

Issues and Challenges of Measurement of Health:Implications for Economic Research

Martine Audibert

▶ **To cite this version:**

Martine Audibert. Issues and Challenges of Measurement of Health:Implications for Economic Research. 2011. halshs-00554267

HAL Id: halshs-00554267
https://shs.hal.science/halshs-00554267

Preprint submitted on 10 Jan 2011

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Document de travail de la série

Etudes et Documents

E 2009.22

Issues and Challenges of Measurement of Health: Implications for Economic Research[1]

Martine Audibert
CERDI – CNRS
Auvergne University

Paper
Prepared for the African Economic Research Consortium

"Health, Economic Growth and Poverty Reduction in Africa"
Framework Papers Review Workshop

Accra, Ghana
April 20-22, 2009

[1] The author would thank Alassane Drabo, a Ph.D student at the Cerdi, for his help with the literature survey.

Abstract

According to the human capital theory, health is a determinant of the economic development and should play a role in the fight against poverty. On the other side, the economic growth, by supplying better sanitation, water quality and hygiene, better education and income, may improve population's health. Economists, in investigating the relations between development and health, asked for valid and relevant health status measurement. But, on the other hand, the health concept is complex as health includes several dimensions, and researchers face a battery of health indicators.

The purpose of this study is to discuss, specifically for economic research, the particularity of each health indicator, the potential bias of their measurement, their advantages, disadvantages, and interest. As health indicators are too numerous, a selection was done and the analysis concerns the most frequent indicators, but also those which should be more used into the economic research perspective. Discussed health indicators are life expectancy and healthy life expectancy at birth, mortality rates (maternal and infant mortality included), cause-specific morbidity rates, Dalys and Qalys.

I – Introduction

It is now well-admitted that health plays a role in the fight against poverty. The theory of human capital told us that not only the quantitative aspect of labour, but also his qualitative aspect (such as education and health) matter in the process of economic growth. After a decline of interest on this topic in the seventies, we actually assist to a re-emergence of studies focusing on the links between health, welfare, and development. The debate in the literature is lively, and some authors consider that communicable diseases had contributed to slow down the economic development of developing countries (Gallup and Sachs, 2001; Bell, Devarajan and Gerbasch, 2003; Sachs, 2003). In 2001, the Commission on Macroeconomics and Health (WHO, 2001) concluded in its report that "diseases are a barrier to economic growth and that countries have to invest in health". The importance of health in the development was again underlined by the UN member states when they signed in 2000 the United Nation Millennium Declaration. Among the eight development goals, three relate directly to health[2].

Beyond the role of health in the economic development, as written in the report of the Commission on Social Determinants of Health: "the development of a society can be judged by the quality of its population's health" (WHO, 2008). Children born today in the world cannot expect to live an equal number of years (80 years in developed countries, less than 45 years in some African countries). If some countries have improved their population's health, we know that many countries will not achieve the health-related Millennium Development Goals (MDGs). The economic development is not the unique cause of this difference as health inequalities are also observed within countries. For the macroeconomic commission (WHO, 2001), a large part of deaths in the low-income countries should be avoidable while many of the non communicable diseases can be addressed by relatively low-cost interventions, especially using preventative actions. For the commission on social determinants of health (WHO, 2008), health inequalities can be avoidable by a new approach of development. They consider that health and health equity should be the result of social policies further that their aim, and that policies and programmes must embrace all the key sectors of society instead.

[2] Child mortality, maternal health, and HIV, Malaria and other diseases (http://www.who.int/topics/millennium_development_goals /about/en/index.html)

Investing in health has at least two justifications, one is economic and one is ethical or moral. Health, and more precisely poor health, has a cost. The cost is first a financial or direct cost, bound up with curative care. While developing countries, specifically Africa countries, did not start their health transition, non communicable diseases such as diabetes, cancers, heart diseases begin to bear in the disease burden. Direct cost should then drastically increase. The cost is then indirect or economic when a decrease in labour productivity occurs as a consequence of illness. By avoiding cases and deaths, health programmes should contribute to decrease direct and indirect costs. Second, improving population's health status and fighting health inequality is in so far ethical as many causes of deaths are avoidable without high-cost interventions.

The health notion is complex as health includes several dimensions. With the progress of the medicine, the definition of health has changed over time. From the absence of disease or infirmity, the WHO's definition of health became "a state of complete physical, mental and social well-being". This definition relates not only to the promotion of well-being, but also implies that people should have access to the treatment and that people affected by physical, mental and social disorders should be rehabilitated. Its also implies to obtain indicators which can measure those different aspects of health. As we will see, the measurement of health is not simple and health indicators are numerous.

Before presenting and discussing issues and challenges of health measurement, it is important to ask for the objectives of this measurement. The question will be: why or for which objective do we need to measuring health? The answer will determine the choice of the health indicator.

Issues and challenges of measurement of health matter with the objectives of the research. We distinguish several types of objectives or perspectives. They would concern:

i) Public health. In this perspective, it will be essential to assess the level of population's health status, to compare its level and its trend over the time within a specific country or between different countries. The definition of health would be sufficiently large, but homogenous, in order to make national or international comparisons. The health public perspective could also have to identify health priorities or rapidly detect epidemics. As previously, the question will be to choose the adequate health indicator;

ii) The monitoring progress towards the health MDGs. The need to use alternative indicators could be asked for (AbouZahr and Warlaw, 2001; Murray, 2007);

iii) The assessment of the effects of economic programmes on health. The intensification of the agriculture (by intensive use of fertilizers or irrigation), or the dramatically increase of the pollution due to fast growth could constitute high health risk factors (Hunter et al., 1993; Schirnding, 2002 ; Evans et Smith 2005);

iv) The economic research in relation with health questions. If we consider that poor health would have a negative effect on growth and economic development (Sachs, 2003; Audibert, 2008), or low income and economic inequality[3] would have an effect on health (Deaton, 2003), we are concerned with valid and relevant health status measurement;

v) The ethical consideration. Beyond the economic aspect of health inequalities (see above), the reduction of this inequality matters to the ethic for at least two reasons. As the commission on social determinants of health wrote, whether a child can growth and develop to its full potential (WHO, 2008) should be the result of social and economic policies. Secondly, the importance of early child development on future well-being and economic gains is sufficiently shown (Mwabu, 2009).

But improving health and health equity, identifying health priorities or providing economic arguments to health policy makers, need to correctly measure health. Following the WHO's definition of health, those concerned with health status measurement have to know whether they consider the only biologic element and refer to biomedical science, or whether they consider the individuals or groups' capacity to live physically, mentally and socially (Breslow, 1989).

II – Health status measurement

As the consequence of progress in medicine, increases of life expectancy and living standard, the idea of health status has changed since the first WHO's definition of health. The willingness to take into consideration not only the disease, but also the consequences of the disease on well-being

[3] By assessing the effect of income inequality on health, researchers help to determine whether and by how much income redistribution can improve population (Deaton, 2003).

and quality of life allowed to enlarging this idea. The health of individuals includes several dimensions. Consequently, the health measurement is not simple and is based on several indicators more or less complex. This measure can take several forms or approaches (Breslow, 1989; Starfield, 1992; Or, 2000; Perronnin, Rochaix and Tubeuf, 2006). The first is objective and based on medical examination allowing to detect physiological or psychological anomalies, and to assess general physical fitness. The second is functional and consists of determining competence for social functioning (one's ability to eat, walk or bathe without assistance, Katz et al., 1963; Fanshel and Bush, 1970; Breslow, 1989). Self-completed questionnaire or observations are used to determining that competence. The third approach is entirely subjective as individuals, questioned on their self-perception of health, have to determine their health status by using a graduate scale, for example.

