Under-five mortality in LDCs:
the long way to reach the Millennium Development Goal

Giuseppe Gabrielli [(*)] - Anna Paterno [(**)]

1. Research topics and aims of the paper

The under-five mortality rate[1] is one of the most sensitive and commonly used indicators of the young children's health and of the socio-economic context (Masuy-Stroobant, 2001). The United Nations include its significant reduction among the eight Millennium Development Goals (MDGs) to be reached before 2015. In detail, the target n. 4 of MDGs is to reduce by two thirds, between 1990 and 2015, the under-five mortality rate.

Deaths in children under five have declined steadily worldwide. For the developing regions as a whole, the under-five mortality rate dropped from 103‰ in 1990 to 74‰ in 2007 (U.N., 2009). Anyway, it still remain very high in many countries, particularly in Sub-Saharan Africa and Southern Asia, where have made little or no progress at all. The synthetic picture of these areas is "staggering," to quote the World Bank, "dire," to quote USAID, "a human disaster," to quote the World Health Organization, a "health emergency," to quote the African Union (U.N. Millennium Project, 2005). Young children continue to die for largely preventable or treatable causes such as: diarrhoea, acute respiratory problems, measles and malaria (UNICEF, 2009).

Among the scholars, five macro-social change theories mainly have tried to explain the variation of the under-five mortality rate across the Less Developed Countries (LDCs): the modernization theory, the dependency/world-systems theory, the gender stratification theory, the economic disarticulation theory, and the developmental state theory (Frey, Field, 2000).

On the ground of these considerations, this paper, considering the widespread literature on this topic and collecting the numerous available macro-data, aims to reach a double target related to the under-five mortality.

We try to synthesize the territorial heterogeneity and the different trend across LDCs, grouping the 110 observed countries according to their patterns. In particular, we consider the rate in 2007, its variation in the period 1990-2007 and the main causes of death in order to define different clusters of countries according to the considered indicators. The subsequent description of the clusters helps to picture the different existing contexts.

Considering the different scenarios described above and the existing theories to explain them, we estimate the main socio-economic and demographic determinants of the under-five mortality according to the literature. In adding we estimate the necessary variations of the main predictors in order to reach the target n.4 of the MDGs. These analyses would provide useful information for policy makers and indications for the interventions need to be done.

[(*)] University of Bari, Dipartimento di Statistica, via C. Rosalba, 53 - 70124 Bari - Italy - Ph: +39 080 5533036; Fax: +39 080 5533036; e-mail: giuseppe.gabrielli@tiscali.it.
[(**)] University of Bari, Dipartimento per lo Studio delle Società Mediterranee, p.za C. Battisti, 1 - 70121 Bari - Italy - Ph: +39 080 5717547; Fax: +39 080 5717272; e-mail: a.paterno@scienzepolitiche.uniba.it.
[1] It is usually estimated by calculating the ratio of the number of deaths of persons aged under 5 in a particular year, to the number of live births in the same year. This ratio is usually expressed per 1000 live births.

2. Data and methods

In the present paper we take into account mainly macro-data by MDG Info 2009, edited by United Nations, that, as well known, provides about 70 indicators related to the Millennium Development Goals referred to all the macro-areas and the countries of the world. We consider also the data of the Statistical Information System edited by the World Health Organization and of the Statistics of the Human Development Report edited by the United Nation Development Programme. Almost all data are updated to 2007. Using these different but homogenous sources, we build a basic dataset having each different country in the world as reference unit and run our elaborations.

We exclude from the analysis the More Developed Countries (comprising, in our definition, European Union, North America, Australia/New Zealand and Japan) and the small countries (less than 1 million of inhabitants). In sum we include 110 units (or countries) in our analyses.

In the descriptive section of the paper, we consider eleven indicators: under-five mortality rate, under-five mortality ranking[2], under-five mortality variation, percentages of deaths by eight main causes. A first preliminary analysis consider the countries separately in order to underline the most particular cases. After that, in order to investigate how countries resemble each other or differ with regard to these indicators, the classical procedure of factor analysis is used with the principal components method (PCA), followed by an hierarchical classification analysis (cluster analysis). The former[3] was used to summarize the variables – not independent of each other – initially adopted for a description of countries. Then, the cluster analysis[4] made it possible to highlight different typologies of countries and "models" of mortality, defined not with respect to the starting parameters, but on the basis of the principal factors emerging from the PCA.

The next regression analyses examine the main determinants, net of the other covariates, of the under-five mortality rate in 2007 and its variation occurred in the period 1990-2007. Among the independent variables, according to the literature, we consider some aspects closely related to the under-five mortality (e.g. the percentage of immunization coverage, the percentage of children underweight for age) and the main socio-economic indicators (e.g. GNP per-capita, education, woman condition, labor force).

In the end, among the most important predictors, we estimate the necessary variations of their coefficients in the regression analyses in order to reach the MDG target. This analysis is conducted using simple extrapolation techniques of the observed trend until 2007.

3. Preliminary results

The evident heterogeneity in the under-five mortality rates in the observed LDCs is witnessed by values that in 2007 vary from 7‰ (of Thailand and Cuba) to about 260‰ (Sierra Leone and Afghanistan). These levels are the results of different average annual rates of variation: during the 1990-2007 period, around 30 of the considered countries halved (or more than halved) their under-five mortality levels, while 10 increased them.

---

[2] To facilitate comparisons between countries, we transform the under-five mortality rate into a unit-free index between 0 and 1 using the formula: $x\text{-}index = [x\text{-}min(x)]/[(max(x)\text{-}min(x)]$, where $min(x)$ and $max(x)$ are the lowest and highest values the variable x can attain, respectively.

