Update / Le point

Tuberculosis: a global overview of the situation today*

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The overall tuberculosis situation in the world in 1990 and its recent trends are reviewed by an analysis of the case notifications to WHO and tuberculosis mortality reports. Estimates of the prevalence of tuberculosis infection and the incidence of tuberculosis disease and deaths predicted in 1990 were carried out with simple epidemiological models.

Approximately one third of the world's population is infected with Mycobacterium tuberculosis. *In the past decade, an average of 2.5 to 3.2 million cases were notified every year globally, the small decrease in notification rates in recent years being offset by population growth. In 1990, an estimated 8 million people developed tuberculosis worldwide and 2.6 to 2.9 million died. The majority of these cases and deaths occurred in Asia, with an increasing number among HIV-infected individuals, especially in Africa where an upward trend is clearly detectable.*

Data on tuberculosis cases notified by WHO Member States demonstrate the magnitude of the problem but must be interpreted with caution. Being less than the expected incidence, they reflect the inadequacies of tuberculosis control programmes. This review confirms the very high global magnitude of the tuberculosis problem and calls for an urgent revitalization of tuberculosis control programmes throughout the world.

Introduction

Tuberculosis, long known to be a major cause of morbidity and mortality throughout the world, has for the past several decades been a neglected disease in both industrialized and developing countries. However, it is now attracting renewed interest, and significant efforts to revive control activities are currently under way (*1*). This is occurring largely because of the increased incidence of tuberculosis in many HIV-epidemic countries (*2, 3*), the availability and proven effectiveness of short-course chemotherapy (*4*), and the realization that tuberculosis control is one of the most cost-effective health interventions in developing countries (*5*).

The present update describes the overall global situation of tuberculosis in 1990 and its trends since 1974. Several epidemiological indicators are used to describe both magnitude and trends; the most important are the prevalence of infection, notification rates, the predicted incidence of disease, and mortality from tuberculosis. Information about these indicators was obtained through official notifications of cases and deaths, and projections made using simple epidemiological models.

Methods and data sources

Annual risk of infection and prevalence of infection

The probability for an uninfected individual to become infected in a one-year period (annual risk of infection) is the most informative epidemiological indicator (*6*). It is used to predict the number of new cases of tuberculosis that can be expected in high-prevalence countries (*7, 8*). The annual risk of infection was calculated from tuberculin survey data,

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available since 1975,[a] using the age-specific prevalence of infection. A model that takes into consideration the annual risk of infection, i.e., the rate of change of the annual risk of infection in the past, and the age distribution of the population was used to determine region- and age-specific prevalences of tuberculosis infection. The prevalence of dual tuberculosis/HIV infection was estimated by applying the prevalence of tuberculosis infection in the 15–49-year age group to populations which are thought to be infected with HIV in this age group.[b]

Case notifications

The Expanded Programme on Immunization (EPI) has been routinely collecting information on tuberculosis morbidity since 1974. Official reports from countries or from WHO Regional Offices are compiled, updated and published twice a year. In this analysis, outliers (defined as numbers of cases notified in one year that are more than three times, or less than one third, of those notified in the previous and the following year) were removed in order to increase the consistency of reporting within a country. This was justified because such large year-to-year variations are likely to be due to programmatic changes rather than to changes in the epidemiology of tuberculosis. Denominators were obtained from World Bank projections (*9*) and were provided by EPI for small countries.[c]

The 10-year average and the highest number of tuberculosis cases notified annually between 1980 and 1989 were obtained for each country. Secular trends were determined using the 5-year annual means or the highest numbers of cases reported annually in these intervals. To compile regional figures, cases reported in all countries of each region were totalled and the regional notification rate was calculated using the population of the region as denominator (the populations of countries not reporting were removed from the denominator).

Expected incidence

The incidence of expected new cases of tuberculosis annually was calculated for each country and compiled for the regions. The calculation was based on the observations that (1) in high prevalence countries, there are 39 to 59 cases of smear-positive pulmonary tuberculosis per 100 000 population for every 1% annual risk of infection, and (2) there are an additional 1.22 cases of smear-negative and extrapulmonary tuberculosis for each case of smear-positive tuberculosis (*8*). The number of cases of tuberculosis expected in each country was calculated using an annual risk of infection of 1.5% to 2.5% for the countries of the African Region, 0.5% to 1.5% for countries in Central and South America and the Eastern Mediterranean Region, and 1% to 2.25% for countries in the South-East Asian and Western Pacific Regions (*8*). The additional number of HIV-related tuberculosis cases was obtained by applying a 10% annual breakdown rate to the number of dually infected individuals (*10*).