Either in a perspective of public health, health research, or economic health research, the worldwide health community faces a battery of health indicators. A lot are recommended but few measured well (Murray, 2007). Improving health measurement and measuring accurately its complex dimensions are the next challenge[4] as it can serve the purpose of improving the quality of decision making (Murray and Frenk, 2008) and the quality of economic evaluation of health. Health statistics are necessary inputs in this purpose and that question was already asked in 1992 by Starfield when he underlined the lack of information on chronic illness in routinely collected data.

Due to the complex dimensions of health, instead of using a unique measure of health, we dispose of some thousands indicators. Some concern one dimension or one specific disease, some includes two or more dimensions. As, it is not possible to present all the available health indicators and as is beyond the purpose of this discussion, I decided to follow the standard classification of health status indicators, and discuss of methodological issues for some of them.

Health indicators could be classified into single measures, summary measures and multidimensional instruments.

[4] See: http://www.healthmetricsandevaluation.org/who/director.html.

a) Single measures of health status

Indicators in this group fall into four categories: life expectancy (LE); mortality; morbidity and nutritional status. Defined and proposed by demographers (LE, mortality indicators) and the medical profession, they are considered as objective, precise, with no ambiguousness and for some on them (mortality and morbidity indicators), immediately available. But, due to methods of data collection, they suffer for important biases, making difficult international comparisons, or the monitoring for reaching the MDG targets (see for example Table 1 which gives an idea of diverging results issued from different sources). They also are criticized as they only capture one dimension of health outcomes, either fatal, underlying the rule of rescue (LE; mortality indicators), either non-fatal (morbidity indicators).

If those indicators are used by demographers, health professionals or epidemiologists in a demographic or health public perspective, they also are used by economists when they have to determine both the direct and indirect economic cost of health. Several inconvenient can be found for health economic research. First, health economists do not contribute or in a small way, to the definition and the calculation of health indicators. Now, the preoccupation of health public and economic researches is different and the relevance of indicators may not be the same, as we will see below. Second, when they use health indicators in order to assess the socioeconomic determinants of health, economists, more commonly use, instead of epidemiological models[5], econometrics models which may not fit well with trend of health or diseases occurrence. Now is the time to accelerate a more narrow collaboration between epidemiologists and economists.

Life expectancy at birth

Life expectancy at birth is a good indicator of the development level, and partly for that reason, this indicator is unsatisfactory for economic research. Due to its high level, life expectancy at birth in developed countries began an inadequate indicator for measuring health status, nor the eventual consequence of social and economic policy on health. The high increase of the length of life in developed countries allowed researchers to questioning its interest if people live their last life years in

[5] For some specific diseases, such as AIDS for example, economists used also epidemiological models.

poor health. An indicator (HALE) which would take into account the number of unhealthy life years a person could expect to living, has then been built (see section 1.2).

As it is only available at countries level, this indicator is used into macro-level analyses. But, due to its high correlation with economic level, the use of this indicator (such as child mortality[6]) into international comparison, for showing that poor health is a blocking factor for the economic development, may be low realist. Using this indicator into economic analysis allowed to assuming that health status is a consequence of the economic development and not the reverse.

Mortality rates

Numerous indicators of mortality are available, either in theory as in practice. They may be classified into gross mortality rates, mortality rates per sex, age, cause and risk factor. In developed countries, mortality indicators are well registered and are easily available. It is not the case for a great part of developing countries, as death registration systems are poor (Mathers *et al*. 2005). Boerma *et al*. (2002) estimate that since 1990, "74% of 152 low-income and middle-income countries had no data, and another 16% were judged to have poor-quality data". With the need to monitor progresses towards the health MDGs, the publication of country mortality statistics has increased since the 2000 years. Now, due to the failure of good death registration systems, figures are based on predictions rather than direct measures A great effort was done by WHO and UNICEF for improving data quality by promoting more homogeneous methods of data collection and using all the available information. But as showed in Table 1, for the example of under-five mortality, data are not yet perfectly adjusted. This situation may ask questions when one would not only check the progress in achieving MDGs, but also assess the effect of health interventions both at macro and micro-level, on mortality.

It is difficult to measure accurately the levels of mortality. Death registration suffers from two biases. First, all deaths might not be recorded, as routine recording is not complete. Second, causes of the death, whether it is due to specific disease or to pregnancy may not have been known. In the lack of adequate or complete death registration system, identification of mortality rates relies on household surveys. The difficulty of getting relatively coherent estimations is underlined in the literature and

[6] The correlation coefficient, R, computing on a panel of 90 countries over the period 1975-2000, between life expectancy at birth or child mortality and GDP per capita is over 0.77(Drabo, 2009).

explains that a lot of studies focused on methods for improving the measure of mortality through surveys and interviews. This literature is more abundant for maternal and child mortality.

Maternal mortality

The WHO defines the maternal death as "the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, for any cause relative to or aggravated by the pregnancy or its management, but not for accidental or incidental causes" (WHO, 2007). Three statistical measures are available. The maternal mortality ratio (MMR), the maternal mortality rate (MMRate) and the adult of lifetime risk of maternal death[7].

Several methods are used for estimating the level of maternal mortality. Each of these methods has limitations, gives different estimations and has uncertainty wide margins. For those reasons, it would be wrong to interpret small numerical differences in countries or between periods, as representing real differences (WHO, 2007). These methods and their limitations are well discussed in the recent literature (see among others authors, Hill, Abou Zarh, Wardlaw, 2001; Smith et al. 2001; Bobak et al. 2002; Boerma et al. 2007; Fauveau, 2006, and also the WHO special bulletin, of 2006, n° 84, and the document on maternal mortality published by the WHO in 2007). We shortly presented here a summary of those methods and their limitations.

One method is based on household surveys which identify pregnancy-related deaths, but not maternal deaths as those deaths are rare events that require large sample sizes to have the probability to correctly observe this event. In order to copy with this necessity, the sisterhood method has been proposed. Information on women deaths is obtain by interviewing a representative sample of respondents about the survival of all their adult sisters (to determine the number of ever-married sisters, how many are alive, how many are dead, and how many died during pregnancy, delivery, or within six weeks of pregnancy). This method is considered as not suitable for use in settings where

[7] MMR is the number of maternal deaths in a population during a given time divided by the number of live births during the same period (per 100.000); MMRate is the number of maternal deaths during a given time in a population divided by the number of women of reproductive age during the same period (per 100.000).
The Adult lifetime risk of maternal mortality = $(T_{15} - T_{50})/ l_{15}$ x MMRate, where l_{15}, T_{15} and T_{50} are quantities from a life table for the female population during the period in question (l_{15} equals the probability of survival from birth until age 15, and $(T15 - T50)/l15$ equals the average number of years lived between ages 15 and 50 – up to a maximum of 35 years – among survivors to age 15) (WHO, 2007).

fertility level is low or where social dislocation is high due to substantial migration. A third method is the verbal autopsy which consists to lead interview with the relatives of the deceased in order to assign the cause of the death. This method is also non exempt of bias as the accuracy of the estimates depends on the extent of family members' knowledge of the events leading to the death and the skill of the interviewers. National population censuses also try to determine in some developing countries, maternal deaths. Stanton et al. (2002) evaluated the use of national census deaths data for assessing maternal mortality. Their conclusion based on data analysis from five national population censuses is that "under favourable conditions a national census is a feasible and promising approach for the measurement of maternal mortality". But, this use may need a careful evaluation of the data and adjustment.

