SPECIAL INVESTIGATIONS ON MORTALITY

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Mortality statistics constitute a fundamental tool in public health and in epidemiology they represent one of the most important sources of information for many kinds of research. According to Mac Mahon,[1] "the introduction of death registration was the foundation of modern epidemiology; it changed the subject from a narrative discipline into a quantitative science".

Historically speaking the vital registrations turned up way before the statistical services and always had, basically, a social meaning, fulfilling therefore a very important function in the community. In law its aim is to reveal certain juridical situations. Thus, its main function is of a juridical nature and consists in registering facts and acts of the civil state allowing the organization and working of the law system ruling the relationship of individuals amongst themselves - the family organization - and its liaisons with the State.[2]

Besides this objective, the statistical function of the vital registrations is to provide data to several sectors such as education, health, economy, industry, commerce, etc.

In the health sector the vital statistics, especially the mortality statistics, are widely used and are of great importance to epidemiological studies.

The primary source of mortality data is the death certificate that is filled out by the physician and thereafter registered, thus starting up the "mortality statistics system". Nevertheless, a great number of physicians ignore the statistical reasons and the uses that the health sector will make of the information they put down in the certificates.

At least in our country, and perhaps in many others also undergoing development, to most of the physicians the death certificate is nothing but a necessary legal document which enables burial and almost always is also necessary for family affairs regarding inheritance matters, social security, etc. The doctors actually forget, or do not even know, the very important statistical function of the death certificate. Here among us, this aspect has not been usually taught in medical schools. This leads to a lack of accuracy, mainly as regards the most important data for epidemiology studies the underlying cause of death.

In the Department of Epidemiology of the Sao Paulo University School of Public Health, some research is under way regarding patterns of mortality for the city of Sao Paulo which we have called "Special Investigations on Mortality". Existing errors due to incorrect filling out of death certificates are dealt with by means of additional information which is obtained by a method which will be commented on later.

In the city of Sao Paulo the death record is virtually complete and 100% of the certificates are filled out by physicians. In cases of violent deaths (or not natural causes) the death certificate is filled out, after autopsy, by the "medico-legista" (coroner); in cases of death due to natural causes and where there was no medical attendance, the death certificate if filled out by a pathologist doctor, after autopsy, on duty at what we call the "Service for the Verification of Death". Almost 20% of all deaths undergo autopsy, including here those where autopsy is asked for in order to clear up diagnosis (mainly in medical school hospitals), those performed by "medico-legista" and those performed at the above mentioned "Service for the Verification of Death".

In this paper some results regarding results obtained through special investigations on mortality for the city of Sao Paulo shall be put forward.

The first research in which we took part, that started up a whole line of investigation at the Department of Epidemiology of the Sao Paulo University School of Public Health, was the "Inter-American Investigation of Mortality",[3] sponsored by Pan American Health Organization (PAHO). It was an international investigation which lasted two years (1962/1963) and that deeply analysed, according to a standardized methodology, the deaths of adults, 15 to 74 year-old age, in 12 cities, 10 being from South America, one from the United States and one from England. In Sao Paulo a sample of 4,361 deaths (one out of six) was investigated and for each case an interview at the home of the deceased was undertaken where besides other information, the place or places where the deceased had received medical attention was obtained. Afterwards, information was collected from doctors, hospital records, necropsy records and from whatever documents related to the case. Thus, it was possible to know the true underlying cause of the death and characterize the patterns of mortality in accordance to several aspects. The results were published by Puffer & Griffith[3]. In 1532 death certificates (35.4% of the total 4361 cases) it was found that the underlying cause declared by the physician was not the correct one. It is interesting, nevertheless, to notice that there are not huge differences as regards greater groups of causes when considering the original death certificates and the results of the investigation. Thus, for example, there were 818 original cases of malignant neoplasms and at the end there were 822. It isn't that the investigation showed up four cases more than the original ones, but that in 196 out of the 818 cases the underlying cause was not malignant neoplasm, thus remaining 622. In addition to these, 200 others, where the investigation discovered malignant neoplasm to be the underlying cause of death and the death certificate did not mention the fact, were summed up. One can say that there was a numerical compensation in this case, but there certainly was no compensation as far as sex and age groups were concerned.

