$ 10.4 million corresponds to mortality costs and US\$ 2.3 million represents losses due to lower levels of education.

The equivalent annual cost of these productivity losses amounts to 0.03% of GDP in Ecuador.

4. Summary of effects and costs

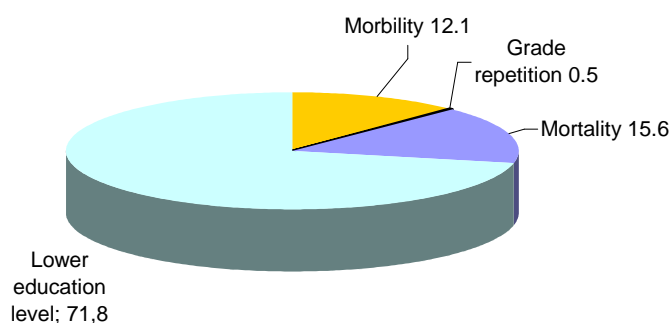
When all sources of costs associated with undernutrition in the cohort of boys and girls under five suffering from undernutrition in 2005 are added together, the present value amounts to US\$ 177.9 million.

TABLE V.11
ECUADOR: SUMMARY OF RESULTS: EFFECTS AND COSTS OF
UNDERWEIGHT IN THE COHORT AGED 0 TO 59 MONTHS, 2005

	Units	Costs (present value) Millions of dollars
Health		
Additional cases of morbidity	225 532	22
Number of additional deaths	5 743	
Education		
Additional repeated grades	2 590	0.9
Differential number of dropouts	64 766	
Productivity		
Hours lost due to mortality	566 934 127	27.8
Fewer years of schooling	2.3	127.8
Total		177.9

Source: ECLAC.

FIGURE V.8
ECUADOR: DISTRIBUTION OF ESTIMATED COST OF UNDERNUTRITION
BY FACTOR (PROSPECTIVE DIMENSION, 2005)
(In percentages)



Source: ECLAC.

This background indicates that the loss of human resources stemming from lower education levels and increased mortality among children suffering from undernutrition account for most of the estimated cost of undernutrition, 71.8% and 15.6%, respectively.

D. Analysis of scenarios: costs and savings

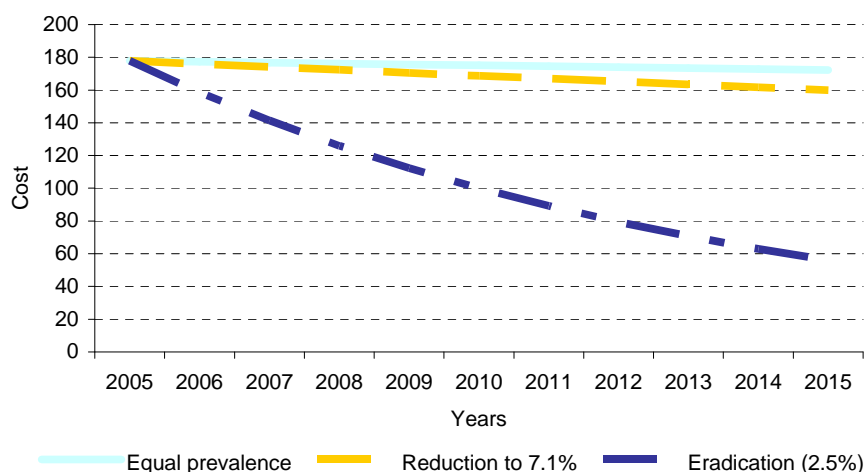
Different scenarios can be projected on the basis of the estimated costs of underweight in the population under the age of five in 2005 in Ecuador. Below are the results of the simulations corresponding to three undernutrition scenarios and their effects on costs for 2015.

The following scenarios were considered:

1. The latest figures available on the prevalence of underweight used in this study remain the same in 2015 (see table V.2).

2. The goal of reducing underweight to half the level of 1990 by 2015, established in the Millennium Development Goals (MDG), is achieved. This would mean a gradual decline to a rate of 7.1% among children under five, a reduction of about 1.5 percentage points beginning in 2006.
3. Underweight is eradicated in the country by 2015, which for purposes of this analysis means achieving a prevalence of 2.5%, the “normal” proportion of cases according to the measurement parameters published by the National Center of Health Statistics (NCHS). To achieve this target, a reduction of more than 6.1 percentage points beginning in 2006 would be required.

FIGURE V. 9
ECUADOR: TREND IN ESTIMATED COSTS OF UNDERWEIGHT
IN THREE SCENARIOS, 2005-2015
(Millions of dollars)



Source: ECLAC.

Figure V.9 illustrates how the gradual reduction in the prevalence of underweight also leads to a gradual decline in the associated costs. If the prevalence remains constant (scenario 1), the costs of undernutrition in Ecuador will fall by 3% if there is a low growth rate in the cohort aged 0 to 4 years. If the MDG is achieved (scenario 2), the costs of underweight will decrease to US\$ 160 million by 2015.⁵⁴ If the eradication scenario comes to pass, costs will fall even further, reaching a present value of US\$ 56 million⁵⁵ by 2015.

Table V.12 contains a comparison of estimated costs for 2005 with projected costs for each scenario as of 2015. The greatest variation in costs can be seen in productivity and health.

⁵⁴ Value updated as of 2015, with a discount rate of 8% annually.

⁵⁵ Value updated as of 2015, with a discount rate of 8% annually.

TABLE V.12
ECUADOR: ESTIMATED TOTAL COSTS OF UNDERWEIGHT FOR
THE BASE YEAR AND THREE SCENARIOS, 2005 AND 2015
(Millions of dollars at present value)

	2005	Scenarios by 2015		
		Prevalence unchanged	Reduction to 7.1%	Eradication (2.5%)
Health	21.5	21.1	17	4
Education	0.9	0.9	0.8	0.3
Productivity				
Loss due to mortality	28	23	20	10
Fewer years of schooling	128	127	122	42
Total	177.9	172.2	159.9	56.2

Source: ECLAC.

Based on the cost trends shown, it is possible to estimate potential savings that would be generated as soon as actions aimed at achieving the proposed targets are initiated.

TABLE V.13
ECUADOR: ESTIMATED SAVINGS ACCORDING TO SCENARIOS, 2015
(Millions of dollars at present value)

	Reduction to 7.1%	Eradication (2.5%)
Health	14.0	69.7
Education	0.1	2.2
Productivity		
Loss due to mortality	9.8	54.0
Fewer years of schooling	17.8	333.8
Total	41.8	459.8

Source: ECLAC.

The distances between the trendlines in figure V.9, comparing scenario 2 with scenario 1 and scenario 3 with scenario 1, illustrate the year-to-year savings that would be generated. These savings would accumulate until 2015 as undernutrition is reduced or eradicated. Expressed in 2005 present value,⁵⁶ they amount to nearly US\$ 42 million and US\$ 460 million for scenarios 2 and 3, respectively. The impact achieved during the first half of the process (2006-2010) would account for 36% and 41%, respectively, of these totals.

This implies that not only could costs be significantly lower in 2015, but major savings could be achieved throughout the process of attaining the proposed target for each scenario. In turn, if appropriate policies remain in place, the projected benefits could continue to accumulate beyond 2015.

The above is a reflection of the economic benefits to be gained from advancing towards the eradication of undernutrition. Any programme that yields effective results in this regard will not only have an impact on people's quality of life but will also yield major savings for society.

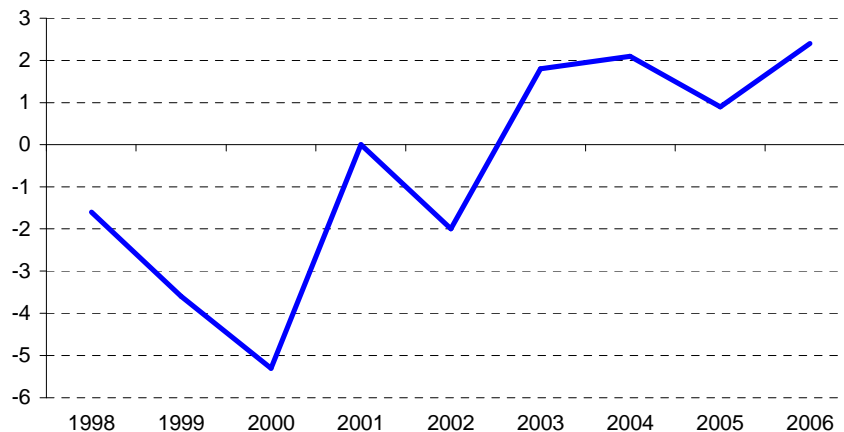
⁵⁶ Value updated as of 2004, with a discount rate of 8% annually.

VI. Results of the study in Paraguay

A. Socio-economic and nutritional background

In 2005, Paraguay's gross domestic product reached US\$ 7,328 billion, which in a population of six million amounts to a per capita GDP of US\$ 1,179 (equivalent to US\$ 1,364 in 2000 dollars). Paraguay has reported positive growth of total GDP in the last few years except for 2000, but behaviour has been variable. In 2000, the growth rate reached a low for the period, with a decline of 3.3% in GDP. In 2001 a recovery was observed, but it was not repeated in 2002, when there was zero growth. This situation was aggravated by unfavourable weather conditions affecting agriculture. By 2006, the Paraguayan economy had begun to bounce back, with a growth rate of 4.3% thanks to the growth in the services sector and the positive results achieved in agriculture (ECLAC, 2001, 2003b, 2007b).

FIGURE VI.1
PARAGUAY: TRENDS IN PER CAPITA GDP, 1998-2006



Source: Authors' compilation based on the Economic Study for Latin America and the Caribbean, 2006 and 2009.

Paraguay has had somewhat unstable per capita GDP growth, reporting negative growth rates between 1998 and 2002. This was because overall GDP grew at a slow pace and at the same time the population grew sharply (ECLAC, 2003b).

When other economic indicators are analysed, it can be seen that Paraguay's unemployment rate remained in the two-digit range during the 2000-2004 period, with a significant increase in 2002. In 2005, the unemployment rate fell to 7.6% despite slow economic growth, but then it rose to 8.9% in 2006. Consumer prices, on the other hand, have remained relatively constant, except for 2003-2005, when prices fell dramatically in 2004 and climbed sharply in 2005, driven by higher prices for petroleum, meat and meat substitutes (ECLAC, 2006).

TABLE VI.1
PARAGUAY: TRENDS IN SOME ECONOMIC INDICATORS, 2000-2006

	2000	2001	2002	2003	2004	2005	2006
Rate of variation in total GDP	-3.3	2.1	0.0	3.8	4.1	2.9	4.3
Rate of variation in private consumption	-5.0	2.6	-7.1	2.9	4.4	3.9	5.1
Rate of variation in gross domestic investment	-15.5	19.3	-13.7	8.5	11.9	-11.1	4.3
Rate of variation in exports of goods and services	8.0	-9.6	15.9	4.4	1.8	12.1	14.6
Rate of open unemployment	10.0	10.8	14.7	11.2	10.0	7.6	8.9
Variation in consumer prices	8.6	8.4	14.6	9.3	2.8	9.9	12.5

Source: Economic Survey of Latin America and the Caribbean, 2005-2006, 2008-2009.

In 2007, 60.5% of Paraguayans were living in poverty, and of that group, 55.2% were in urban areas, compared to 68% in rural areas. Total poverty has not varied much recently despite other fluctuations, due in part to the fact that urban poverty rose in 2004 and has remained above 50% for nearly a decade. Moreover, 31.6% of the population is indigent, with 23.8% of indigents living in urban areas and 42.5% in rural areas.

Paraguay has one of the lowest prevalences of undernutrition in Latin America and the Caribbean, as approximately four out of every 100⁵⁷ boys and girls under the age of five have weight deficits and 14 out of 100 suffer from stunting.⁵⁸

According to estimates made on the basis of the 2005 Household Survey, 35,000 boys and girls under five years of age are underweight ("moderate" and "severe") and about 98,000 have stunting. Boys and girls living in rural areas and those whose mothers have a low level of education are most likely to be affected.

Just over seven in 100 newborns have low birth weight.⁵⁹

Although the lack of representative data precludes an in-depth analysis of the nutritional situation of pregnant women, as in the case of other Latin American countries, unofficial data indicate that this group also has serious problems of undernutrition. Thus, the cycle of undernutrition is reflected from intrauterine life onward.

⁵⁷ In this case the applicable formula is Underweight (Points z Weight/Age $< -2DE$).

⁵⁸ Low height = Points z Height/Age $< -2DE$.

⁵⁹ Birth weight less than 2500 grams.

