

Child mortality and the Millennium Development Goals: characteristics, trends and determinants

Anna Paterno

Abstract: Child mortality shows very different levels around the world. In 2007, under-five mortality in about 110 developing countries varied from 7‰ (in Thailand and Cuba) to about 260‰ (in Sierra Leone and Afghanistan). Children die, particularly in Sub-Saharan Africa, for largely preventable or treatable causes. The Millennium Development Goal n. 4 of the United Nations is to reduce the under-five mortality rate by two thirds from 1990 to 2015. Bearing in mind the widespread literature on this topic and collecting numerous available macro-data, this article aims to reach a double objective. Classical procedures of factor analysis and hierarchical classification analysis are used in order to describe the observed countries and to highlight different “patterns” of mortality with regard to their characteristics and trends. Moreover, multivariate analysis techniques are applied to estimate the main demographic and socio-economic determinants of each country’s chance of reaching MDG n. 4. These analyses would provide useful information for policy makers and indications for needed interventions.

Key words: Child mortality; Millennium Development Goals, Demography of developing countries

1 Introduction

Child mortality is, as well known, one of the main processes of demographic dynamics. It can also be considered as an indicator of overall development, reflecting the social, economic and environmental conditions in which children live, as well as their health care.

Anna Paterno
Political Sciences Faculty, University of Bari, P.zza C. Battisti n. 1, 70121 Bari;
e-mail: a.paterno@scienze politiche.uniba.it

At present, the various regions of the world are characterized by profound differences. Particularly, with reference to the less and the least developed countries (since now LDCs), their overall picture can be defined as “staggering”, to quote the World Bank, “a human disaster”, to quote the World Health Organization (since now WHO), a “health emergency”, to quote the African Union [6].

The persistence of high levels of childhood mortality in the LCDs led the United Nations (since now U.N.) to include its significant reduction in the eight Millennium Development Goals (since now MDGs) to be reached before 2015¹. Specifically, the target of MDG n. 4 is to reduce the under-five mortality rates (since now UFMR) by two thirds, from 1990 to 2015. According to the latest data, it seems evident that, as a consequence of the differences existing in the respective initial contexts, as well as the kind and intensity of the efforts made, not all the countries involved in reaching the goal will succeed in doing so.

On the ground of these considerations, this article has a double aim. Firstly, after having provided an overview of the general context, some aspects of childhood mortality will be analyzed, so as to classify the observed countries in homogeneous groups and facilitate their description. Secondly, taking into account the trends shown from 1990 and their effect on the chances of each country reaching the goal, the main determinants of such dynamics will be identify.

These analyzes, to be carried out using the clues derived from the literature available on the topic and through the use of data published by numerous major international sources², would provide useful information for policy makers and indications for necessary interventions.

2 An overview

The topic of mortality at young ages³ is one of the “cornerstones” in demography. It has been used for the description of demographic transitions in historical populations of More Developed Countries (since now MDCs). Subsequently, elaborated models and methods were applied to the analysis of LDCs, which exhibited (or still exhibit) levels and patterns of infant and childhood mortality typical of the past.

As is well known, over the course of demographic transition, the improvements in

¹ The targets of the eight MDGs are to: 1) eradicate extreme poverty and hunger; 2) achieve universal primary education; 3) promote gender equality and empower women; 4) reduce child mortality; 5) improve maternal health; 6) combat hiv/aids, malaria and other diseases; 7) ensure environmental sustainability; 8) develop a global partnership for development.

² In this article we take into account mainly macro-data by MDG Info 2009, edited by the U.N., that provide about 70 indicators referred to all the regions and the countries of the world. We also consider the data of the Statistical Information System edited by the WHO, of the Child Info System edited by UNICEF and of the Statistics of the Human Development Report edited by the UNDP. Almost all these different but almost homogenous sources are updated to 2007.

