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**A REVIEW OF CURRENT EPIDEMIOLOGICAL DATA AND ESTIMATION OF
FUTURE TUBERCULOSIS INCIDENCE AND MORTALITY**

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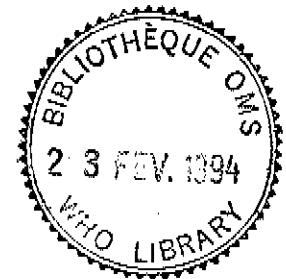
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SUMMARY

The incidence of tuberculosis in 1990 is estimated at 7.5 million cases of which 3.1 million were in the South-East Asian region of WHO, 1.8 million in the Western Pacific region, 1.0 million in sub-Saharan Africa and 1.6 million in the remainder of the world. The estimates for South-East Asian and Eastern Mediterranean regions are higher than previously thought, while the estimates for the Western Pacific and African regions are lower. Forty-four percent of all cases occurred in China and India.

Annual incidence is predicted to increase to 8.8 million cases by 1995, 10.2 million by 2000 and 11.9 million by 2005, an increase of 58% compared with 1990 incidence. Demographic factors, such as population growth and changes in age structure of populations, will account for 77% of the predicted increases in incidence. Increasing incidence rates, particularly in Africa, will account for 23% of the increase in new cases. In the Eastern Mediterranean region and Central and South America, age-specific incidence rates are expected to fall during 1990-2005 but the total number of new cases will increase because of population growth.

It is estimated 315,000 (4.2%) of the 7.5 million incident cases of tuberculosis in 1990 were attributable to HIV infection. Over half of such cases occurred in sub-Saharan Africa where 23.8% of new cases of tuberculosis in adults aged 15-59 were attributable to HIV infection. By the year 2000, it is estimated that over 1.4 million (13.8%) of the forecast 10.2 million incident cases occurring annually will be attributable to HIV infection.

During the 10-year period 1990-1999 it is estimated that 88.2 million people will develop tuberculosis, of which 8.0 million cases will be attributable to HIV infection.

In 1990, 2.5 million persons are estimated to have died of tuberculosis. Assuming availability of treatment remains at its 1990 level, it is predicted 3.0 million tuberculosis deaths will occur annually by 1995 and 3.5 million deaths annually by 2000. Of the 3.5 million tuberculosis deaths predicted to occur annually by the year 2000, 0.5 million (14%) will be attributable to HIV infection.

During the decade 1990-1999 it is estimated that 30.0 million tuberculosis deaths will occur, of which 2.9 million will be attributable to HIV infection. Around 6.0 million tuberculosis deaths are expected in sub-Saharan Africa during the decade, 1.5 million (25%) of which will be attributed to HIV infection.

1. Introduction

WHO has declared tuberculosis a global emergency and warned that the disease claims millions of lives each year and that the situation will rapidly worsen unless immediate action is taken to curb its spread.

This document presents estimates of the present global situation and forecasts of increasing morbidity and mortality in the near future. Estimates are given for the world, WHO regions, and for selected countries.

Specific areas addressed in these forecasts include the impact of world population growth, the impact of demographic aging of the world's population, and the impact of the HIV epidemic.

The information presented here are forecasts of morbidity and mortality based on current levels of intervention. Tuberculosis is curable, and treatment is inexpensive. Much of the forecast burden of disease could be prevented if sufficient global resources were directed immediately towards the control of this disease.

2. Review of previous estimates of 1990 incidence

Tuberculosis incidence in 1990 was estimated for developing countries by Murray (1) and extended by Sudre (2) to include industrialised countries. Both authors based their estimates on a comprehensive review of survey data on annual risk of infection (ARI) in developing countries (3). Annual tuberculosis incidence was estimated by applying Dr Styblo's conversion factor, a 1% increase in ARI correlates to 50 additional smear positive cases per 100,000 population per year(4), to regional ARI estimates.

However, estimates based on such a methodology need to be interpreted with caution for a number of reasons. First, the conversion factor is based on measurements of certain populations and the validity of applying this to other populations is unknown. Second, the review of ARI only covered survey data up to 1985 (3) and few comprehensive surveys have been undertaken since 1985. Third, for most regions of the world there is sparse ARI data. For example, the estimates for the Caribbeans, Central and South America (46 countries) were based on survey data from two countries only. Fourth, previous immunisation with BCG excludes survey subjects from the calculation of ARI. In many areas where recent surveys were undertaken, most of the sample population had previous BCG immunisation and thus was excluded from the calculation. For example at least 80% of the survey population was previously immunised in Botswana and Malaysia, and at least 50% in a range of other countries, including Algeria, Argentina, Burundi, Libya, Republic of Korea, Samoa and Tanzania (3). Thus, subjects included in the ARI calculation in regions with high BCG immunisation coverage may not be representative of the population from which they were drawn.