TABLE VI.2
PARAGUAY: POPULATION AND UNDERWEIGHT

Age	Population size (2005)	Population affected (2005) ^b	Prevalences (in percentage)			
			1990	1997/98	2000/01	2004/05
Newborn (IUGR) ^a	172 437	4 424	2.6 ^c
0 to 11 months ^d	172 437	5 173	3.2	4.1	5.2	3.0
12 to 23 months	168 969	10 307	6.9	6.3	6.1	6.1
24 to 59 months	490 581	21 586	2.7	4.9	4.0	4.4
Total	831 987	41 490	4.5	5	4.6	4.2

Source: Authors' compilation, based on special tabulations of Household Surveys (General Directorate of Statistics and Census, DGEEC) and CELADE demographic estimates.

^a In a given year, the population of newborns is the same as that of children aged 0 to 11 months.

^b Estimated on the basis of the latest available prevalence figure.

^c Estimated on the basis of the equation of De Onis et al, 2003.

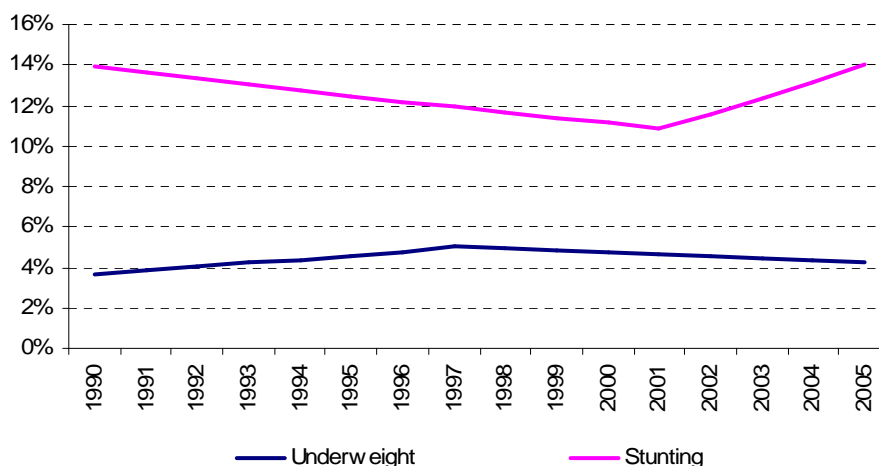
^d The rate used for the "0 to 11 months" range actually corresponds to the "28 days to 11 months" range with demographic data for "0 to 11 months".

Various studies conducted in the region reveal that in Paraguay the risk of undernutrition during early childhood has grown significantly for children in the first 59 months of life (reaching nearly 4.2% in 2005), but then it declines and stabilizes during the rest of the preschool years.

It should also be noted that undernutrition in Paraguay primarily affects boys and girls in rural areas. However, this increased risk should not draw attention away from the high levels of undernutrition in urban populations, and especially among children whose mothers have low levels of education.

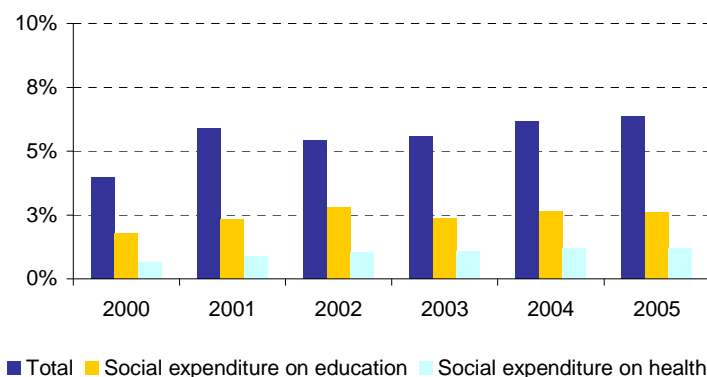
As figure VI.2 shows, the rate of underweight in Paraguay began to decline in 1990, but picked up again in 1997. In any case, according to the available data, throughout the period it remained between 4.2% and 5%, relatively low levels compared to other countries in the region.

FIGURE VI.2
PARAGUAY: ESTIMATED UNDERNUTRITION TRENDS IN CHILDREN UNDER FIVE



Source: Authors' compilation, based on the Demographic and Health Survey (1990) and Household Surveys (1997, 1998, 2001 and 2005).

FIGURE VI.3
PARAGUAY: PUBLIC SOCIAL EXPENDITURE, BY SECTOR, 2000-2005
(As a percentage of GDP)



Source: ECLAC, public social expenditure database.

In response to the problems of undernutrition, Paraguay considerably boosted public social expenditure by the central government. In 1990, this expenditure amounted to 2.8% of GDP, and between 2000 and 2005 it climbed to about 8% of GDP. On average, 4.0% of GDP was devoted to education and 1.2% to health,⁶⁰ with both categories accounting for 63% of all public expenditure by the central government.

It is worth noting that major advances in the institutionalization of food policy have been made during the past decade in Ecuador. In 2005, the Food and Nutrition Assistance Programme (PROAN)⁶¹ was established, and the Paraguayan government allocated US\$ 3 million in the national expenditure budget for this purpose.⁶²

PROAN is run by the Ministry of Public Health and Social Welfare, and its objective is to reduce undernutrition in boys and girls under the age of five. Although it is a national programme, the first phase involves intervention in 5 of the 18 departments in the country. Those departments, in turn, have given priority to the most vulnerable districts (based on poverty and undernutrition criteria).

The programme provides nutritional assistance in the form of a package of food and vitamin and mineral supplements that is delivered to boys and girls under five who have or are at risk for undernutrition and to pregnant women whose weight is low.

B. Effects and costs of underweight in 2005: analysis of the incidental retrospective dimension

As indicated in the methodology developed for these studies, this dimension is used to estimate and analyse the effects and costs on education, health and productivity incurred as a result of undernutrition in a specific year, in this case 2005.

⁶⁰ Does not include Decentralized Agency Health Spending.

⁶¹ Presidential Decree N° 5,273. May 2005.

⁶² Budget Act N° 2,530. Fiscal year 2005.

1. Undernutrition and health

1.1 Effects on health

Undernutrition at an early age predisposes people to a greater risk of morbidities as well as mortality, which can be analysed through probability differentials.

To estimate these effects, data from epidemiological follow-ups and the country's official health statistics have been combined with information gathered in interviews with national specialists and special tabulations of household surveys and health databases.

1.1.1 Morbidity

In Paraguay, the effects of undernutrition on morbidity rates for the various pathologies associated with it resulted in 42,000 additional cases in 2005. Among these, the most noteworthy are acute diarrheal diseases (ADD), acute respiratory infections (ARI) and anemia.

In addition, there are the pathologies specific to critical nutritional deficiencies in calories and proteins, such as marasmus and kwashiorkor, which accounted for 101 cases in 2005.⁶³

1.1.2 Mortality

Undernutrition affects mortality through several different pathologies in Latin America and the Caribbean, the most significant of which are diarrhoea, pneumonia, malaria and measles. In order to limit the number of errors resulting from the poor quality of official records on cause of death, the estimates made by Fishman et al (WHO, 2004), which define relative differential risks for all causes of death among children under the age of five, were considered for each country together with the mortality rates estimated by the Latin American and Caribbean Demographic Centre (CELADE-Population Division).

On this basis, it is estimated that between 1941 and 2005, just over 44,000 children under five died from causes associated with undernutrition. Considering the survival rates of the different cohorts throughout the period, just over 11% would still be alive in 2005 if they had not suffered from underweight. In addition, it is estimated that of the total number of deaths that occurred in the population under five years of age in 2005, almost 5,000 (11%) were associated with underweight.

TABLE VI.3
PARAGUAY: MORTALITY OF CHILDREN UNDER FIVE ASSOCIATED WITH
UNDERWEIGHT, ADJUSTED BY SURVIVAL RATE, 1941-2005

Period	Number of deceased children
1941-1950	5 172
1951-1960	6 176
1961-1970	6 108
1971-1980	6 283
1981-1990	7 592
1991-2000	8 639
2001-2005	4 146
Total	44 116

Source: ECLAC, based on CELADE population and mortality statistics, relative risks estimated by Fishman et al, DHS 1990 and the 1997-2005 Household Surveys.

⁶³ Paraguay has very few cases of marasmus and kwashiorkor relative to the rest of Latin America and the Caribbean. Only the direct effects of underweight are considered, not those of deficiencies in micronutrients.

Furthermore, as shown in table VI.3, between 1941 and 1990 undernutrition caused the deaths of 31,000 children under five, who would have been between 15 and 64 years of age in 2005 and therefore would have been part of the working-age population (WAP).⁶⁴ As demonstrated in section 3 of this chapter, this has had a major impact on productivity in the country.

1.2 Health costs

The institutional (public) and private health costs stemming from increases in the treatment of pathologies associated with undernutrition⁶⁵ among children under five are concentrated in the age range of 24 to 59 months: 52% of the population affected and 47% of total health costs for the cohort during the year in question. This is closely tied to the higher number of treatments required by the affected population.

The public and private health cost estimated for Paraguay is equivalent to US\$ 35 million, 0.5% of GDP for that year and 41% of public expenditure on health⁶⁶ for the same year.

When the origin of the spending categories is analysed, it is observed that 54% corresponds to the public sector and 46% to the private sector. The largest share of private sector spending corresponds to medical inputs not covered by the public health system, which is 23 times the amount corresponding to the time and transportation required for treatment.

The 42,000 cases requiring health care due to illnesses associated with undernutrition, shown in table VI.4, include 37,000 direct treatments of boys and girls solely for underweight.

TABLE VI.4
PARAGUAY: HEALTH COST OF UNDERWEIGHT, 2005

Age	Number of cases	Millions of guaranis	Millions of dollars
Newborn (IUGR)	4 424	58 201	9
0 to 11 months	5 219	13 905	2
12 to 23 months	10 374	43 392	7
24 to 59 months	21 683	101 175	16
Total	41 700	216 673	35

Source: Authors' compilation.

2. Undernutrition and education

2.1 Effects on education

Education coverage is high for primary education (94%) but low for secondary education (57%),⁶⁷ according to Paraguay's official statistics.

⁶⁴ For the purposes of comparing cost estimates in this study, the WAP is defined as the population between 15 and 64 years of age.

⁶⁵ In the case of public costs, indicators were estimated on the basis of information reported by different agencies of the Ministry of Health. For estimating private costs, the official minimum wage, urban public transport fares and inputs not covered by the public health-care system were considered.

⁶⁶ Central Government Public Spending on Health.

⁶⁷ <http://stats.uis.unesco.org>.

According to the 2005 household survey, the average education level of the adult population (aged 20 to 64 years) is 8.2 years of schooling, reflecting a gradual increase in school attendance. Thus, among those aged 55 to 64, the average number of years of schooling is 3.6, less than the average for those aged 20 to 24. However, school completion rates are still low, and coverage is deficient, such that only 21% of the latter age group has finished secondary school.⁶⁸

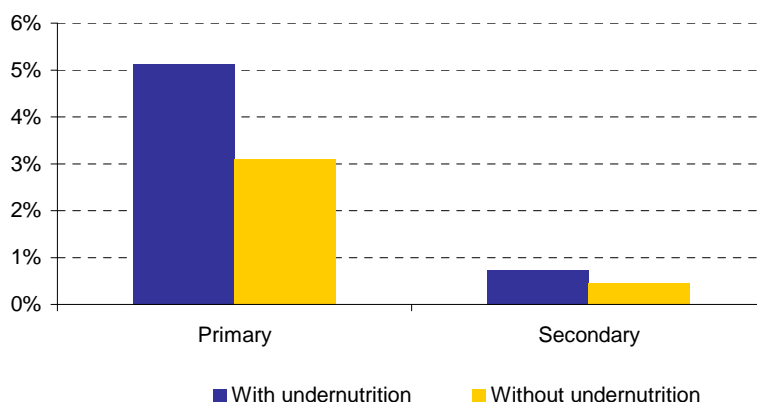
The Paraguayan population suffering from undernutrition has an average education differential that is 1.9 years less than the average for those without undernutrition, including both primary and secondary schooling. One reason for this may be that a larger percentage of those who suffered from undernutrition during their preschool years did not even complete the first grade of primary school.

When just the population with some schooling is considered, 84% of those who suffered from undernutrition attended just primary school, compared to 56% of those not suffering from undernutrition. This ratio is gradually reversed for secondary education, such that less than 5% of those with undernutrition attain 12 years of schooling, compared to 20% of those without undernutrition. These differences are very important indicators of the labour and income opportunity gaps between the two groups during their working years.

Underweight in Paraguay caused an additional 2,000 grade repetitions in 2005, which led to the corresponding incremental costs. Of those repetitions, 96% were in primary school.⁶⁹

One element worth mentioning is that children who have suffered from undernutrition have a greater concentration of repeated grades in the early years of primary school than “normal” children. However, as figure VI.4 shows, the rates for both groups are higher in primary school, but those suffering from undernutrition still lag behind.

FIGURE VI.4
PARAGUAY: EFFECTS OF UNDERWEIGHT ON GRADE REPETITION, 2005
(In percentages)



Source: ECLAC, based on data from the Education Ministry (2005), the 2005 Household Survey and CELADE population estimates (2005).