In conclusion, it remains difficult to measure accurately the levels of maternal mortality. Hill, AbouZahr and Wardlaw (2001), tried to compare the maternal mortality on 188 countries, using a variety of adjustment procedures depending of the nature of the date used. Results give so wide uncertainty bounds that the authors estimated that comparisons between countries should be made with caution, and no valid conclusions can be drawn about trends over a period of time.

Now, maternal mortality is a good indicator of the performance of health care systems. And, several researchers recommend to use process indicators, such as the percentage of births assisted by a skilled health care worker and rates of caesarean delivery for comparing reproductive health between countries or across time periods and monitoring purposes (Hill, AbouZahr and Wardlaw, 2001; Prual et al. 2000).

Child mortality

For similar reasons of that for maternal mortality (lack of good registration systems), it is difficult to measure accurately child mortality (see Table 1 and the different estimations depending of data sources and then methods used for estimating child mortality). Several indicators are available and concern specified age between birth and five years. They may be estimated for both female and male. These are among others:

i) Neonatal mortality rate that is the number of deaths during the first 28 completed days of life per 1000 live births;

ii) Infant mortality that is the number of children who die before one year of age in a given year divided by the number of live births in the same year;

iii) Under-five mortality that is the probability of a child born in a specific year or period dying before reaching the age of five, if subject to age-specific mortality rates of that period, (http://www.who.int/whosis/indicators/compendium/2008/3mr5/en/).

Child mortality suffers from under registration and needs the use of several methods in order to measure more accurately its real level. Despite the use of improved methods, significant differences in its measure remain according to the sources of the data (Table 1). Demographers consider that the analysis of child mortality trends allows to monitoring the health transition process over countries. Garenne and Gakusi (2006), using 66 Demographic and Health Surveys (DHS) from 32 countries, might calculate death rates by yearly period and tested changes in trends using a linear logistic model[8]. They then might identify countries that entered into health transition and those that did not. For economists, child mortality, and more specifically infant and under-five mortality, are considered, like life expectancy, as a good indicator of the economic development, and then is highly correlated with his level.

Table 1: Under-five mortality in some (arbitrary chosen) African countries from two different sources

Mortality indicator	Under-five mortality (per 1000)							
year	2000		2003		2004	2006	2000	2006
Source	WHO		WHO			UNICEF	UNICEF's MICS	
Country	H	F	H	F	H&F	H&F	H&F	
Bénin	162	151	166	158	152	148	140	126
Cameroun	149	140	162	158	149	149	151	148
Ghana	112	98	106	99	112	120	111	114
Kenya	107	98	119	113	120	121	117	121

Source: WHO (2002, 2006), MICS = Multiple Indicator research Cluster Surveys
UNICEF: http://www.unicef.org/statistics/index_24302.html; http://www.unicef.org/infobycountry/index.html

Cause-specific mortality and morbidity

Improving population health status by reducing mortality and morbidity induces to study the causes of mortality and morbidity. Whatever target populations (under-five children, pregnant women, 15-49 years age people, high-risks population, etc) it is difficult to determine accurately the causes of

[8] Logit [q(5)] = a + b x year. They found that in a smooth health transition, the slope (b) tends to be constant over long periods of time.

deaths or illness in developing countries. Once again, the limited or no functioning vital registration system, but also the lack of adequately trained and qualified personnel and appropriate equipment in developing countries do not allow to setting adequate diagnostics (Gouws *et al*. 2005).

The sources of health data are numerous. Among them, we find vital registration systems, sample registration systems, administrative data, health facilities data, nationally representative household surveys (DHS and MCIS), sentinel demographic surveillance sites (DSS), epidemiological studies. We saw that some of them do not allow to measure accurately age-specific or cause-specific health status. International organizations are conscious of the low quality of health statistics in developing countries. Great efforts are made since several years in order to help improving this quality. They then decided to work together by confronting the sources of data, inducing researchers to improve the measurement methods. For example, estimates of HIV prevalence have been developed by UNAIDS and WHO for most Member States and revised periodically to account for new data and improved methods[9] (WHO health report, statistical annex).

Demographers, epidemiologists and public health researchers complain that the lack of adequate data:

- obstructs the process of planning and evaluation of interventions to control diseases,
- does not allow policy-makers to generate cost-effective interventions.

They then proposed several alternative approaches to copying with inadequate data. After a systematic and comprehensive literature review of all studies published since 1980 reporting under-5 diarrhoea mortality, Boschi-Pinto et al. (2008) estimated a logit model to relate studies and population characteristics to proportional mortality from diarrhoea and to predict its distribution in national populations[10]. Becker *et al*. (2006) try to propose an effective ranking list of the leading causes of death using Taucher's criteria causal categories, and grouping diseases upon measures that could prevented them, such as prevention by vaccination (measles, tetanus) or avoidable by early diagnosis and adequate treatment (tuberculosis, malaria). And they proposed, like Hill, Abou-Zahr and Wardlaw

[9] Two different types of models are used, depending on the nature of the epidemic in countries.
[10] Logit (% diarrhoea deaths) = 5.31 + 2.38(ln5q0) + 2.01(time) + 8.56 (region).

(2001), Abou-Zarh and Wardlaw (2001), to use process indicators[11] for comparing health between countries or across time periods and for monitoring and evaluation purposes.

As in the case of maternal mortality, the method of verbal autopsy (VA) is used in order to determine cause-specific mortality and largely discussed in the literature. Using this approach, Fantahun *et al*. (2006) estimated a probabilistic model for interpreting community-based VA interview in order to investigate patterns of cause-specific mortality in rural Ethiopia. They found that the model fit well for determining cause-specific mortality[12] and was less labour-intensive than interpretation by physicians. But, VA is not always considered as an effective method. In the case of malaria, this approach has low sensitivity and low specificity (Boerma et al., 200; le Hesran, 2000).

Nutritional indicators

The measurement of the nutritional status into a population is an important stake for several reasons. First, malnutrition seems to be a main cause of child mortality in developing countries. It is associated with about 50% of all deaths among children as it constitutes a risk factor of death associated with specific diseases. Association has been found with diarrhoea and acute respiratory infection (Rice *et al*., 2002). As mentioned by Rice *et al.* (2002), this association has important implications for the evaluation of nutritional intervention programmes as the programs effectiveness may vary with different disease profiles. Second, adult malnutrition is also a cause of mortality and morbidity. Overweight and obesity are at increased risk of adverse metabolic outcomes and subsequently, increase the risk of diseases, such as coronary heart disease, diabetes or cancer. Third, malnutrition during childhood will have negative consequence on future gains. Four, malnutrition is a risk factor of maternal mortality, associated with malaria and HIV/AIDS.

Several nutritional indicators are available. The most common used for economic research are, as they are easy to obtain, anthropometric measures that allow to assessing malnutrition status by relating

[11] Process indicators are the advantages to be better measured and highly correlated with the cause or the consequence of the disease. We find in this category, indicators associated:

- with maternal mortality, such as percentage of births assisted by a skilled health care worker and rates of caesarean delivery
- with child mortality and morbidity, such as percentage of child completely vaccinated, the number of child sleeping under insecticide bed nets.