Coverage

Coverage (also called case detection ratio) represents the fraction of all individuals with active tuberculosis who have been diagnosed, treated and reported. For practical purposes, it is approximated by the ratio of reported cases to expected cases, expressed as a percentage.[d]

The highest, the average, and the lowest numbers of notifications expected in 1990 were obtained for each country by applying the 1980–89 highest, average and lowest notification rates to the 1990 population. These numbers were then compared with the numbers of cases predicted in 1990 to make estimates of the range of coverages.

Mortality

Tuberculosis mortality is due to failure or delay in diagnosing the disease or to ineffective treatment (lack of compliance, resistant organism). Death certificates are used to determine the overall mortality and the relative importance of tuberculosis deaths among all the other causes of death. Mortality figures available from 62 countries were abstracted from the *World health statistics annual 1988* (*11*) and *1990* (*12*).

The expected tuberculosis mortality was calculated assuming that 50% of the untreated cases predicted in 1990 died (*8*). It was also assumed that, when the cure rate is 50–60%, as currently observed in most developing countries, the fatality of notified cases is 15% on average (*8*). Although case fatality is higher in treated smear-positive tuberculosis than

[a] **Cauthen, G.M. et al.** *Annual risk of tuberculosis infection.* Unpublished WHO document, WHO/TB/88.154, 1988.

[b] *Current and future dimensions of the HIV/AIDS pandemic: a capsule summary.* Unpublished WHO document, WHO/GPA/SFI/90.2.Rev 1, 1990.

[c] *Expanded Programme on Immunization. Information system.* Unpublished WHO document, WHO/EPI/CEIS/90.2, 1990.

[d] **Snider, D.E. et al.** *Evaluation of tuberculosis control programmes.* Unpublished WHO document, April 1990.

in smear-negative patients, the same case fatality was used for smear-positive cases and smear-negative cases because, in developing countries, the former are largely identified and therefore as likely to survive as the smear-negative patients (*8*). The proportion of treated patients was obtained using the average and the high estimate of the coverage to calculate a low and a high estimate of mortality.

Two estimates of the number of HIV-related tuberculosis deaths were calculated: the lower estimate assumed that the case fatality ratio and the treatment coverage were identical for HIV-infected and non-infected tuberculosis cases; the higher estimate was calculated assuming that the case fatality for HIV-related tuberculosis cases was 50% regardless of treatment.

The WHO regional classification of countries was used for the European, Eastern Mediterranean, African and South-East Asian Regions. However, China (because no notification report was available) and Japan, Australia, New Zealand, Canada and the USA (because they are industrialized countries with a low prevalence of tuberculosis) were classified separately. Therefore, the American and Western Pacific Regions referred to in this article do not exactly cover the areas as in the WHO definition.

Results

Prevalence of tuberculosis infection

One third of the world's population (1700 million) is infected with *Mycobacterium tuberculosis*. The prevalence is highest in the Western Pacific Region (44% of the population infected) and lowest in the Eastern Mediterranean Region (19%). The majority of infected individuals live in the South-East Asian Region (25%), China (22%), and in Europe and the five industrialized countries mentioned above (22%) (Table 1).

The age distributions of tuberculosis infection in sub-Saharan Africa and Western Europe are presented in Fig. 1 and 2. Although the overall prevalences of infection are similar in both parts of the world (28% in Western Europe and 34% in sub-Saharan Africa), the majority of infected individuals in Europe are 50 years or older (80%) and in Africa are less than 50 years old (77%). In the African, South-East Asian and Western Pacific Regions, more than 50% of the adult population aged ≥ 15 years are infected (54%, 52% and 62% respectively).

In 1990, more than 3 million individuals worldwide were dually infected with tuberculosis and HIV. The vast majority (78%) lived in Africa (2 375 000) because the prevalence there of HIV infection is the highest and an estimated 48% of the adult population (aged 15 to 49 years) are infected with tuberculosis. Although more than 1.5 million individuals were infected with HIV in Europe and the five industrialized countries the prevalence of tuberculosis infection was relatively low among 15–49-year olds so that dual HIV/tuberculosis infection was relatively infrequent; less than 6% of all dual HIV/tuberculosis infected people lived in these countries (Table 2).

Table 1: **Worldwide prevalence of tuberculosis infection, 1990**

Region	Prevalence (%)	Number infected (millions)	Percentage of total
Africa[a]	33.8	171	9.9
Americas[b]	25.9	117	6.8
Eastern Mediterranean[a]	19.4	52	3.0
South-East Asia[a]	34.3	426	24.7
Western Pacific[c]	43.8	195	11.3
China	33.7	379	22.0
Europe[a] and others[d]	31.6	382	22.2
All Regions	32.8	1722	100

[a] Includes all countries in the WHO Region.
[b] Includes all the countries of the American Region of WHO, except USA and Canada.
[c] Includes all the countries of the Western Pacific Region of WHO, except China, Japan, Australia and New Zealand.
[d] USA, Canada, Japan, Australia and New Zealand.