On the basis of the above concerns about calculating global incidence of tuberculosis from survey data on ARI, a new set of estimates of tuberculosis incidence in 1990 have been produced using an independent methodology.

3. Tuberculosis incidence in 1990

WHO routinely collects data on the number of new tuberculosis cases in Member States each year (5). Within each WHO region, except the African region, an overall regional crude incidence rate was calculated by estimating the incidence in the most populated countries. Reliable notification data were preferentially used for these estimates. Notification data were considered reliable when provided by programmes with an established surveillance system. For countries with unreliable notification data, ARI was used to estimate incidence. Notification data are relatively poor for the African region, so a slightly different approach was used. The African region was divided into four geographic areas and within each area, a crude incidence rate was estimated based on the most reliable notification data (e.g., United Republic of Tanzania for East Africa, Côte d'Ivoire for West Africa).

Estimates of incidence based on notification data will partly reflect under reporting, and thus must be considered as conservative estimates. While notification data are of poor quality for many countries, and any estimates based on such data will seriously risk underestimating incidence, reliable data are available from other countries, particularly those where good tuberculosis control programmes are established.

Shown in Table 1 are the new 1990 estimates. Based on notification data, the number of incident cases of tuberculosis in 1990 is estimated at 7,537,000. While these estimates must be considered conservative, they are consistent with the ARI-based estimate of 8.0 million incident cases in 1990 by Sudre (2).

In the following sections, more detailed information is given on the calculation of tuberculosis incidence for each WHO region.

3.1 South-East Asian Region

The notification rate for India, the most populated country in the region, was 153 per 100,000 population in 1990. Not included in the Indian notification system were patients treated privately and patients hospitalised in the more than 40,000 tuberculosis hospital beds. Of the 438 administrative districts in India, only 378 had district tuberculosis programmes, and of these only 278 (63% of all districts) notified cases in 1991. It has been estimated that 57% of identified cases were included in notification reports (6). In many countries, relapse cases are usually included with incident cases in reports to WHO. For India it is not known what proportion of notifications were relapse cases, but other countries in the region have reported around 5% were relapse cases. This suggests tuberculosis incidence in India during 1990 was approximately 242 per 100,000 population.

In Indonesia, the second most populated country in the region, only 2,700 of the 6,000 health centres are currently included in the national tuberculosis programme. Notification data only includes smear positive cases and thus underestimates total incidence. Tuberculin surveys undertaken during 1983-87 in various regions including Java, Sumatra and Kalimantan found an ARI of 1.7-4.1%. In at least five districts the ARI was above 2.3% (7). ARI of this magnitude suggests an incidence rate at least as high as that for India where ARI is around 1.5-2%. For other countries of the region (e.g. North Korea, Mongolia, Myanmar, Thailand) notification data suggest an incidence rate half that of India.

The 1990 incidence rate for the South-East Asian region is estimated at 237 per 100,000 population. This is higher than the previous estimates of 165-200 per 100,000 given by Murray (1) and 194 per 100,000 population given by Sudre (2). Based on these calculations, it is estimated 3.1 million new cases occurred in the South-East Asia region during 1990, including 2.1 million new cases in India and 0.4 million in Indonesia.

3.2 Western Pacific Region

Thirty two countries were included in the Western Pacific region. The three industrialised countries of the region (Japan, Australia and New Zealand) have been excluded and grouped with Europe and North America.

In 1990, the population of the Western Pacific region was around 1,350 million, the most populated of all the WHO regions. Approximately 85% of the population live in China, with the remaining 15% spread across the other 31 countries. Thus, the incidence of tuberculosis in China strongly influences the overall regional incidence.

Murray (1) estimated an ARI of 1-2% for Asia while Sudre (2) estimated 1-2.25% for the Western Pacific region. However, data from the 1984-5 and 1990 national tuberculosis surveys of China suggest an ARI of around 1.0% (8,9). This suggests that previous estimates of tuberculosis in China, and thus the whole of the Western Pacific region, may have overestimated the situation.

