

Trends in Infant and Child Mortality

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Abstract: Infant and child mortality rates tend to decline over the last decades on a worldwide basis. Specifically, between 1980 and 2003, death rates dropped by 46% for infants, 51% for ages 1 to 4, 44% for children ages 5 to 14 and 32% for teens ages 15 to 19.

Relative bibliography and autopsy evidence helps us derive valuable information and conclusions on the causes regarding infant and children deaths, as well as other epidemiological and statistically based conclusions on the nature of these deaths.

The main causes of death for infants include congenital anomalies, Sudden Infant Death Syndrome (SIDS), prematurity and low birthweight. They can also be attributed to respiratory, circulatory, neoplastic and other reasons that have lower probability of appearance in those ages.

Concerning children's mortality: around the world, neonatal disorders, diarrhea, pneumonia, and malaria, malnutrition and underweight account for most of the children deaths around the world. However, children's health discussions in Europe and the USA focus on issues such as asthma, neurodevelopmental disorders, male genital malformations and childhood cancer. Diseases of the nervous and cardiovascular systems, account for one third of the sudden, unexpected and non violent deaths of children aged 1 to 19 years. Accidental injuries, child abuse, homicides and teenage suicides increase mortality rates, especially among young children and teenagers.

Keywords: Infant mortality, child mortality, SIDS, SUD.

INTRODUCTION

Social and biomedical research has indicated that infant and child mortality rates are important indicators of a nation's health status and well being. These rates vary, depending on sociodemographic variables, such as race and ethnicity, education, family income, geography and environment. The fact worth mentioning is that both these rates tend to decline almost steadily since they were first written down, in the 1930's, although the rates of decrease vary each year and depending on the country. Specifically, between 1980 and 2003, death rates dropped by 46% for infants, 51% for children age 1 to 4, 44% for children age 5 to 14 and 32% for teens age 15 to 19 [1].

Trends in Infant Mortality

The global infant mortality rate (IMR=deaths/1000 live births) for both Less Developed Countries (LDCs) and More Developed Countries (MDCs), has declined from 198 in 1960 to 83 in 2001. However, IMR in 2001 remained 10 times higher in LDCs than in MDCs. In the Least Developed Countries (within the LDC space), the IMR is 17 times higher than in the MDCs. Also, while both LDCs and MDCs

have made dramatic reductions in infant mortality rates, reductions among LDCs are, on average, much lower than in MDCs [2]. Moreover, despite the fact that IMR in the US is steadily declining since 1933, it remains consistently higher than in many other industrialized countries, as the pace of this decline has not yet equaled that of other industrialized countries [3]. Worldwide and according to the Child Trends Databank, rates for infants under the first year of age fell from 1,288 to 683 per 100,000 children between 1980 and 2001. In 2002 and 2003, however, death rates for infants rose, reaching 700 deaths per 100,000 in 2003. According to the Centers for Disease Control and Prevention, the main reason for this recent increase is the increase in the number of babies born at a very low birthweight [1].

Leading Causes of Infant Death

The past four decades have witnessed dramatic declines in the US infant mortality rate, largely as a result of considerable declines in mortality from the major leading causes; ten of them, as reported in the International Classification of Diseases, 9th Revision (ICD-9) in 1991, will be explained below.

These cause-of-death data were based on deaths from underlying causes rather than multiple causes and were coded according to the ICD-9. Congenital anomalies were the leading cause of infant death for the total population in 1991, accounting for one of every five infant deaths. The

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second, third, and fourth leading causes for the total population were: sudden infant death syndrome, prematurity and low birthweight, and respiratory distress syndrome, which respectively accounted for 14.5%, 11.3% and 7% of all infant deaths in 1991. Maternal complications of pregnancy, complications of placenta, cord and membranes, accidents (unintentional injuries), perinatal infections, pneumonia and influenza and intrauterine hypoxia and birth asphyxia rounded out the top ten causes of infant death in 1991 [3].

Racial Differences

It should be noted that the decline in infant mortality from 1950 through 1991 differed significantly between African-American and Caucasian infants. The IMR for Caucasian infants during this period declined by 3.23% per year, compared to 2.89% for African-American infants. The racial disparity in the IMR data increased between 1950 and 1991, even though there were periodic convergences during the late 1960s and mid 1970s. In 1950 the rate was 43.9 deaths per 1000 live births for African-American infants, about 64% higher than the rate (26.8) for Caucasian infants. By 1991, the relative infant mortality situation for African-American infants had deteriorated, with their rate of 16.5 being 2.2 times greater than the rate (7.5) for Caucasian infants.