⁶⁸ Population aged 20-24 years that completed secondary school.

⁶⁹ To estimate education gaps caused by undernutrition, the estimates contained in a longitudinal study conducted in Chile between 1987 and 1998 (Ivanovic 2005) were adapted. According to these estimates, in socio-economically similar populations, persons who have suffered from undernutrition during their preschool years have a risk of repeating one or another grade in school equivalent to 1.65 times the risk run by those who did not have undernutrition. In the absence of estimators, and considering the characteristics of the educational systems, this relative risk of grade repetition was used, along with a dropout differential of about 1.4 for the entire education cycle, to obtain comparable estimates among the different Andean countries.

2.2 Education costs

The additional burden of repeated grades by those who have suffered from undernutrition is a central issue in the cost of operating the education system. The differential repetition probability means more than 2,000 additional students attending school in 2005, at a cost of US\$ 833,000, 0.28% of social expenditure on education and 0.011% of GDP for that year.

TABLE VI.5
PARAGUAY: COSTS OF DIFFERENCE IN GRADE REPETITION
DUE TO UNDERWEIGHT, 2005

	Primary	Secondary
Annual cost per student (2005 guaranis) 2005)	2 505 996	2 437 131
Additional annual cost (2005 guaranis) 2005)	4 942 119 582	205 252 795
Additional annual cost (US\$ 2005)	799 960	33 223
		833 183
% Social expenditure on education		0.28%
% of GDP		0.011%

Source: ECLAC, based on Household Survey (2005) and DHS (1990).

3. Productivity

3.1 Effects on productivity

As indicated previously, undernutrition has an adverse impact on a country's production capacity as a result of the higher prevalence of mortality among children under the age of five caused by pathologies associated with undernutrition and the lower education levels achieved by those suffering from undernutrition.

Table VI.6 shows the magnitude of the productivity loss resulting from the 44,000 deaths among children under the age of five, mentioned previously (1941-1990 period). Considering the country's employment rates by cohort, the resultant cost is equivalent to 49 million hours of work, a little more than 1.31% of the hours worked by the economically active population (EAP).

If the potential number of hours worked per year is estimated at 2,400 for all age groups, these deaths associated with undernutrition represent an estimated 49 million lost work hours, equivalent of 1.1% for the EAP.

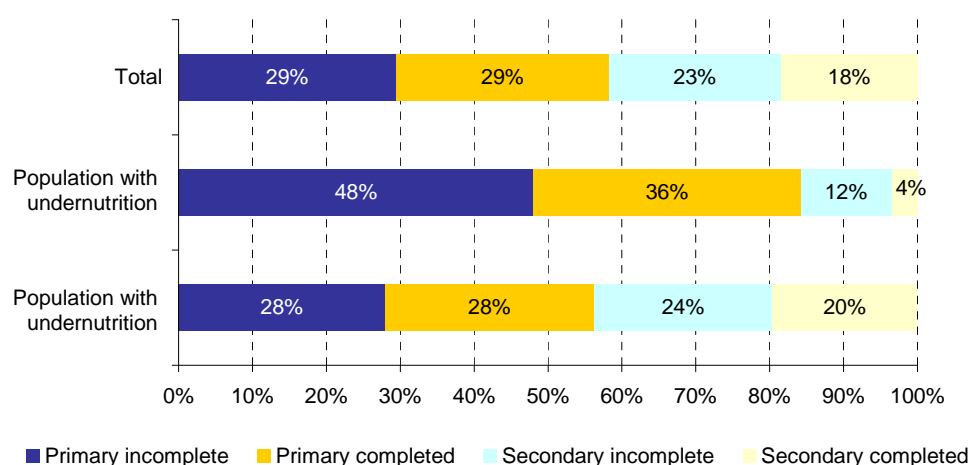
The effect of the schooling gap on productivity corresponds to the differences in the education level distribution of the population. Those who have suffered from undernutrition have lower rates of primary and secondary school completion than those not suffering from undernutrition, as depicted in figure VI.5.

TABLE VI.6
PARAGUAY: PRODUCTIVITY EFFECTS OF MORTALITY DUE TO UNDERWEIGHT

Age group	Mortality caused by undernutrition (N, 1941-1990)	Lost work hours (2005)
15 to 24 years	7 592	6 994 496
25 to 34 years	6 283	11 089 647
35 to 44 years	6 108	12 168 653
45 to 54 years	6 176	11 172 755
55 to 64 years	5 172	7 736 431
Total	31 332	49 161 982
Hours lost in relation to EAP		1.1%

Source: Authors' compilation, based on CELADE population and mortality statistics, relative risks estimated by Fishman et al, Ministry of Education and Culture. System of Continuing Statistical Information (SIEC), Departmental Statistical Unit (UDE). Asunción and 2005 Household Survey.

FIGURE VI.5
PARAGUAY: EFFECTS OF UNDERWEIGHT OF EDUCATION
LEVELS DISTRIBUTION, 2005 (POPULATION AGED 25 TO 64 YEARS)



Source: ECLAC, based on Household Survey (2005), DHS (1990) and CELADE population estimate (2005).

3.2 Productivity costs

The higher productivity costs are a function of the economic value resulting from the aforementioned effects. For 2005 it is estimated that lower levels of schooling led to losses totalling more than US\$ 73 million, equivalent to 3.1% of social expenditure for the year, 6.4% of public expenditure on education and approximately 1% of GDP.

Moreover, the loss of productivity due to deaths caused by undernutrition in the population that would have been of working age in 2005 is estimated at US\$ 40 million, approximately 0.54% of GDP. Thus, if not for the levels of undernutrition suffered by the country in recent decades, productivity would have been 1.6% higher in 2005.

4. Summary of costs

To sum up, underweight in the different cohorts of the population in 2005 cost approximately 921,648 billion guaranis, equivalent to US\$ 149 million. These values represent 2.0% of GDP and nearly 25% of total social expenditure for that year.

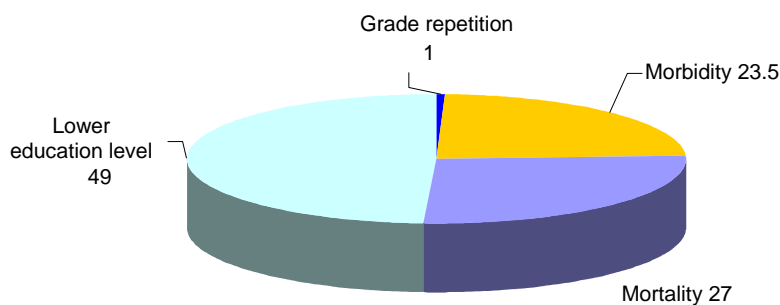
TABLE VI.7
PARAGUAY: SUMMARY OF RESULTS: EFFECTS AND COSTS OF UNDERNUTRITION,
2005 (INCIDENTAL RETROSPECTIVE DIMENSION)

	Units	Millions of guaranis	Millions of dollars
Health			
More cases of morbidity	41 700	216 673	35
Number of additional deaths	31 332		
Education			
Additional repeated grades	2 056	5 147	0.8
Differential number of dropouts	81 677		
Productivity			
Loss of hours due to mortality	49 161 982	246 429	39.9
Fewer years of schooling	1.9	453 398	73.4
Total		921 648	149.2
Social expenditure (in %)			24.6
GDP (in %)			2.0

Source: ECLAC.

As the figure below indicates, the costs of lost productivity due to mortality and lower education levels account for 76% of the total cost, whereas costs associated with morbidity caused by underweight represent 23.5%.

FIGURE VI.6
PARAGUAY: COST DISTRIBUTION OF UNDERWEIGHT BY FACTOR,
2005 (INCIDENTAL RETROSPECTIVE DIMENSION)
(In percentages)



Source: Authors' compilation.

C. Effects and costs in the cohort aged 0-59 months in 2005: analysis of the prospective dimension

The present and future losses (and potential savings) stemming from medical treatment, grade repetition and lower productivity caused by the prevalence of underweight in Paraguay among those under the age of five in 2005 can be estimated through this dimension.

1. Health effects and costs

As demonstrated in the previous chapter, undernutrition at an early age increases the risk of dying and suffering from certain diseases.

Based on projections from census data, it is estimated that in the cohort aged 0 to 59 months in 2005, 25,249 deaths will occur before the fifth birthday. Of these deaths, nearly 3,000 (11%) are associated with the prevalence of undernutrition, with 1,300 cases in 2005.⁷⁰ Accordingly, whereas nearly 4% of children suffer from undernutrition, the resultant mortality figure increases to 11% because of the greater risk of death among those suffering from underweight.⁷¹

Table VI.8 shows that the highest incidence of death occurs before the first birthday, during which time the probability of death is 1.2 times greater than for the rest of the cohort. However, more than 2,000 children could also die from causes associated with underweight between one and four years of age.

As for morbidity in Paraguay, it is estimated that in the cohort aged 0 to 59 months in 2005, a little more than 295 additional cases of diseases associated with underweight will occur before the fifth birthday. Of these cases, 48% will be in the group aged 24 to 59 months.

TABLE VI.8
PARAGUAY: MORTALITY CASES ASSOCIATED WITH UNDERWEIGHT
IN CHILDREN UNDER FIVE, 2005-2009

Age	2005	2006	2007	2008	2009	Percentage
0 to 11 months	691					24
12 to 59 months	612	612	456	302	150	76
Total	1 303	612	456	302	150	2 824

Source: ECLAC, based on CELADE population and mortality statistics, differences in prevalence and the 2005 Household Survey.

In addition to the morbidity cases indicated in table VI.9, the direct treatment of underweight boys and girls must be taken into consideration. They totalled 41,000 in 2005, and there were another 16,000 between 2006 and 2009, of which 4,424 were children with low birth weight due to intrauterine growth retardation (LBW-IUGR).

The added health costs resulting from additional cases of disease linked to undernutrition amounted to US\$ 35 million in 2005 alone, with a present value⁷² of US\$ 45.6 for the 2005-2009 period.

⁷⁰ All the estimates for the cohort aged 0-4 years in 2005 have gradually diminished in the years prior to 2009 as a result of the transition of the individuals in that cohort into higher age groups.

⁷¹ UNICEF 1998

⁷² With a discount rate of 8% annually.

TABLE VI.9
PARAGUAY: MORBIDITY CASES ASSOCIATED WITH UNDERWEIGHT
IN CHILDREN UNDER FIVE, 2005-2009

Age	Total estimated cases of disease					Percentage
	2005	2006	2007	2008	2009	
0 to 11 months	46					16
12 to 23 months	67	42				37
24 to 59 months	97	28	12	3	0	48
Total	210	70	12	3	0	295

Source: ECLAC, based on CELADE population and mortality statistics, differences in prevalence and the 2005 Household Survey.

The values indicated in table VI.10 translate into an equivalent annual cost (EAC)⁷³ of US\$ 13.8 million for the period, amounting to about 16% of public expenditure on health and 0.2% of GDP.

TABLE VI.10
PARAGUAY: COSTS OF MORBIDITY ASSOCIATED WITH UNDERWEIGHT, 2005-2009
(Millions of dollars)

Age	2005	2006	2007	2008	2009
Newborn	9.4				
1 to 11 months	2.3				
12 to 23 months	7.0	4.4			
24 to 59 months	16.4	4.7	2.0	0.4	0.1
Total	35.1	9.1	2.0	0.4	0.1
PNV	45.6				

Source: Authors' compilation.

2. Education effects and costs

When the education figures for children under five in 2005⁷⁴ are projected, the probability differential for level of education can be estimated, along with the additional costs of the approximately 57,000 future students who now have undernutrition in Paraguay.

Using official information, it can be estimated that between 2007 and 2022 there will be 964 additional cases of grade repetition. Of these, 99% will be in primary education and 1% in secondary, which can be explained by the larger percentage of repeated grades in primary school.

As a result of the extra grades, the education costs expressed in present value (at an 8% discount rate) will be 1,484 billion guaranis, equivalent to US\$ 240,000.

⁷³ Ibid.

⁷⁴ This projection is based on the education coverage of the school-aged population and the education levels achieved by the cohort aged 20 to 24 years in the latest household survey (2005).

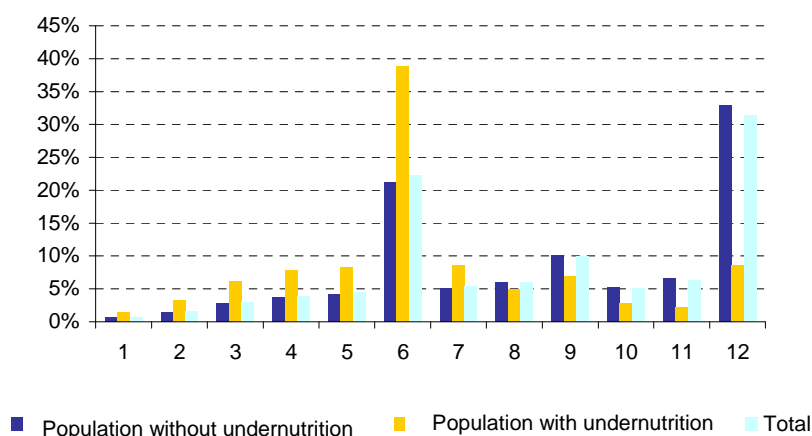
Converting these values to an equivalent annual value for the 16 year period during which the cohort in question will be of school age (2007-2022) results in a total of US\$ 30,000 in 2005 dollars, which represents 0.01% of social expenditure on education for that year.