[12] Among causes of deaths, kwashiorkor, blood diarrhoea, diarrhoea, malaria, TB, HIV, were claimed.

body measurements (weight and height/lenght) to an individual's age or height. Three indicators, stunting, wasting, and being underweight, are available for assessing child nutritional status.

Stunting indicates chronic under-nutrition. It is measured by the height-for-age that express past retardation growth. Wasting indicates acute under-nutrition. It is measured by the weight for height indices that concern current malnutrition. Underweight children may either be chronically or acutely malnourished or a combination of both. It is measured by the weight-for-age. Anthropometric values are compared across individuals using a standardized age- and sex-specific growth reference (the National Center for Health Statistics and WHO (NCHS/WHO) international reference since 1970[13]). Z-scores are calculated for each anthropometric value[14]. The *Z*-score system expresses anthropometric values as several standard deviations (SDs) below or above the reference mean or median value:

$$\text{Z-score} = \frac{\text{anthropometric value of the studied population} - \text{Median value of the reference population}}{\text{Standard deviation of the reference population}}$$

Growth retardation prevalence may then be calculated per age, sex, region, and country. The prevalence of each type of malnutrition is the proportion of weight-for-age, height-for-age and weight-for-height below -2 and -3 standard deviations (SDs).

As for under-nutrition, over-nutrition is a health problem. Overweight and obesity both in adult and child populations become to be an increasing public health problem. The WHO considers that this problem is affecting many low- and middle-income countries. "In 2007, an estimated 22 million children under the age of 5 years were overweight throughout the world. More than 75% of overweight and obese children live in low- and middle-income countries…. More than 1 billion adults are overweight and at least 300 million of them clinically obese"[15]. Now, childhood obesity is associated with a higher chance of premature death and disability in adulthood. Body Mass Index (BMI) was the classical tool for indicating nutritional status in adults. It was defined as the weight in kilograms divided by the square of the height in meter (kg/m²). This index allowed to

[13] New growth standards for infants and children up to the age of 5 years were developed in 2006 by the World Health Organization. www.who.int/chilgrowth/en.
[14] They are: height-for-age *Z*-scores (HAZ), weight-for-age *Z*-scores (WAZ), weight-for-height *Z*-scores (WHZ).
[15] http://www.who.int/dietphysicalactivity/childhood/en/

classifying overweight and obesity (Table 2). It was now currently used for school age children and adolescents, and is recommended for use with children under-five years old (WHO, website).

Using BMI classification, the prevalence of overweight and obesity among adults (percentage of 15 years and older population with a BMI $\geq$ 30.0 kg/m²), adolescents and children may be calculated.

Table 2: BMI classification for adults

Definition	BMI
Underweight	< 18.5
Normal range	18.5 – 24.9
Overweight	$\geq$ 25
Pre-obese	25 – 29.9
Obese	$\geq$ 30.0

Source: http://www.who.int/dietphysicalactivity/childhood_what/en/index.html

Conclusion concerning the single measures of health status

i) If mortality indicators remain essential, due to poor registration system, they suffer from bias in measurement. This bias is yet higher when cause-specific mortality or morbidity are considered, those indicators should be used, but results may be interpreted with caution and need to be largely discussed.

ii) These measures have the disadvantage to take into consideration one dimension of health. For that consideration, they could no be used as a representative measure of global health status;

iii) Cause-specific morbidity rates, measured by prevalence and incidence rates of specific disease, are inaccurately measures of the severity of the disease and then the real consequence of the disease on the population well-being and quality of life.

b) Summary measures

Summary measures have been developed in order to mitigate the partial measurement of both mortality and morbidity health indicators, by capturing both fatal and non-fatal health outcomes. The objective of those measures is to give an indication of the burden of disease. Two indicators have been proposed: the healthy life expectancy at birth (HALE) and the disability-adjusted life year (DALY).

Healthy life expectancy (HALE) at birth

The high increase of life expectancy at birth and the great interest into the quality of life in developed countries, allowed demographers to introducing the notion of full health in the life expectancy indicator. A new indicator, the HALE, was then proposed. It is expressed as the “average number of years that a person can expect to live in "full health" by taking into account years lived in less than full health due to disease and/or injury”. It adds up expectation of life for different health states, adjusted for severity distribution making it sensitive to changes over time or differences between countries in the severity distribution of health states. (http://www.who.int/whosis/indicators/2007HALE0/en/). This indicator was calculated per country, and sex, but only in 2002 (WHO, 2002, World health report, 2002).

The correlation between LE and HALE is very strong, and if this last indicator is interesting for monitoring the quality degradation of the length of life in developed countries, and also in developing countries, it does not bring better advantages or information by using this indicator for international comparisons in studies determining economic effect of poor health.

Table 2: Life expectancy (LE) and healthy life expectancy (HALE) at birth in some WHO members state, estimates for 2002 (both sexes)

Member state	LE (years)	HALE (years)	Difference (years)	Member state	LE (years)	HALE (years)	Difference (years)
Argentine	74.4	65.3	9.1	Indonesia	66.4	58.1	8.3
Belgium	78.4	71.1	7.3	Kenya	50.9	44.4	6.5
Bolivia	63.2	54.4	8.8	Mauritania	52.1	44.5	7.6
Burkina Faso	41.7	35.6	6.1	Namibia	49.3	43.3	6
China	71.1	63.1	8.0	Niger	42.6	35.5	7
Denmark	77.2	69.8	7.4	Nigeria	48.8	41.5	7.3
Egypt	67.1	59	8.1	Philippines	68.3	59.3	9
Ethiopia	48	41.2	6.8	Russia	64.6	58.4	6.2
France	79.8	69.3	10.5	Sierra Leone	34	28.6	5.4
Germany	78.7	71.8	6.9	U S A	77.3	69.3	8
Ghana	57.6	49.8	7.8	Viet Nam	69.6	61.3	8.3

Source: WHO (2004), statistical annex

Disability Adjusted Life Year[16]

In 1993, the World Bank and WHO proposed a new health measure that would give an indication of the burden of disease, the disability-adjusted life year (DALY). The DALY can be thought of one lost year of healthy life, due to disease or injury. The first statistics upon DALYS were published in the 1993 World Bank annual report. The purpose of this indicator has been to take into consideration three dimensions of health: mortality, disability and incapacity through the severity of the disease.

DALYs are calculated as the sum of years life lost due to premature mortality (YLL) in the population and years of life lost due to disability (YLD) for incident cases of the disease or injury (i.e. years lived with disability, WHO, 2004, statistical annex;).

DALY = YLL + YLD

where:

YLL = N x L

YLL corresponds to the number of deaths (N) multiplied by the standard life expectancy at the age at which death occurs (L);

YLD = I x DW x L

YLD corresponds to the number of disability (incident) cases (I) multiplied by the average duration of the disease (L, in years) multiplied by a weight factor that reflects the severity of the disease (DW, disability weight) on a scale from 0 (perfect health) to 1 (death)[17]. Disability weights reflect societal preferences for difference health states in the relation to the societal ideal of good health. Disability refers to departures from ideal health in important domains of health: mobility, self-care, participation in usual activities, pain and discomfort, anxiety and depression, cognitive impairment (WHO, 2004, chapter 3). The approach for measuring preference for defined health states has changed since the beginning[18]. The new approach used a standard health states description based on eight core domains of health (mobility, self care, pain and discomfort, cognition, vision, interpersonal activities, sleep and

[16] A large part of this section is based on the GBD, update (WHO, 2004).
[17] This assignment is inverted compared to that used for the QALY, where 0 is death and 1, perfect health. But, while QALY measures equivalent healthy years lived, DALY measures loss of health (GBD, 2004).
[18] Small groups of participants (medical and public health experts) were asked for making a judgement about the severity of the condition and the preference for time spent in each severity level.

energy, affect). In 2003, disability weights are revised and based on health state valuations from large representative population samples in over 70 countries.

