

# **Registration of Births, Deaths, and Causes of Death to Inform Public Health Policies**

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## **Abstract**

The paper briefly reviews the history of vital registration in Europe and in some other countries before the 20<sup>th</sup> century. It analyses in particular the use of death registration for monitoring epidemics and to inform public health practitioners. Vital statistics have also been the key to documenting and understanding the demographic transition during the 20<sup>th</sup> century, both for fertility and for mortality trends. Further information on causes of death has been fundamental to analyze mortality decline in developed countries.

In developing countries, the completeness of vital registration systems (VRS) remains low in many instances. Despite low coverage of death registration, VRS data can still be used to document demographic trends. This paper describes a few case studies showing the use of VRS to document a major mortality decline (such as Sri Lanka) and major mortality crises (HIV/AIDS in Abidjan, famine in Antananarivo). Information on births can also be used to document the effect of family planning programs.

In addition to classic vital registration, other systems have been developed to improve the quality of estimates when VRS were deficient, such as sample registration systems (SRSs), as in India, and demographic surveillance systems (DSSs), as in many population observatories in Africa and South Asia. When causes of death data are not available, verbal autopsies can also produce useful information, both at local (population observatories) and national levels (as in Morocco).

This paper advocates for improving current health information systems in developing countries, particularly to improve the completeness of birth and death registration, and to develop appropriate alternative methodologies in case of deficient data, especially for causes of death. Analyzing currently available data and publishing the results might be an additional incentive for improving current reporting systems, and could be very valuable for research.

## **Introduction**

A civil registration system (CRS) is an administrative system that systematically records changes in civil status in the population, primarily births, deaths, and marriages. Modern registration system typically record nine types of vital events: birth, death, marriage, divorce, annulment, separation, adoption, legitimation, and recognition.<sup>1</sup> A CRS is central to modern legal systems, because it is the basis for defining legal existence of individuals and unions, ancestry, age, nationality, and, therefore, many individual rights. Closely linked to regular CRS is the registration of causes of death by the medical system. Registration of causes of death is an important part of modern health systems because it is the basis for understanding where the most important challenges lie (leading causes of deaths), and where progress has been achieved (declining mortality).

Vital registration statistics (VRS) and cause of death statistics (CDS), together with other demographic, social and economic statistics are now part of basic statistics in developed countries. VRS and CDS are central to health information systems (HISs) and the basis for analyzing changes in population and health parameters. Birth and death statistics are necessary for estimating population flows and making population projections. Together with the census, which provides a count of the population, they are the sources of data necessary for computing life tables and fertility tables—the statistical tools that produce critical demographic indicators such as life expectancy, total fertility rates, and net reproduction rates. Although demographic surveys have been used to supply estimates of demographic indicators in case VRS were not available, no other method can replace a precise measure of age-specific birth and death

rates, and no other method can provide a precise measure of yearly, monthly, and daily fluctuations of birth and death rates, which are crucial to understanding the processes of birth and death. Similarly, a precise account of causes of death by age, sex, and time are invaluable to understanding health problems, and no other method can replace proper CDS. As early as 1824, Chadwick advocated the use of vital statistics to identify health problems and inequalities.<sup>2</sup>

Various international agencies have devoted numerous meetings and publications to recommend improving civil registration systems, vital registration statistics, and cause of death statistics. The first international meetings of public health statisticians were already concerned with controlling infectious diseases and with vital registration, starting with the 1851 First International Sanitary Conference in Paris and the 1853 First International Statistical Congress in Brussels. International cause of death classifications started in 1893 (Bertillon) and were revised 10 times in the 20<sup>th</sup> century, following the early attempts by British and French statisticians in the 19<sup>th</sup> century.<sup>3</sup> The 10<sup>th</sup> revision of the International Classification of Diseases and Causes of Deaths (ICD-10) was published in 1993, under the authority of the World Health Organization.<sup>4</sup> The United Nations Population Division (UNPD), the United Nations Statistics Division (UNSD), the United Nations Fund for Population Activities (UNFPA), and the International Statistical Institute (ISI) have devoted critical publications to various issues of vital registration statistics since the 1950s. More recently, the International Institute for Vital Registration and Statistics (IIVRS), founded in 1974, has monitored the progress and challenge of CRS and VRS throughout the world, and publishes information regularly in a series of technical papers.