Of these costs, 10% would be paid by the children's families and 90% by the education system.

Moreover, the greater risk of school attrition among these children means that 13,000 students would drop out of school early due to undernutrition.

Consequently, a differential of 2.2 years of schooling can be estimated for children with and without undernutrition, with an average of about 6.4 years for those with undernutrition.

FIGURE VI.7
PARAGUAY: ESTIMATED DISTRIBUTION OF GRADE COMPLETION FOR THE COHORT
AGED 0-59 MONTHS IN 2005, WITH AND WITHOUT UNDERWEIGHT
(In percentages)



Source: ECLAC, based on Household Survey (2005) and CELADE population estimates.

Furthermore, for the entire cohort it is estimated that nine out of every 100 children suffering from undernutrition will attain 12 years of education, compared to 33 out of every 100 children who have not had undernutrition. This reflects the greater probability that the latter group will complete their schooling.

3. Productivity effects and costs

The education differential discussed in the previous point translates into less cumulative human capital because of persons with undernutrition, and it has a direct negative effect on their productivity.

In addition, 2,824 more deaths can be expected as a result of undernutrition in the cohort aged 0 to 59 months in the 2005-2009 period, leading to a potential productivity loss of more than 278 million hours of work during the cohort's working life (between 2015 and 2069).

Against this backdrop, it is estimated that productivity losses associated with underweight in children under five in Paraguay in 2005 will total 381,594 billion guaranis, equivalent to US\$

62 million in 2005 dollars.⁷⁵ Of this total, US\$ 51 million is a result of lower education levels and US\$ 11 million of differential mortality.

Considering the entire period in which these values would be produced (2015-2069), the equivalent annual cost is 31 billion guaranis, or US\$ 5 million. Of that total, US\$ 1 million corresponds to mortality costs and US\$ 4 million represents losses due to lower levels of education.

The equivalent annual cost of these productivity losses amounts to 0.06% of GDP in Paraguay.

4. Summary of effects and costs

When all sources of costs associated with undernutrition in the cohort of boys and girls under five suffering from undernutrition in 2005 are added together, the present value amounts to 313 billion guaranis, that is, US\$ 51 million.

TABLE VI.11
PARAGUAY: SUMMARY OF RESULTS: EFFECTS AND COSTS OF UNDERWEIGHT
IN THE COHORT AGED 0 TO 59 MONTHS, 2005

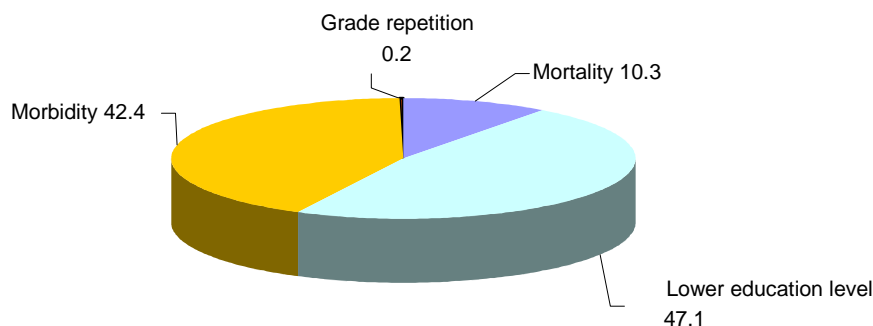
	Units	Costs (present value)	
		Millions of guaranis	Millions of dollars
Health			
Additional cases of morbidity	57 750	281 816	46
Number of additional deaths	2 824		
Education			
Additional repeated grades	964	1 485	0.24
Differential number of dropouts	13 127		
Productivity			
Loss of hours due to mortality	278 431 120	68 638	11
Fewer years of schooling	2.2	312 957	51
Total		664 896	107.6

Source: Authors' compilation, based on official data from the country.

The results shown here demonstrate that the loss of human resources stemming from higher health costs caused by morbidity and lower education levels account for the bulk of the estimated cost of undernutrition, 42% and 47%, respectively.

⁷⁵ With a discount rate of 8% annually.

FIGURE VI.8
PARAGUAY: DISTRIBUTION OF ESTIMATED COST OF UNDERNUTRITION
BY FACTOR (PROSPECTIVE DIMENSION, 2005)
(In percentages)



Source: Authors' compilation.

D. Analysis of scenarios: costs and savings

Different scenarios can be projected on the basis of the estimated costs of underweight in the population under the age of five in 2005 in Paraguay. Below are the results of the simulations corresponding to two undernutrition scenarios and their effects on costs for 2015.

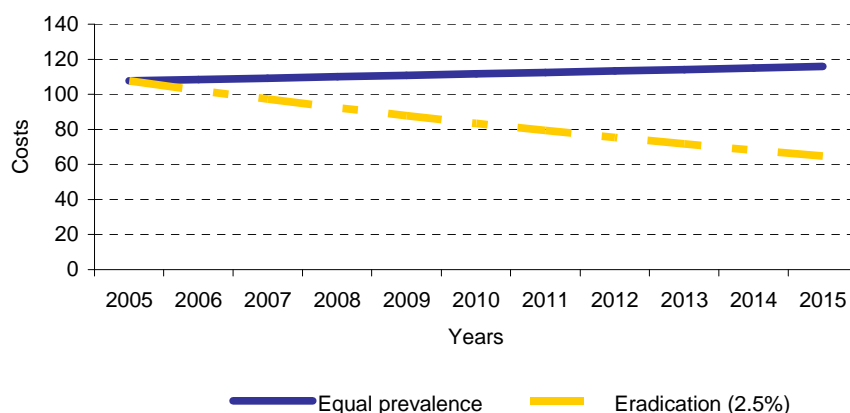
The following scenarios were considered:

1. The latest figures available on the prevalence of underweight used in this study remain the same in 2015 (see table VI.1).
2. Underweight is eradicated in the country by 2015, which for purposes of this analysis means achieving a prevalence of 2.5%, the “normal” proportion of cases according to the measurement parameters published by the National Center of Health Statistics (NCHS). To achieve this target, a reduction of just over 0.17 annual percentage points would be required.

Figure VI.9 illustrates how the gradual reduction in the prevalence of underweight also leads to a gradual decline in the associated costs. If the prevalence remains constant (scenario 1), in view of the fact that the cohort aged 0 to four years is growing in Paraguay, costs in 2015 will increase by 8%. If the MDG is achieved (scenario 2), the costs of underweight will fall to US\$ 64.7 million⁷⁶ by 2015, which in this case would mean the eradication of undernutrition. This is because the prevalence of undernutrition in Paraguay was 4.2 in 1990, so half of that is 2.1, equal to the level of eradication (2.5). For this reason, the savings were estimated using the latter rate.

⁷⁶ Value updated as of 2015, with a discount rate of 8% annually.

FIGURE VI.9
PARAGUAY: TREND IN ESTIMATED COSTS OF UNDERWEIGHT
IN TWO SCENARIOS, 2005-2016
(Millions of dollars)



Source: Authors' compilation.

Table VI.12 contains a comparison of estimated costs for 2005 with projected costs for each scenario as of 2015. The greatest variation in costs can be seen in productivity and health.

TABLE VI.12
PARAGUAY: ESTIMATED TOTAL COSTS OF UNDERWEIGHT FOR THE
BASE YEAR AND TWO SCENARIOS, 2005 AND 2015
(Millions of dollars at present value)

	2005	Scenarios for 2015	
		Prevalence unchanged	Eradication (2.5%)
Health	45.6	49.5	24.3
Education	0.2	0.3	0.2
Productivity			
Loss due to mortality	11.1	10.0	7.2
Fewer years of schooling	50.7	56.0	33.1
Total	107.6	115.8	64.8

Source: Authors' compilation.

Based on the cost trends shown, it is possible to estimate potential savings that would be generated as soon as actions aimed at achieving the proposed targets are initiated.

The distances between the trendlines in figure V.9, comparing scenario 2 with scenario 1, illustrate the year-to-year savings that would be generated. These savings would accumulate until 2015 as undernutrition is reduced or eradicated. Expressed in 2005 present value⁷⁷ they equal nearly US\$ 179 million for scenario 2. Of that amount, 37% would come in the first half of the process (2006-2010).

⁷⁷ Value updated as of 2004, with a discount rate of 8% annually.

This implies that not only could costs be significantly lower in 2015, but major savings could be achieved throughout the process of attaining the proposed target for each scenario. In turn, if appropriate policies remain in place, the projected benefits could continue to accumulate beyond 2015.

TABLE VI.13
PARAGUAY: ESTIMATED SAVINGS ACCORDING TO SCENARIOS, 2015
(Millions of dollars at present value)

	Eradication (2.5%)
Health	89.8
Education	0.4
Productivity	
Loss due to mortality	10.2
Fewer years of schooling	78.8
Total	179.1

Source: Authors' compilation.

The above is a reflection of the economic benefits to be gained from advancing towards the eradication of undernutrition. Any programme that yields effective results in this regard will not only have an impact on people's quality of life but will also yield major savings for society.

VII. Results of the study in Peru

A. Socioeconomic and nutritional background

Currently, Peru is one of the countries with the best macroeconomic indices in the region. From 2001 to 2006, it had average sustained growth of 4.8% of its GDP⁷⁸ (the highest in the region) and an inflation rate of 1.96%⁷⁹ (one of the region's lowest), as shown on table VII.1.

TABLE VII.1
PERU: TRENDS IN SOME ECONOMIC INDICATORS

Indicator	Year					
	2001	2002	2003	2004	2005	2006
Real GDP (% var.)	0.21	5.02	4.03	5.11	6.74	7.56
Private Consumption (% var.)	1.50	4.60	3.10	3.50	4.40	6.50
Total Exports (% var.)	1.02	9.79	17.85	40.90	35.59	37.04
Consumer Price Index (Annual Avg. Var.)	2.00	0.20	2.30	3.66	1.62	2.00
Nominal Exchange Rate (% var.)	0.52	0.27	-1.09	-1.88	-3.43	-0.67

Source: Author's compilation based on the *Banco Central de Reserva del Perú* (Central Reserve Bank) 2006 Annual Report.

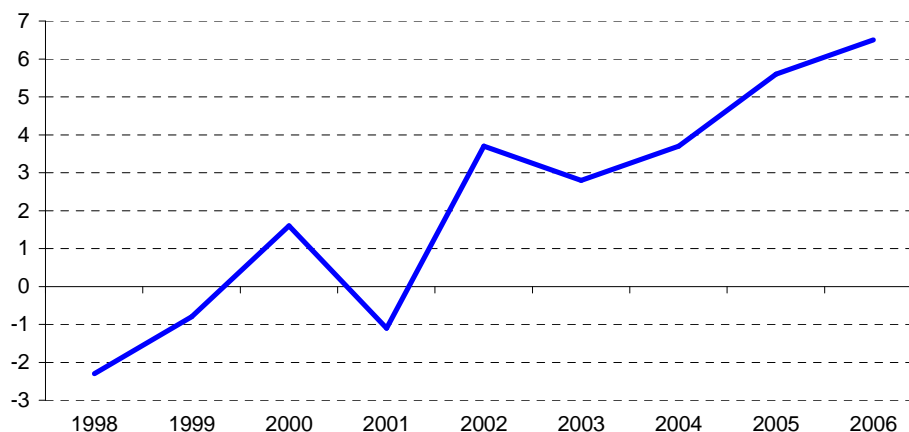
A large part of the economic growth is based on the sustained growth in the country's exports (traditional and non-traditional),⁸⁰ the private investment (with the real estate sector as a strong component) and a higher private consumption, reversing the negative private investment rates recorded in the nineties. Commercial openness and legal stability, together with near elimination of political violence in the country, have been the general framework for this economic improvement process.

⁷⁸ Annual Memory 2006. Central Bank of Reserve, Peru, Lima. 2006.

⁷⁹ Idem.

⁸⁰ From 1997, the rate of growth of the exports overcame the rate of growth of the GDP, coming to peaks closely from 15 % in the year 2004 and 2005. Source: Central Bank of Reserve Peru.

FIGURE VII.1
PERU: TRENDS IN PER CAPITA GDP, 1998-2007



Source: Author's compilation based on Economic Study for Latinamerica and the Caribbean, 2009.

However, these improvement indices for the whole of the country have not necessarily been reflected in the country's social welfare. With nearly half of the population living in poverty, education indicators that place the country among those lagging behind in the region and quite high undernutrition levels, economic growth is still paradoxical, since it is not reflected in improved macroeconomic levels.