Tuberculosis notifications

Country reports. Out of 194 countries and states listed in the EPI file, 8 (4%) have not reported tuberculosis cases at all since 1974: 3 out of 46 (6%) in the African Region of WHO (Comoros, Namibia, St Helena), 1 out of 47 (2%) in the Region of the Americas (Netherlands Antilles), 1 out of 11 (9%) in the South-East Asian Region (Democratic Peoples Republic of Korea), 1 out of 34 (3%) in the Western Pacific Region (China), and 2 out of 32 in the European Region (Albania and San Marino).

Notifications. The mean number of tuberculosis cases reported annually and the highest number of cases reported in one single year between 1980 and 1989 are presented, by region, in Table 3. On average, about 2.5 million cases of tuberculosis have been reported each year in the past decade: 40% occurred in South-East Asia and the rest almost equally distributed in the other five Regions (8% to 14%). Case notification rates were lowest in industrialized countries and close to 50 per 100 000 in Africa and Latin America. The highest annual rate, however, was still relatively low in the latter (56 per 100 000),

Fig. 1. **Prevalence of tuberculosis infection, by age, in tropical and southern Africa, 1990.**

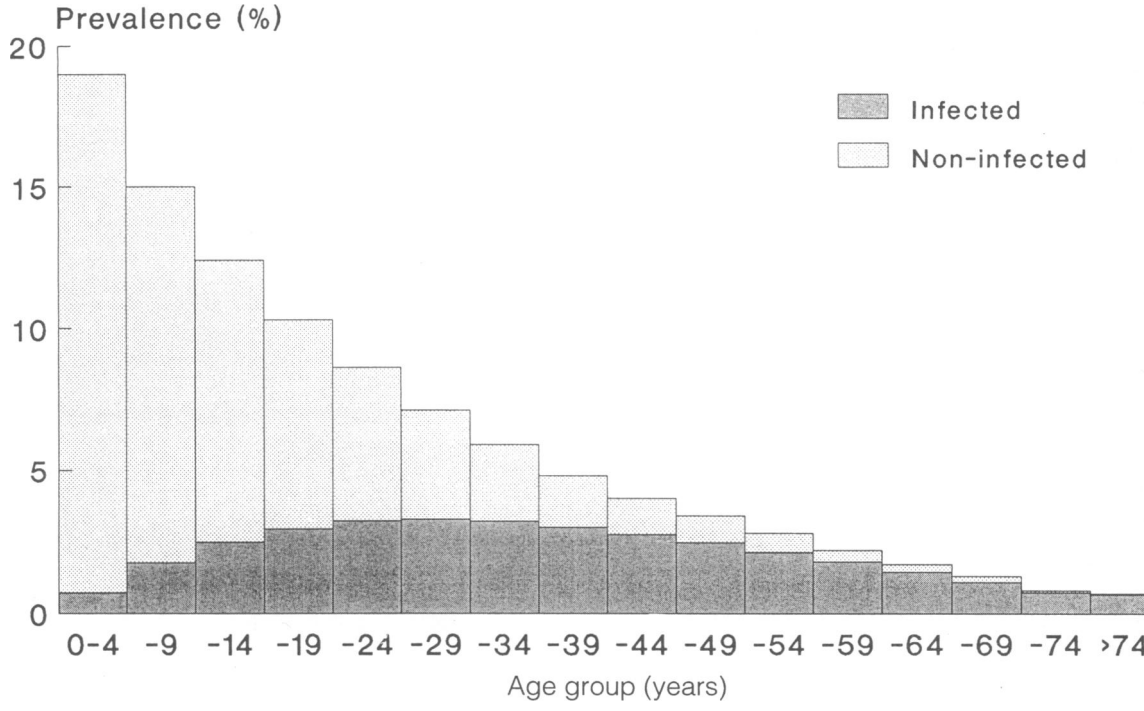

Fig. 2. **Prevalence of tuberculosis infection, by age, in Western Europe, 1990.**