Although much progress has been accomplished over the past 50 years, much remains to be done in developing countries. This point is crucial, since the most salient demographic and health problems lie in these countries. The aim of this paper is to describe the potential and limits of VRS and CDS in developing countries, with special focus on Africa, where the gaps are the widest. More than a criticism of the failures of VRS in developing countries, which has been done many times by various international agencies, we want to emphasize what can be done with what is currently available and affordable, and how the results can be used to inform health policies.

### **Brief history of civil registration**

When complex societies developed an administration to monitor, protect, and regulate economic flow, they felt the need to have an account of population size and flows. For instance, in China, the first attempts at a systematic household registration system (HRS) were conducted by the Western Zhou Dynasty (1100–771 B.C.). This system was rediscovered in the 14<sup>th</sup> century, improved in 1741 by the Qing dynasty, and known as the *Baojia* family registration system (FRS). The current Chinese system, modernized in 1958 and known as the NHRS (national household registration system), is just an extension of earlier versions. Other Far Eastern societies developed their system based on the Chinese model, such as the *Koseki* system in Japan, modernized in 1872, and the Korean system, modernized in 1910. On the other side of the world, the Inca empire also had a basic civil registration system, known as the *Quipus* system.<sup>5</sup>

In the Western world, some early attempts were conducted by the Roman Republic and the Roman Empire. For instance, as early as 443 B.C., births and deaths occurring during the previous five years of censuses were recorded among Roman citizens. In the first century B.C., Roman families officially recorded births, deaths, marriages, and divorces with two copies, in front of seven witnesses.<sup>6</sup> With the Roman Empire, birth registration became compulsory for citizens within 30 days after the naming ceremony (4 A.D.). Roman insurance companies also had some kind of death registration because they were able to compute life expectancies at various ages.<sup>7</sup> Birth and death registration was later forgotten for several centuries, despite local attempts by Oriental churches in the sixth century.

Systematic civil registration in Europe started in the Middle Ages. In France, in 1406, the Archbishop of Nantes required the parish priests to record births systematically. He was soon imitated by many of his peers, and, by the 16<sup>th</sup> century, births, deaths, and marriages were registered in many French provinces. In 1539, the French king wanted to reorganize the administration and made compulsory the registration

of births, deaths, and marriages by the priests in the French language, and no longer in Latin in the *édit de Villers-Cotterêts*.

These early laws were revised several times, in particular in 1667, 1736, and 1787. During the French revolution, the modern system of civil registration was installed independent of the church (1792, 1803). In Spain, civil registration was also started in the 15<sup>th</sup> century and extended to the newly conquered Peru, replacing the old Inca system.

In England, civil registration started in 1538. The Bills of Mortality were probably the first death registration statistics (1532), and were used to monitor the impact of plague epidemics in the 16<sup>th</sup> and 17<sup>th</sup> century. They were analyzed by John Graunt in 1662, who computed the first known life table. Civil registration and vital statistics became systematic in 1837 in England and Wales, and compulsory and complete after 1874.

Northern European countries started civil registration in the 17<sup>th</sup> century: Sweden (1608, compulsory after 1686), Finland (1628), Denmark (1639, compulsory after 1646), and Norway (1685). In the United States, a first attempt at gathering such statistics took place in 1639 in Massachusetts, but became systematic only in the 19<sup>th</sup> century (1841 in Massachusetts), compulsory in 1909, and complete for all states in 1930. In Canada, VRS started in 1919, and much earlier in Australia and in New Zealand.

In addition to registration of births, deaths, and marriages, attempts to record causes of death began also early in Europe, in the 17<sup>th</sup> century. Of course, causes of death were recorded as perceived by the family, with only local knowledge, quite removed from our modern systems. But they were useful to monitor major epidemics, such as the plague, smallpox, measles, and, later, cholera. As early as 1630 in London there were death searchers, usually women, who made inquiries to families about causes of death of recently deceased persons. They reported their findings every week.<sup>8</sup>

In non-Western countries, there were several attempts to gather vital statistics in the 19<sup>th</sup> century. For instance, in Egypt, the Sultan, who was concerned with cholera epidemics, started civil registration in 1839, which became compulsory after 1912. In Indonesia, a system was put in place in 1849 and modernized in 1933. Also with the aim of monitoring epidemics, India instituted civil registration in 1850, then modernized it in 1950 and 1969. In the Philippines, a system was put in place in 1889. Table 1 summarizes the earliest dates of publication of vital registration statistics in a number of countries, often 50 to 100 years after registration was organized. This table shows the lag between the date recording started and the date statistics became available to analysts.