³ It seems necessary to review the terminology used to analyze child mortality, since different stages of the first period of life could be characterized by different levels and by different causes of deaths. For the purpose of this article, we can distinguish: *neonatal mortality*, that refers to the first month of life; *infant mortality* that refers to the whole first year of life and *under-five (or childhood) mortality*, that refers to the period between the first and fifth birthday.

infant and child survival lead to rapid population growth and to a shift in reproductive behavior. Some scholars have argued that early mortality decline is a sufficient cause of fertility decrease and hence accounts for demographic transitions. Besides, the low childhood mortality of the transitional regime, together with high fertility, further accentuate the young age structure of populations [2].

Among the scholars, much research has been done on the causes of childhood illness and mortality. The framework proposed by Mosley and Chen [5] provides a clear distinction between proximate determinants (most commonly analyzed in medical research) and socio-economic determinants (on which social science research has devoted most of its efforts) of child survival in LDCs. Proximate determinants include: maternal factors (age at birth, parity and birth intervals), environmental contamination (air, water and food contamination, insect vectors, etc.), nutrient deficiency (food availability to the infant or to the mother during pregnancy and lactation), injury (accidental, intentional) and personal illness control (personal preventive measures and medical treatments). The socio-economic determinants, which are operating through the proximate determinants, are grouped into three broad categories of factors: individual-level factors (individual productivity and tradition/norms/attitudes); household-level factors (income/wealth effects) and community-level factors (ecological setting, political economy and health system).

Five main macro-social change theories mainly have attempted to explain the variation of the child mortality across the LDCs. The first one is the modernization theory and its proponents argue that industrialization and economic development promote alternative forms of human well-being (education, nutrition, health care, public services, etc.) that reduce childhood mortality. The dependency/world-systems theory, deriving from a vision of a capitalist world system characterized by exploitative relations between countries in different positions, claims that these relations can retard human well-being in the dependent countries, including mortality in the first years of life. The gender stratification theory, observing the existing social, economic, political and educational disparities between males and females, asserts that improvement in the status of women decreases infant and child mortality. Among these factors a relevant role is attributed to the mothers' education. The economic disarticulation theory proponents draw attention to the fact that disconnections and inequalities in the development levels of various sectors of the national economic system reduce the quantity of funds devoted to health and welfare, with negative effects on childhood mortality. Finally, the developmental state theory supporters assert that activist governments can increase the population well-being and meet the needs of the poor, by providing educational, health and other social services that can reduce mortality in the first years of life [3]. Each one of these theories is supported by findings of sub-national and/or cross-national researches.

This theoretical context makes up the reference point for the analyses showed in this article, which take into consideration 111 countries with a population of at least 1 million in 2007 and defined, according to U.N. classification, "less" or "least" developed countries.

The large number of countries observed and the great differences in the occurrence of childhood mortality and in its characteristics in different national contexts makes maximum summarization necessary in these first pages in which description is focused on only some of these aspects.

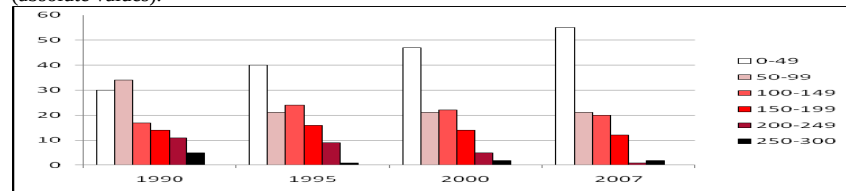
Particularly, under-five mortality is analyzed; it is considered as an excellent measure of child health and survival, since at present deaths among children under age

five account for about 4/5 of global mortality among children under age eighteen.

Worldwide the number of children dying before age five has fallen below 10 million for the first time since 2006. This is a 25% cut from the nearly 13 million child deaths in 1990, which is the baseline for the MDG's target. About 4.8 million children who die are from Sub-Saharan Africa. Ten of the eleven countries with the highest UFM⁴ are located in this region⁵, that has, as a whole, a rate of 146‰. More moderate levels of this measure characterize South Asia (78‰), the Middle East and North Africa (38‰), while East Asia, Latin America and the Caribbean and the Commonwealth of Independent States (since now CIS) do not exceed 30‰. On the other hand, the UFM⁴ is about 6‰ in MDCs [7].