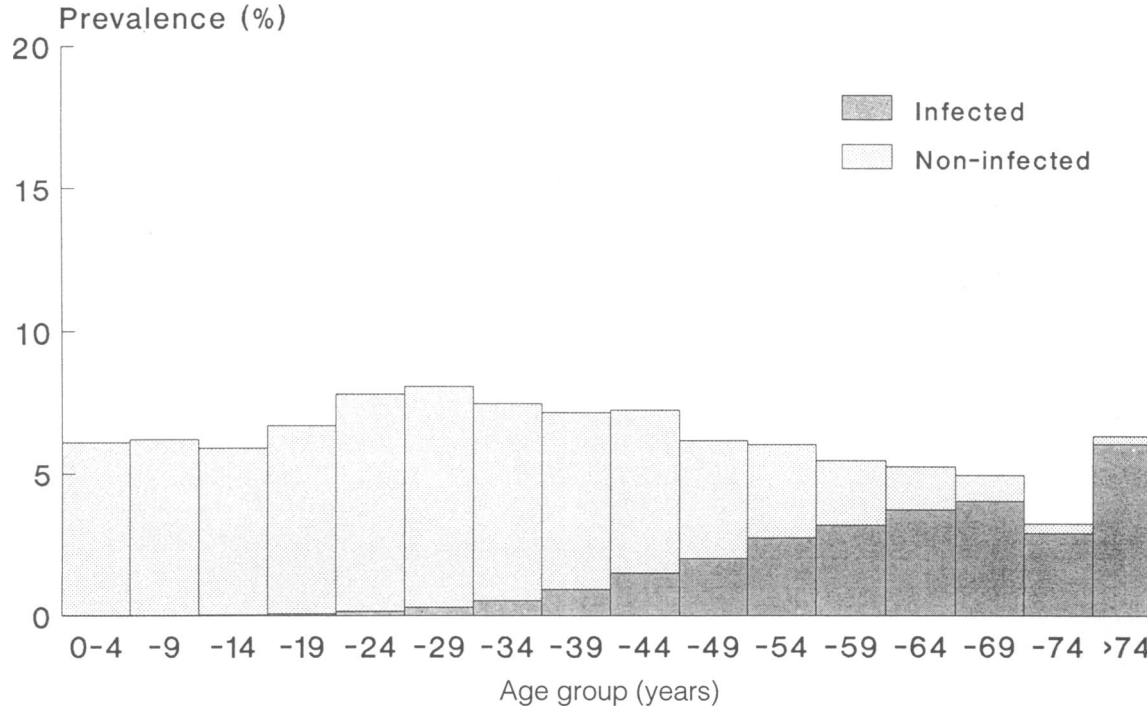

Table 2: **Worldwide prevalence of tuberculosis and HIV infection in 15–49-year-olds, 1990**

Region	HIV infected (x1000)	Prevalence of TB infection (%)	HIV/TB infected	
			No. (x1000)	%
Africa[a]	5000	48	2375	77.8
Americas[b]	1000	30	301	9.9
Eastern Mediterranean[a]	30	23	7	0.2
South-East Asia,[a] Western Pacific[c] and China	500	40	200	6.6
Europe[a] and others[d]	1500	11	170	5.6
All Regions	8030	34	3053	100.0

[a] Includes all countries in the WHO Region.
[b] Includes all the countries of the American Region of WHO, except USA and Canada.
[c] Includes all the countries of the Western Pacific Region of WHO, except China, Japan, Australia and New Zealand.
[d] USA, Canada, Japan, Australia and New Zealand.

an indication of the limited variability of the data, whereas it was much higher in Africa (70 per 100 000).

Trends in tuberculosis notifications. Trends were compared by using the mean and the highest numbers of cases reported for any one year in each of the three periods 1974–79, 1980–84 and 1985–89. Results are presented in Table 4 for the mean numbers of cases. Overall, there was an increase in 1980–84, compared with the previous period, from 2 million cases (reported from 178 countries) to 2.4 million cases (from 180 countries) and a decrease in the following 5-year interval to 2.2 million cases (from 164 countries). The same trend was observed in almost all regions when rates per 100 000 population rather than cases were compared. In Europe and the five industrialized countries, however, there was a consistent decrease in the past 15 years and the increase in the number of cases reported in 1985–89 originated in the USSR, which began reporting to WHO in 1988. Comparison of the figures from the late 1970s with those for 1985–89 show that tuberculosis notifications (1) decreased both in absolute number and in rate per 100 000 in the Eastern Mediterranean Region and in Europe and the five industrialized countries, (2) increased both in absolute number and in rate per 100 000 in Africa and South-East Asia, and (3) decreased in rate per 100 000 in Central and South America and in the Western Pacific Region, as well as globally, while the actual number of cases increased, an indication that population growth exceeded the decrease in case notification rate (Table 4). Over the 15-year time span, case notification rates decreased in 101 countries and increased in 59 (1.7:1). When the Euro-

Table 3: **Mean and highest number of tuberculosis cases reported annually in the world, 1980–89**

Region	Mean		Highest	
	Cases	Rate per 100 000	Cases	Rate per 100 000
Africa[a]	234 862	52	317 840	70
Americas[b]	200 608	50	225 816	56
Eastern Mediterranean[a]	361 720	110	602 875	183
South-East Asia[a]	974 869	85	1 223 173	106
Western Pacific[c]	334 206	169	432 847	219
Europe[a]	288 469	35	336 300	41
Others[d]	90 084	22	105 877	26
All Regions	2 484 818	52	3 244 728	69

[a] Includes all countries in the WHO Region.
[b] Includes all the countries of the American Region of WHO, except USA and Canada.
[c] Includes all the countries of the Western Pacific Region of WHO, except China, Japan, Australia and New Zealand.
[d] USA, Canada, Japan, Australia and New Zealand.