**Table 1 Dates when vital registration statistics became available in Europe<sup>9</sup>**

Country	Date annual statistics available	Earliest date with estimation	Country	Date annual statistics available	Earliest date with estimation
<i>Europe</i>			<i>Outside Europe</i>		
Norway	1735		Japan	1875	
Sweden	1736		Mexico	1900	
Finland	1751		Argentina	1900	
France	1800	1740	Chile	1900	
Denmark	1800		Uruguay	1900	
Germany	1817		New Zealand	1900	
Austria	1820		Singapore	1900	
Belgium	1830		Sri Lanka	1900	
England & Wales	1838	1735	Australia	1901	
Netherlands	1840		Philippines	1903	
Scotland	1855		Taiwan	1906	
Spain	1858		Mauritius	1910	
Rumania	1859		Egypt	1912	
Greece	1860		Canada	1921	
Hungary	1861		USA	1930	1900
Russia	1861		Fiji	1930	
Italy	1862		India	1932	
Serbia	1862		Malaysia	1932	
Ireland	1864		Tunisia	1946	
Portugal	1866				
Switzerland	1870				
Bulgaria	1881				
Iceland	1900				
Cyprus	1901				
Bohemia, Czech R.	1919	1750			
Poland	1921				
Ireland	1922				
Albania	1938				

With a few exceptions, CRSs were instituted in Africa during the colonial period, but only a few African countries publish routine vital statistics today (table 2).

**Table 2 Date when vital registration systems were established in Francophone Africa<sup>10</sup>**

Country	Date of first VRS law	Last update
Benin	1939	1950
Burkina Faso	1939	1950
Cameroon	1917	1965
Cape Verde	1803	
Central African Rep.	1894	1969
Congo	1889	1958
Côte d'Ivoire	1950	1964
Gabon	1912	1963
Mauritius	1667	1830
Madagascar	1878	1961
Niger	1939	1950
Rwanda	1963	1969
Senegal	1916	1972
Chad	1939	1961
Togo	1909	1962
Zaire (Rep. Congo)	1939	1958

### **Use of vital statistics in demographic research**

Vital registration statistics have been the source of critical demographic research. For example, the theory of demographic transition was developed after analyzing birth and death statistics of the 19<sup>th</sup> and early 20<sup>th</sup> century.<sup>11 12</sup> By analyzing detailed data at the provincial level in most of Western Europe, Coale and his colleagues at Princeton were able to describe precisely the spread of the fertility transition in Europe.<sup>13</sup> If demographic surveys and censuses were used later as a primary source of data in developing countries to document the fertility transition, vital registration statistics were still used in many situations, particularly in Latin America and in some Asian countries, such as Taiwan.

Similarly, critical work on mortality transition by cause of death was conducted by analyzing cause of death data. For instance, the seminal work conducted by McKeown was based on causes of death registered and published in England and Wales since 1837.<sup>14</sup> It is remarkable to note that these early statistics were produced long before the germ theory of diseases was developed by Pasteur, Koch, and others in the 1880s. Still, they could be used to understand mortality decline for such critical diseases as smallpox, measles, whooping cough, tuberculosis, scarlet fever, diphtheria, pneumonia, diarrheal diseases, and so on. This fact has implications for today's research, because it shows that a simple typology based on clinical signs and symptoms can be sufficient to identify the most important diseases and to permit major conclusions about mortality decline by cause of death.

Similarly, Preston's fundamental work on mortality patterns and causes of death was also based on vital registration and causes of deaths in various countries of the world, primarily among European populations.<sup>15</sup> This study documented the role of main disease categories in mortality decline. A large number of studies have used vital registration data and causes of death to document and analyze mortality changes throughout the world.

### **Vital registration in developing countries: Problems and limits**

Vital registration in developed countries has been invaluable because birth and death registration have been virtually complete for more than a century, and causes of death have become standardized at least since World War II, and in some countries since the mid- or late 19<sup>th</sup> century. This is not the case, however, in many developing countries, although some have now reached the level of Western countries, despite the fact that virtually all countries have passed a law making birth, death, and marriage registration compulsory.