Referring to the observed countries, figure 1 highlights that the number of those that have a rate below 50‰ has significantly risen from 30 to 55 in the years from 1990 to 2007. In the same period, the number of countries that had a value of at least 150‰ has been halved from 30 to 15.

Figure 1: Distribution of the 111 observed countries by under-five mortality rates, 1990-2007, (absolute values).



Source: our elaborations on MDG Info data.

Child mortality has declined in every region of the world since 1990. However, the extent to which it has decreased varies widely between regions. The drop has been greater in East Asia, Latin America and the Caribbean and CIS, where estimated UFM⁴ at present are about half that in 1990. Over the same period, this rate has fallen only 14% in Sub-Saharan Africa [7].

Observing the trends, the “speed” of reduction in under-five mortality increased for the period 2000-07, compared with the 1990s. More specifically, figure 2 shows that the decrease in UFM⁴ during the 1990s was lower than 20% in more than 60 of the 110 observed countries and higher than such a rate in less than 30, while from 2000 to 2007 these figures amount to 44 and 50 countries respectively. Furthermore, the number of countries in which there has not been a decrease (and in certain cases increase) is about 20 during the 1990's and only 10 in the subsequent period. Consequently, from 1990 to 2007, 13 countries experienced a decline of over 60% in the levels of child mortality, reaching the MDG's target eight years in advance, while 70 countries had a decrease between 60 and 20%.

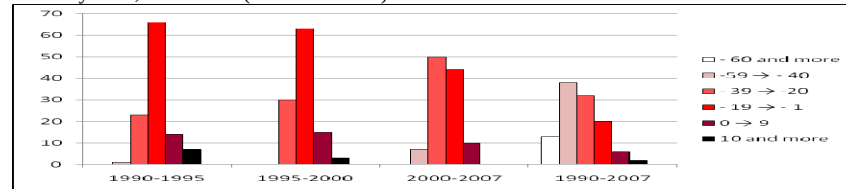
In recent years, under-five mortality has increased in some Sub-Saharan countries. The hiv/aids epidemic, social instability and armed conflict have contributed to the

⁴ This indicator is not strictly a rate, since it is not calculated by dividing the number of deaths by the population at risk. Rather, it represents the probability of dying before age 5 derived from a life table.

⁵ In descending order, these countries are: Sierra Leone (262‰), Afghanistan (257‰), Chad (209‰), Guinea-Bissau (198‰), Mali (196‰), Burkina Faso (191‰), Nigeria (189‰), Burundi (180‰) Niger (176‰) and Central African Republic (172‰).

worsening situation for children in this region. Meeting the MDG's target in these countries will require dramatic measures.

Figure 2: Distribution of the 111 observed countries by percentage variation of under-five mortality rates, 1990-2007 (absolute values).



Source: our elaborations on MDG Info data.

3 Heterogeneity and homogeneity: an attempt to synthesize

From the picture portrayed so far, considering only under-five mortality intensity and its variation during the years 1990-2007, a great heterogeneity appears among the countries observed. This heterogeneity is significantly amplified if we include other equally important aspects in the analysis such as gender differences, the incidence of mortality at each age and the frequency of the different causes of death. As such aspects may contribute to tracing different “patterns” of the phenomenon in LDCs, it seemed useful to apply the classical procedure of factor analysis to the available data, used with the principal components method (since now PCA). The aim of these elaborations is to summarize, for the 111 statistical units corresponding to the considered countries, 12 observed variables (not independent of each other), obtaining new synthetic variables (or components) by the linear combination of the original ones, so that they represent the widest possible portion of the total variability. The variables included in the analysis are: the under-five mortality rank⁶, the percentage of variation of the rates from 1990 to 2007, the difference between male and female UFM, the ratio between deaths in the first year of life and deaths in the first five years (since now D_{0-1}/D_{0-5}) and the percentage of deaths by eight main causes (neonatal, hiv/aids, diarrhea, measles, malaria, pneumonia, injuries, others).