In the above mentioned study, that took place in the US, there were substantial differences in the US infant mortality rate, depending on race and ethnic groups. While Chinese, Japanese and Filipino ethnic groups exhibited the lowest infant mortality rates, Hawaiians and American Indians showed significantly higher rates than Caucasian but lower rates than African American. Among Hispanics, Cubans had the lowest infant mortality rate, while Puerto Rican infants in particular experienced a relatively increased risk of death [3].

Global Mortality Rates

According to the CIA World factbook, on Infant Mortality rates (see Table 1), evidence appear that point to certain empirical, albeit purely correlative and in need of further study assumptions.

- A) The top of the list is dominated by countries with high access to healthcare support, a developed healthcare system, and homogeneity in social structure and racial profiling
- B) Conversely, countries with high technological support, topographical access to major metropolitan hospitals, big country size or wealth appear to be scattered around the list indicating that the above factors may play a much less significant role in reducing infant deaths.
- C) Scandinavian countries, famous for their healthcare system are present in the top 15 countries with the lowest mortality rate. It is notable that countries like Finland with few metropolitan centers appear very high in the chart, despite difficult access to major hospitals.
- D) On the other hand the US appears on the 46th place, due probably to it's chronically deficient social security system and vast inequities in treatment and standards of living between the different ethnic and racial backgrounds.

- E) On the bottom of the list one may find countries such as Angola, Sierra Leone, Afghanistan, Liberia or Somalia, with vast numbers of attrition within local population due to continuous civil wars and ethnic cleansing. It becomes clear that political factors may constitute a non-medical-specific reason behind the increase in infant mortality rates and alter the data.

Sudden Infant Death Syndrome (SIDS)

Sudden Infant Death Syndrome (SIDS) continues to be one of the most common causes of postneonatal infant death. SIDS is a complex, multifactorial disorder, the cause of which is still not fully understood. However, it is known that interactions between environmental and genetic risk factors may be of critical importance in determining an infant's actual risk of SIDS [4]. Maternal and antenatal risk factors, such as smoking during pregnancy, can double the risk of SIDS incidence, [5] while infant related risk factors, such as non-supine sleeping position and soft bedding, are some of the modifiable environmental risk factors. In addition, emerging evidence substantiates an expanding number of genetic risk factors and suggests new genetic vulnerabilities supporting a key role for abnormalities in brainstem serotonin systems in the pathophysiology of this syndrome [6].

The epidemiology of infant deaths classified as SIDS has been extensively reported. Known factors have included higher incidence between midnight and noon especially in boys, [7] infants of low birthweight or short gestational age, a peak in the winter months and a characteristic age distribution. Few infants die of SIDS in the first few weeks of life, as death peaks between 2 and 5 months, steadily declining thereafter. There has been a strong association between SIDS and young maternal age, with an increased risk for the infants of single mothers and for multiple births. Deaths have occurred across all social strata, but a significant proportion has been among socially deprived families [8].

It is remarkable to mention that SIDS still accounts for about 25% of all deaths between 1 month and 1 year of age in the More Developed Countries, being the leading cause of postneonatal infant death, despite the fact that its rates have become less than half, over the last ten years in Canada [4]. This is partly attributed to the "back to sleep" campaign that became widespread during the 1990s, mostly through the pediatricians' encouragement to the mothers to place their infants to sleep in supine position and on firm, safe sleeping surfaces [9].

Trends in Children Mortality

An overview of current global prevailing causes of child mortality is of great interest, as child deaths depend on socioeconomic differentiations and environmental factors, making them frequently avoidable. Mortality differentiations between the developed and developing regions of the world are more pronounced in childhood (ages one to under five years) than at any other age. While some developing countries have substantially reduced the level of mortality in childhood, in others it remains very high. In contrast, in the Most Developed Countries (within the MDC space), child death rates are now so low, that they no longer serve as useful measures of public health [10].