Table 4: **Trends in the average number of tuberculosis cases notified in the world, 1974–89**

Region	1974–1979			1980–1984			1985–1989		
	Cases	Rate[a] per 100 000 population	Countries reporting (%)	Cases	Rate[a] per 100 000 population	Countries reporting (%)	Cases	Rate[a] per 100 000 population	Countries reporting (%)
Africa[b]	187 084	56	42 (91)	230 063	57	43 (93)	210 695	57	32 (70)
Americas[c]	172 220	52	44 (94)	203 345	54	44 (94)	173 654	42	41 (87)
Eastern Mediterranean[b]	274 643	108	23 (96)	427 832	143	23 (96)	224 302	67	22 (92)
South-East Asia[b]	696 931	73	10 (91)	943 140	87	10 (91)	1 023 850	85	10 (91)
Western Pacific[d]	288 885	174	26 (81)	337 907	183	27 (84)	304 238	154	26 (81)
Subtotal	1 617 763	78	145 (92)	2 142 287	90	147 (94)	1 936 739	72	131 (83)
Europe[b]	279 905	54	28 (88)	179 941	34	28 (88)	273 166[f]	33[g]	28 (88)
Others[e]	132 701	35	5 (100)	96 617	25	5 (100)	82 224	20	5 (100)
All Regions	2 032 369	63	178 (95)	2 418 845	68	180 (93)	2 239 694	58	164 (85)

[a] Rates are calculated using only countries that are reporting.
[b] Includes all countries in the WHO Region.
[c] Includes all the countries of the American Region of WHO, except USA and Canada.
[d] Includes all the countries of the Western Pacific Region of WHO, except China, Japan, Australia and New Zealand.
[e] USA, Canada, Japan, Australia and New Zealand.
[f] The USSR started reporting to WHO in 1988 (119 767 cases).
[g] Excluding the USSR, this rate would be 28 per 100 000.

pean and five industrialized countries were removed from this comparison, the ratio decrease/increase was 1.2:1 during the same period. This may be an indication of the absence of any significant improvement in the tuberculosis situation in the past 15 years.

Impact of HIV on notification rates. In Africa, 13 countries for which the prevalence of HIV infection is known to be high (Burundi, Congo, Côte d'Ivoire, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, United Republic of Tanzania, Uganda, Zaire, Zambia, Zimbabwe) (P. Eriki, personal communication, 1990) were compared with the other countries of the Region. Reports were updated using the results of a WHO questionnaire survey in 1989 and the data from programmes assisted by the International Union against Tuberculosis and Lung Disease (IUATLD). In the past 15 years, while the average rate of reported tuberculosis cases decreased in the non-HIV-epidemic countries from 60 to 59 to 47 cases per 100 000 in the 1974–79, 1980–84 and 1985–89 time periods, respectively, it increased from 51 to 56 to 64 per 100 000 in the same periods in the HIV-epidemic countries.

Incidence of tuberculosis

Expected incidence. The regional distribution of the 8 million cases of tuberculosis estimated to have occurred in the world in 1990 is presented in Table 5. The largest numbers occurred in the South-East Asian Region (2 470 000, 31%), China (2 127 000, 27%), and the African Region (1 160 000, 15%). According to these estimates, the annual incidence was highest in the African Region (220 cases per 100 000) and much lower in the American Region (120 per 100 000). Using the average 1980–89 notification rate for Europe and the five industrialized countries (31 per 100 000), 392 000 cases of tuberculosis were expected in 1990.

Impact of HIV on expected incidence. Prevalence information presented in Table 2 was used to estimate the additional number of tuberculosis cases arising among dual HIV/tuberculosis infected individuals. In 1990, 238 000 HIV-related tuberculosis cases may have occurred in Africa, 30 000 in Central and South America, 20 000 in South-East Asia and Western Pacific, and 17 000 in Europe and the five industrialized countries. Although, the global impact of HIV seems limited with 305 000 additional tuberculosis cases worldwide in 1990 (4% of all tuberculosis cases), the cases represent a massive increase in Africa, boosting the overall incidence of tuberculosis from 220 per 100 000 to 265 per 100 000 (20% additional cases).