The average notification rate for tuberculosis in China during 1987-90 was 49 per 100,000 population. Data from the 1984-85 national survey of China suggest that approximately 40% of cases had been registered (8). Recent notification data from China show that relapse cases account for approximately 7.5% of cases notified to WHO. Applying the 40% coverage rate to notification data and allowing for inclusion of

relapse cases, gives an estimated 1990 incidence rate of 113 per 100,000 population for China. This estimate is approximately 40% lower than the estimate of 192 per 100,000 population by Sudre (2).

Of the 15% of the region's population that live in countries other than China, half reside in the Philippines and Republic of Korea. During 1988-90, the Philippines reported 312 incident cases per 100,000 population and Republic of Korea reported 194 per 100,000 population. Assuming 7.5% of notified cases were relapses and a case-finding rate of 80% (a conservative estimate), the 1990 incidence estimate for the Philippines is 360 per 100,000 population and for the Republic of Korea is 225 per 100,000.

Only 8% of the population live in the other 29 countries of the region. For these countries, notification rates ranged from 30 to 300 cases per 100,000 population with a weighted average of 100 per 100,000 population. Allowing for 45% case-finding rate (reported by various countries within the region) and inclusion of relapse cases (7.5%), it is estimated an incidence rate of 205 per 100,000 could be applied to these countries.

For the entire Western Pacific region, it is estimated that there were 1.8 million new cases (136 per 100,000 population) in 1990, 28% lower than estimated previously. Around 1.3 million cases occurred in China.

3.3. African Region

Africa was divided into four geographical areas and within each area estimates of incidence were based on the most reliable notification data. For Eastern Africa, recent notifications ranged from 50 to 220 cases per 100,000 with a mean of 110 cases per 100,000. Tanzania, with one of the best tuberculosis programmes, reported approximately 105 cases per 100,000 population in 1990. Highest notification rates in East Africa were reported by countries with a high incidence of AIDS (e.g. Malawi, Zambia). Reports from national tuberculosis programmes suggest that relapse cases account for 5% of reported incident cases. Allowing for around 50% case-finding for all countries in the area, the 1990 incidence rate for Eastern Africa is estimated at 200 cases per 100,000 population.

In Central Africa, recent notifications range from 50 to 200 cases per 100,000 with a mean of 80 per 100,000 population. These rates are similar to those reported by Eastern Africa countries, suggesting an incidence rate similar to that estimated for Eastern Africa.

Notifications from countries in Southern Africa ranged from 170 to 225 cases per 100,000 population with a mean of 205 per 100,000. The Republic of South Africa reported 220 cases per 100,000 population. Allowing for inclusion of relapse cases (5%) and 70% case-finding, the underlying incidence rate for the Republic of South Africa was approximately 300 cases per 100,000 population. This rate was applied to other countries in Southern Africa.

West African notification rates are lower than other areas of sub-Saharan Africa. Notifications ranged from 20 to 140 cases per 100,000 population, with a mean of 50 per 100,000. Côte D'Ivoire, with one of the best surveillance systems in West Africa, reported 65 cases per 100,000 population in 1991. Relapse cases accounted for 5% of notifications and case-finding was estimated at 50%. This together with data from other countries in the area suggests an incidence rate of around 150 cases per 100,000 population in West Africa during 1990.

It is estimated that the 1990 incidence of tuberculosis for all Sub-Saharan Africa was 992,000 cases (191 per 100,000 population), 28% lower than previously estimated.

3.4. Eastern Mediterranean Region

Pakistan, the most populated country in the region, reported 169 cases per 100,000 population in 1988. No data is available on the proportion of relapse cases included in notifications from Pakistan. Data from other countries in the region suggest that around 5% of reported incident cases are relapses and a case-finding rate of around 65%. The 1990 incidence rate for Pakistan is estimated at 250 cases per 100,000 population.

Notification rates for other countries in the region, trend to fall into three categories. Allowing for 50% case-finding and inclusion of relapse cases, incidence rates for Djibouti, Somalia, Sudan and Yemen are estimated at 200 cases per 100,000 population. For Saudi Arabia, Syria, Oman, Qatar and Iran incidence is estimated at 100 cases per 100,000 population while for the remaining countries of the region, incidence is estimated at 50 cases per 100,000 population.

The 1990 incidence of tuberculosis for the entire Eastern Mediterranean region is estimated at 641,000 cases (165 per 100,000 population), similar to previous estimates. It is estimated 306,000 cases occurred in Pakistan and 335,000 cases in the other 22 countries of the region.