For summary reasons, the correlation matrix among the variables is not reported. It must be highlighted that the under-five mortality rank has significant positive relations with the percentage of variation from 1990 to 2007, with the quota of deaths by malaria and the percentage of deaths by pneumonia. On the contrary, there are negative relations between the under-five mortality rank with the D_{0-1}/D_{0-5} variable and with the quota of deaths by neonatal causes⁷. There are also positive relations between the D_{0-1}/D_{0-5} variable

⁶ To facilitate comparisons between countries, the UFM was transformed into a unit-free index varying between 0 and 1, using the formula: $x\text{-index} = [x - \min(x)] / [(\max(x) - \min(x))]$, where $\min(x)$ and $\max(x)$ are the lowest and highest values the variable x can attain, respectively 7‰ (of Cuba) and 262‰ (of Sierra Leone).

⁷ It is widely known that, as the UFM decreases, infant deaths and especially neonatal deaths make up an increasing proportion of all under-five deaths. Thus, reducing mortality during the first periods of life is essential to achieving the MDG n. 4.

and the quota of deaths by neonatal causes on the one hand, and the percentage of deaths by pneumonia and the quota of death by diarrhea on the other hand.

The elaborations carried out has also allowed for the identification of three components which explain 66.4% of the total variability. The analysis of factor loadings, which express the correlation of variables with components, allows for an attribution of meaning to the latter (tab. 1). The first of these absorbs a large amount of the total variance (41.2%). It summarizes the intensity and the trend of under-five mortality, set against its age and gender distribution. The already mentioned relations seem to emerge between the first two aspects and the infant and neonatal mortality, which are difficult to reduce even in the presence of relatively low childhood mortality levels. The second component explains the 16.1% variance, highlights the “environmental and viral” causes of death (diarrhea and pneumonia), presumably linked to poor hygienic and health conditions. The third component, which absorbs 9.1% of the total variance, seems strongly linked to “epidemic” causes of death (hiv/aids and measles), probably linked to the poor distribution of immunization instruments and treatments, such as vaccinations and adequate therapy.

Table 1: Components' Matrix^(*).

Variables	Component 1	Component 2	Component 3
Under-five mortality rank, 2007	0.863	0.371	0.069
Under-five mortality rates variation (%), 1990-07	0.775	-0.154	-0.207
Male-female UFM, 2007	0.545	0.178	-0.150
D ₀₋₁ /D ₀₋₅ , 2007	-0.811	-0.215	-0.096
Deaths due to neonatal causes (%), 2004	-0.794	-0.147	-0.200
Deaths due to hiv/aids (%), 2004	0.398	-0.361	-0.614
Deaths due to diarrhea (%), 2004	0.097	0.919	0.148
Deaths due to measles (%), 2004	0.369	0.097	0.578
Deaths due to malaria (%), 2004	0.498	0.056	0.018
Deaths due to pneumonia, (%), 2004	0.361	0.861	0.116
Deaths due to injuries (%), 2004	-0.127	-0.568	0.555
Deaths due to other causes (%), 2004	-0.587	-0.350	-0.029

^(*) Rotation Method: Varimax with Kaiser Normalization.

Source: our elaboration on U.N. and WHO data.

In a second step, the individually observed countries were classified in homogeneous groups as far as possible, according to the factorial scores obtained by each of them, applying a hierarchical classification analysis technique (cluster analysis⁸). In this way, it was possible to highlight different typologies of countries and “patterns” of mortality, defined not with respect to the starting parameters, but on the basis of the principal components emerging from the PCA. The best classification obtained seems to be the one formed in 6 clusters. Table 2 resumes the main characteristics of each of them, bringing us to the following description, while figure 3 shows their territorial distribution.

Cluster a: presents the lowest UFM in 2007 and decreases in the period 1990-2007; deaths are concentrated in the first year of life and, among the causes of death, “others” and neonatal prevail; it includes 3 countries belonging to the CIS, 5 to Latin America and the Caribbean and Kuwait.

Cluster b: shows a low mortality, which concerns mainly the first periods of life

⁸

The cluster analysis was performed using “Ward’s method”, which creates partitions that ensure the minimum intraclass and maximum interclass variability.