In Appendix I the original classifications and final assignments to some causes of death at ages

15-74 years in Sao Paulo are exposed.

We also took part in the "Inter-American Investigation of Mortality in Childhood",[4] also sponsored by PAHO, where a similar methodology was employed. Here deaths of under-fives were investigated in 14 selected areas totalling 25 projects. Areas from Latin America, one from the United States and another from Canada were included. In Sao Paulo a sample of 4,312 deaths (1 out of 4.25) which occurred between July 1, 1968 and May 31, 1970 were studied. Interviews at the homes of the deceased were also carried out as well as with physicians and at the hospitals which cared for each child, not only during the disease causing death but also before, throughout other consultations and medical episodes. The domiciliary interview collected a greater quantity of information than the anterior investigation performed for adults. We were able to obtain, therefore, information on family composition, type of housing (number of rooms, water and drainage facilities, toilet), occupation of parents, pregnancy history of the mother, data on parents (age, marital status, education), prenatal care, pregnancy complications, type of pregnancy, birth weight, breast-feeding, weaning food used, medical attention received by the child, clinical history, laboratory tests results, autopsy reports, and other information.

In this investigation not only was the underlying cause of death codified, but the associated causes as well.

As regards the underlying cause of death, some important aspects can be pointed out in the results obtained. For example, in the sample studied in Sao Paulo, the original death certificates informed in 91 cases that the underlying cause of death was measles, whilst the investigation showed that there actually were 156 cases, therefore 1.71 times as much. As regards whooping cough, this relation was 1.84. In reference to perinatal causes the number went up from 1,072 cases to 1,119 the relation being, therefore, 1.04. As to this aspect the difference was very small between the original certificates and the final results of the investigation. But, when the specific causes of death among the perinatal ones were analysed, the differences became more intense, as for example in those cases put down as "Difficult Labor" which rose from 14 cases to 168, twelvefold more. In Appendix 2 the infant deaths from certain perinatal causes as underlying causes based on death certificates and on final assignments, with corresponding ratios, are presented.

Another aspect that was able to have been analysed refers to the multiple causes of death. The classification of causes was based on information obtained in the interviews. The underlying cause was classified according to the definition * and the rules for selection and modification set forth in the International Classification of Diseases (8th Revision). Once the underlying cause was selected and the intermediary and terminal diseases or morbid conditions were established, the contributory causes** were determined.

In this "investigation" the multiple causes of death were classified into 2 main groups: underlying and associated. The latter took in both contributory and consequential causes, that is, those morbid conditions that commonly are included in the train of events enhanced by the underlying cause involving both intermediate and terminal ones. As Puffer & Serrano[4] put it,

> ...from the study of interrelations of causes in the Investigation it appears in reality that the intermediate and terminal causes (complications or consequences) are not the result of the underlying cause alone. Instead, it is the complex of underlying-contributory cause which together give origin to the fatal complications. The implications of this concept are exceedingly important from the preventive view point because measures aimed at preventing the underlying cause are not sufficient if the contributory conditions remain. One example is the common association of nutritional deficiency and infection, which necessitates prevention of both components of the complex, without which the phenomenon of "substitution" may come into play - that is, a death prevented by suppressing one underlying cause (usually an infection) may later occur as the result of another underlying cause (another infection) if the contributory condition (nutritional deficiency) remains".

The "Investigation" showed that nutritional deficiency, as associated cause, exerts an important role in the death of the children from Sao Paulo, mainly when the underlying cause of death is an infectious disease. Thus, the prevention of deaths among children should not be directed solely towards the prevention of infectious diseases, but should take in the infection-malnutrition relationship. In 2,354 deaths due to all causes of under-fives, with the exception of the neonatal deaths, nutritional deficiency showed up as underlying or or associated cause of death in 47.1% of the cases. When the underlying cause was due to infectious disease this value was 59.6%. One must point out, nevertheless, that malnutrition did not come to this amount when the original death certificates were analysed, but to much lower values. In Appendix 3 the results of the "Investigation" are shown as regards nutritional deficiency as an associated cause of death, by some groups of underlying causes, in Sao Paulo and in the Latin-American projects on the whole.