For example, the Gini coefficient⁸¹ decreased from 0.525⁸² to 0.505 over the 2000-2005 period. In 2005, 7.6% of the boys and girls under five years of age suffered from underweight,⁸³ which was a slight increase compared to the figure for the year 2000 (7.1%). If this figure continues to increase or remains stable, it is quite possible that the country will not achieve its commitment under the MDG.

Looking at the long-term trend, the prevalence of underweight in Peru has decreased steadily over the last 30 years, with greater intensity in the 1975-1996 period (8.3% points lower), remaining relatively stable since 1996 (approximately 8%).

Regarding stunting, despite the 10.7 percentage point reduction at the national level, from 36.5% (1990) to 25.8% (1996), the level of prevalence has remained almost the same in recent years, decreasing slightly from 25.4% (2000) to 24.2% (2005).

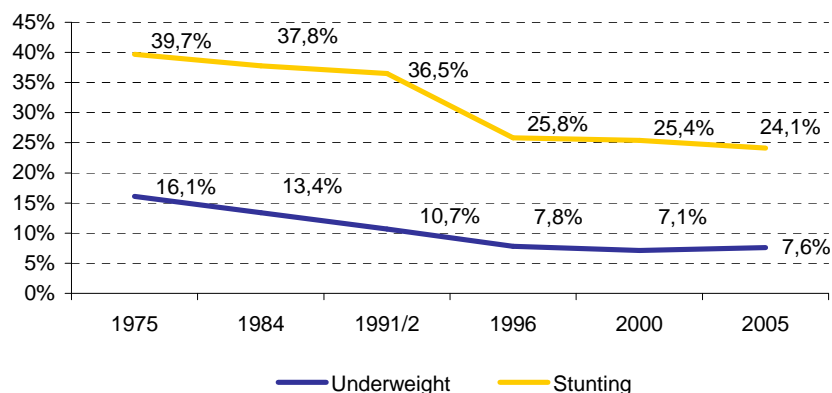
An analysis of the characteristics of the population affected reveals greater prevalence of underweight in children from 24 to 47 months of age (13.2%); additionally, underweight is greater in boys and girls who have suffered from severely restricted intrauterine growth (nearly 17 out of 100 children with low birth weight suffer from undernutrition).

⁸¹ Gini's coefficient is used to measure the inequality in the income of a country. It is a number between (among) 0 and 1, where 0 it (he, she) corresponds (fits) with the perfect equality (they they all have the same income) and 1 corresponds (fits) with the perfect inequality (a person has all the income and the others none). CEPAL, Social Panorama in Latin America, 2006.

⁸² ECLAC, Social Panorama, 2006.

⁸³ National Institute of Statistics and computer science, Reporto f the Demographic and Health National Survey (Endes) 2005. Lima 2005.

FIGURE VII.2
PERU: ESTIMATED UNDERNUTRITION TRENDS IN CHILDREN UNDER FIVE, 1975-2005



Source: Author's compilation based on National Demographic and Health Surveys (1975, 1977, 1984, 1991/92, 1996 and 2005).

TABLE VII.2
PERU: CHILDREN AND UNDERWEIGHT

Age	Number of children (2005) ^b	Children affected (2005)	Prevalence (in percentages)			
			1992	1996	2000	2005
Newborn (IUGR)						
0 to 11 months ^a	605 453	10 898	5.1	3.9	2.9	1.8
12 to 23 months	597 358	63 917	15.9	12.1	10.7	10.7
24 to 59 months	1 794 377	156 11	10.9	7.5	7.0	8.4
Total	2 997 188	230 926	10.7	7.8	7.1	7.6

Source: Author's compilation based on National Demographic and Health Surveys (Endes)-INEI, and Celade-ECLAC estimates.

^a In a given year, the population of newborns is the same as the 0 to 11-month population.

^b Estimate based on the latest prevalence figure available.

With regard to geographic distribution, underweight is greater among boys and girls living in rural areas (12%) and in the highlands and jungle (10%). Children whose mothers have lower levels of education also show higher rates (18.2% for children of illiterate women and 12.5% for children of mothers who have only completed primary school). By the same token, in relation with economic level, children from the first quintile of income are more affected, where the undernutrition level is 15.8%.

It should also be noted that, as in other Andean countries, “boys and girls from indigenous language-speaking families have a significantly higher probability of suffering from undernutrition than those from non-indigenous language-speaking families” (ECLAC, 2005). In the case of Peru, in 2000, the Endes survey found a prevalence of 48.1% among children of indigenous families, but only 21.4% for non-indigenous children. It is also noteworthy that among those who speak Quechua, the rate rises to 49.2%, while for those who speak Aymara it is 34.5%.

Regarding the evolution of the risk of undernutrition during the first years of life, as highlighted by different studies conducted in the region, the problem in Peru has a significant

growth phase in the first 24 months of life (reaching nearly 10.7% in 2005), with a subsequent decrease and stabilization in the remaining preschool phase.

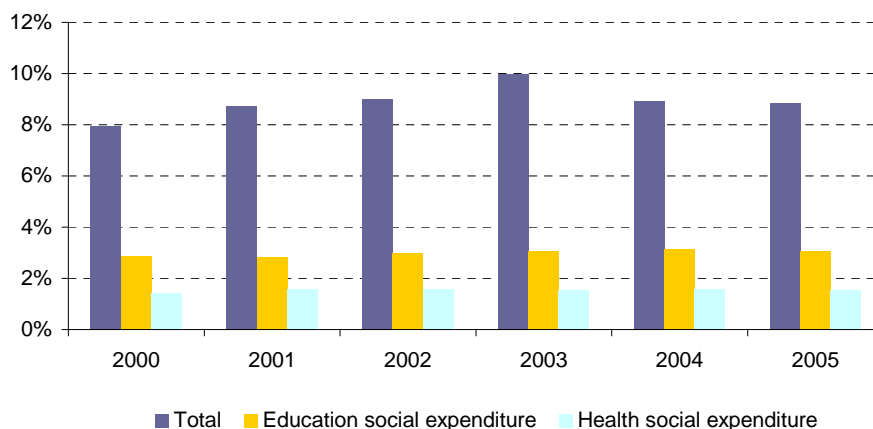
Low birth weight (LBW)⁸⁴ is a risk factor for the health and survival of newborns, as well as for their future nutritional state. In 2005, among boys and girls who were weighed at birth, 8% weighed less than 2.5 kilograms, which was higher than the 6% found in the Endes surveys of 1996 and 2000.

Although there are still considerable levels of under-recording of information (under-recording decreased from 28% in 2000 to 18% in 2005), it is important to note that this LBW indicator is 46% among the poorest mothers and 39% to 45% among mothers who give birth to a sixth or subsequent child and non-educated mothers, respectively. Additionally, this indicator is 33% among mothers living in rural areas, which is a cause for concern because it reflects an under-registration of information that could distort the real magnitude of LBW.

Among South American countries, Peru has the second highest prevalence of underweight,⁸⁵ following Ecuador, without significant differences from the Plurinational State of Bolivia and Colombia.

The country's socioeconomic inequality is reflected in the differences in prevalence of child undernutrition: low weight-for-age in the bottom quintile is 15.8% compared to the top quintile, for which it is 1.9%. Similarly, stunting in the bottom quintile is 45.8% compared to 4.4% in the top quintile.

FIGURE VII.3
PERU: PUBLIC SOCIAL EXPENDITURE, BY SECTOR, 200-2005
(As a percentage of GDP)



Source: ECLAC, public social expenditure database.

As an offset to the undernutrition problem, in 2005, Peru earmarked 9% of its GDP for social expenditure (including pension expense), with an average of 3.1% for education and 1.5% for health care, which together accounted for 54% of total social expenditure. In relation with the

⁸⁴ Born with less than 2,500 grams.

⁸⁵ The weight for the age is a general indicator of the undernourishment, does not differentiate the chronic undernourishment, that would have to structure factors of the society, of the acute undernourishment, that corresponds to loss of recent weight. He is very useful to detect changes in the nutritional state of children who are being seen in continuous form.

GDP for each year, from 1990 to 2000, total social expenditure increased 3.7% (0.8% for education and 0.7% for health care).⁸⁶ From 2000 to 2005, total social expenditure rose from 8% to 9% (mostly for health care), peaking at 10% in 2003.

It is possible to emphasize that in the increase observed in the decade of 1990, most is current cost (social wages and obligations), component that registered an increase of 11.5% in the 2000 to 21.9% in the 2005.

The food/nutrition issue currently has an important position in our country, as one of the primary objectives that the governmental administration has included on the political agenda is achieving a 10 percentage-point reduction in chronic child undernutrition during its term.⁸⁷

In this regard, a series of actions has been coordinated among the different sectors of the government in order to reach the established goal, highlighting that the protection of human capital is one of the highest-priority commitments of the current administration that shows the firm political decision to attain it. The administration has established concrete goals and called for technical support from cooperating agencies, institutions and people committed to the fight against poverty and stunting through coordinated efforts.

On August 24, 2006, the president of the Council of Ministers presented the administration's highest political priorities to the full session of Congress, sustaining that the priority is "to overcome poverty and reduce the inequality and exclusion that affect over 13.5 million Peruvians. The strategy is aimed at capacity building and the state must ensure that the conditions exist for this to occur". Within this framework, the President of Peru set a goal of reducing chronic child undernutrition by 10 percentage points by 2011, due to which efforts must be directed toward the articulation of public and private resources in order to deal with the causes in a comprehensive –not sectorial– manner. In this way, the commitment has become an operating instrument for achieving the objectives set forth, through the National Strategy for Fighting Undernutrition, approved through Executive Decree No. 055-2007-PCM on July 2, 2007, which establishes articulated intervention by the national, regional and local governments in the fight against child undernutrition. The Interministerial Commission on Social Issues (Spanish acronym: CIAS) is in charge of coordinating and following up on the *Crecer* (Grow) Program, the purpose of which is to join efforts to guarantee that all boys and girls under five years of age in our country are well nourished.

Another important action was reforming the Ministry of Women and Social Development's (Mimdes) Nutritional Programs under the management of the National Food Assistance Program (known by its Spanish acronym, Pronaa), merging the six original programs into one called the Comprehensive Nutrition Program (Spanish acronym: PIN), whose purpose is to protect and develop human capital within the framework of their fundamental rights. Additionally, this reform provides for a change from an assistance approach to a preventive/promotional approach, with the educational component as a fundamental pillar.⁸⁸

Recognizing that our country has important legal instruments that provide the necessary framework to combat hunger and undernutrition at all levels is of key importance. In this regard, we have:

1. The Fifteenth State's Policy, which explicitly mentions the promotion of food and nutrition security in the following terms:

⁸⁶ ECLAC, Social Development Division: <http://www.cepal.org/dds/GastoSocial/datos.htm>.

⁸⁷ Speech of the President of the Republic. July 2006.

⁸⁸ Diseño de Programa Integral de Nutrición. Convenio Mimdes/Pronaa-PMA. Autor: Mónica Saavedra Chumbe.

“...To establish a food security policy that makes sufficient food with adequate quality available and accessible to the population in order to guarantee an active, healthy life within the concept of integral human development...”

“...Shall develop an intersectorial, participatory food security policy with decentralized programs that deal with the problem of undernutrition in a comprehensive manner...”

2. Executive Decree No. 118-2002-PCM: National Food Security Strategy (ENSA). This document makes the goals of the country’s food policy explicit, with a comprehensive approach to access, availability and use of food, as well as the sustainability of its production. It also incorporates a territorial development approach, since it makes it clear that the food policy itself must be defined within the most pertinent territorial spaces; that is, the actions related to the policy must not necessarily be limited to political-administrative delimitations, but rather to geopolitical spaces, such as economic corridors.

The goals related to food security to be attained by 2015 are also specified. The main goals indicated are a reduction of the percentage of children under three years of age and pregnant women with inadequate food and nutrition practices from 60% to 40%, a reduction of stunting in children under five years of age from 25% to 15%, a reduction of households with a caloric deficit from 35.8% to 25%, an increase in the food trade surplus (due to increased productivity) and, lastly, an increase in the per capita daily availability of calories from foods of domestic origin by 10%.

3. The National Plan of Action for Children and Adolescents 2002-2010, approved by means of Executive Decree No. 003-2002-Promudeh, which has the force of law according to Law No. 28487, also establishes objectives aimed at fostering healthy living for boys and girls. Its Strategic Objective Nr. 1, “To ensure healthy living for boys and girls from 0 to five years of age”, considers the rights established by the Convention on the Rights of the Child: right to life, right to health and nutrition, right to development and social protection. Within this framework, some expected outcomes as of 2010, such as those listed below, have been established:

- Conditions created for healthy, safe pregnancy and childbirth:
 - Goal: To incorporate 85% of the expectant mothers living in areas with extreme poverty as users of the nutritional supplementation program.
- All boys and girls under two years of age have access to breastfeeding and optimum complementary nourishment:
 - Goal: To reduce the percentage of newborns with low birth weight by 20%.
 - Goal: To reduce stunting by 20% among children under three years of age, throughout the country.
 - Goal: To improve the nutrition of 80% of the boys and girls under two years of age.
- The micronutrients nutritional status of boys and girls improved:
 - Goal: To reduce stunting by 20%.
 - Goal: To reduce acute undernutrition in areas with extreme poverty by 30%.
 - Goal: To eliminate diseases caused by vitamin A deficiency in a sustainable manner.