3.5. American Region, excluding USA and Canada

Included in this region were countries of the Caribbean, Central America and South America. Canada and the USA have been excluded and grouped with Europe and other industrialised countries. Of the 46 countries included in the region, 23 have populations of less than one million. Each of these countries reports only a small number of cases annually, and any estimates based on these numbers would be subject to Poisson variation. Of the other 23 countries in the region, notifications ranged from 20 to 180 cases per 100,000 population with a weighted average of 50 cases per 100,000. Brazil, the most populated country in the region reported around 50 cases per 100,000 population, although notifications only covered Rio de Janeiro.

Allowing for incomplete reporting, a case-finding rate of around 70%, and data from other countries in the region, the 1990 incidence for the region is estimated at 127 cases per 100,000 population (569,000 cases), similar to the estimate of Sudre (2). It is estimated 191,000 (34%) of these cases occurred in Brazil and 378,000 (66%) in the other 45 countries of the region.

3.6. European Region and USA, Canada, Japan, Australia and New Zealand

The region was considered in two sections: (a) Eastern Europe and independent states of the former USSR and (b) Western Europe and the five other industrialised countries.

For Eastern Europe and independent states of the former USSR, the weighted average of 1990 notification rates was 42 cases per 100,000 population. Notification rates for Western European and other industrialised countries ranged from less than 10 per 100,000 in Canada, Denmark, the Netherlands, Norway and Sweden to more than 60 per 100,000 in Portugal. The weighted average of notifications for all Western European and other industrialised countries was 21 per 100,000 population.

If an 85% registration rate is assumed and allowing for 5% of reported cases to be relapses, the resulting estimates of 1990 incidence are 47 per 100,000 population for Eastern Europe and independent states of former USSR and 23 per 100,000 for Western Europe and the five other industrialised countries. For the entire region, it is estimated that 390,000 incident cases occurred in 1990 (31 cases per 100,000 population), similar to previous estimates.

3.7. Summary

It is estimated there were 7,537,000 incident cases of tuberculosis in 1990. Over 4.9 million cases (65%) occurred in the South-East Asian and Western Pacific regions and particularly in India (2.1 million), China (1.3 million) and Indonesia (0.4 million).

One million cases are estimated to have occurred in sub-Saharan Africa during 1990, 0.6 million cases in the Eastern Mediterranean region (including 0.3 million cases in Pakistan) and 0.6 million in the Central and South America (including 0.2 million cases in Brazil).

Around 0.2 million cases occurred in Eastern Europe and independent states of the former USSR and 0.2 million cases in Western European and other industrialised countries.

The global estimate based on notification data is similar to that estimated by Sudre (2) based on ARI data. This should allay some of the concerns expressed about the use of ARI for estimating incidence rates.

However, the two methods do yield different estimates for some regions. In particular, the notification-based estimates suggest a substantially greater incidence of tuberculosis in South-East Asia than previously thought. Conversely, a lower incidence in China and hence the entire Western Pacific Region was estimated when based on notifications.

4. Tuberculosis incidence in 1995, 2000 and 2005

In estimating future disease incidence, allowances were made for demographic factors (changes in the size and age structure of populations) and epidemiological factors (changes in age-specific incidence rates). To accurately allow for both demographic and epidemiological factors, age-specific incidence rates were estimated for the years 1995, 2000 and 2005 and then applied to age-specific population projections for these years.

This was undertaken at the regional level in two steps. First, data available at WHO on the age distribution of notified cases in each region during 1990 were applied to the 1990 regional crude incidence rates to derive 1990 regional age-specific incidence rates. Second, trends in regional notification rates during 1985-1990 were applied to the 1990 regional age-specific incidence rates to derive age-specific incidence rates for the years 1995, 2000 and 2005. This approach assumes that age-specific trends will remain unchanged. The derived rates were then applied to regional age-specific population projections to calculate the number of incident cases expected in 1995, 2000 and 2005.

In forecasting future burden of disease, it has been assumed that intervention (i.e. the activities of national programmes) remains at the 1990 level.

4.1. 1990 age-specific incidence rates

Age was categorised into four groups: 0-14 years, 15-34 years, 35-59 years and 60+ years. Table II shows the age structure of incident cases for each region in 1990, based on data supplied to WHO by national tuberculosis programmes. The majority of cases are aged between 15 and 59 years in each region. Variation between regions partly reflect differences in age structure of the underlying populations.

The number of incident cases aged 0-14, 15-34, 35-59 and 60 and older in each region was estimated by applying the age distribution of cases shown in Table II to the revised 1990 incidence estimates shown in Table I. Regional age-specific incidence rates for 1990 were then calculated by dividing these estimates by regional age-specific population estimates (10).