The analysis of mortality due to multiple cause was performed in Sao Paulo the first time in the

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* Underlying cause is "the disease or injury which initiated the train of morbid events leading directly to death".

** Contributory cause is "any other significant condition which unfavorably influenced the course of the morbid process and this contributed to the fatal outcome, but which was not related to the disease or condition directly causing death".

"Inter-American Investigation of Mortality in Childhood"[4]. The good deal of information this investigation lead up induced us to go into another investigation, studying a sample of deaths of all ages, only those that occurred in hospitals of Sao Paulo (70% of all deaths) from March 1, 1972 to February 28, 1973.[5] Differently from the preceding two investigations, in this one additional data were gathered only from the hospital where the deceased received final medical attention. No domiciliary interviews were performed, neither was any sort of information looked up at other hospitals or medical services at which the deceased might have been seen. One of the main objectives was to see whether only data collected at the hospital during the final episode were good enough to furnish information as good as that gathered through relatives and parents and other medical services where the deceased had been before this final hospitalization. In this type of investigation one verified that as many additional diagnoses are obtained as in the other one. In fact, in the sample of 1,832 deaths, 852 were under-fives and for these there were 2,575 diagnoses, that is, an average of 3.0 diagnoses per case. In the investigation performed before this one and which included interviewing at the home of the deceased and at the other hospitals and mdeical services, for a sample of 4,312 cases, we obtained 12,988 diagnoses, an average therefore of 3.0, as well, per case.

For adults this comparison was not possible, as in the anterior investigation there was no research regarding multiple causes of death in adults. For adults in Appendix 4 the data regarding Ischaemic heart disease and its associations with other causes in the original death certificates and after the investigation are shown.

A special investigation on mortality in which the obtention of additional data is only in hospitals where death occurred proved to be, at least for under-fives, as regards causes of death, as good as any other investigation, with the advantage of being very much cheaper. The disadvantages include the impossibility of studying other factors such as family composition, feeding habits, type of medical attention received, time of residence at the place of death.

Special Investigation in Sudden and Unexpected Death in Adults

Sudden death in adults is becoming more important and several epidemiological studies have been undertaken in order to find out which are the risk factors and certain characteristics as regards occurrence, so as to ensure some preventive measures.

In Sao Paulo, knowledge as to frequency of sudden death in the general population by means of data registered in death certificates is almost impossible to obtain, because even when doctors do write down the proper cause of death and the sequency of causes up to the direct cause, very rarely do they put down the time elapsed between the beginning of the morbid process and death itself. Besides, hardly ever does one see the information "sudden death". Even when sudden death does occur in a person who was not receiving any medical attention whatsoever, for example on the street or in any other public place, and autopsy is performed, the death certificate indicates the findings but does not mention sudden death.

The knowledge and the study of sudden death in the population of Sao Paulo would only be possible by means of a special investigation, conducted as those that have already been done, in which the family would be interviewed in relation to the suddeness of the death.

During a period of twelve months (October 1, 1974 to Sept. 30, 1975), we undertook an investigation of mortality in adults, 15 to 74 years old, going along the same lines as in the "Inter-American Investigation of Mortality in Adults" (1962-1963)[3], save that data on variables that were not included before were now analysed according to multiple causes of death. A sample of one out of nine deaths in the above-mentioned age group of those residents in Sao Paulo was selected. Among the several analyses which are being performed the epidemiologic study of sudden death stands out.

The definition of sudden and unexpected death for this investigation was the same as that of Kuller et al.[6]: "An individual who died due to natural causes and who was not restricted to his home, a hospital or institution, or unable to function in the community for more than 24 hours prior to death, and in which the time interval from the onset of the fatal event until death was less than 24 hours".

Only some of the provisional results are being presented here as a more detailed analysis is underway. Such results are being shown as it is the first time that this sort of work has been undertaken amongst us.

The sample was of 2,738 deaths, of which 370 were due to non-natural causes (accidents, homicides, etc.) leaving 2,368 to natural causes. Of the latter 138 or 5.82% were due to sudden and unexpected deaths.