Several issues are at stake in developing countries:

- *Geographical coverage*: Although many large cities now have a reasonable CRS, many rural areas lag far behind, and sometimes lack even the basic infrastructure for registration.
- *Demographic completeness*: Even when civil registration is compulsory, and when the proper infrastructure exists, registration is often not complete, especially for the deaths of young children. Completeness is defined as the proportion of cases formally registered. Completeness is often high for birth registration, because in many instances a birth certificate is required for entering school. It is often much lower for deaths, however, especially for young children, and remains very low for marriages in traditional societies.
- *Timing and errors*: Even when events are registered, they are often deficient because of late declaration, and sometimes are falsified (age and date in particular).

### *Completeness of vital registration*

Several methods have been devised to estimate the completeness of birth and death registration. These are:

- *Comparison case by case*: One starts by sampling births or deaths in the population, asks the family whether the event has been notified and where, and goes on to verify the declaration in the corresponding office. This is often difficult to do, because dates stated by the family might be erroneous or unknown, and names may be spelled quite differently on the register. This has been tried, for example, in Dakar and Abidjan.<sup>16</sup>
- *Comparison of estimates with surveys*: If a survey provides birth and death rates with a good degree of confidence and a small sampling interval of confidence, one can compare these estimates to those of vital registration. This method is probably the most accurate for estimating completeness of birth and death registration. It has been tried in various instances, such as Saint Louis (Senegal), Brazzaville (Congo), Yaoundé (Cameroon), Libreville (Gabon), and Madagascar.<sup>17</sup>
- *Indirect methods*: These methods have been derived by demographers to estimate death registration among adults. They are based on models and depend on certain hypotheses, such as population stability (constant birth and death rates and no migration for a long time) and constant underregistration by age. They have been used with some success in Latin America and are described in the UN Manual X.<sup>18</sup>

Table 3 gives estimates of completeness of birth and death registration in the world, according to IIVRS. Among the 213 countries surveyed, only 92 (43 percent) had complete registration for births, and 90 (42 percent) for deaths. An additional 29 had a high registration rate ( $\geq 90$  percent) for births, and 23 had a high registration rate for deaths ( $\geq 90$  percent).

**Table 3 Completeness of birth and death registration in the world<sup>19</sup>**

Country	Completeness (percent)		Country	Completeness (percent)	
	Births	Deaths		Births	Deaths
C= Complete    U= Unknown					
AFRICA					
Algeria	C	U	Mali	U	U
Angola	U	U	Mauritania	U	U
Benin	U	U	Mauritius	100	100
Botswana	U	U	Morocco	82	20
Burkina Faso	U	U	Mozambique	U	U
Burundi	U	U	Namibia	...	...
Cameroon	85	30	Niger	U	U
Cape Verde	C	C	Nigeria	U	U
Central African Rep.	11	6	Réunion	C	C
Chad	U	U	Rwanda	51	51
Comoros	U	U	Saint Helena	C	C
Congo	74	41	Sao Tomé and Príncipe	C	C
Djibouti	U	U	Senegal	54	39
Egypt	100	100	Seychelles	100	100
Equatorial Guinea	53	58	Sierra Leone	U	U
Ethiopia	U	U	Somalia	0	0
Gabon	...	...	South Africa	64	60
Gambia, The	50	10	Sudan	25	5
Ghana	45	20	Swaziland	23	26
Guineau	U	U	Tanzania	U	U
Guinea-Bissau	U	U	Togo	80	15
Ivory Coast	...	...	Tunisia	C	U
Kenya	U	U	Uganda	35	25
Lesotho	45	20	Western Sahara	U	U
Liberia	35	12	Zaire	U	U
Libya	90	62	Zambia	15	10
Madagascar	U	U	Zimbabwe	U	20
Malawi	1	1			
NORTH AMERICA					
Anguilla	C	C	Haiti	...	...
Antigua and Barbuda	C	C	Honduras	U	U
Bahamas, The	72	97	Jamaica	90	90
Barbados	85	80	Martinique	C	C
Belize	U	U	Mexico	96	89
Bermuda	100	99	Montserrat	100	100
British Virgin Islands	C	C	Netherlands Antilles	C	C
Canada	100	100	Nicaragua	80	40
Cayman Islands	100	100	Panama	95	75
Costa Rica	97	95	Saint Kitts and Nevis	100	100
Cuba	100	100	Saint Lucia	100	100
Dominica	C	C	Saint Pierre and Miquelon	C	C
Dominican Rep.	35	5	Saint Vincent and the	99	97