4.2. Trends in incidence rates

Trends in notification rates during 1985-90 were analysed to predict trends during 1990-2005. While notification-based data are subject to variation in completeness of reporting, they do provide a useful source of information and, when used with data on trends in ARI, trends in incidence rates can be estimated.

South-East Asian Region

In India, notifications increased by approximately eight additional cases per 100,000 population per year during 1985-90. This probably reflects improvements in completeness of reporting. It is also possible the underlying incidence rate may be increasing. The extent of dual HIV-tuberculosis infection in the Indian population is unclear. However, it seems reasonable to assume there is a pool of persons with dual infection, and without intervention, the pool could be expected to increase. It is estimated the incidence of tuberculosis in India will increase during 1990-2005 by 0.4 additional case per 100,000 population per year, largely due to increasing prevalence of HIV infection.

For other countries in the region, notification data suggest annual incidence is decreasing by approximately 1.0 cases per 100,000 population per year. For the region as a whole, the weighted average trend is a reduction in incidence by 0.09 cases per 100,000 population per year. However, this trend could

be reversed if a marked increase in the prevalence of HIV infection among persons infected with tuberculosis occurs.

Western Pacific Region

Data from the 1979, 1984-85 and 1990 national surveys of China suggest the ARI among seven year old children was similar in each survey period (8,9). Data from these surveys also suggest the prevalence of infection among children aged 0-5 was higher in 1990 than in 1979. Analysis of registration data shows notifications have been increasing by approximately 0.5 additional cases per 100,000 population each year since 1986. Based on the available data, it is estimated that the annual incidence rate in China during 1990-2005 is likely to remain at the 1990 level, in the absence of intervention.

For most other countries in this region, notification rates have generally been falling in recent years by one case per 100,000 population each year. There are a few exceptions to this trend but mostly among the less populated countries.

The underlying annual incidence rate for the Western Pacific region as a whole is predicted to decrease by 0.13 cases per 100,000 population per year.

African Region

Around 1985 some African countries, particularly those in Eastern and Central Africa started reporting increases in tuberculosis rates. Although an increase in notifications for one country may reflect improved completeness of reporting, increasing notification rates across an entire region suggests that changes in reporting alone may not account for the increase.

For countries of Eastern and Central Africa with annual notification rates for AIDS of at least 10 cases per 100,000 population (e.g. Burundi, Congo, Malawi, Rwanda, Uganda and Zambia), tuberculosis notifications rates have been increasing, on average, by 10 additional cases per 100,000 population per year since 1985. The increase in notifications in Eastern and Central Africa correlates with the increasing prevalence of dual HIV-tuberculosis infections.

Increases of 5-10 additional tuberculosis notifications per 100,000 population have also occurred in other parts of Africa during 1985-90, including countries currently reporting less than 10 new cases of AIDS per 100,000 population per year (e.g. Cameroon, Equatorial Guinea, Mozambique, Senegal and South Africa). The interpretation of these trends is that the high prevalence of HIV infection seen initially in Eastern and Central Africa is now occurring in other parts of sub-Saharan Africa. In parallel with the spread of the AIDS epidemic, dual HIV-tuberculosis infection is increasing throughout the region. It is estimated, based on increases in notification during 1985-90, the underlying incidence rates across Sub-Saharan Africa will continue to increase by 10.0 additional new cases per 100,000 population per year during 1990-2005.

Eastern Mediterranean Region

Murray (1) estimated ARI to be decreasing during 1985-90 in the Eastern Mediterranean region. Notification data for this period confirm this trend. Notification rates fell in 13 of the 17 countries that have consistently reported cases to WHO.

However, the notification rate for Pakistan, the most populated country in the region, has been increasing in recent years by 4.0 additional cases per 100,000 population each year. It is thought the increase in the notification rate for Pakistan results from improved reporting. It is also possible that some increase in notifications could result from increases in underlying incidence rates. The prevalence of dual infection with HIV-tuberculosis in Pakistan is largely unknown, but thought to be relatively low. It is estimated, based on available data, that incidence rates in Pakistan will continue at their 1990 level during 1990-2005.

The weighted average of notification rates for other countries in the region is decreasing by around 1.0 cases per 100,000 population each year. Based on this, the underlying incidence rates for these other countries are predicted to decrease by 1.0 case per 100,000 population per year during 1990-2005.

For the Eastern Mediterranean region as a whole, underlying incidence rates are predicted to decrease by 0.68 cases per 100,000 population per year during 1990-2005.