As regards the causes of sudden death, the following was observed:

	n.	%
Arteriosclerotic heart disease	55	39.85
Cerebrovascular disease	22	15.94
Dissecting aneurism of the Aorta	9	6.52
Hypertensive heart disease	9	6.52
Meningococcal meningitis	6	4.35
Other cardiovascular diseases	4	2.89
Other causes	5	3.62
Unknown causes	28	20.30
	138	100.00

The main cause of sudden death, as in studies performed in other countries, was the Arteriosclerotic Heart Disease, that in Sao Paulo was held responsible for 39.85% of the cases. In 20.30% of the cases we were not able to conclude towards a diagnosis, remaining this group as that of unknown causes; one should take note that in the 28 cases where it was not possible to conclude as to the cause of death in 15 (53.57%) the doctor had declared that death had occurred due to "Miocardial Infarction" but in fact with all the possible disposable information we were not able to come to this conclusion. The other causes of death are not very different from those which are observed in studies undergone in other countries. Nevertheless, Meningococcal Meningitis stands out as the 5th cause and that hasn't been observed in other studies. During this investigation in Sao Paulo an epidemic was underway.

As regards sex, a 2.18 ratio was observed as to male/female cases. As regards age, it was observed that the greatest percentage of sudden deaths occurred in the 35 - 44 year age group, in which 17.98% of all deaths were of the sudden type, a percentage that is by far superior to that of any other age group, as shown below:

Age	Deaths (natural causes)	Sudden Deaths n.	%
15-24	102	7	6.86
25-34	184	11	5.97
35-44	278	20	17.98
45-54	455	22	4.83
55-64	621	37	5.95
65-74	728	41	5.63
Total	2368	138	5.82

As to Arteriosclerotic Heart Disease (AHD), it was shown that 12.0% of deaths due to this cause were sudden ones. Some of the characteristics of the sudden deaths due to this cause were that the male/female ratio was 3.58 and as regard age, the greatest percentage of sudden deaths occurred in the 25-34 and 35-44 age groups, as follows:

Age	AHD-Deaths	AHD - Sudden Deaths n.	%
15-24	-	-	-
25-34	5	2	40.00
35-44	28	11	39.28
45-54	67	7	10.44
55-64	147	12	8.16
65-74	211	23	10.90
Total	458	55	12.00

As to duration of symptoms, that is the time elapsing between the first symptoms and death, the following was observed:

Duration	n.	%
Up to 15 minutes	20	36.36
15 min. to 2 hours	21	38.18
from 2 to 24 hours	14	25.46
	55	100.00

As to the habit of smoking, 50.90% of those who underwent AHD - sudden deaths were smokers. Arterial hypertension was present in 45.45% of the cases and diabetes in 21.81% of sudden deaths due to Arteriosclerotic Heart Diseases.

In 34.54% of the cases diagnosis was established by autopsy. In those cases where autopsy was not performed, the final clinical picture was suggestive of miocardial ischaemia there having been confirmation by electrocardiogram in the vast majority of cases where the interval between the initial symptoms and death was more than one hour.

In Appendix 5 data regarding death rates by all causes, natural causes, Arteriosclerotic Heart Diseases and sudden death rates are shown.

Other characteristics regarding sudden death, either by Arteriosclerotic Heart Disease or by other causes, such as temporal distribution, place of occurrence, type of occupation, marital status, preceding medical assistance and at the time of death, are being at present analysed and shall be presented in the near future.

As a general conclusion one can say that special investigations in mortality are extremely useful, allowing the correction of data, especially the causes of death. On the other hand, notwithstanding this aspect, they allow epidemiologic analyses regarding variables that are not usually part of the information registered in the death certificates.