			Grenadines		
El Salvador	C	C	Trinidad and Tobago	98	100
Greenland	C	C	Turks and Caicos Islands	C	C
Grenada	94	90	United States	99	99
Guadeloupe	C	C	Virgin Islands	C	C
Guatemala	95	90			
SOUTH AMERICA					
Argentina	98	100	Guyana	81	86
Bolivia	U	U	Paraguay	27	48
Brazil	75	75	Peru	88	80
Chile	100	100	Suriname	95	95
Colombia	90	98	Uruguay	95	100
Ecuador	15	22	Venezuela	100	100
French Guyana	...	...			
ASIA					
Afghanistan		...	Jordan	95	60
Armenia	100	100	Kampuchea (Cambodia)	...	...
Azerbaijan	99	28	Kazakhstan	C	C
Bahrain	87	U	Korea, North	...	...
Bangladesh	U	U	Kuwait	C	C
Bhutan	70	70	Kyrgyzstan	C	C
Brunei	C	C	Laos	...	...
China	90	90	Lebanon	U	U
Cyprus	85	85	Macau	100	100
Georgia	C	C	Malaysia	93	74
Hong Kong	100	100	Maldives	C	C
India	47	54	Mongolia	100	100
Indonesia	...	...	Myanmar (Burma)	90	90
Iran	U	U	Nepal	24	9
Iraq	U	U	Oman	...	...
Israel	100	100	Pakistan	35	35
Japan	100	100	Philippines	85	73
Qatar	95	95	Thailand	70	60
Saudi Arabia	...	...	Turkey	80	95
Singapore	100	100	Turkmenistan	C	C
South Korea	95	95	United Arab Emirates	...	...
Sri Lanka	99	94	Uzbekistan	C	C
Syria	88	54	Vietnam	...	...
Tajikistan	98	84	Yemen	...	...
EUROPE					
Albania	C	C	Italy	100	100
Andorra	...	...	Latvia	C	C
Austria	100	100	Liechtenstein`	C	U
Belarus	100	100	Lithuania	100	100
Belgium	100	100	Luxembourg	100	100
Bosnia-Herzegovina	C	C	Macedonia	C	C
Bulgaria	C	C	Malta	100	100
Channel Islands	C	C	Moldova	...	...



Croatia	C	C	Monaco	C	U
Czech Republic	100	100	Netherlands	100	100
Denmark	100	100	Norway	100	100
England and Wales	100	100	Poland	100	100
Estonia	C	C	Portugal	85	99
Faroe Islands	100	100	Romania	100	100
Finland	100	100	Russia	C	C
France	100	100	San Marino	C	C
Germany	100	100	Scotland	C	C
Gibraltar	100	100	Slovakia	100	100
Greece	99	99	Slovenia	100	100
Hungary	100	100	Spain	C	C
Iceland	100	100	Sweden	100	100
Ireland	100	100	Switzerland	100	100
Isle of Man	100	100	Yugoslavia	100	100
OCEANIA					
American Samoa	C	C	New Zealand	100	100
Australia	99	99	Niue	100	100
Cook Islands	94	98	Papua New Guinea	...	...
Fiji	95	97	Solomon Islands	75	75
French Polynesia	U	U	Tonga	95	90
Guam	98	98	Tuvalu	26	9
Kiribati	70	60	Vanuatu	40	30
Marshall Islands	C	C	Wallis and Futuna	...	...
Nauru	C	C	Western Samoa	30	36
New Caledonia	C	C			

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In other countries, civil registration was very deficient. In particular, among the 55 African countries, only seven had complete registration systems, none of which from continental sub-Saharan Africa (Egypt, Cape Verde, Mauritius, Réunion, São Tomé and Príncipe, Saint Helen, and the Seychelles). In addition two North-African countries, Tunisia and Algeria, had complete birth registration, despite incomplete death registration. A few African cities were analyzed earlier by various authors (table 4).

**Table 4 Coverage of vital registration data in selected African countries and cities<sup>20 21 22</sup>**

National	%	Urban	%	Rural	%
Cameroon		Yaounde, 1986–1987	32	Ngaoundere, 1965	16
Congo, 1969	29				
Côte d'Ivoire		Abidjan, 1975	50	Rural, 1970	21
		Abidjan, 1980	63		
		Abidjan, 1973–1983	66		
Gabon, 1970	19				
Ghana, 1974	22				
Kenya, 1970	34				
Kenya, 1979–1980	22				
Madagascar, 1970	51			Ambinanitelo, 1967	74
Madagascar, 1972	54	Antananarivo	99		
Mali, 1987	15				
Niger, 1985, 1989	40				
Rwanda, 1971	26				
Rwanda, 1973	65				
Sénégal, 1973	23	Saint Louis 1987–88	95	Niakhar, 1961–1965	5
Zaïre		Urban, 1970	26		

Results show that VRS were often deficient in these African cities, although some had virtually complete coverage, such as Saint Louis in Senegal and Antananarivo in Madagascar.