Table 1. CIA World Factbook, Infant Mortality Rates / Country

S. No	Country	Mortality Rate
1	 Singapore	2.31
2	 Bermuda	2.46
3	 Sweden	2.75
4	 Japan	2.79
5	 Hong Kong	2.92
6	 Macau	3.22
7	 Iceland	3.23
8	 France	3.33
9	 Finland	3.47
10	 Anguilla	3.52
11	 Norway	3.58
12	 Malta	3.75
13	 Andorra	3.76
14	 Czech Republic	3.79
15	 Germany	3.99
16	 Switzerland	4.18
17	 Spain	4.21
18	 Israel	4.22
19	 Slovenia	4.25
20	 Liechtenstein	4.25
21	 South Korea	4.26
22	 Denmark	4.34
23	 Austria	4.42
24	 Belgium	4.44
25	 Guernsey	4.47
26	 Luxembourg	4.56
27	 Netherlands	4.73
28	 Jersey	4.73
29	 Australia	4.75
30	 Portugal	4.78
31	 Gibraltar	4.83
32	 United Kingdom	4.85
33	 New Zealand	4.92
34	Monaco	5.00

Table 1. Contd....

S. No	Country	Mortality Rate
35	 Wallis and Futuna	5.02
36	 Canada	5.04
37	 Ireland	5.05
38	 Greece	5.16
39	 San Marino	5.34
40	 Taiwan	5.35
41	 Isle of Man	5.37
42	 Italy	5.51
43	 European Union	5.72
44	 Cuba	5.82
45	 Guam	6.05
46	 United States	6.26
47	 Faroe Islands	6.32
48	 Croatia	6.37
49	 Belarus	6.43
50	 Lithuania	6.47
51	 Northern Mariana Islands	6.59
52	 Cyprus	6.60
53	 Poland	6.80
54	 Slovakia	6.84
55	 Saint Pierre and Miquelon	6.87
56	 Cayman Islands	6.94
57	 New Caledonia	7.05
58	 Estonia	7.32
59	 French Polynesia	7.55
60	 U.S. Virgin Islands	7.56
61	 Chile	7.71
62	 Hungary	7.86
63	 Puerto Rico	8.42
64	 Latvia	8.77
65	 Costa Rica	8.77
66	 Kuwait	8.96
67	Ukraine	8.98
68	Macedonia	9.01

Table 1. Contd....

S. No	Country	Mortality Rate
69	 Netherlands Antilles	9.09
70	 Bosnia and Herzegovina	9.10
71	 Nauru	9.25
72	 American Samoa	10.18
73	 Russia	10.56
74	 Greenland	10.72
75	 Uruguay	11.32
76	 Argentina	11.44
77	 Saudi Arabia	11.57
78	 Tonga	11.58
79	 Fiji	11.58
80	 Mauritius	12.20
81	 Brunei	12.27
82	 Barbados	12.29
83	 Seychelles	12.30
84	 Botswana	12.59
85	 Qatar	12.66
86	 Panama	12.67
87	 United Arab Emirates	12.70
88	 Moldova	13.13
89	 Palau	13.14
90	 Grenada	13.23
91	 Saint Lucia	13.43
92	 Dominica	13.65
93	 Aruba	13.79
94	 Turks and Caicos Islands	13.89
95	 Saint Kitts and Nevis	13.94
96	 British Virgin Islands	14.65
97	 Jordan	14.97
98	 Saint Vincent and the Grenadines	15.14
99	 Jamaica	15.22
100	 Bahrain	15.25
101	 Malaysia	15.87
102	 West Bank	15.96

Table 1. Contd....

S. No	Country	Mortality Rate
103	 Montserrat	16.08
104	 Georgia	16.22
105	 Antigua and Barbuda	16.25
106	 Oman	16.88
107	 Cook Islands	16.90
108	 Thailand	17.63
109	 Saint Helena	17.63
110	 Bulgaria	17.87
111	 Gaza Strip	18.35
112	 Mexico	18.42
113	 Tuvalu	18.43
114	 Sri Lanka	18.57
115	 Albania	18.62
116	 Suriname	18.81
117	 Colombia	18.90
118	 Solomon Islands	19.03
119	 Armenia	20.21
120	 China	20.25
121	 Philippines	20.56
122	 Ecuador	20.90
123	 Libya	21.05
124	 El Salvador	21.52
125	 Venezuela	21.54
126	 Lebanon	21.82
127	 Tunisia	22.57
128	 Brazil	22.58
129	 Vietnam	22.88
130	 Romania	22.90
131	 Belize	23.07
132	 Bahamas, The	23.17
133	 Uzbekistan	23.43
134	 Honduras	24.03
135	 Samoa	24.22
136	 Paraguay	24.68

Table 1. Contd....