American Region

It has been estimated that ARI was falling in Central and South America during 1985-90 (1). Analyses of notification data confirm this trend and suggest underlying incidence rates are falling by approximately 1.5 case per 100,000 population per year in the region.

Notification rates for some countries have risen in recent years, possibly due to the AIDS epidemic (e.g. Haiti, Honduras) but the impact of this on regional notification rates to date has been minimal because the population of the countries showing an upward trend are relatively small compared with other countries within the region.

Underlying regional incidence rates are predicted to continue falling by around 1.5 cases per 100,000 population per year during 1990-2005, unless the prevalence of dual HIV-tuberculosis infection increases appreciably.

European Region and USA, Canada, Japan, Australia and New Zealand

Tuberculosis notification rates increased during 1985-90 in several countries (including The Netherlands and USA) by approximately 0.5 additional cases per 100,000 population per year. However, for most other countries in Western Europe, notifications decreased during 1985-90 by 0.5-1.0 cases per 100,000 population per year. It seems reasonable to assume that rates in other countries in Western Europe will also increase in the near future, partly because of increasing migration of people to Western Europe from regions of the world with higher incidence of tuberculosis, and partly because of the increasing number of persons with dual HIV-tuberculosis infection. It is estimated that tuberculosis incidence in Western Europe and the other industrialised countries will either remain at their current levels or increase slightly during 1990-2005.

In Eastern Europe and states of the former USSR, notifications decreased during 1985-90 by approximately one case per 100,000 population per year. However, it is not clear that the decline in incidence rates can be maintained in these countries. It is assumed underlying incidence rates in Eastern Europe and states of the former USSR will remain at their 1990 level in the near future.

4.3. Incidence estimates in 1995, 2000 and 2005

The forecast trends in underlying regional incidence rates during 1990-2005 (section 4.2) were applied to 1990 age-specific incidence rates (section 4.1) to produce estimates of age-specific incidence rates for the years 1995, 2000 and 2005. These rates were then applied to age-specific population projections (10) to derive the number of incident cases expected in each year.

Table III shows the number of incident cases of tuberculosis predicted to occur in 1990, 1995, 2000 and 2005. The number of incident cases is expected to increase from 7.5 million new cases a year in 1990 to 8.8 million in 1995, 10.2 million in 2000, and 11.9 million new cases a year in 2005, an increase of 57.6% over 15 years. Around 4.5 million new cases annually can be expected in the South-East Asian region, 2.8 million in the African region and 2.5 million in the Western Pacific region by the year 2005.

The age-specific incidence rates for the Eastern Mediterranean region and Central and South America were predicted to fall during 1990-2005, but the actual numbers of incident cases are expected to increase. This indicates that demographic factors (changes in size and age structure of populations) are stronger than epidemiological factors (changes in age-specific incidence rates). The impact of demographic and epidemiological factors on the forecasts is examined below.

4.4. Impact of demographic and epidemiological factors

The effects of demographic factors (population growth and changes in the age structure of populations) were examined by fixing age-specific incidence rates at their 1990 levels (i.e., no change in age-specific incidence rates during 1990-2005) and applying these rates to age-specific population estimates for the years 1995, 2000 and 2005.

Table IV shows the expected increase in incidence due solely to demographic factors. With age-specific incidence rates fixed at their 1990 level, the number of incident cases of tuberculosis occurring each year increases from 7.5 million cases annually in 1990 to 10.9 million cases annually by 2005, an increase of 45%. This increase is due solely to demographic factors.

The influence of changing age structure is reflected in changes to the crude incidence rate. The global crude incidence rate (Table IV) is predicted to increase from 143 cases per 100,000 population in 1990 to 161 cases per 100,000 population by 2005, although age-specific incidence rates were fixed at their 1990 level. This occurs because the proportion of the world's population in the middle and older age groups is increasing and tuberculosis incidence rates are highest among these age groups.

While incidence is predicted to increase from 7.5 million cases annually in 1990 to 10.9 million in 2005 due to demographic factors only, it was forecast in Table III that incidence would rise to 11.9 million by 2005 when allowing for both demographic and epidemiological factors. This indicates that demographic factors will account for most of the predicted increase in annual incidence.

Shown in Table V are the predicted additional cases of tuberculosis, compared with 1990 incidence, due to demographic and epidemiological factors. Over three-quarters of the predicted increase will result from demographic factors, such as population growth and changing age structure of the population.