(first month and first year); it is distinguished from the previous cluster by a wider diffusion of “environmental” death causes (diarrhea and pneumonia); it includes 35 countries, among which are China, all the North-African countries, 6 Middle-Eastern Asia countries, and 13 Latin America and the Caribbean countries.

Cluster c: highlights a quite low mortality which has reached the most remarkable improvements, counterbalanced by the remaining diffusion of “environmental” diseases; it includes 17 countries, among which are 6 of the CIS, 7 of Asia (among these are India, Pakistan e Bangladesh) and Brazil.

Cluster d: shows an intermediate mortality which has shown small decreases; it is characterized both by the diffusion of hiv/aids and malaria, that reduce the role played by the other causes, and by great gender differences (at a disadvantage of males); it includes 19 countries of Sub-Saharan Africa, beyond Timor-Leste.

Cluster e: shows a high mortality, which has experienced a great reduction in time; this involves more than elsewhere older children and males; the most prominent causes of death are (besides neonatal) diarrhea and pneumonia; it includes 22 countries, among which are 17 of Sub-Saharan Africa, in addition to Afghanistan, Cambodia, the Democratic Republic of Korea and Myanmar.

Cluster f: is a high mortality group, which differs from the previous one above all for the slowness of the reductions; it highlights the highest death proportion for measles, but other diseases are also widespread; it includes 6 countries of Sub-Saharan Africa (Central African Republic, Chad, Liberia, Nigeria, Somalia and Sudan).

Table 2: Characteristics of the 6 clusters (mean values) and number of included countries^(*).

Variables	Clusters					
	a	b	c	d	e	f
Under-five mortality rank	0.02	0.07	0.18	0.40	0.53	0.60
Under-five mortality rates variation (%)	-7.56	-28.46	-49.76	-20.79	-49.45	-30.33
Male - female UFRM, 2007	2.44	4.29	5.06	13.16	15.32	3.00
D ₀₋₁ /D ₀₋₅	81.70	83.60	78.61	66.35	62.55	60.51
Deaths due to neonatal causes (%)	38.66	40.29	33.89	26.16	23.08	20.55
Deaths due to hiv/aids (%)	1.44	0.94	0.30	16.74	1.79	2.77
Deaths due to diarrhea (%)	1.06	13.02	19.63	11.28	19.91	14.67
Deaths due to measles (%)	0.00	0.33	1.49	0.38	2.12	9.83
Deaths due to malaria (%)	0.00	0.12	0.71	15.55	10.18	15.58
Deaths due to pneumonia (%)	3.22	11.02	18.22	12.54	23.30	18.15
Deaths due to injuries (%)	9.40	8.93	3.65	3.05	2.33	2.87
Deaths due to other causes (%)	46.18	25.34	22.11	14.29	17.28	15.62
Number of countries	9	35	17	19	22	6

^(*) 3 of the 111 observed countries were eliminated due to missing basic data.

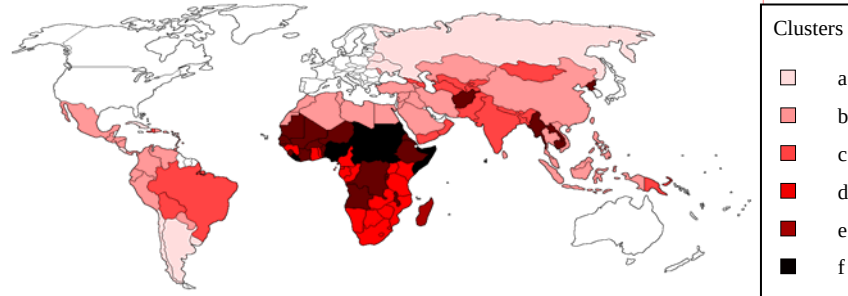
Source: our elaboration on U.N. and WHO data.