- Goal: To reduce the prevalence of anemia among boys and girls under three years of age by 40%.

B. Effects and costs of underweight in 2005: analysis of the retrospective incidental dimension

As indicated in the methodology used for these studies, this dimension makes it possible to estimate and analyze the education, health and productivity effects and costs generated by undernutrition in a specific year, in this case 2005.

1. Undernutrition and health

1.1 Effects on health

Undernutrition at an early age predisposes a person to a greater risk of morbidity, as well as mortality, which can be analyzed through probability differentials.

In order to estimate these effects, data was taken from the National Demographic and Health Survey (Endes), which is representative of the universe of households nationwide, complemented by information gathered through interviews with national specialists from the Ministry of Health.

1.1.1 Morbidity

In Peru, the effects of undernutrition on the morbidity rates of the different associated pathologies would have resulted in 44,306 additional cases in 2005. Among these, acute diarrheal disease (ADD) with 9,847 cases, acute respiratory infections (ARI) with 15,582 cases and iron deficiency anemia with 18,877⁸⁹ stand out. This situation is a result of the differences in prevalence (DP).⁹⁰

The greater differences in prevalence among children suffering from undernutrition and not suffering occur in the first year of life for the three pathologies. The difference in the prevalence of anemia in malnourished children compared to non-malnourished children in the 0 to 11 month age group is approximately 18% and 11% in children from 24-59 months of age. However, there are no significant differences for the 12-23-month-old age group.

The difference in the prevalence of ADD in the 0-11-month-old age group is approximately 10% (OR=1.7); in the 12-23-month-old age group, it decreases to 8% (OR=1.5), and further decreases to 2.3% in children from 24-59 months of age (OR=1.4).

In the case of ARI, the difference in the prevalence is greater in the 1-11 month-old age group (21%), and decreases progressively among children from 12-23 months of age (9%) and those from 24-59 months of age (5%).

In addition to the foregoing are pathologies related to critical nutritional deficiency in calories and protein, such as marasmus and kwashiorkor. According to information on cases reported, in 2005 there were 744 cases, accounting for less than 1% of the population of children under five years of age in Peru.

⁸⁹ The estimates of effects and costs presented in this report are averages, and are subject to the original sources' margins of error.

⁹⁰ DP refers to the higher probability that those suffering from undernutrition will have a pathology (i) as a "consequence" of their undernutrition.

1.1.2 Mortality

There are several pathologies through which undernutrition affects mortality, among which the following stand out: diarrhea, pneumonia, malaria and measles. To limit the errors derived from the quality of official records on causes of death, in order to assess the situation in each country, the estimates made by Fishman et al. (WHO, 2004), which defined relative risk differentials for all causes of death among children under five years of age, were considered together with the mortality rates estimated by Latin American and Caribbean Demographic Center (CELADE, Population Division).

Based on the foregoing, it is estimated that from 1941 to 2005, slightly more than 1.7 million children under five years of age would have died from causes associated with undernutrition. Considering survival rates for the different cohorts throughout the period, 81% (1.38 million) would still have been alive in 2005 if they had not suffered from underweight.⁹¹ Additionally, it is estimated that of the total number of deaths among the population under five years of age in 2005, nearly 39 thousand (18%) would have been associated with underweight.

TABLE VII.3
PERU: MORTALITY AMONG CHILDREN UNDER FIVE ASSOCIATED WITH UNDERWEIGHT, ADJUSTED FOR THE SURVIVAL RATE, 1941-2005

Period	Nr. of deaths among children
1941-1950	193 396
1951-1960	248 677
1961-1970	299 455
1971-1980	297 605
1981-1990	198 493
1991-2000	106 501
2001-2005	38 294
Total	1 382 420

Source: Authors' compilation based on Celade-ECLAC population and mortality statistics, relative risks estimated by Fishman et al., and the Endes survey 2005 – INEI.

As shown on table VII.4, from 1941 to 1990, undernutrition was the apparent cause of the deaths of 1,237,626 children under five years of age who would have been between 15 and 64 years old in 2005 and, therefore, would belong to the working-age population (WAP).⁹² As indicated in section 3 of this chapter, this has a significant impact on the country's productivity.

1.2 Health costs

The institutional costs (paid by the public health care system) and private health costs resulting from increased health care related to pathologies associated with undernutrition,⁹³ which afflict children under five years of age, are concentrated in the age range from 12 to 59 months: 91% of the population affected and 89.3% of the total health costs for the cohort during the year. However, the highest unit costs are found newborns with low birth weight due

⁹¹ Total population of reference: Population that died by causes associated to the undernourishment.

⁹² For purposes of comparing the cost estimates, in this study the WAP is defined as the population between 15 and 64 years of age.

⁹³ In the case of public costs, indicators were estimated base don information reported by various agencies of the Health Ministry. Private costs were estimated using the official minimum wage and urban public transportation fares.

to intrauterine growth restriction (LBW_{IUGR}) because the treatment protocols for this age group are more expensive.

Estimated public and private health costs for Peru in 2005 totaled S/.174 million, equivalent to US\$52.7 million, which represents 0.07% of GDP of that year and equivalent to 4.4% of public expenditure on health for that year.

When these costs are broken down, it can be seen that 18% corresponds to the public sector and 82% to the private sector. The greatest cost to the private sector corresponds to the time and transportation required for medical attention, as well as medical supplies not covered by the public health system.

TABLE VII.4
PERU: HEALTH COST OF UNDERWEIGHT, 2005

Age	Number of cases	Million nuevos soles	Million dollars 2005
Newborn (IUGR)	10 815	3.4	1.0
28 days to 11 months	16 423	15.2	4.6
12 to 23 months	75 013	55.6	16.9
24 to 59 months	184 540	99.7	30.3
Total	286 791	173.9	52.8

Source: Authors' compilation based on Celade-ECLAC population and mortality statistics, National Demographic and Health Survey 2005 and administrative records of the Ministry of Health-Peru.

The 287 thousand cases requiring medical attention due to diseases associated with undernutrition shown on table VII.4 include 241 thousand direct treatments required by boys and girls solely due to being underweight.

2. Undernutrition and Education

1. Effects on education

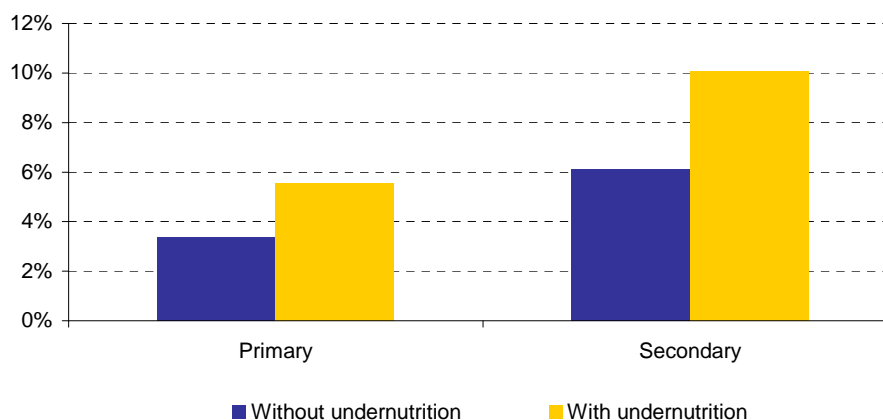
In the regional context, the educational coverage shown in the official Peruvian statistics is high for primary education (96%), even though it is relatively low for secondary education (70%).⁹⁴

According to the Endes survey for 2005, average schooling among the adult population (20 to 64 years of age) is nine years of school, reflecting a progressive increase in schooling. Among those who are 55 to 64 years old, average schooling is almost five years less than for those from 20 to 24 years of age, but academic success remains low, especially in the average number of adults who have finished high school, which is less than 20% of the national population.

Population suffering from undernutrition has a lower proportion of students who finished high school (27%) compared to those who have normal nutrition (76%). These differences are very important indicators in relation with job opportunity and income gaps between the two groups over their working lives.

⁹⁴ <http://stats.uis.unesco.org>.

FIGURE VII.4
PERU: EFFECTS OF UNDERWEIGHT ON GRADE REPETITION, 2005
(In percentages)



Source: Authors' compilation based on Celade-ECLAC population and mortality statistics, Endes 2005 and administrative records of the Ministry of Education-Peru.

Between the primary and secondary levels, the Peruvian population with undernutrition shows an average schooling differential 2.2 years lower than that with normal nutrition students. This is partially due to that fact that among those who suffered from undernutrition in their preschool phase, there is a larger proportion that never even attained first-grade primary education.

Furthermore, underweight in Peru is estimated to have caused 30,590 additional students to repeat school years in 2005, which implies increased costs. Of these, 65% were in primary school.⁹⁵

It should be noted that children who have suffered from undernutrition show a greater concentration of cases of repeating the first years of primary school than "normal" children. However, as shown on figure VII.4, in both groups the rates are higher at the secondary level; but there is always a gap between those who have suffered from undernutrition and those who have not.

2.2 Education costs

The additional cost of running the system due to a greater rate of school years repeated by those who have suffered from undernutrition is one of the major costs of education. The nearly 31 thousand additional students estimated for 2005 due to the probability of repeating school years imply a cost differential of S/.33.4 million, equivalent to US\$10.2 million, which accounts for 0.4% of social expenditure on education and 0.013% of GDP for that year.

⁹⁵ The estimate of educational gaps caused by undernutrition is based on an adaptation of the estimates made in a longitudinal study conducted in Chile between 1987 and 1998 (Ivanovic, 2005). According to these estimates, in socioeconomically similar populations, persons who have suffered from undernutrition in their pre-school years run a risk of repeating (a grade in school) equivalent to 1.65 times the risk by those with normal nutrition. In the absence of estimators for Central America, and in view of the characteristics of the educational systems, comparative estimates among the Central American countries were arrived at by using this relative risk for repeated grades and an attrition differential during the years of schooling of approximately 1.2.

TABLE VII.5
PERU: COSTS RESULTING FROM REPEATING SCHOOL YEARS
DUE TO UNDERWEIGHT, 2005

	Primary	Secondary
Annual cost per student (nuevos soles 2005)	1 019	1 247
Additional annual cost (thousands of nuevos soles 2005)	20 221 542	13 205 737
Additional annual cost (thousands of dollars 2005)	6 135 471	4 006 787
		10 142 258
% Social expenditure on education		0.42%
% GDP		0.013%

Source: ECLAC, based on official data from the Ministry of Education (2005).

3. Productivity

3.1 Effects on productivity

As shown previously, undernutrition has a negative impact on the productive capacity of a country, which is a result of the greater prevalence of mortality among children under five years of age due to pathologies associated with undernutrition, as well as the lower educational level attained by the population suffering from undernutrition.

Table VII.6 depicts the magnitude of the loss of productivity as a consequence of the 1.24 million deaths of children under five years of age who, if they had not died of undernutrition, would form part of the working-age population (WAP). Considering the country's employment rates per cohort, the resulting cost is equivalent to 1,916 million hours of work, which is equivalent to nearly 11% of the hours worked by the economically active population (EAP).