Less than 25% of the predicted increase will result from changes in age-specific incidence rates. These forecast changes due to epidemiological factors represents the balance between increasing rates due, largely, to the HIV epidemic versus falling rates due to effective intervention strategies. For example, by the year 1995, epidemiological factors are expected to account for 234,000 additional cases expected annually (Table V). This results from the 423,000 additional cases expected due to the HIV epidemic (see section 4.5), minus 189,000 additional prevented cases due to intervention strategies. Clearly the impact of prevention programmes, assuming they remain at their 1990 level, will be overshadowed by both population growth and the HIV epidemic.

While the number of new cases per year in each region is forecast to increase dramatically, the data in Table V indicate that prevention programmes are working. In South-East Asia, Western Pacific, Eastern Mediterranean and particularly the Americas, epidemiological factors (falling age-specific incidence rates) are preventing tens of thousands of additional cases from occurring each year. Unfortunately, at the global level, these achievements are overshadowed by the increasing age-specific rates in Africa.

The interpretation of above findings is that advances are being made in preventing new cases of tuberculosis, as seen by the falling age-specific rates. However, these efforts are insufficient to counter the strong effects of population growth, the demographic aging of populations, and the HIV epidemic.

Tables VI-XII show forecast annual incidence of tuberculosis in 1995, 2000 and 2005 at the regional level. The top half of each table shows predicted incidence due solely to demographic factors (age-specific rates fixed at 1990 levels), while the lower half of each table shows predicted incidence when allowances are made for both demographic and epidemiological factors.

In the South-East Asian region (Table VI), the benefits of a small decrease in age-specific rates will be overshadowed by the strong effects of demographic factors. By the year 2005, an additional 1.3 million cases will occur each year in South-East Asia. The effect of changing age structure of the population is clearly shown in the top half of Table VI. With age-specific rates fixed at their 1990 levels, the crude incident rate would increase from 237 per 100,000 population in 1990 to 257 per 100,000 in 2005. This results from the increasing proportion of people in the middle and older age groups.

The Western Pacific (Table VII), Eastern Mediterranean (Table IX) and American regions (Table X) all show a similar pattern: age-specific incidence rates are predicted to fall during 1990-2005 but the number of new cases each year will continue to increase due to population growth, and the crude incidence rates (all ages) will continue to increase because of the demographic aging of regional populations.

In sub-Saharan Africa (Table VIII), the number of incident cases each year is predicted to almost triple during 1990-2005. This is the only region where epidemiological factors are stronger than

demographic factors. Age-specific incidence rates are forecast to increase by around 10 additional cases per 100,000 population per year through to the year 2005. This increase is almost entirely due to the HIV epidemic.

In Eastern Europe (including independent states of the former USSR), Western Europe and other industrialised countries (Tables XI-XII), age-specific incidence rates are forecast to stay at their 1990 level during 1990-2005, but increases in the number of new cases are expected due to demographic factors.

Tables XIII-XVII show predicted incidence in 1995, 2000 and 2005 for selected countries: China, India, Indonesia, Pakistan and Brazil.

4.5. Impact of HIV epidemic

The interaction between HIV infection and tuberculosis infection has been reviewed elsewhere (11). HIV infection in persons with a prior tuberculosis infection dramatically increases their risk of developing tuberculosis.

Shown in Table XVIII is the prevalence of HIV infection by age among tuberculosis cases in 1990. Prevalence was estimated from WHO data on HIV seroprevalence in tuberculosis patients from 75 countries in 1989-1992. The data suggest that in 1990 around 25% of tuberculosis cases aged 15-59 were HIV seropositive in sub-Saharan Africa, 5% in Western Europe and industrialised countries and Central and South America, 2-3% in South-East Asia and 1-2% in the Western Pacific, Eastern Mediterranean and Eastern Europe. There was little HIV infection among cases aged more than 60. For children, there were limited data on the prevalence of HIV infection among those with tuberculosis. Data from Zambia suggest that 40% of children with tuberculosis were HIV seropositive (11). In Eastern Africa it is estimated that around 20% of children with tuberculosis were HIV seropositive in 1990. For other regions of the world, it is assumed few children with tuberculosis were HIV seropositive.

Estimates of the prevalence of HIV infection among tuberculosis cases in 1995 and 2000 (Table XVIII) were based on previous trends of HIV seroprevalence in tuberculosis patients and on consensus opinion of programme staff at WHO.