Table 5: **Cases of tuberculosis expected in the world in 1990**[a]

Region	Cases	Rate per 100 000 population	Percentage of all cases
Africa[b]	1 160 000	220	15
Americas[c]	534 000	120	7
Eastern Mediterranean[b]	594 000	155	7
South-East Asia[b]	2 470 000	194	31
Western Pacific[d]	420 000	191	5
China	2 127 000	191	27
Europe[e] and others[e]	392 000	31	5
HIV-related[f]	305 000	6	4
All Regions	8 002 000	152	100

[a] Calculated using an annual risk of infection of 1.5–2.5% in Africa, 0.5–1.5% in the Americas and the Eastern Mediterranean, and 1–2.25% in South-East Asia and Western Pacific Regions.
[b] Includes all countries in the WHO Region.
[c] Includes all the countries of the American Region of WHO, except USA and Canada.
[d] Includes all the countries of the Western Pacific Region of WHO, except China, Japan, Australia and New Zealand.
[e] USA, Canada, Japan, Australia and New Zealand.
[f] The distribution of HIV-related tuberculosis cases by region is as follows: 238 000 cases in Africa (78%); 30 000 cases in Latin America (10%); 17 000 cases in Europe and the five industrialized countries (6%); 693 cases in Eastern Mediterranean (0.2%); and 20 000 cases in South-East Asia and the Western Pacific Regions (6%).

Coverage

The estimated 1990 coverage was 46% worldwide, ranging from 32% to 61% when the lowest and the highest numbers of cases reported for a given year were compared with the number of expected cases. The coverage appeared to be lowest in Africa where, on average, 24% of expected cases were actually reported (range, 16% to 32%), and highest in the Eastern Mediterranean Region at 70% (37% to 100%) and Western Pacific Region at 88% (61% to 100%). Coverage was 42% (33% to 47%) in Latin America and 44% (34% to 56%) in South-East Asia.

Mortality

Reported mortality. From 1984 to 1989, 77 809 tuberculosis deaths were reported to WHO from 62 countries (Table 6). Most countries in the European Region reported (27/32), but only a few in the other Regions: 3/46 in Africa, 22/45 in the Americas, 3/24 in the Eastern Mediterranean, 1/11 in South-East Asia, and 6/35 in the Western Pacific. In Europe (excluding the USSR) the average annual reported tuberculosis mortality rate was 2.16 per 100 000; in the USSR it was 7.70 per 100 000. A difference of the same order of magnitude was observed between North

Table 6: **Annual number of tuberculosis deaths in the world reported in the *World Health Statistics Annual 1988* and *1990***

WHO Region	Year of report[a]	Countries reporting	Tuberculosis deaths reported	Death rate per 100 000 population
Africa[b]	1984–87	3/46	26	2.18
Americas:	1984–88	22/45	24 932	3.99
North[c]	1988	2/2	2 029	0.76
South/Central[d]	1984–88	20/43	22 903	6.03
Eastern Mediterranean[e]	1987–88	3/24	1 275	2.36
South-East Asia[f]	1985	1/11	1 177	7.12
Western Pacific (excluding China)[g]	1987–89	5/34	4 137	2.76
China	1989	1/1	15 121	1.45
Europe:	1986–89	27/32	31 141	4.12
USSR	1988	1/1	21 800	7.70
Rest[h]	1989	26/31	9 341	2.16
All Regions		62/191	77 809	2.96

[a] Year of report varies by country.
[b] Mauritius, São Tome & Principe, and Seychelles.
[c] USA. and Canada.
[d] Argentina, Bahamas, Barbados, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, Guyana, Mexico, Jamaica, Panama, Paraguay, Peru, Puerto Rico, Saint Lucia, Trinidad & Tobago, Uruguay, and Venezuela.
[e] Bahrain, Egypt, and Kuwait.
[f] Sri Lanka.
[g] Australia, New Zealand, Japan, Hong Kong, and Singapore.
[h] Not reporting: Romania, Albania, Turkey, San Marino, and Monaco.

and Latin America (0.76 and 6.03 deaths per 100 000, respectively).

Expected mortality. For 1990, the range of the estimated number of tuberculosis deaths globally is from 2 600 000 to 2 900 000 (49 to 55 deaths per 100 000 population), depending on the level of coverage used to estimate how many cases received antituberculosis treatment. Although 32% of all deaths occurred in the South-East Asian Region (819 000 to 928 000) and 27% in China (688 000 to 780 000), the tuberculosis death rates were greater in the African Region (91 to 100 deaths per 100 000) than anywhere else (Table 7). In 1990, there were an additional 120 000 to 150 000 estimated deaths among HIV-infected tuberculosis cases. Most of them (83%) occurred in Africa (100 000 to 125 000).

Discussion

Prevalence of infection

About one third of the total world population is infected with *M. tuberculosis* and two epidemiological patterns can be distinguished. (1) In the developing countries the majority of infected individuals are below 50 years of age. This is because the annual risk of infection is still significantly high and because, in many instances, half of the population is less than 15 years old. Since the prevalence of HIV infection is also largest in the 15–49-year age group, the interaction between HIV and tuberculosis will become an important consideration when planning and targeting tuberculosis control programmes. (2) In the industrialized countries, the prevalence of infection is very low among those less than 50 years old, but is still high in the relatively large older age groups. This is a reflection of the high risk of infection in the past. In these countries, an increasing proportion of tuberculosis cases is likely to occur in the elderly. A limitation of these projections is that they represent an average for several countries and only consider age as a determinant of the prevalence of infection. They do not take into consideration large variations in the annual risk of infection in various subgroups of the population in which the true prevalence of infection is likely to be much higher.