TABLE VII.6
PERU: PRODUCTIVITY EFFECTS OF MORTALITY DUE TO UNDERWEIGHT, 2005

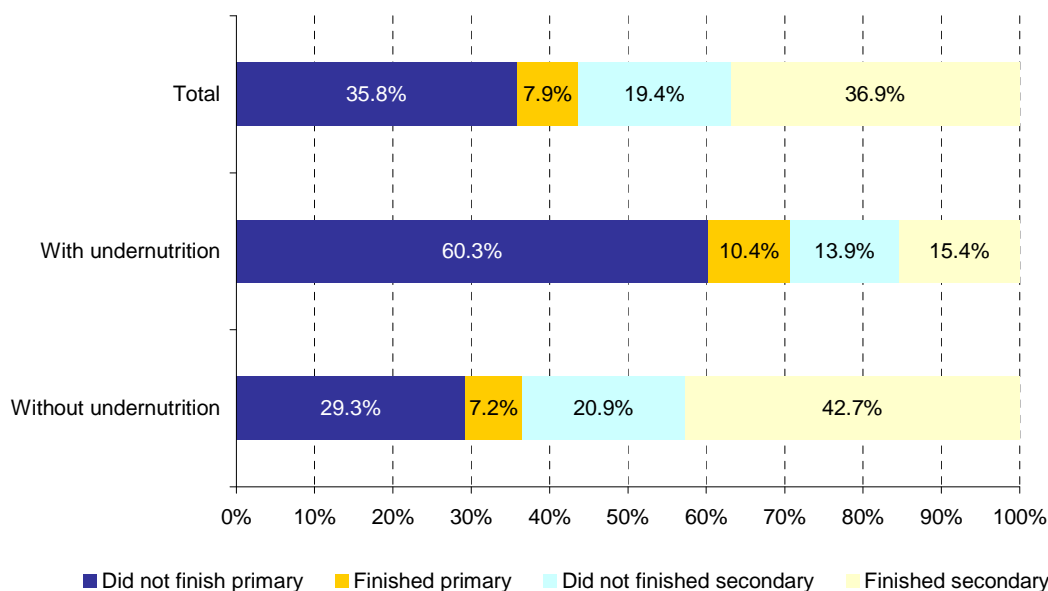
Age group	Mortality due to undernutrition (Nr, 1941-1990)	Lost hours of work (2005)
15-24 years old	198 493	147 571 429
25-34 years old	297 605	500 619 219
35-44 years old	299 455	566 356 415
45-54 years old	248 677	436 298 136
55-64 years old	193 396	265 894 289
Total	1 237 626	1 916 739 488
Hours lost in relation with the EAP (in percentage)		10.9

Source: Authors' compilation based on Celade-ECLAC population and mortality statistics, relative risks estimated by Fishman et al., and the National Demographic and Health Survey 2000.

The lower productivity resulting from the education gap corresponds to the differences in the distribution of the population by years of primary and secondary schooling among those who have suffered from underweight and those who have not. Figure VII.5 reflects the levels attained by those who had access to school.

Figure VII.5 shows that, on average, the people suffering from undernutrition achieved a lower level of education: completion of primary school is the highest level reached by 73% of the people suffering from undernutrition, compared to the people not suffering from undernutrition, the majority of whom made it to secondary school, regardless of whether they graduated (58%).

FIGURE VII.5
PERU: EFFECTS OF UNDERWEIGHT ON EDUCATION LEVEL DISTRIBUTION,
2005 (POPULATION FROM 20 TO 64)



Source: Authors' compilation based on Celade-ECLAC population and mortality statistics, National Demographic and Health Survey 2005 and administrative records from the Ministry of Education – Peru.

3.2 Productivity costs

The higher productivity costs correspond to the economic value of the previously mentioned effects. For 2005, it is estimated that the lower level of schooling generated losses amounting to S/.3 billion, equivalent to US\$911 million, which represents approximately 13% of social expenditure for the year, 37% of public expenditure on education and approximately 1.1% of the GDP.

In addition, the loss of productivity due to the deaths that it is estimated were caused by undernutrition among the population that would have been members of the working-age population in 2005 has been calculated at nearly S/.4.7 billion, equivalent to US\$1.419 billion, which accounts for 1.8% of GDP.

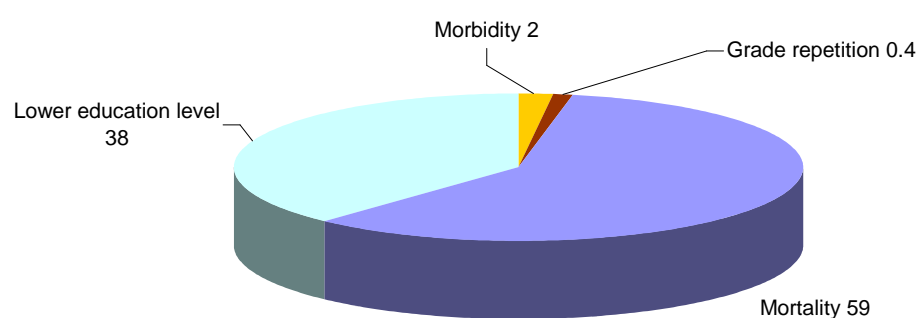
4. Summary of costs

In summary, for 2005, the underweight to which the population of the different cohorts was exposed generated an approximate cost of S/.7.882 billion, equivalent to US\$2.393 billion. These values represent 3% of GDP and a little over a third of the country's total social expenditure for that year.

As shown on figure VII.6, the costs related to loss of productivity due to mortality and years of schooling account for 97% of the total cost, while the costs associated with morbidity and repeated school years due to undernutrition represent 2% and 0.4% respectively.

In conclusion, it can be determined that the intergenerational consequences of undernutrition have a strong impact on the Peruvian economy, not only in relation with health care and education costs; they seriously affect the productivity of its population and its socioeconomic development capacity.

FIGURE VII.6
PERU: DISTRIBUTION OF THE COST OF UNDERWEIGHT BY FACTOR, 2005
(RETROSPECTIVE INCIDENTAL DIMENSION)
(In percentages)



Source: Authors' compilation.

TABLE VII.7
PERU: SUMMARY OF RESULTS: EFFECTS AND COSTS OF UNDERWEIGHT, 2005
(RETROSPECTIVE INCIDENTAL DIMENSION)

	Units	Million nuevos soles	Million dollars 2005
Health			
Additional cases of morbidity	286 791	174	53
Number of additional deaths	1 237 26		
Education			
Additional school years repeated	30 435	33	10.2
Differential Lumber of dropouts	305 866		
Productivity			
Hours lost due to mortality	1 916 739 488	4 677	1 419
Fewer years of schooling	2.2	3 004	911
Total		7 888	2 393 4
Social expenditure			34
% GDP			3

Source: Author's compilation.

C. Effects and costs in relation with the 0-59 month-old cohort of 2005: analysis of the prospective dimension

Through this dimension, an estimate can be made of present and future losses (and potential savings) related to health care, repeated school years and lower productivity as a consequence of the prevalence of underweight in Peru in 2005 among children under five years of age.

1. Health-related effects and costs

As indicated in the preceding chapter, undernutrition at an early age increases a person's risk of dying young and suffering from certain diseases.

Based on projections made with census data, it is estimated that among members of the cohort of 2005 between the ages of 0 and 59 months, 64,497 will die before they turn five. Of these, nearly 31 thousand (47.3%) deaths will be associated with undernutrition, of which 11,666 cases correspond to 2005.⁹⁶

As shown on table VII.8, the highest incidence of death occurs in the first year of life, during which the probability of death is twice that of the rest of the cohort. However, over 26 thousand children may die from causes linked to underweight between the ages of one and four.

TABLE VII.8
PERU: MORTALITY ASSOCIATED WITH UNDERWEIGHT IN
CHILDREN UNDER FIVE, 2005-2009

Age	2005	2006	2007	2008	2009	Total	%
0 to 11 months	4 004					4 004	13
12 to 59 months	7 663	7 683	5 723	3 791	1 886	26 745	87
Total	11 666	7 683	5 723	3 791	1 886	30 749	100

Source: Authors' compilation based on Celade-ECLAC population and mortality statistics, relative risks reported by Fishman et al., and the National Demographic and Health Survey 2005.

Regarding morbidity, for Peru it is estimated that in the first five years of life, in the cohort from 0 to 59 months of age in 2005, there will be nearly 67 thousand additional cases of diseases associated with underweight, mainly anemia, acute diarrhea and acute respiratory infection. Of these, 61% are likely to occur in the age group from 24 to 59 months old.

In addition to the cases of morbidity indicated on figure VII.6, there is the direct medical attention required by underweight boys and girls, which total 241,742 appointments in 2005 and another 124,278 thousand from 2006 to 2009. Of these, 10,815 thousand correspond to children with low birth weight due to intrauterine growth retardation (LBW-IUGR).

The additional health costs as a result of additional cases of diseases caused by undernutrition amount to US\$52.8 million only for 2005, with a net present value (NPV)⁹⁷ of US\$78.25 million during the 2005-2009 period (S/.258 million).

⁹⁶ All estimates for the cohorte aged 0-4 years in 2005 will gradually decrease through 2009 as a result of the members moving up into higher age groups.

⁹⁷ With an annual discount rate of 8%.

TABLE VII.9
PERU: MORBIDITY CASES ASSOCIATED WITH UNDERWEIGHT
IN CHILDREN UNDER FIVE, 2005-2009

Age	Total estimated cases of disease					
	2005	2006	2007	2008	2009	%
0 to 11 months	5 525					8
12 to 23 months	11 096	9 677				31
24 to 59 months	28 429	7 648	3 858	816	159	61
Total	45 050	17 325	3 858	816	159	67 207

Source: Author's compilation based on CELADE-ECLAC population and mortality statistics, relative risks reported by Fishman et al., and the National Demographic and Health Survey 2005.

The values indicated on table VII.10 imply an annual equivalent cost (AEC)⁹⁸ of S/.78 million; that is, US\$23.6 million in that period, which represents approximately 2% of social expenditure on health care and 0.03% of GDP.

TABLE VII.10
PERU: COSTS OF MORBIDITY ASSOCIATED WITH UNDERWEIGHT, 2005-2009
(Millions of dollars 2005)

Age	Year				
	2005	2006	2007	2008	2009
Newborn	1.02				
1 to 11 months	4.63				
12 to 23 months	16.87	14.71			
24 to 59 months	30.25	8.14	4.10	0.87	0.17
Total	52.76	22.85	4.10	0.87	0.17
PNV	78.25				

Source: Authors' compilation based on Celade-ECLAC population and mortality statistics, relative risks reported by Fishman et al., and the National Demographic and Health Survey 2005.

2. Education effects and costs

When projecting the education process for children under the age of five in 2005,⁹⁹ an estimate is made for the differential probability of academic achievement, as well as the corresponding cost of educating 366 thousand additional Peruvian students who are expected to be malnourished in their first five years of life.

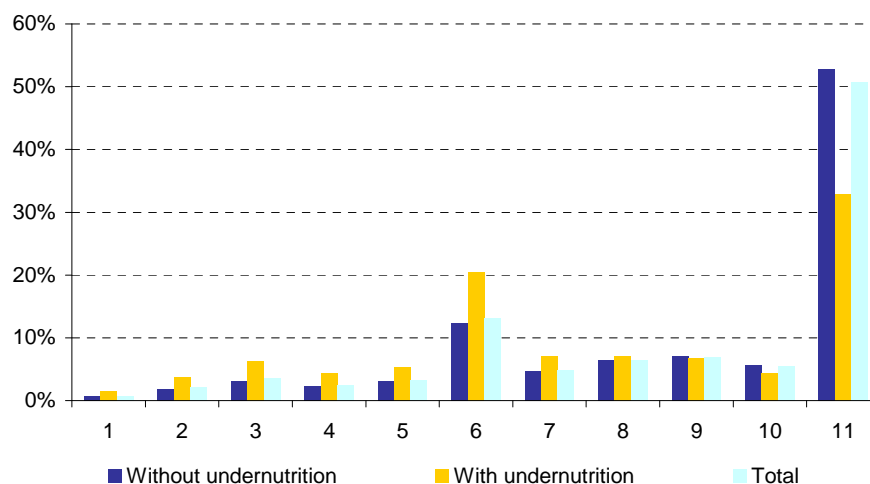
According to official information, it is possible to estimate that from the year 2007 to 2022 there will be 20,371 additional cases of repeated school years. Of these, 85.6% will occur in primary education and 14.4% in secondary, as there is greater coverage at the primary level. As a result of the additional repeated school years, education costs, stated in present value (at a discount rate of 8%), shall amount to S/.21.4 million, equivalent to US\$6.5 million.

⁹⁸ Ibid.

⁹⁹ This projection is based on education coverages of the school-age population and educational levels achieved by the cohort aged 20 to 24 as of the latest household survey (2005).

The estimate of these values as an equivalent annual cost over the 16-year period during which the cohort analyzed will be school-age (2007-2022) amounts to S/.10.9 million; that is, US\$3.3 million in 2005 dollars, which represents 0.02% of social expenditure on education and 0.0005% of GDP for that year. Of these costs, 28% shall be assumed by the children's families and 72% shall be covered by the educational system. In addition, the greater risk of school attrition by children suffering from undernutrition will mean 32,771 students will quit school earlier.

FIGURE VII.7
PERU: ESTIMATED DISTRIBUTION OF GRADE COMPLETION FOR THE COHORT
AGED 0-59 MONTHS, WITH AND WITHOUT UNDERWIGHT, 2005



Source: Authors' compilation based on Celade-ECLAC population and mortality statistics, relative risks reported by Fishman et al., and the National Demographic and Health Survey 2005.

As a result of the foregoing, a difference of 1.26 years of schooling between students suffering from undernutrition and the one not suffering is estimated, with an average of approximately seven years of schooling for undernourished.

Additionally, in the cohort as a whole, it is estimated that 33 out of 100 children who have suffered from undernutrition will complete 12 years of school, while 53 out of 100 of those with normal nutrition will complete their full education.

3. Productivity-related effects and costs

The schooling differential indicated in the preceding point implies reduced cumulative human capital among the malnourished and it has a direct negative effect on their productivity.