S. No	Country	Mortality Rate
137	 Nicaragua	25.02
138	 Marshall Islands	25.45
139	 Kazakhstan	25.73
140	 Turkey	25.78
141	 Syria	25.87
142	 Dominican Republic	25.96
143	 Micronesia, Federated States of	26.10
144	 Egypt	27.26
145	 Algeria	27.73
146	 Guatemala	27.84
147	 Peru	28.62
148	 Maldives	29.53
149	 Guyana	29.65
150	 Trinidad and Tobago	29.93
151	 Indonesia	29.97
152	 India	30.15
153	 Kyrgyzstan	31.26
154	 Zimbabwe	32.31
155	 Iran	35.78
156	 Morocco	36.88
157	 Sao Tome and Principe	37.12
158	 Mongolia	39.88
159	 Timor-Leste	40.65
160	 Tajikistan	41.03
161	 Cape Verde	41.35
162	World	42.09
163	 Eritrea	43.33
164	 Kiribati	43.48
165	 Iraq	43.82
166	 South Africa	44.42
167	 Bolivia	44.66
168	 Papua New Guinea	45.23
169	 Turkmenistan	45.36
170	 Namibia	45.51

Table 1. Contd....




















S. No	Country	Mortality Rate
171	 Nepal	47.46
172	 Burma	47.61
173	 Bhutan	49.36
174	 Vanuatu	49.45
175	 Ghana	51.09
176	 North Korea	51.34
177	 Gabon	51.78
178	 Madagascar	54.20
179	 Azerbaijan	54.60
180	 Yemen	54.70
181	 Kenya	54.70
182	 Cambodia	54.79
183	 Togo	56.24
184	 Mayotte	56.29
185	 Senegal	58.94
186	 Bangladesh	59.02
187	 Burundi	59.64
188	 Haiti	59.69
189	 Cameroon	63.34
190	 Mauritania	63.42
191	 Benin	64.64
192	 Uganda	64.82
193	 Pakistan	65.14
194	 Guinea	65.22
195	 Comoros	66.57
196	 Gambia, The	67.33
197	 Cote d'Ivoire	68.06
198	 Swaziland	68.63
199	 Tanzania	69.28
200	 Western Sahara	69.66
201	 Lesotho	77.40
202	 Laos	77.82
203	Congo, Republic of the	79.78
204	Central African Republic	80.62

Table 1. Contd....

S. No	Country	Mortality Rate
205	 Ethiopia	80.80
206	 Congo, Democratic Republic of the	81.21
207	 Equatorial Guinea	81.58
208	 Rwanda	81.61
209	 Sudan	82.43
210	 Burkina Faso	84.49
211	 Malawi	89.05
212	 Nigeria	94.35
213	 Djibouti	97.51
214	 Chad	98.69
215	 Guinea-Bissau	99.82
216	 Zambia	101.20
217	 Mali	102.05
218	 Mozambique	105.80
219	 Somalia	109.19
220	 Niger	116.66
221	 Liberia	138.24
222	 Afghanistan	151.95
223	 Sierra Leone	154.43
224	 Angola	180.21

Comparison of previous statistics by UNICEF, the World Bank and the United Nations with new ones, identified countries and WHO regions, where sustained improvement has occurred or setbacks are evident. It is estimated that 10.5 million children aged 0 to 4 years died in 1999, about 2.2 million or 17.5% less than a decade earlier. On average, about 15% of newborn children in Africa are expected to die before reaching their fifth birthday. The corresponding figures for many other parts of the developing world are in the range of 3-8%, while that for Europe is under 2%. During the 1990's the decline in child mortality decelerated in all the WHO regions, except the Western Pacific, but there is no widespread evidence of rising child mortality rates. At a country level, there are exceptions in southern Africa, where the prevalence of HIV is extremely high, and in Asia, where a few countries are beset by economic difficulties. The slow-down in the rate of decline is of particular concern in Africa and South-East Asia, as it is observed in regions with relatively high mortality levels and in countries experiencing severe economic dislocation. As the HIV/AIDS epidemic in Africa continues, particularly in southern Africa and in parts of Asia, further reductions in child mortality become increasingly unlikely until substantial progress in controlling the spread of HIV is achieved [11].