Notifications

Careful analysis of notifications can provide a good insight into the tuberculosis situation, tuberculosis control activities, and their trends. When most of the population has access to health care services and when case-reporting is mandatory (as in most industrialized countries), tuberculosis notifications of newly diagnosed cases represent quite accurately the incidence of tuberculosis (*13*). Official notifications, however, are only as good as the national tuberculo-

Table 7: **Projected tuberculosis mortality in the world in 1990**

Region	Low estimate[a]		High estimate[b]		Percentage of all TB deaths
	Deaths	Deaths per 100 000 population	Deaths	Deaths per 100 000 population	
Africa[c]	481 000	91	531 000	100	18
Americas[d]	197 000	44	205 000	46	7
Eastern Mediterranean[c]	137 000	36	163 000	43	5
South-East Asia[c]	819 000	63	928 000	72	32
Western Pacific[e]	99 000	45	110 000	50	4
China[f]	705 000	63	780 000	72	27
Europe[g]	33 000	3.9	33 000	3.9	1
Others[g, h]	6 000	1.4	6 000	1.4	0.2
HIV-related[i]	119 000	2.3	151 000	2.9	5
All Regions	2 596 000	49	2 907 000	55	100

[a] Using the "high level of coverage" for the calculation.
[b] Using the "average level of coverage" for the calculation.
[c] Includes all countries in the WHO Region.
[d] Includes all the countries of the American Region of WHO, except USA and Canada.
[e] Includes all the countries of the Western Pacific Region of WHO, except China, Japan, Australia and New Zealand.
[f] Assumes the same annual risk of infection and the same service coverage as in South-East Asian countries.
[g] Number of tuberculosis deaths reported in 1988.
[h] USA, Canada, Japan, Australia, New Zealand.
[i] The distribution of HIV-related tuberculosis deaths would be as follows: Africa, 125 000 deaths (82%); Latin America, 14 000 deaths (9%); Europe and five industrialized countries, 3000 deaths (2%); Eastern Mediterranean Region, 150 deaths (<1%); South-East Asian and Western Pacific Regions, 9000 deaths (6%).

sis programme can afford and, in many developing countries, their usefulness in assessing the trend of the incidence of tuberculosis is limited (*13*).

Data compiled over a 10-year period and figures available from 185 countries show that, on average, 2.5 million cases of tuberculosis were reported annually in the 1980–89 period and that the overall notification rate was 52 to 69 per 100 000. The number of cases reported has increased globally in all regions except the industrialized countries and the Eastern Mediterranean. The apparent small decrease in the case notification rate reflects population growth, which has been more rapid than the increase in the number of cases. There were 1.2 million cases of tuberculosis officially notified to WHO from 145 countries (111 per 100 000) in 1967, 1.0 million cases from 130 countries in 1971 (96 per 100 000), and 1.8 million cases from 157 countries in 1976–77 (68 per 100 000) (*14, 15*). The increased number of countries reporting and the increased number of cases notified in the 1980s may not reflect an increased incidence of disease but is more likely to represent increased accessibility to tuberculosis control services.

One of the limitations of the notification reports is that, among the requirements making a case of tuberculosis reportable, precise case definitions and case-finding methods were not specified. It was assumed that case definitions and case-finding methods did not change over time in one single country or that such changes would not occur in a large number of countries in a short period of time.

The proportion of the population that has access to a reporting tuberculosis unit varies within countries and between countries and, more importantly, it may change over time. Increased notification rates may only reflect the programme expansion and the fact that a larger proportion of a country's population has access to the programme. When there is a large and active private sector, cases of tuberculosis officially reported are lower than the number of patients identified and treated. In this review, because no information about the population served by the national programmes was available, the population of the whole country was used to calculate the notification rates.

The numbers of cases reported in most of Africa declined slightly in the late 1980s except in HIV-epidemic countries. Although this is probably related to the HIV epidemic, it may also be due, at least in part, to increased tuberculosis control activities and surveillance in HIV-epidemic countries. Most reports for 1985–89, however, concern the early part of this period, when the impact of the AIDS epidemic was not yet strongly felt. The difference between HIV and non-HIV epidemic countries may become more

striking when all the reports from the late 1980s are received.

Although the figure for a particular country may not be reliable for one single year, the methodology used considered that variations in reporting precision occurred essentially at random. In the comparisons, variations were limited by compiling 5- or 10-year averages and by comparing large areas rather than individual countries, assuming there is no systematic bias that would simultaneously affect all countries in the same direction. This method increased the validity of the comparisons of trends and made it possible to compare regions even when some countries failed to report tuberculosis each year.