[3] The PCA estimates new synthetic variables (principal components) obtained by the linear combination of the original ones, so that they represent the widest possible portion of the total variability. This procedure facilitates the exploration of the associations among variables and also, thanks to suitable graphical representation, the collocation of countries in relation to those variables on the factor plane.

[4] The cluster analysis is performed using "Ward's method" which creates partitions that ensure the minimum intraclass and maximum interclass variability. Obviously, in this type of analysis, the greater is the level of aggregation (with a lesser number of groups individuated) the greater is the level of variability observed within each group.

Preliminary results of the factor analysis and the hierarchical classification analysis (that, at the moment, need to be deepened and sharpened) show that the observed countries can be divided in different clusters. Stratifying these units in only four groups, that represent various "models" of under-five mortality, we can observe (see tab. 1) that:

- The first cluster, that consider only 6 countries of South-Africa, is characterized by middle levels of under-five mortality ranking and by very high decreases of it in the observed period. The main feature of this group is the exceptional incidence of HIV in the distribution of causes of death among children aged less than 5 years.
- The second cluster, grouping 27 countries (18 located in Western-Central Africa and 7 in Eastern-South Africa), is branded by a very high under-five mortality and by low decreases along the period. The most characterizing causes of death are, not considering the neonatal, malaria and pneumonia, presumably due to the environmental stress (intensity of air and/or water contamination) occurred in these countries.
- The third cluster, formed by 24 countries (13 located in Latin America & the Caribbean area and the others mainly in Western Asia and in the Commonwealth of Independent States), is characterized by low incidence and high decreases of the under-five mortality. Observing the main causes of death, we note the importance of neonatal mortality (due to endogenous factors).
- The fourth cluster doesn't define a particular geographical area. In our opinions, this group can be considered as "residual" by a territorial point of view and "intermediate" with regard to the level and evolution of the considered phenomenon. The neonatal, diarrhoeal, pneumonial mortalities prevail among the other causes of death.

Tab. 1 - Under-five mortality ranking, its variation in the 1990-2007 (%) and distribution of causes of death among children aged <5 years (%). Mean values by cluster.

Cluster	M_{0-5} ranking 2007	ΔM_{0-5} 1990-2007	Distribution of causes of death among children aged <5 years(%)							
			Neonatal	Hiv/Aids	Diarrhoea	Measles	Malaria	Pneumonia	Injuries	Other
1	0.25	-30.82	26.37	37.33	8.05	0.03	2.02	8.98	3.18	13.95
2	0.55	-8.14	23.48	4.59	14.56	3.22	19.06	17.32	2.74	15.05
3	0.05	-17.38	40.00	1.43	5.59	0.35	0.06	5.97	12.13	37.47
4	0.21	-26.03	34.38	0.89	18.00	1.01	1.87	17.19	4.07	22.59

The second step analyses about the main determinants of under-five mortality rate and its variation are still in progress and no results are shown in this abstract.

In this section, we refer to the main demographic contributes and theories for the study of child mortality determinants in LDCs (among the others Masuy-Stroobant, 2001; Frey, Field, 2000). Basically, their framework provides a clear distinction between proximate determinants (such as age at birth, water contamination, nutrient availability to the infant, use of specific immunizations or prophylactics) and socio-economic determinants (such as education, housing conditions, health care, sanitation).

In particular, we concentrate on the cultural, environmental, social and behavioral factors, which may influence the likelihood of ill health, disease and death in early infancy (Schell et al., 2007). Generally speaking, the mother's status indicators (such us mother's education, decisional autonomy, and gender iniquities acceptance) are positively related to the general children's health (Maffioli et al., 2009). As well as, it is also abundantly documented among the scholars the importance of ecological conditions and the infant feeding practices to reduce the child illness (Flegg, 1982).

About the possibility to reach the MDG in 2015 (thus reduce by two thirds the under-five mortality rate) UNICEF, WHO, The World Bank and U.N. (2007) estimate that 30 countries register an insufficient improvement and 26 countries have no-improvement in 2007. Our analyses

could help to understand why it occurred and what can be attempt in the long way to reach the Millennium Development Goal according to our predictors.

References

Flegg A.T., 1982, *Inequality of Income, Illiteracy and Medical Care as Determinants of Infant Mortality in Underdeveloped Countries*, Population Studies, vol. 36, n. 3, pp. 441-458.

Frey S., Field C., 2000, *The determinants of Infant Mortality in the Less Developed Countries: A Cross-National Test of Five Theories*, Social Indicators Research, vol. 52, n. 3, pp. 215-234.

Maffioli D., Gabrielli G., Sacco P., 2009, *Women position in the family and child nutritional status: Asia-Africa comparisons*, paper presented at XXVI IUSSP International Population Conference – Marrakech (Morocco), 27 Sept./02 Oct.

Masuy-Stroobant G., 2001, *The determinants of infant mortality: how far are conceptual frameworks really modelled?* Document de Travail n° 13, Université catholique de Louvain, Louvain.

Schell C.O., Reilly M., Rosling H., Peterson S., Ekström A.M., 2007, *Socioeconomic determinants of infant mortality: A worldwide study of 152 low-, middle-, and high-income countries, S*candinavian Journal of Public Health, vol. 35, n. 3, pp. 288-297.

U.N., 2009, *The Millennium Development Goals Report*, New York.

U.N. Millennium Project 2005. *Who's Got the Power? Transforming Health Systems for Women and Children*, Task Force on Child Health and Maternal Health, Washington D.C.

UNICEF, 2009,*The State of the World's Children. Special edition. Celebrating 20 Years of the Convention on the Rights of the Child*, New York.

UNICEF, WHO, The World Bank and U.N., 2007, *Population Division, Levels and Trends of Child Mortality in 2006: Estimates developed by the Inter-agency Group for Child Mortality Estimation*, New York.