Causes

On the whole, children as well as infant deaths can be attributed to respiratory, circulatory as well as other reasons, less likely to occur in these ages, including neoplasias [12]. Moreover, there are environmentally related illnesses of childhood that are increased nowadays and can lead to death. Accidental deaths, that can be related to motor vehicle crashes, fires or other reasons, are also quite frequent as well as child abuse related homicides and teenage suicides, in rates ranging between different regions around the world [9].

Respiratory Causes

A survey that took place in England and Wales showed that in children aged 1 to 16 years, the overall mortality rate (per 100,000 children) declined from 49.9 in 1968 to 16.3 in 2000 and the rates due to respiratory illness fell from 8.6 to 1.3. The proportion of all deaths caused by respiratory illness in children aged 28 days to 16 years fell from 30.8% in 1968 to 9.9% in 2000. In post-neonatal infants (aged 28 to 364 days), the "all cause" mortality rate fell from 592.8 in 1968 to 176 in 2000 and the rates due to respiratory illness fell from 280 to 22.8. In 2000, pneumonia, asthma and Cystic Fibrosis (CF) together, accounted for 73% of all respiratory

deaths in children 1 to 16 years old. In this age group, mortality rates per 100,000 for pneumonia fell from 4.22 to 0.57, for asthma from 0.83 to 0.25, and for CF from 0.66 to 0.12 between 1968 and 2000. Over the same period mortality rates for pneumonia in post-neonatal infants fell from 165 to 6.78 per 100,000 and for CF from 4.88 to 0.33. Bronchiolitis mortality rates per 100,000 in post-neonatal infants fell from 21.47 in 1979 to 1.82 in 2000. Evidently, mortality rates due to any kind of respiratory illness in children have significantly fallen in the last three decades. This decline has been more rapid than the overall decline in childhood mortality and respiratory diseases are now responsible for a smaller proportion of deaths in children [13].

Circulatory Causes and SUD (Sudden Unexpected Death)

Many causes of sudden death in the young and the children are due to genetic heart disorders which can lead to both structural (e.g. hypertrophic cardiomyopathy) and arrhythmogenic (e.g. familial long QT syndrome) abnormalities [14]. Syncope, usually vasovagal, in childhood is a frequent and potentially lethal problem that can be related to emotion or exercise, to history of familial syncope or sudden death in the young and to any abnormalities on clinical exam or ECG tracings. "Channelopathies" such as the long QT syndrome and catecholaminergic ventricular tachycardia are increasingly recognized in children and carry a high risk of sudden death [15]. Most commonly, sudden cardiac death in the young can be the first presentation of an underlying heart problem. Sudden unexpected cardiac death in the age group of 1 to 21 years usually is due to myocarditis, hypertrophic cardiomyopathy, aortic valvar stenosis and coronary arterial abnormalities. The hearts of 70 patients under the age of 21 who died suddenly, were reviewed, according to a research that took place in Minnesota, USA. Twenty patients were < 1 year of age and 50 were 1 to 21 years old. The cardiac findings were compared with those in 68 age-matched controls with known cardiac disease who did not die suddenly. Significant cardiac abnormalities were present in 13 (65%) of the 20 infants; 10 (50%) had anomalies of the aortic origin of the coronary arteries. Among the 50 older patients, cardiac abnormalities were found in 40 (80%), among whom coronary arterial anomalies existed in 12 (24%). Anomalies of aortic origin more frequently involved the left than the right coronary artery in both groups [16].

Although SUD is very infrequent among children and young people, it has great clinical significance because it affects people in good health and occurs without warning symptoms [17]. Specifically in the United States, SUD has a reported incidence of 1.5 deaths per 100,000 live births compared with 56 deaths per 100,000 live births for sudden infant death syndrome in 2001 [18]. SUD in children with heart defects was predominantly of cardiac origin. Pump failure and arrhythmias were the terminal events in a significant number of patients in the entire population [19] In addition, SUD attributed to clinically undiagnosed neoplasia has also been recognized, as a rare phenomenon in infancy and childhood. In the majority of instances, the tumors involve critical structures within the heart or central nervous system and include gliomas, medulloblastomas, rhabdomyomas, and neoplasms of stromal elements [20].