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Appendix 1

Original Classification and Final Assignments to Some Causes of Death with Changes in S.Paulo, 1962/1963.(Inter-American Investigation of Mortality - Adults, 15 - 74 years)

Causes of Death	Original	Exclusions	Additions	FINAL
TOTAL	4361	1532	1532	4361
Infective and parasitic diseases	246	33	74	287
Malignant neoplasms	818	196	200	822
Cardiovascular diseases	1872	704	620	1788
Chronic rheumatic heart disease	89	19	36	106
Arteriosclerotic heart disease	499	80	122	541
Hypertensive heart disease	155	77	170	248
Diseases of the respiratory system	258	128	122	252
Influenza and pneumonia	126	57	23	92
Diseases of the digestive system	274	114	125	285
Ulcer of stomach and duodenum	29	2	19	46
Cirrhosis of liver (without alcoholism)	79	62	8	25
Cirrhosis of liver(with alcoolism)	28	6	63	85
Maternal Causes	24	3	15	36
Accidents and Violence	350	107	135	378
Remainder	519	246	238	510

Appendix 2

Infant Deaths from Certain Perinatal Causes as Underlying Causes Based On Death Certificates and on Final Assignments, with Ratios. São Paulo, 1968/1970(Inter - American Investigation of Mortality in Childhood)

Perinatal Causes		Original Certificate	Final	Ratio
TOTAL (760-778)*		1072	1119	1.04
Maternal conditions (760-763)		10	105	10.50
Difficult labor (764-768)		10	168	12.00
Other complications pregnancy, chilbirth(769)		33	247	7.48
Conditions of placenta,cord (770,771)		15	99	6.40
Birth injury, cause unspecified	(772)	58	52	0.90
Hemolytic diseases of newborn	(774,775)	20	26	1.30
Anoxic,hipoxic conditions	(776)	487	352	0.72
Immaturity	(777)	357	41	0.11
Other conditions of newborn	(778)	78	32	0.41

* ICD - 8th Revision

Appendix 3

Nutritional Deficiency as Associated Cause of Death in Children Under 5 years of Age (Excluding Neonatal Death) by Underlying Cause Group in S.Paulo Project and in 13 Latin American Projects Combined.1968/1970 (Inter - Americam Investigation of Mortality in Childhood)

Cause Group	S.Paulo			13 L.A.Project Combined		
	TOTAL DEATHS	With nutritional deficiency		TOTAL DEATHS	With nutritional deficiency	
		n.	%		n.	%
All Causes	2,354	1,108	47.1	21,951	10,349	47.1
Infective and parasitic diseases	1,191	710	59.6	12,598	7,667	60.9
Diarrheal diseases	844	529	62.7	8,770	5,331	60.8
Measles	156	74	47.4	2,103	1,311	62.3
Other	191	107	56.0	1,727	1,025	59.4
Nutritional deficiency	97			1,163		
Diseasesof respiratory system	525	181	34.5	4,469	1,435	32.1
Other causes	541	217	40.1	3,721	1,247	33.5

Appendix 4

Arteriosclerotic Heart Disease(AHD) associated with some other causes of death according to the original death certificates and the final results of the investigation. Sample of 1,832 hospital deaths,São Paulo, 1972/1973

Associated Causes	Original Certificates (AHD = 149)		Final (AHD = 200)	
	n.	%	n.	%
Infective and parasitic diseases	1	0,67	14	7.00
Malignant neoplasms	4	2.68	19	9.50
Diabetes	13	8.72	24	12.00
Hypertensive diseases	24	16.11	58	29.00
Cerebrovascular diseases	16	10.74	50	25.00
Diseases of arteries, arterioles and capilares	25	16.78	77	38.50

Appendix 5

Deaths rates by All Causes, Natural Causes, Arteriosclerotic Heart Disease and Sudden Death rates. Sample of 2738 deaths, 15 - 74 years, São Paulo, 1974/1975.

(Rates per 100.000 population)

Age	All Causes		Natural Causes		AHD		SUDDEN Deaths			
							Natural Causes		AHD	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
15 - 24	191	132.91	102	70.98	-	-	7	4.87	-	-
25 - 34	272	232.02	84	71.65	5	4.26	11	9.38	2	1.70
35 - 44	355	390.03	278	305.43	28	30.76	20	21.97	11	12.08
45 - 54	499	783.54	455	714.45	67	105.20	22	34.54	7	10.99
55 - 64	665	1735.74	621	1645.64	147	389.54	37	98.04	12	31.79
65 - 74	756	3520.86	728	3390.46	211	982.67	41	190.94	23	107.11
15 - 74	2738	576.61	2368	498.69	458	96.45	138	29.06	55	11.58