The DALY indicator measures the differences between a current situation and an ideal situation where everyone lives up to the age of the standard health expectancy, and in perfect health. The standard life expectancy at birth is set at 80 years for men and 82.5 for women (GBD, 2004). The time social preference (people preferring a healthy year of life now rather than in the future) and the age social preference (people valuing more highly a year lived by a young adult than a year lived by young child or older person) were taken into consideration. Calculations of YLL and YLD use a 3% time discounting and non-uniform age weights that give less weight to years lived at young and older ages (WHO,2004, statistical annex; Jamison et al, 2006).

DALYs were calculated for about one hundred causes or diseases, including maternal, perinatal and nutritional conditions, and injuries, both intentional and unintentional. They also are calculated for risk factors. Risk factors are factors that cause diseases. Among them, they are underweight, overweight, unsafe sex, blood pressure, tobacco, unsafe water, sanitation and hygiene, indoor smoke from solid fuels (WHO, 2002; Lopez et al, 2006). DALYs were calculated per sex, and mortality stratum in WHO regions (Africa, the Americas, Eastern Mediterranean, Europe, South-East Asia, and Western Pacific). Data were available for 1999, 2000, 2001 and 2002 (WHO 2000 to 2003). DALYs per WHO member state were calculated only for one year, in 2002 (World Health Report, 2004).

Since 2002, partial updates of GBD ranking have been published. Now, the Institute of health metrics (http://www.healthmetricsandevaluation.org) estimated that disease burden measure contains some outdated and inconsistent information. Researchers of this institute observed that substantial data gaps and deficiencies remain, particularly for regions with limited death registration data. They underlined the need of “reassess in a newly comprehensive study”. They work in that direction, and undertook to update projections to the year 2030, using the updated GBD 2004 results as a starting-point (http://www.healthmetricsandevaluation.org/who/director.html).

For summarizing, DALY, as a summary measure, has the advantage to take into consideration either the two dimensions of health outcome (mortality and disability), as disease severity and social

preferences for health states valuation. This indicator serves to measure health differences in the world, and then to improve health status and healthy expectancy life. It has at least four objectives (GBD, 2004):

i) To provide a summary measure of health status and then contribute to determining health priorities;

ii) To contribute to identify the most unhealthy population group and then to target health intervention;

iii) To provide a comparable health measure for assessing the effect of health interventions;

iv) To help country governments to more rapidly reach the MDGs.

Although, the Quality-Adjusted Life Year (QALY) is a well-known health indicator, we choose to just introduce it here for two reasons. The concept of QALY was initially introduced in 1968 by Dr. H. Karman's team after having observed that the quality of life of their patients was highly different depending on the treatment they received for the same disease (Goerdt *et al*. 1996). This indicator may be more appropriate for improving the quality of healthcare than for establishing health priorities (as also questioned by Jourdain, 1993, and Williams, 1996). Beyond the debate on the concept of utility upon which this indicator is based, the concept of quality of life is not a concrete concept for population from developing countries while the notion of rescue in health is highly present.

The formula for calculating QALY (Q), is:

$$Q = S \times W$$

Where:

S, is the number of life years saved thank to the treatment

$$W = \sum_i (V_i x P_i) / N$$

With V_i, the value or social preference for the health status i, P_i, the number of persons being in the health status i, N the total number of persons concerned by all described health status, from perfect health to death.

Adults' health status

Self-reported illness symptoms and limitations in the physical ability to perform activities of daily living (ADL) were two health measures used to study adults' health status. Initially, ADL's measure was developed for studying disability levels among the elderly. Referred as the Katz ADL, this index was developed in order to detect elderly' problems in performing activities of daily living (Katz *et al*. 1963). Six functions were defined and concerned bathing, dressing, toileting, transferring, continence, and feeding. They were scored yes (=1) or no (=0) for independence. A score of 6 indicated full function, 4, moderate impairment, and 2 or less, severe functional impairment.

While self-reported illness symptoms are suspected to be correlated with income and education, ADL measure is bias-exempt and considered as reliable and valid measures, whatever the local culture context (Reijneveld, Spijker and Dijkshoorn, 2007; Gertler and Gruber, 2002; Strauss *et al*. 1993). Questionnaires for capturing ADLs may be more or less short[19]. ALDs are divided into basic and intermediate activities. Basic ADLs concern the ability to perform the six initial functions (to bathe, feed, clothe yourself, etc.). Intermediate ADLs concern for example, ability to carry a heavy load for 20 meters or take water from a well (Gertler and Gruber, 2002). ADLs may be found in some national household surveys. They also may be collected in specific surveys, as it is easy to collect information on its components. This measure has been used in studies of the relationships between health and labour market outcomes (Strauss and Thomas, 1996) and of assessing the health change over time (Gertler and Gruber, 2002). Finally, the ADL questionnaire could be short and simple, but also valid as the EuroQol questionnaire (EQ-5D) is (see the discussion around the advantages of a non complicated instrument in Dorman et al., 1997).

III – Implication for economic research

Facing to more than thousand health indicators, economists have to choose which health indicator fits well for their studies. The use of that health indicator, instead of another one, is upon the objective of the undertaken economic study. The first question is which kind of economic research is

[19] The EuroQol questionnaire (EQ-5D) included five questions whose three are summary physical abilities (walk, bathe & clothe, current activities).

done when economists work in the health field? The main goal of economic research in health is to contribute to the fight against poverty through health improvement. For that, at least five targets may be followed by economists:

i) The first is to assess the direct and indirect economic costs of health. Studies on direct cost induce to find the means to decrease that cost by improving the efficiency and effectiveness of health system, and preventing illness occurrence. But they also allow to identify the economic and social determinants of healthcare demand and to measure the inequity level in health access. Studies on indirect cost induce to assess the effect of health on the development or household economic status;

ii) The second is to identify the different sources of health financing for, as resources are insufficient, improving the supply of financing, but also the efficiency of both public and private health expenditures;

iii) The third is to identify the best cost-effectiveness health interventions for helping policy-makers to prioritize public health interventions;

iv) The fourth is to assess the effect of economic interventions on health;

v) The fifth is to identify the economic and social determinants of health.

When economists provide information on the cost of healthcare, whether cost is supported by states or by households, they want to know how much time states could finance this cost (this question is a crude question in the case of HIV/AIDS) or whether healthcare cost will bring people to poverty due to catastrophic payments. It is well-known that the frequentation of health facilities in Africa is very low (the number of contacts per person per year is between 0.2 and 0.5; Audibert *et al*, 2005). The question asked by policy-makers is why people do not use health facilities. Is the barrier to healthcare, an economic, social or cultural problem? Economists may answer to that question by using healthcare demand models. That study needs to undertake household surveys in which people are questioned about the occurrence of health problems during the four weeks preceding the survey (as in DHS surveys for example) and the access to healthcare. The health status is not really defined as people describe symptoms because they are often unable to identify the cause of illness. However, it

would be easy to add a question on global health and to ask people to determine their health status using a graduate scale (see the EuroQol questionnaire, EQ-5D version). Although, we know that the poor report less illness episodes than the rich, the analysis of this kind of surveys and the data they provided, is useful for assessing direct health cost.