Overall, therefore, it can be presumed that the first three groups are the best-positioned in the fight against under-five mortality. Such countries, in fact, differ from the others not only in the intensity of the mortality in the first periods of life, but also in the importance of the different causes of death. On the other hand, in the remaining three groups of countries, in which the childhood mortality rate is higher, exogenous causes⁹ prevail. In the different national realities, however, the routes are not so

⁹ It is useful to recall the well-known distinction between endogenous and exogenous causes of death. The first of them, occurring mostly during the first month, are associated with biological and genetic factors influencing the survival chances after birth (fetal malformation, low

homogeneous and so it would seem appropriate to focus our attention on the individual countries, in order to understand which of them may reach the established target and under which conditions.

Figure 3: Classification of the 111 observed countries by cluster.



4 Towards the Millennium Development Goal

As previously recalled, the member countries of the U.N. in 2000 adopted unanimously a set of far-sighted goals, known as MDGs, to free a major portion of humanity from the shackles of extreme poverty, hunger, illiteracy and disease and enhance global development (see note 1).

The goal concerning the reduction of under-five mortality represents a long-term target, based on global historical trends (as observed over the previous 25 years) and to be achieved over a 25 year period (from 1990 to 2015). To monitor the outcomes reached in the meantime, we need to understand whether each country or region is maintaining, as a minimum, the same pace of progress it achieved in the recent past.

Such an attempt has been recently carried out, producing estimates regarding every region and country in the world [8]. According to this estimates, achieving the goal requires that the UFMR decline globally by 4.4% every year in the 1990-2015 period. Between 1990 and 2006, however, the average annual rate of reduction (since now AARR) in under-five mortality was only 1.6%. To reach the target, the pace of change must accelerate: mortality would have to decrease by an average of 9.4%. However, the global numbers mask wide variations between regions and countries. East Asia, Latin America and the Caribbean are considered to be “on track” in achieving the MDG. At the other extreme, the rate in Sub-Saharan Africa has declined by just 1%.

In such a perspective, in this article the estimates concerning each of the considered countries were updated to 2007, grouping the countries into the six clusters described above. Observing the trend shown up to now, both the chance each country has of reaching the target and the number of countries which should reach it for each cluster were estimated.

birth weight, high susceptibility to infections, abnormalities of body functions, etc.). The second causes occur mostly in the following period, depending on pathological socio-economic and cultural conditions in which the child lives (poor hygienic and/or sanitary conditions, malnutrition, epidemics, infections, etc.).

By adapting the methodology used in such estimates to our case [4], the AARRs are calculated as:

$$AARR_{(t_1,t_2)} = 1/(t_2-t_1) \times \ln [{}_5q_0(t_2)/{}_5q_0(t_1)]$$

where t_1 and t_2 are the year of start and the year of end of the observed period (1990-2007) and ${}_5q_0$ is the under-five mortality rate.

Table 3 shows, for each cluster, the average values of UFMR in 1990 and 2007 and those required for reaching the target in 2015. Furthermore, it contains the AARRs observed during the 1990-2007 period and those required to meet the target. It shows also the number of countries “on track”, as to say those who, according to the mentioned U.N methodology, have reached UFMR lower than 40‰ or have UFMR higher than 40‰ and AARRs higher than 4%.

There are substantial differences between the first three and the last three clusters. In fact, while in clusters a, b, and c the total number of countries that presumably will reach the target is 55 out of 61, in clusters d, e, and f it is only 4 out of 47. Such a large difference is above all linked to the low level of successes in the fight against mortality in the period 1990-2007.

Table 3: Under-five mortality rates observed (1990 and 2007) and required by MDG in 2015, average annual rate of reduction in under-five mortality (1990-2007) observed and required (mean values by clusters) and number of countries on track toward the MDG.

Variables	Clusters					
	a	b	c	d	e	f
Under-five mortality rate, 1990	20.00	54.03	102.18	129.84	191.00	189.33
Under-five mortality rate, 2007	12.44	25.57	52.41	109.05	141.55	159.00
Under-five mortality rate required, 2015	6.67	18.01	34.06	43.28	63.67	63.11
AARR observed, 1990-2007	3.02	4.65	4.33	1.03	1.99	1.13
AARR required, 1990-2007	6.46	4.24	5.59	11.53	9.65	10.77
N. of countries “on track” toward MDG	9	34	12	1	3	0

^(*)3 of the 111 observed countries were eliminated due to the presence of missing basic data.