Children's Malignancies

Child mortality has declined remarkably during the last decades. While neonatal disorders, diarrhea, pneumonia and malaria as well as being underweight account for most of the child deaths worldwide, children's health discussions in Europe and the USA focus on other issues such as asthma, neurodevelopmental disorders, male genital malformations and childhood cancer [21]. According to the End Results Program for childhood cancer incidence and the National Vital Statistics System for childhood cancer mortality, the annual incidence of childhood cancer increased from 1975 until approximately 1990 and seems to have become fairly stable since. Childhood cancer mortality has declined substantially during the past 25 years. Incidence of certain types of cancers has increased since 1974, including acute lymphoblastic leukemia, central nervous system tumors and non-Hodgkin's lymphoma [22]. Data indicate that developed countries have a gradually increasing incidence in leukemia, with a corresponding drop in the incidence of lymphoma. Increases in brain tumor frequency may be related to the development and wide application of new diagnostic capabilities, rather than a true change in the incidence of malignant disease. With a better prognosis for childhood cancer survival, secondary cancers following chemotherapy appear to be increasing. A wide range of environmental factors is thought to have an impact on children's health. These factors include nutrition (protein, vitamins, antioxidants), lifestyle and behavior choices such as tobacco and alcohol use, parental health, socio-economic status, choice of living environment (urban versus rural, etc.) and parent-sibling behavior [21].

Usefulness of Autopsy

A study that took place in (Funen County) Denmark, including all stillbirths (273) and infant deaths (351), between 1986 and 1996, resulted that the overall autopsy rate for infant deaths was 57%. There was a significant decline in infant autopsy rates during the years 1991-1996 as compared to 1986-1990. Regarding infant death, the autopsy changed the diagnosis in 10% of the cases, whereas in 40% the clinical diagnosis was maintained, but additional information was obtained. This is quite strong evidence that autopsy is a useful investigation [23]. A wide variation in the rates of perinatal autopsy worldwide is observed. The rate of neonatal and pediatric autopsies appears to be lower than that of stillbirths [24]. In addition there is a substantial decline in the rate of neonatal and pediatric autopsies in Western countries. Various reasons are responsible for the present drop in pediatric autopsies in children's hospitals: extraordinary progresses of surgery for some malformations, like cardiac malformations, termination of pregnancies of babies with lethal malformations detected by ultrasound and sometimes MRI (for neurological malformations for instance). In most west European countries, the examination of some of these malformations has moved from autopsies of live born babies to fetal autopsies. Other reasons for the drop of pediatric autopsies are negative parental views and clinicians' unease with post mortem examination, both increased by the recent overexposure in the media of some specific situations [25].

Youth Mortality

It is important to mention the decline in mortality for teens ages 15 to 19, between 1980 and 2003, from 98 per

100,000 to 66 per 100,000, respectively. The overall decline was 32 percent although there was a period of considerably higher rates among teens during the late 1980's. Injury is the leading cause of death among both children and youth, accounting for half of all deaths among teens ages 15 to 19. Death rates for males are substantially higher than for females for every age group of children and youth, but the largest difference occurs among teens, ages 15 to 19, where males are more than twice likely to die than females (92 deaths per 100,000 teens versus 40 deaths per 100,000, respectively, in 2003) according to the Child Trends Data-Bank. Many of the accidental deaths are attributed to motor vehicle crashes or are fire-related. Furthermore, there are abuse related homicides or teenage suicides that increase the mortality rate among youth, and are usually related with socioeconomic and environmental conditions [26].

CONCLUSIONS

This article presents data concerning the trends of infant and child mortality, as they were observed and reported in surveys taking place in various countries. The encouraging fact is that, according to published evidence, both infant and child mortality tend to decline in most countries, even the Least Developed ones. This decrease is not proportional and the mortality rates depend on variables including race and ethnicity, environmental, genetic and socioeconomic reasons or even the age and the gender of a child. Respiratory, cardiac and infectious diseases, as well as neoplasias and accidents are the most important fatal conditions. While many deaths can occur suddenly and without being easily explained, autopsy should be done in most cases to reveal the real causes of death.

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