The indirect cost of health is the cost induced by productivity and work days lost. In this perspective, one considers that poor health is a cause of poor household economic status or low development. Economists working on this topic are faced to a huge problem of health measure. When, they want to assess the effect of poor health at the macro-economic level, they have to choose an indicator that measure overall health status. As a summary indicator, the DALY should be used as a measure of overall health status as it includes more than hundred causes of disability or deaths. But this indicator is, calculated per WHO region and not per country, except from 2002.

Economists use then health indicators supposed to be indirect measures of overall health status as life expectancy at birth and child mortality. The measure of child mortality (as maternal mortality) was traditionally done by demographers and epidemiologists. We saw the difficulty they encountered, due to biases in data records, to provide accurate measures of mortality in general and maternal and child mortality in particular. Now, maternal and child mortality are largely used into the perspective of the health MDGs for providing information concerning progress towards achieving the MDG4 and MDG5 targets, and the performance of health systems. Demographic and Health Surveys (DHS), using a direct sisterhood approach and verbal autopsy, provide data on maternal and child mortality. Acute discussion rose around biases from DHS mortality data in order to assess the quality of the data collected and discuss the appropriate use of these data (Stanton, Abderrahim, Hill, 2000; Garenne and Gakusi, 2006). Economists have little to do in that debate: their contribution into health metric will be highest by interpreting the results of their economic research in health, keeping in mind that the measure of health is not free from bias.

Economists may have other useful health indicators, such as anthropometric measures (height and weight) both for child and adult. They are rapid and inexpensive to obtain, and easy to use. Data could also be found in a number of data sources such as nationally representative household surveys, including DHS, and WHO Global database. Anthropometric measures will serve for assessing the

economic effect of poor past health. Relationships between past malnutrition and adult gains have been set[20]. They also serve for other field research. The WHO Global database allows scientists in economic research to undertake international comparison of nutritional status, evaluating nutritional and other public health interventions, monitoring trends in child growth.

However, such as public health researchers, economists may need to obtain adequate measure of health indicators per cause-specific mortality and morbidity. Economists will have to use cause-specific mortality and morbidity indicators with caution. In order to cope with bias measurement of these indicators, some researchers proposed to use process indicators as indirect measures of health status. Process indicators are easy to collect, best measured and highly correlated with the cause or the consequence of diseases. Then, they could be used for comparing health between countries or across time periods, and for monitoring and evaluation purposes (Hill, Abou-Zahr, Wardlaw, 2001; Abou-Zarh et Wardlaw, 2001; Becker *et al.,* 2006). In other hand, even if all countries did not enter their epidemiological transition, non-communicable diseases become more important and may cause economic losses. Non-communicable diseases currently represent 43% of the global burden of disease and are expected to account for 60% of the disease burden and 73% of all deaths in the world by 2020 (Sarrafzadegan et al. 2009). Chronic diseases will be no exceptional in developing countries (Malone et al. 1999). Communicable diseases are projected to account for 20% of total DALYs lost in 2030, compared with just fewer than 40% in 2004. The non communicable disease burden is projected to increase to 66% in 2030, and to represent a greater burden of disease than communicable diseases in all income groups, including low-income countries[21]. Due to lack of data, studies on the economic effect of non communicable diseases may not be undertaken. Economists may add their voice when public health researchers and epidemiologists ask for including in household surveys target disease (Murray and Frenk, 2008; Sarrafzadegan, 2009). At the last, when economists want to assess the economic effect of a specific disease at microeconomic level, they are faced with a problem of obtaining health indicator that accurately measures the severity of the disease. Economists may ask

[20] For example, a delay in childhood development (height), or low weight at birth would have an impact on future wages or labour productivity (Strauss and Thomas, 1998; Huffman and Orazem, Berham, 1999; Behrman and Rosenzweig 2004).
[21] http://www.healthmetricsandevaluation.org/who/director.html.

epidemiologists for providing indicators in closer relation with health economic research. A narrow collaboration between epidemiologists and economists may allow to improving health measurement for both evaluating health interventions and assessing economic effects of health. That could be done with more multidisciplinary studies.

If health may be to have negative effect on economic status, the reverse is true: economic status (such as level as economic inequality) may determine health status. Then, studies of health economic and social determinants could help to orient health interventions, but also economic programs forward the poor. For example, Banerjee, Deaton and Duflo (2004) studied the relationship between health, happiness and economic status. They used several health indicators: self-reported health, BMI, the haemoglobin count and blood pressure. They showed that individuals in the lower third of the per capita income distribution have, on average, a lower level of self-reported health, lower BMI, and tare more likely to have a haemoglobin count below 12 than those in the upper third.

The DHS surveys in providing population-based estimates of the current health of women, men and children, and also demographic, social and economic characteristics of individuals and households allow to identifying the role of economic status on health in numerous developing countries. For example, Lachaud (2007) used the Burkina Faso DHS data and found a positive relationship between HIV prevalence in adult women and men and living standards of individuals.

IV – Conclusion

If, due to the multi-dimensional characteristic of health, and the lack of adequate registration system, the measure of health is difficult, researchers are faced to a lot of health indicators. In one sense, that abundance, nourished by a great availability of health statistics databases, would serve health economic research. Databases are provided by international organisations such as WHO, UNDP, UNICEF, the World Bank, UNAIDS, USAID and UNFPA. The WHO, for example, provides health statistics into her WHOSIS database (http://www.who.int/whosis/fr/). USAID, in financing DHS surveys in number of developing countries, allowed to providing a lot of both direct and indirect health indicators.

As an indicator of the disease burden, the DALY will be an interesting indicator for international studies concerning:

- The relation between health and development, using the total number of DALYs.

- The role of communicable and non-communicable diseases on poverty, using DALYs per cause.

- The role of specific diseases, such as chronic non-communicable disease or endemic communicable disease on poverty, using DALYs per specific disease.

We propose some recommendations that are:

- to encourage economic researchers to more use existing international and national databases, such as the WHOSIS and MCIS databases that have not been fully exploited, and DHS;

- to exploit the resources providing by the DALYs indicators, either by cause or by risk factor. As burden disease indicators, they measured health status in a more comprehensive means that only mortality or morbidity rates. The DALYs per cause and risk factor may be more used in the economic research in order to assess the economic role of health. Although, this indicator is calculated per WHO region, the proposed decomposition per mortality stratum gives the opportunity to use this indicator at macroeconomic research and to wait for a new update revision of DALYs per country;

- to systematically collect anthropometric measures and ALDs measures while economists undertake household surveys, as they are easy and low expensive to collect;

- to develop narrow collaboration between epidemiologists and economists in order to improve results both in health economic research and health public research.

References

AbouZahr C., Wardlaw T., (2001), Maternal mortality at the end of a decade: signs of progress? *Bulletin of the World Health Organization*, 79: 561–568.

Antunes J.L.F., Waldman E.A., (2002), Trends and spatial distribution of deaths of children aged 12–60 months in Sao Paulo, Brazil, 1980–98, *Bulletin of the World Health Organization*, 80, 8, 391-398.

Audibert M, de Roodenbeke E (2005), « Utilisation des centres de santé de premier niveau au Mali : issues et perspectives », African Region Human Development*, Working Paper Series*, 87, 33643, The World Bank, (en collaboration avec I.S. Traore, A. Pavy-Letourmy), 2005, 118 p.