Added to that are the 30,749 additional deaths estimated as a result of undernutrition in the cohort from 0 to 59 months old in the 2005-2009 period, which, if their labor potential of 2,400 hours of work per year is considered, represents a potential loss of productivity equal to 2,924 million hours of work over their working lives (years 2015 to 2069).

Based on this background, it is estimated that the economic losses in productivity associated with underweight in the Peruvian population under five years of age would amount to

S/.872 million in 2005, equivalent to US\$264 million for the same year.¹⁰⁰ Of this total, 157 million can be attributed to the lower level of education and 107 million to differential mortality.

Considering the entire period during which these values would be produced (2015-2069), the annual cost amounts to S/.70.75 million, equivalent to US\$21.4 million. Of this amount, US\$12.8 million correspond to costs due to mortality and US\$8.7 million represent losses due to less schooling.

This equivalent annual cost amounts 0.02% of GDP and 0.31% of social expenditure in Peru.

4. Summary of effects and costs

When all sources of costs related to undernutrition are grouped together for the cohort of boys and girls under five years who suffer from undernutrition in 2005, they yield a present value of S/.1.139 billion; that is US\$345.7 million.

This means that the loss of human resources due to lower education levels and the loss of productive hours (MH) due to mortality account for the majority of the estimated cost of undernutrition, 45% and 31%, respectively.

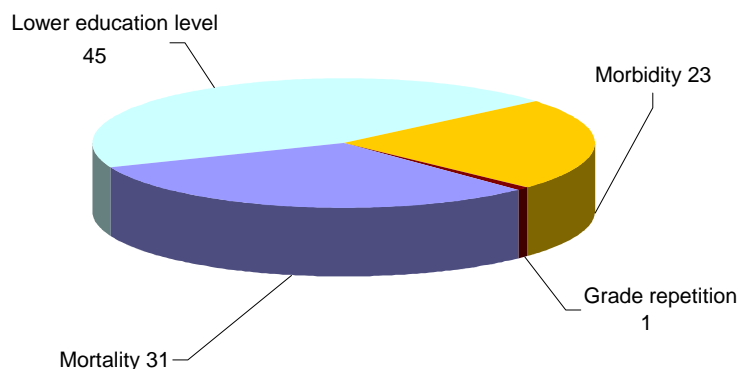
TABLE VII.11
PERU: SUMMARY OF RESULTS: EFFECTS AND COSTS OF UNDERWEIGHT
IN THE 0 TO 59 MONTH COHORT, 2005

	Units	Costs (Present value)	
		Million nuevos soles	Million dollars
Health			
Additional cases of morbidity	433 227	257.9	78.2
Number of additional deaths	30 749		
Education			
Additional repeated grades	20 371	10.9	3.3
Differential number of dropouts			
Productivity			
Hours lost due to mortality	2 923 771	352.9	107.1
Fewer years of schooling	1.3	517.6	157.1
Total		1 139.3	345.7

Source: Authors' compilation.

¹⁰⁰ Considering an annual discount rate of 8%.

FIGURE VII.8
PERU: DISTRIBUTION OF THE ESTIMATED COST OF UNDERNUTRITION
BY FACTOR (PROSPECTIVE DIMENSION, 2005)
(In percentages)



Source: Authors' compilation.

D. Analysis of scenarios: costs and savings

Based on the costs estimated for Peru, as a consequence of the prevalence of underweight in the population under five years of age in 2005, it is possible to project different scenarios. The results of simulations corresponding to three scenarios for trends in undernutrition and its effects on costs for 2015 are presented below.

The scenarios considered are the following:

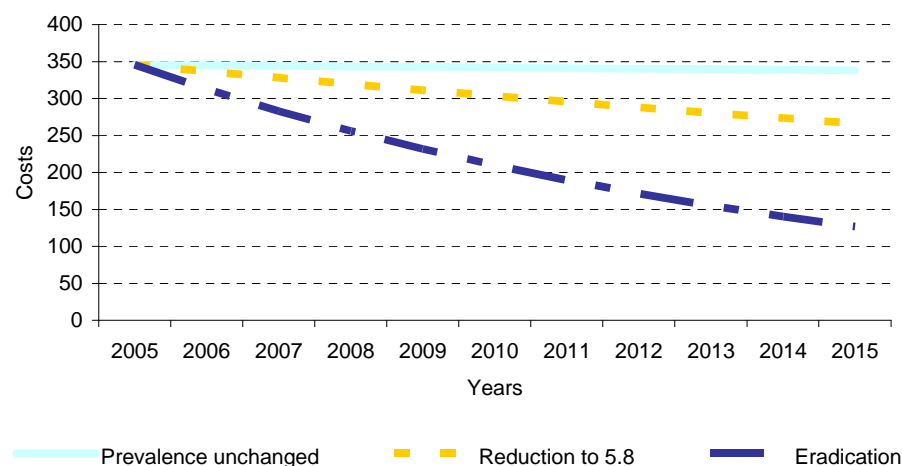
1. As of 2015, the latest figures available on the prevalence of underweight used in this study remain stable (see table VII.2).
2. In 2015 the target established in the Millennium Development Goals (MDG) of decreasing underweight by half of the prevalence in 1990 is reached. This implies progressive reduction until a rate of 5.8% among children under five years of age is attained, which would be an average annual reduction of approximately 0.22 percentage points.
3. By 2015, underweight is eradicated in the country, which for purposes of this analysis is equivalent to a prevalence of 2.5%, representing the "normal" proportion of cases according to the measurement parameters used by the National Centre for Health Statistics (NCHS). In order to achieve this, an annual reduction greater than 0.5 percentage points would be required.

Figure VII.9 illustrates how a progressive reduction in the prevalence of underweight also generates a steady decline in the costs associated with it. If the prevalence remains constant (scenario 1), given that Peru has a tendency to reduce the size of the age 0 to four years cohort, the costs in 2015 will drop by 2.2%. If the goal pertaining to the MDG is achieved (scenario 2), the costs of underweight in 2015 will decrease by US\$266.4 million.¹⁰¹ If underweight is

¹⁰¹ Value updated to 2015, with an annual discount rate of 8%.

eradicated (scenario 3), the costs will drop even further, amounting to a present value of US\$126.86 million¹⁰² as of 2015.

FIGURE VII.9
PERU: TREND OF ESTIMATED COSTS OF UNDERWEIGHT
IN THREE SCENARIOS, 2005-2015
(Millions of dollars)



Source: ECLAC.

Table VII.12 presents a comparison of the estimated costs for 2005 and those projected for each scenario as of 2015. On this table, it can be noted that the largest variation in costs corresponds to productivity and health care.

TABLE VII.12
PERU: ESTIMATED TOTAL COST OF UNDERWEIGHT
FOR THE BASE YEAR AND THREE SCENARIOS, 2005 AND 2015
(Millions of dollars)

	2005 (PV)	Scenarios for 2015		
		Prevalence without modification	Decrease to 5.8%	Eradication (2.5%)
Health	78.25	80.35	61	25
Education	3.3	3.38	2.62	1.17
Productivity				
Losses due to mortality	107	90	76	44
Fewer years of schooling	157	164	127	56
Total	345.67	338.16	266.36	126.86

Source: ECLAC.

Based on the cost trends presented, it is possible to estimate the potential savings generated from the time the actions aimed at achieving the established goals begin.

¹⁰² Value updated to 2015, with an annual discount rate of 8%.

The distances between the trend lines on figure VII.12 –scenario 2 with regard to scenario 1 and scenario 3 with regard to scenario 1– illustrate the savings that would be generated from year to year, accumulating until 2015 to the extent that progress is made toward reducing or eradicating undernutrition. These savings, stated at present value for 2005¹⁰³, equal US\$245 million and US\$814 million for scenarios 2 and 3, respectively. Of these savings, 36% and 40%, in each case, would be obtained from the impact generated in the first half of the process (2006-2010).

This means that not only would costs in 2015 be significantly lower, but also that significant savings could be obtained throughout the process to achieve the goal established for each scenario. If adequate policies remain in force, the projected benefits could continue to accumulate in the years subsequent to 2015.

TABLE VII.13
PERU: ESTIMATED SAVINGS FOR SCENARIOS, 2015
(Millions of dollars)

	Reduction to 5.8%	Eradication (2.5%)
Health	66.0	213.7
Education	2.6	8.5
Productivity		
Losses due to mortality	50.6	179.2
Fewer years of schooling	126.1	412.9
Total	245	814

Source: ECLAC.

The preceding information reflects the economic benefits of progressing toward the eradication of undernutrition. All effective programs in this area shall make a positive impact on the quality of living of individuals and result in significant savings to society.

¹⁰³ Value updated to 2015, with an annual discount rate of 8%.

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Annex

Annex 1

Sources of information

Below are the sources from which the data for this study were compiled. Some are generic sources for all countries and others are country-specific.

A. Generic sources

1. World Bank, World Development Indicators, 2005.
2. ECLAC, public social expenditure data base.
3. ECLAC, processing of the household survey 2001-2004.
4. ECLAC, exchange rate data base.
5. MACRO ORC, Demographic and Health Surveys (DHS) (all the surveys available for each country).
6. WHO, Statistical Information System (1979-2004).
7. WHO, Global Database on Child Growth and Malnutrition www.who.int/gdgm/p-child_pdf.
8. CELADE, Population Division of the Economic Commission for Latin America and the Caribbean ECLAC, Population and mortality projections 1940-2068.

B. Sources by country

Plurinational State of Bolivia

1. Unit of analysis of Social and Economic Policy, Social and Economic Statistics dossier, volume 16, 2006.
2. National Institute of Statistics (Household Surveys 2005, ENDSA 1989, 1993, 1998 and 2003).
3. Ministry of Finance, Plurinational State of Bolivia.
4. National Institute of Statistics, National Survey about the Nutritional Situation 1981.
5. Statistic Unit of Child Hospital "Dr. Ovidio Aliga Uríade la ciudad de la Paz", Plurinational State of Bolivia.
6. Ministry of Health and Sports, "Estrategia de Atención Integrada a las Enfermedades prevalentes de la Infancia – AIEPI/Bolivia, 2005".
7. National System of Information (SNIS) of the Ministry of Health and Sports.
8. Ministry of Health and Sports, Unit of Universal Mother Child Assurance (SUMI).
9. Educational Information system (SIE) from the Ministry of Education and Culture of the Plurinational State of Bolivia.
10. Interviews with national specialist for the public and private sector.

Ecuador

1. National Institute of Statistics (INEC), Living conditions Survey (ECV) 2005-2006.
2. National Institute of Statistics (INEC), Births survey.

3. Ministry of Economy and Finance.
4. Ministry of Education and Culture (MEC). Education Planning Unit (DINAMEP). National System of Statistics in Education, 2003-2004, 2004-2005.
5. Interviews with national specialist for the public and private sector.

Peru

1. Central Reserve Bank of Peru, Annual Memory 2006.
2. National Demographic and Health survey (ENDES) 1996, 2000, 2004, and 2005.
3. National institute for Statistics and Computer science (INEI). Permanent employment Survey, Lima Metropolitan (EPE, 2005), Household Survey (ENAHO) 2003, 2004.
4. Ministry of Economy and Finance, "Marco Macroeconomic Multiannual 2005-2007".
5. Ministry of Economy and Finance, Finance Administration System (SIAF).
6. National Census on Height and Weight of Elementary School First Grade Students, Peru, 2005.
7. Ministry of Health, Database of the General Office for Statistic and Computer science.
8. Ministry of Health, Reports of the National Institute "Materno-Perinatal", 2006.
9. Ministry of Health, Nutrition Information (SIEN), Consolidate, 2005.
10. National program of Food Assistance (Pronaa), Institutional Operative Plan, 2005.
11. National program of Food Assistance (Pronaa), Consultancy Report "Reforma y fusión de los Programas Nutricionales", design del "Programa Integral de Nutrición".
12. Interviews with national specialist for the public and private sector.

Paraguay

1. Central Bank of Paraguay.
2. National Demographic and Health survey (DHS): 1990.
3. National Statistic Office, Surveys en Census (2005). Household Survey.
4. Ministry of Health, Biostatistics Office, 2004.
5. Ministry of Health, Intervention Strategy to Diseases Prevalent on the Infancy (AIEPI).
6. Records of the Pediatric Hospital "Acosta Ñu", 2006.
7. Evaluation of the impact on cost, efficiency, quality, access and equity of Basic services on health - USAID / Measure - 1998. "Descentralización del Sector Salud en Paraguay".
8. Data from "Centro Materno Infantil de San Lorenzo", 2003.
9. Center for Development Information and Resources (CIRD).
10. National University of Asunción, Medicine Faculty, data from Maternal-child centre.
11. Hospital "San Pablo", data from the Unit of Intensive Therapies for neonatal and pediatrics.
12. Ministry of Education and Culture. Statistic Unit (UDE). Asunción.
13. Ministry of Education and Culture, Planning Department.
14. Ministry of Finance.
15. Interviews with national specialist for the public and private sector.