Source: our elaboration on U.N. and WHO data.

5 At the root of differences

The low number of countries that, according to previous elaborations, will probably succeed in reaching the MDG n. 4 (only 59 out of 108 considered countries) has made the identification of the determinants of such a situation necessary. For this purpose, three stepwise models of logistic regression have been estimated¹⁰, whose dependent variable consider as reference group the countries which have not done sufficient progress to reach the target (that assume value 0), versus the countries considered “on track” (that assume value 1).

In the first model, only the cluster classification was considered as an independent

¹⁰

Further models of linear regression have been developed using, as a dependent variable, the difference for each country between the AARR levels observed and required to reach the target in the period 1990-2007. It seemed preferable to illustrate logistic regression models according to their simplicity, considering the general affinity among the results obtained.

variable and the results (not shown here for lack of space) show a significant difference ($p < 0.01$) among the groups in the chance of reaching the target. This result confirms the above described results (see § 4).

In the second model, it seemed appropriate to include other independent variables, in addition to the cluster classification. These were selected according to indications derived from literature (see § 2) and to the availability of data. Among these are characteristics both directly connected to childhood mortality¹¹ and indirectly related¹². Among the latter, it was included at least one indicator regarding each of the MDGs (excluding n. 6, as it is too specific, see note 1), in order to highlight interrelations among them. The results obtained (not shown here for lack of space) demonstrate that the influence of other variables tends to reduce, net of other covariates, the significance of the cluster classification, thus showing the considerable effects produced by aspects concerning demo-sanitary, social and economic conditions on the dependent variable.

The third model appears in table 4 and, excluding the cluster classification, shows only the significant variables. Among these, there appears first of all the net primary school enrolment ratio for females (that is to say the ratio of girls who are enrolled in primary school compared to the total population of girls of official school age). Such a result confirms the indications coming from the literature, according to which in many LDCs the fastest improvements have occurred where female literacy has increased the most. Therefore, behavioral changes connected with higher education levels have improved survival. The new behaviors appear to be readily adopted because they act to support values that favor life. The same goes for the variable related to the antenatal care coverage (as to say the quota of women attended to at least once during pregnancy by skilled health personnel). This aspect, which is linked to the spread of education and of new behaviors, highlights the importance of reproductive health in determining favorable results for the children survival. The quota of population which has access to improved drinking-water sources holds the same statistic significance and positive effect, showing the influence of hygienic conditions on the chance to be “on track” toward MDG n. 4¹³. A last determinant which has a direct, but less significant, relation on the chances of reaching the target is the density of physicians, which may be considered a useful indicator of sanitary system conditions in each country.

The variables which act negatively, but less significantly, on the dependent one correspond to the amount of carbon dioxide emission pro capita, to the quota of population living below \$1.25 a day and to the adolescent fertility rate (15-19 years old). They underline the relevant role played by the environmental context (that is the level of pollution), the economic level and the demo-sanitary context respectively¹⁴.

¹¹ These variables are: maternal mortality ratio, adolescent fertility rate, antenatal care coverage, births attended by skilled health personnel, low birth weight newborns, immunization coverage, quota of children stunted and underweight for age.

¹² These variables are: access to improved drinking-water source, access to improved sanitation, density of physicians, density of hospital beds, government expenditure on health, gross national income per capita, quota of population living below \$1.25 a day, net primary school enrolment ratio, net secondary school enrolment ratio, net tertiary school enrolment ratio, female adult literacy rate, government expenditure on education, gender empowerment measure, women employed in the non-agricultural sector, carbon dioxide emission per capita and official development assistance per capita.

¹³ This variable is strongly related to the share of the population that has access to improved sanitation, which is for this reason not included in the model.

¹⁴ The small number of significant variables is a common factor to many studies on childhood mortality in LDCs, which use macro data and consider the countries as statistic units.

Table 4: Determinants of the chances of reaching the MDG in 2015. Logistic regression model.