Banerjee A, Deaton A, Duflo E (2004), Health, health care, and economic development, Wealth, Health, and Health Services in Rural Rajasthan, *The American Economic Review*, 94, 2, Papers and Proceedings of the One Hundred Sixteenth Annual Meeting of the American Economic Association San Diego, CA, January 3-5, 326-330.

Barbotte E., Guillemin F., Chau N., and the Lorhandicap Group, (2001), Prevalence of impairments, disabilities, handicaps and quality of life in the general population: a review of recent literature, *Bulletin of the World Health Organization*, 79 (11) 1045-1055.

Becker R, Silvi J, Ma Fat D, L'Hours A, Laurenti R (2006), A method for deriving leading causes of death, *Bulletin of the World Health Organization*, 84, 297-304.

Bell, C., Devarajan, S.,, Gersbach, H. (2003), The Long-run Economic Costs of AIDS: Theory and an Application to South Africa. *World Bank Economic Review* 20(1): 55-89.

Behrman J.R, Rosenzweig M.R (2004), Returns to birthweight, *The review of Economics and Statistics* 86, 2, 586-601.

Birchenall J.A, Soares R.R (2009), Altruism, fertility, and the value of children: Health policy evaluation and intergenerational welfare, *Journal of Public Economics* 93, 280-295.

Bobak M., Murphy M., Pikhart H., Martikainen P., Rose R., Marmot M., (2002), Mortality patterns in the Russian Federation: indirect technique using widowhood data, *Bulletin of the World Health Organization*, 80 (11) 876-881

Boschi-Pinto C., Velebit L., Shibuya K. (2008), Estimating child mortality due to diarrhoea in developing countries, *Bulletin of the World Health Organization* 86, 710–717.

Boerma J.T., Stansfield S.K. (2007), Health statistics now: are we making the right investments? *Lancet* 369, 779-786.

Breslow L. (1989), Health Status Measurement in the Evaluation of Health Promotion, *Medical Care* 27, 3, Supplement: Advances in Health Status Assessment: Conference Proceedings, S205-S216.

Cox C.L., Lensing S., Rai S.N., Hinds P., Burghen E., Pui C.H., (2005), Proxy Assessment of Quality of Life in Pediatric Clinical Trials: Application of the Health Utilities Index 3, *Quality of Life Research* 14, 4, 1045-1056

Deaton A. (2003), Health, Inequality, and Economic Development, *Journal of Economic Literature* 41, 1, 113-158.

Diamond I (2000), Child mortality – The challenge now, *Bulletin of the World Health Organization* 78, 10, 1174.

Dorman P.J., Slattery J., Farrell B., Dennis M.S., Sandercock P.A. (1997), A randomised comparison of the EuroQol and Short Form-36 after stroke, *BMJ*, 315-461.

Drabo A. (2009), Interrelation between health, environment and economic development: What consequence on economic convergence? Cerdi, Unpublished working Paper.

Erickson P., Kendall E.A., Anderson J.P., Kaplan R.M., (1989), Using Composite Health Status Measures to Assess the Nation's Health, *Medical Care*, 27, 3, Supplement: Advances in Health Status Assessment: Conference Proceedings, S66-S76

Essink-Bot M.L, Krabbe P. F. M., Bonsel G. J., Aaronson N. K (1997), An Empirical Comparison of Four Generic Health Status Measures: The Nottingham Health Profile, the Medical Outcomes Study 36-Item Short-Form Health Survey, the COOP/WONCA Charts, and The EuroQol Instrument, *Medical Care* 35, 5, 522-537.

Evans M. F., Smith V.K. (2005), Do new health conditions support mortality – air pollution effects? *Journal of Environmental Economics and Management* 50, 496-518.

Fantahun M, Fottrell E, Berhane Y, Wall S, Högberg U, Byass P (2006), Assessing a new approach to verbal autopsy interpretation in a rural Ethiopian community; the InterVa model, *Bulletin of the World Health Organization* 84, 204-210.

Fanshel S., Bush J.W. (1970), A Health-Status Index and Its Application to Health-Services Outcomes *Operations Research*, 18, 6, 1021-1066.

Fauveau V. (2006), Assessing probable causes of death without death registration or certificates: A new science, Public Health Classics, *Bulletin of the World Health Organization* 84, 3, 246-247.

Gallup, J.L, Sachs J.D. (2001) "The Economic Burden of Malaria," *American Journal of Tropical Medicine and Hygiene*, 64(1, 2) S, 85-96.

Garenne M, Gakusi E (2006), Health transitions in sub-Saharan Africa: overview of mortality trends in children under five years old (1950-2000), *Bulletin of the World Health Organization* 84, 470-478.

Gertler P., Gruber J. (2002), Insuring consumption against illness", *American Economic Review* 92, 1, 51-70.

Goerdt *et al* (1996), ''Non-fatal health outcome.'', In: *Global Comparative Assessments in the Health Sector, Disease Burden, Expenditures and Intervention Package*, Murray C.J.L. et Lopez, A.D. (eds), WHO, Geneva.

Gouws E., Bryce J., Pariyo G., Schellenberg J.A., Amaral J., Habicht JP., (2005), Measuring the quality of child health care at first-level facilities, *Social Science and Medicine* 61, 613–625

Hill K, AbouZahr C, Wardlaw T (2001), Estimates of maternal mortality for 1995, *Bulletin of the World Health Organization* 79, 182–193.

Huffman W.E, Orazem P.F (2007), Agriculture and human capital in economic growth: farmers, schooling and nutrition, In: R. Evenson, P. Pingali (Eds), Handbook of Agricultural Economics, vol3, Elsevier/North Holland, Chapter 43,

Hunter J.M, Rey L, Chu K.Y, Adekolu-John E.O, Mott K.E (1993), Parasitic diseases in water resources development, The need for intersectoral negotiation, WHO, Geneva, 152p.

Jourdain, A (1993), La qualité de vie peut-elle guider les choix de planification sanitaire ? Les QALYs ou l'essai non transformé de l'Angleterre, *Sciences Sociales et Santé*, 11, 1, 75-106.

Joyce R., Webb R., Peacock J.L., Stirland, H (2002), Adjusted mortality rates: a tool for creating more meaningful league tables for stillbirth and infant mortality rates, *Public Health* 116, 315–321.

Katz, S., Ford A.B, Moskowitz R.W, Jackson B.A, Jaffe M.W. (1963), Studies of illness in the aged. The index of ADL: A standardized measure of biological and physiological function, *JAMA* 185, 914.

Kerkhofs M, Lindeboom M. (1995), Subjective health measures and state dependent reporting errors. *Health Economics*, 4: 221-235.

Kruijshaar M.E., Barendregt J.J., Hoeymans N., (2002), The use of models in the estimation of disease epidemiology, *Bulletin of the World Health Organization*, 80, 8, 622-628.

Lachaud J-P (2007), HIV prevalence and poverty in Africa: Micro- and macro-econometric evidences applied to Burkina Faso, *Journal of Health Economics* 26 (2007) 483–504.

Law C.K., Yip P.S.F (2003), Healthy life expectancy in Hong Kong Special Administrative Region of China, *Bulletin of the World Health Organization* 81, 43-47.

Le Hesran J.C (2000), Particularités du paludisme chez l'enfant, *Revue de Médecine Tropicale* 60, 92-98.

Lopez AD, Mathers CD, Ezzati M, Murray CJL, Jamison DT (2006), Global burden of disease and risk factors, New York, Oxford University Press, 2006.