#### **Using vital registration statistics in developing countries: Three case studies**

Perhaps more important than formal estimates of coverage, completeness, and accuracy is the fact that VRS can be used to inform health professionals in developing countries. Three case studies were selected to illustrate this point, one from Asia and two from Africa, the continents where VRS deficiency is the most striking. As for England and Wales of the mid-19<sup>th</sup> century, when death registration was neither complete nor accurate for causes of death, but still useful to understand the health transition, the cases presented below show, through examples, what can be drawn from VRS in lesser developed countries (LDCs).

#### *Sri Lanka and the impact of malaria control*

Sri Lanka (formerly Ceylon) has had a good system of vital registration since the beginning of the 20<sup>th</sup> century, although not complete before 1950. This country is one of the most famous success stories of the malaria eradication effort undertaken just after the end of World War II. Sri Lanka had a complex profile for malaria before 1945, with some highly endemic areas and some areas with lower prevalence. Malaria was eradicated within about a year following a comprehensive program of home spraying of insecticide drugs. Several models were developed to estimate the demographic impact of malaria eradication. Some took a linear approach to additive causes of death, others a multiplicative approach, such as for risk factors.<sup>2324</sup> In both cases, they used vital registration data by causes of death and detailed geographical locations to estimate the net impact of malaria eradication. Without entering into academic

debates about the optimal approach, it was clear from all studies that malaria eradication had a major impact on mortality, and accounted for about 30 to 40 percent of the observed sharp mortality decline in the years following eradication. Without vital registration and causes of death data, none of these studies would have been possible.

#### *Abidjan and the impact of HIV/AIDS*

Another good example of use of vital registration data, despite some deficiencies, is that of Abidjan. The capital city of Côte d'Ivoire has maintained a relatively good system of vital registration since the turn of the 20<sup>th</sup> century. Although quite deficient for children, completeness remained relatively high for adults of both sexes. Statistics were not published, so a team from the Ivoirian Statistical Office (INS) undertook to code the deaths for 20 years, from 1973 to 1992—that is, 10 years before and 10 years after the onset of the HIV/AIDS epidemics in that country.<sup>25</sup>

Using various methods, the study estimated completeness to be about 97 percent for male adults and about 81 percent for female adults in 1975. This was high enough coverage to make an estimate of the demographic impact of HIV/AIDS. By comparing death rates after 1986 to previous trends, the authors estimated that HIV/AIDS was responsible for at least 25,000 deaths in the city by 1992, a much higher figure than estimated earlier. The demographic estimates were supplemented with cause of death data recorded in Abidjan hospitals, which confirmed that most of the mortality increase was due to HIV/AIDS and opportunistic infections. The pattern of mortality increase in the city identified from the VRS further allowed researchers to reconstruct the dynamics of the HIV epidemic and document the sex differentials of AIDS mortality. Despite deficient data, these estimates of AIDS mortality were far more accurate and useful than those made earlier from confirmed cases in hospitals and from non-representative seroprevalence surveys. This indicates once more that VRSs can be useful, even when they are incomplete.

#### *Antananarivo and the impact of urban famines*

A study in Antananarivo, the capital city of Madagascar, is another case of using vital registration data for health information purposes. The death registration data revealed a mortality crisis that had been totally overlooked before. Madagascar has a long history of civil registration, beginning in 1878, when Malagasy queen Ranaivalona II decided to make registration of births and deaths compulsory. The main purpose of this law was to monitor plague epidemics, as in London in the 16<sup>th</sup> century. In 1996, a team from the Ministry of Health in Madagascar undertook the coding of registered deaths for the period 1976–1995.<sup>26</sup> This period was crucial for the country, since it was the end of the Malagasy communist period and the beginning of the new more liberal period after structural adjustment programs were implemented. The analysis revealed a severe mortality crisis during the years of the transition (1984–1986), after several years of steady mortality increase (1976–1983). The crisis, which could be analyzed with the help of causes of death recorded in the hospitals, was due primarily to a famine during the 24 months of the transition.<sup>27</sup> As in South Asia, the famine was due primarily to poor state management and speculation by the main economic actors controlling the rice market. This famine had never been documented before or discussed in the newspapers. It was revealed only by the detailed analysis of death rates and causes of deaths that were found in various registers of the VRS and hospitals.