Expected incidence

In 1990, an estimated 8 million individuals developed tuberculosis worldwide. More than 4.5 million cases occurred in Asia and the highest incidence rate was observed in Africa. These results are similar to those of Murray et al. (*8*) who estimated that, in developing countries, there would be 7.1 million cases of tuberculosis in 1990. Styblo projected that in 1977 there were about 3.7 million new cases of smear-positive pulmonary tuberculosis (*13*). Assuming that there are 1.22 additional cases of tuberculosis for each case of smear-positive pulmonary tuberculosis, 8.3 million cases would have been expected annually at that time in the world. In Africa, 20% additional HIV-related tuberculosis cases were expected. These cases would concentrate in only a few countries where HIV is highly epidemic and in the majority of these countries most cases would occur in the urban areas.

The model for obtaining the expected number of tuberculosis cases was developed using data from the Netherlands (*7*). It has been validated in the developing countries (*8*) and has proved useful and fairly reliable in areas where the incidence of tuberculosis is relatively high. Because this model does not account for additional tuberculosis cases expected among HIV-infected individuals, it is likely to underestimate the true incidence of tuberculosis in countries with HIV epidemics. For this reason, the number of dual HIV/tuberculosis infected individuals and a breakdown rate of 10% were used to account for the additional HIV-related tuberculosis cases. Although this breakdown rate may seem high, this projection does not take into consideration the additional infection and disease that new HIV-related tuberculosis cases will cause in the community and in the HIV-positive population. This simple calculation also assumes that HIV and tuberculosis infections are independent which may not always be true, especially in countries with low tuberculosis prevalence.

Coverage

Comparing reported and expected cases of tuberculosis, the estimated average coverage was 46% worldwide in 1990. Murray's estimates of coverage (*8*) for developing countries were slightly higher (55%), probably because the highest number of cases reported in the past 10 years was adjusted upwards by 20% to account for cases identified in the private sector.

Although this comparison of reported and expected cases is the simplest way to assess coverage of case-finding activities,[e] coverage is a crude indicator which does not reflect actual identification of cases and case-holding. This measure may have overestimated the true coverage if tuberculosis was overdiagnosed or overreported or if the expected number of tuberculosis cases was underestimated because, for example, there was a large pool of chronic cases not accounted for in the calculation of expected cases. Conversely, coverage may have been underestimated because tuberculosis was underdiagnosed or underreported or if the expected number of tuberculosis cases was overestimated.

Mortality

Approximately 78 000 deaths (2.96 per 100 000) were notified annually between 1984 and 1989 from the 62 countries that routinely reported tuberculosis mortality. A total of 168 229 tuberculosis deaths (19.6 per 100 000) were notified in 1967 from 69 countries, 149 983 (16.1 per 100 000) in 1971 from 99 countries, and 105 735 (9.2 per 100 000) in 1976–77 from 103 countries (*14, 15*). The quality of mortality information depends upon the efforts and the competence of the persons responsible for completing death certificates and the frequency of routine post-mortem examinations. Overreporting of tuberculosis deaths may occur if patients who have died *with* tuberculosis, but from another disease, are considered as tuberculosis deaths. This is likely in countries with a high prevalence of dual HIV/tuberculosis infection. However, tuberculosis deaths are generally underestimated in official statistics because many people dying of tuberculosis are missed both by tuberculosis programmes and vital statistics. According to mortality projections, there were 2.6 to 2.9 million deaths (49 to 55 per 100 000) due to tuberculosis worldwide in 1990, the majority in China and South-East Asia and an increasing number among HIV-infected individuals especially in Africa. These projections are similar to the estimates published by Murray et al. (*8*) predicting 2.549 million deaths (range, 1.1 to 3.9 million) in the developing countries alone in 1990.

[e] See footnote *d* on page 150.

Conclusion

Because the quality of the information on notified cases of tuberculosis collected by WHO Member States is not consistent and reflects the actual level of activity and the performance of tuberculosis control programmes, these results should be interpreted with caution. This review, however, using official notifications and projections, confirms the very high global magnitude of the tuberculosis problem. Tuberculosis may be the most common cause of death in the world due to a single infectious pathogen. Unless major efforts to revitalize tuberculosis control programmes throughout the world are successful, the situation is likely to deteriorate because of the HIV pandemic.

One of the first steps in improving the performance of national tuberculosis control programmes is to improve the quality of reporting and ensure the comparability of information. For this purpose, guidelines for tuberculosis reporting using a uniformly applicable case definition of tuberculosis have been developed in collaboration with a large group of experts. National tuberculosis control programmes interested in testing these new guidelines and introducing the newly developed case definition should contact WHO for further information.

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