Malone D.C., Billups S.J., Valuck R.J, Carter B.L. (1999), Development of a Chronic Disease Indicator Score Using a Veterans Affairs Medical Center Medication Database, *Journal of Clinical Epidemiology* 52, 6, 551–557.

Martins J.O, de la Maisonneuve C (2006), Les déterminants des dépenses publiques de santé et de soins de longue durée : une méthode de projection intégrée, *Revue économique de l'OCDE* 43, 2, 133-178.

Mathers C.D., Ma Fat D., Inoue M, Rao C, Lopez A.D. (2005), Counting the dead and what they died from: an assessment of the global status of cause of death data, *Bulletin of the World Health Organization* 83, 171-177.

Meslé F, Vallin J (2007) De la transition épidémiologique à la transition sanitaire, Médecine Tropicale, 67, 545-551.

Mishra V., Vaessen M, Boerma J.T., Arnold F, Way A., Barrere B., Cross A., Hong R., Sangha J. (2006), HIV testing in national population-based surveys: experience from the Demographic Health Surveys, *Bulletin of the World Health Organization* 84, 537-545.

Murray C.J.L. (2007), Good practices for health statistics: lessons from the Millennium Development Goal health indicators, *Lancet* 369, 862-873.

Murray C.J.L, Frenk J (2008), Health metrics and evaluation: strengthening the science, *Lancet* 371, 1191-1199.

Mwabu G. (2009), The Production of Child Health in Kenya: A Structural Model of Birth Weight Journal of African Economies, 18, 2, 212-260.

Onis de M, Blössner M (2003), The World Health Organization global database on child growth and malnutrition: methodology and applications, *International Epidemiological Association* 2003, 32, 518-526.

Or Z (2000), Déterminants de la performance des pays industrialisés en matière de santé : une analyse temporelle transversale, *Revue économique de l'OCDE* 30, I, 58-82.

Perronnin M, Rochaix L, Tubeuf S (2006), Construction d'un indicateur continu d'état de santé agrégeant risque vital et incapacité, Questions d'économie de la santé, Bulletin d'informations en économie de la santé, IRDES, 107,

Portrait F, Lindeboom M., Deeg D (2001), Life expectancies in specific health states: results from a joint model of health status and mortality of older persons, *Demography* 38, 4, 525-536.

Pullum T.W (2008,) An Assessment of the quality of data on health and nutrition in the DHS surveys, 1993-2003, *DHS Methodological Report* n° 6, Macro International Inc, USAID.

Prual A., Bouvier-Colle M.-H., de Bernis L., Bréart G. (2000), Severe maternal morbidity from direct obstetric causes in west Africa: incidence and case fatality rates, *Bulletin of the World Health Organization*, 78, 5,

Reijneveld S.A, Spijkerc J., Dijkshoorn H. (2007), Katz' ADL index assessed functional performance of Turkish, Moroccan, and Dutch elderly, *Journal of Clinical Epidemiology* 60, 382-388.

Rice A.L., Hyder L.S., Black, R.E., (2000), Malnutrition as an underlying cause of childhood deaths associated with infectious diseases in developing countries, *Bulletin of the World Health Organization*, 78: 1207–1221.

Rothman M.L., Hedrick S.C., Bulcroft K.A., Hickam D.H., Rubenstein L.Z., (1991), The Validity of Proxy-Generated Scores as Measures of Patient Health Status, *Medical Care*, 29, 2, 115-124.

Roos N.P., Roos L.L., Mossey J., Havens B., (1988), Using Administrative Data to Predict Important Health Outcomes: Entry to Hospital, Nursing Home, and Death, *Medical Care*, 26, 3, 221-239

Rutstein S.O. (2000), Factors associated with trends in infant and child mortality in developing countries during the 1990s, *Bulletin of the World Health Organization*, 78: 1256–1270.

Sachs J (2003), Institutions matter, but not for everything: the role of geography and resource endowments in development shouldn't be underestimated, *Finance and Development* 38-41.

Shadbolt B., McCallum J., Singh M. (1997), Health outcomes by self-report: Validity of the SF-36 among Australian hospital patients, *Quality of Life Research* 6, 4, 343-352.

Sarrafzadegan N., Kelishadi [a], Esmaillzadeh A., Mohammadifard N., Rabiei K., RoohafzaH, Azadbakht L., Bahonar A., Sadri G., Amani A., Heidari S. Malekafzali H. (2009), Do lifestyle interventions work in developing countries? Findings from the Isfahan Healthy Heart Program in the Islamic Republic of Iran, *Bulletin of the World Health Organization* 87, 39-50.

Schirnding V.Y. (2002), International environmental law and global public health, *Bulletin of the WHO*, 80, 12.

Smith J.B, Fortney J.A, Wong E., Amatya R., Coleman N.A., de Graft Johnson J. (2001), Estimates of the maternal mortality ratio in two districts of the Brong-Ahafo region, Ghana, *Bulletin of the World Health Organization* 79, 400-408.

Starfield B (1992), Child and Adolescent Health Status Measures, *The Future of Children* 2, 2, U.S. Health Care for Children, 25-39

StantonC, Abderrahim N, Hill K (2000), An Assessment of DHS Maternal Mortality Indicators *Studies in Family Planning*, 31, 2, 111-123.

Stanton C., Hobcraft J., Hill K., Kodjogbe N., Mapeta W.T., Munene F., Naghavi M., Rabeza V., Sisouphanthong B., Campbell O. (2001), Every death counts: measurement of maternal mortality via a census, *Bulletin of the World Health Organization* 79, 657–664.

Strauss J, Gertler P, Rahman O, Fox C (1993), Gender and life-cycle differentials in the patterns and determinants of adult health, *Journal of Human Resources* 28, 4, 791-837.

Strauss J., Thomas D. (1998), Health, nutrition and economic development, *Journal of Economic Literature*, vol XXXVI, 766-817.

Tole T.J, Morley C. J., Thornton A. J., Fowler M. A., Hewson P. H. (1991), A Scoring System to Quantify Illness in Babies under 6 Months of Age, *Journal of the Royal Statistical Society*, Series A (Statistics in Society), 154, 2, 287-304

VanderZee K.I, Sanderman R., Heyink J. (1996), A Comparison of Two Multidimensional Measures of Health Status: The Nottingham Health Profile and the RAND 36-Item Health Survey 1.0, *Quality of Life Research*, 5, 1, 165-174.

van Doorslaer E., Jones A. (2003), Inequalities in self-reported health: validation of a new approach to measurement, In: Workshop on Health Economics and Public Policy, *Journal of Health Economics*. 22, 1, 61-78.

WHO (2000, 2001, 2002, 2003, 2004, 2006), World health report, Statistic annex.

WHO (2001), Macroeconomics and health: Investing in health for economic development, Report of the Commission of Macroeconomic and Health, 190p.

WHO (2004), The Global Burden of Disease: 2004 update.

WHO (2007), Maternal mortality in 2005: estimates developed by WHO, UNICEF, UNFPA The World Bank, 40p.

WHO (2008), Closing the gap in a generation, Health equity through action on the social determinants of health, Commission on Social Determinants of Health.

Williams, A. (1996), Qalys and ethics: a health economist's perspective, *Social Science and Medicine* 43, 12, 1795-1804.

Williams A, Cookson R (2000), *Equity in health*, in A.J. Culyer and J.P. Newhouse (Eds), Handbooks of Health Economics, 1B, North Holland, Elsevier, Chapter 35, 1863-1910.

World Bank (1993), Investing in health, Annual report.