#### **Sample Registration System (SRS)**

When vital registration statistics were inadequate and could not be used, other systems have been developed. The most famous is probably the Indian Sample Registration System, where births and deaths are recorded routinely from a representative sample of the population. This system is supposed to be relatively cheap and more accurate than formal VRS. It has been working in India since 1964. The system is sophisticated, with routine recording of events over time and an independent check every six months. This independent check is in fact a dual record system, and is assumed to be very accurate.

#### **Local Registration: Demographic Surveillance Systems (DSS)**

When national systems are not available, people have devised local schemes, usually with the explicit aim of conducting in-depth research. These schemes are called demographic surveillance systems (DSSs). They have been working for some 50 years in many areas throughout the world, primarily in

South Asia and in Africa. Das Gupta *et al.* have summarized the experience with population observatories before 1990,<sup>28</sup> and a network (called In-Depth network) is currently federating the some 40 sites currently functioning in the world. These are small populations, accounting for roughly 20,000 to 200,000 people, that are followed carefully over time. Births and deaths are recorded routinely, together with in and out migrations, through regular visits to households. Visits can be as often as every week or as rare as every year, and typically are every three or four months. These sites allow demographic and health research and are well suited for evaluating interventions. Most are focused on health topics, and many have been the sites for vaccine trials, disease control, and nutritional or therapeutic interventions. With a few exceptions, these sites are rural and have relied on verbal autopsies to assess causes of death.

### **Verbal autopsies at national level: Example of Morocco**

Verbal autopsies using standardized questionnaires have been developed in population observatories to compensate for the lack of cause of death statistics in rural areas of developing countries, where most deaths occur outside health facilities.<sup>29 30 31</sup> When conducted properly, such verbal autopsies can provide reliable estimates of causes of death for a limited number of conditions: major infectious and parasitic diseases, accident and violence, and some non-communicable diseases. Validation studies have shown that sensitivity and specificity can be reasonable for these conditions, compared to hospital diagnoses.

Verbal autopsies can also be used at the national level when cause of death registration is poor. This has been done in Morocco in two studies conducted in 1987 and 1997, at ten-year intervals, on a representative sample of deaths of under-five children.<sup>32 33</sup> Results not only provided estimates of cause specific mortality, but also allowed evaluation of the demographic impact of a series of health interventions conducted during the 1987–1996 period. Results showed the major impact of vaccinations (measles, whooping cough, tetanus) and oral rehydration therapies, whereas mortality from pneumonia and neonatal mortality from birth trauma and prematurity did not change over the period, suggesting a failure of current strategies against these conditions.

### **Conclusions**

Civil registration, vital registration, and cause of death statistics remain a necessity for all countries that desire efficient population and health policies and want to be able to monitor the outcomes of these policies. CRSs and VRS are critical both for administrative and for statistical purposes. Both require merely more than political will and organization, and all of the countries that have made the necessary efforts seem to have succeeded. Installation and proper functioning of a CRS and a VRS take about a generation, if proper steps are taken, so there is no excuse for any country in the world not to have an efficient system by now, since most passed a law more than 25 years ago making CRS compulsory. Even if international agencies help, nothing can replace the state's political will to make CRS and VRS work.

Cause of death registration, coding, and statistics are more difficult to achieve. First, they require that almost all people die in health facilities, or that deaths are certified by a physician. Many developing countries simply do not have the necessary infrastructure and personnel to accomplish this. A proper CDS also requires standardization in coding causes of death and an efficient statistical system to publish the information. Many countries fall far short of this ideal state.

When data are deficient, alternative ways of producing vital statistics and cause of death statistics can be devised. In particular, verbal autopsies could provide valuable information for a number of important diseases, even at a national level.

Perhaps the most important message at this point is to show how VRS and CDS can be used in order to convince policymakers and health professionals to produce them. Even imperfect data, such as in England and Wales in the 19<sup>th</sup> century, or in Africa in the late 20<sup>th</sup> century, can be very informative for health planning purposes and research. Therefore, more efforts should be devoted to analyzing the currently available data.

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