Variables	Coeff.	S.E.	Sig.
Adolescent fertility rate (x 1,000 women 15-19 years old), 2000-07	-0.039	0.02	*
Access to improved drinking-water source (%), 2006	0.119	0.06	**
Net primary school enrolment ratio for female (%), 2000-08	0.337	0.13	***
Antenatal care ^(a) (%), 2000-07	0.104	0.05	**
Population living below \$1.25 a day (%), 2000-07	-0.087	0.05	*
Density of physicians (per 10,000 population), 2000-07	0.238	0.13	*
Carbon dioxide emission pro capita, 2005	-0.115	0.07	*
Constant	-31.039	12.21	***
$R^2 = 0.80$			

* p<0.1; ** p<0.05; *** p<0.01.

^(a) Percentage of women attended at least once during pregnancy by skilled health personnel.

Source: our elaboration on U.N., UNDP, UNICEF and WHO data.

The significant variables in the model recall both some of the proximate determinants (maternal age, air and water contamination and personal preventive measures) and some of the socio-economic determinants (individual productivity, represented by the educational level, income effects, represented by the poverty spread, and health system, represented by the density of physicians) identified by Mosley and Chen (see § 2) as the main causes of childhood mortality. This makes our results coherent with the analytical framework designed by the two scholars.

Furthermore, referring to the five macro-social change theories summarized in § 2, obtained results seem to support the indication coming from the gender stratification theory and the developmental state theory. Considering the first one, the significance of the net primary school enrolment ratio for females seems to confirm that, because of the mother's role for her own care during pregnancy and the care of her child, improvements in her educational level can increase her skills in health care practices, with a positive consequence on survival in the first years of life. Referring to the second theory, the presence of the density of physicians among the determinants could lead us to hypothesize that the governments which are more engaged in redistributive efforts (such as the provision of public health personnel and services) can improve the well-being of the population, obtaining, in particular, gains in the fight against childhood mortality.

Finally, it should be underlined that the significance of variables which correspond to indicators linked to at least 4 of the other MDGs (numbers 1, 3, 5 and 7) shows relevant links among themselves. This would confirm the necessity of making a global action plan, so as to stimulate the overall relapse which each intervention may have on the sectors other than that at which it is aimed.

6 Conclusions

The previous analyses highlight that we have made important progress in fighting child mortality, but much remains to be done, since we have been moving too slowly

Being aware of the necessity of completing such an approach with the help of individual data, it is useful to highlight that the previously described determinants should be interpreted in a general sense, that is to say as indicative of sectors of strategic importance in reaching the target.

(particularly in poor countries) and today we face a global economic crisis whose full repercussions have yet to be felt. At present, every day about 29,000 children die before they reach their fifth birthday, the vast majority from preventable causes [1].

The results of this article confirmed that effective and affordable interventions are needed to prevent and/or treat each major cause of under-five mortality. The possible actions to be taken may be divided into at least two fields of action. The first one should be finalized towards acting on the factors highlighted by the different patterns of mortality which, as shown in § 3, characterize the different groups of countries. In fact, the majority of children who die could be saved by simple and, for the most part, low-cost, measures such as skilled attendants at childbirth, immunization, proper nutrition, vitamin A supplementation, rehydration, vaccines, antibiotics and bed nets. The second field of action should regard the “external” determinants which influence the probability of reaching the target, shown in § 5 and which act on the demo-sanitary, social, economic and environmental contexts. Improvements in public health services, water and sanitation supply systems, education (especially for girls) and instruments to fight poverty and pollution are essential for the reduction of childhood mortality. Moreover, it should be ensured that services reach those who need them most.

An extraordinary effort is required by the international community, governments, non-governmental organizations, civil society and others. Obviously a key role can be played by the MDCs. Financial support, knowledge diffusion and cooperation for the development of the receiving countries may be of strategic importance in reaching the MDG n. 4. But the MDCs may not easily realize that spending on the MDGs is an essential driver for global economic recovery, not a luxury. For instance, it was estimated that the additional investments in health, that would be repaid many times over in millions of lives saved each year, enhance economic development and strengthen global security, requires of donors roughly 0,1% of their gross national income [1]. Italian Official Development Assistance for health at present amount to just 0,025%...

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