Among adults co-infected with HIV and *M.tuberculosis*, approximately 5-10% develop tuberculosis each year on average (11-14). By comparison, at most 0.2% of adults with *M.tuberculosis* infection only develop tuberculosis each year on average (15). Based on these data, the risk of developing tuberculosis for persons infected with both HIV and *M.tuberculosis* is at least 30 times higher than for persons infected with *M.tuberculosis* only. Using a relative risk of 30, the attributable fraction (16) (i.e., (relative risk - 1)/relative risk) for co-infection with HIV is 95%. Thus, 95% of tuberculosis cases co-infected for HIV are attributable to the HIV infection. The remaining 5% of co-infected cases would have developed tuberculosis irrespective of their HIV status and reflect the occurrence of disease in the absence of the HIV epidemic.

The number of incident tuberculosis cases in each region attributable to co-infection with HIV (Table XVIII) was calculated by applying the attributable fraction and the regional estimates of HIV seroprevalence among tuberculosis cases to the estimates of regional tuberculosis incidence in 1990, 1995 and 2000.

Of the 7.5 million incident cases of tuberculosis in 1990, 315,000 (4.2%) were attributable to co-infection with HIV. These cases would not have occurred if the persons were not co-infected with HIV. In sub-Saharan Africa, 25% of tuberculosis cases among persons aged 15-59 are estimated to have been HIV seropositive and 95% of such cases were attributable to HIV. Thus in sub-Saharan Africa, 23.5% of all tuberculosis cases among adults aged 15-59 during 1990 were attributable to HIV infection. Less than 2% of tuberculosis cases in the Western Pacific, Eastern Mediterranean, Europe and other industrialised countries were attributable to HIV infection.

By the year 1995 it is estimated 738,000 (8.4%) of the predicted 8.8 million new cases occurring each year will be attributable to HIV infection. These estimates assume the prevalence of HIV infection among tuberculosis cases will increase as shown in Table XVIII.

By the year 2000, 1.4 million (13.8%) of the 10.2 million new cases expected to occur each year will be attributable to HIV infection. Substantial changes in the prevalence of HIV infection among persons infected with *M.tuberculosis* would alter the proportion of cases attributable to HIV infection.

4.6. Total incidence during 1990-1999

During the 10-year period 1990-1999 it is estimated that 88.2 million people will develop tuberculosis, of which 8.0 million cases will be attributable to HIV infection.

In South-East Asia 35.1 million new cases of tuberculosis will occur during the decade, of which 2.8 million will be attributable to HIV infection. Around 20.5 million new cases will occur in the Western Pacific of which 0.4 million will be attributable to HIV infection, while 15.0 million cases will occur in sub-Saharan Africa of which 3.9 million will be attributable to HIV infection.

At the end of the decade, an extra 2.7 million tuberculosis cases will be occurring each year, compared with 1990. Around 1.1 of these additional cases (40%) will be attributable to the HIV epidemic.

5. Tuberculosis Mortality Estimates

Notification data from Western Europe and other industrialised countries suggest that around 7% of tuberculosis cases die of the disease (17). These deaths probably result from late presentation for treatment and failure to diagnose tuberculosis as the underlying disease. Notification data from Eastern Europe suggest a case-fatality rate of around 15%, while for Central and South America it was assumed that around 20% of tuberculosis cases die of the disease. For other regions, case-fatality rates were estimated using the approach of Murray and colleagues (1991). A case-fatality rate of 55% is assumed for cases not receiving treatment, and 15% for those receiving treatment (18-20). It is also assumed that all notified cases have been treated and that around 5% of treated patients are not notified (due to factors such as incomplete reporting or exclusion of patients treated privately). By applying these assumptions to notification data, it is estimated the case-fatality rate is around 35% in South-East Asia and the Western Pacific and slightly higher in the Eastern Mediterranean and sub-Saharan Africa (Table XIX).

Annual tuberculosis mortality was calculated by applying the regional case-fatality rates to the estimates of annual incidence. The number of tuberculosis deaths attributable to HIV infection was estimated by applying case-fatality rates to the estimates of HIV-attributable cases. These rates were conservatively assumed to be the same as those among HIV-uninfected cases.

Table XX shows the estimated number of tuberculosis deaths in each region of the world for the years 1990, 1995 and 2000. It is estimated that 2,530,000 tuberculosis deaths occurred in 1990 of which 116,000 were attributable to HIV infection. Around 1.1 million tuberculosis deaths occurred in South-East Asian in 1990.

By the year 2000 it is estimated, assuming the proportion of cases treated remains at the 1990 level, 3.5 million tuberculosis deaths will occur annually, almost 40% more than in 1990. Half a million of these deaths will be attributable to HIV infection, almost half of which will occur in Sub-Saharan Africa. In South-East Asia, 1.4 million deaths per year are anticipated by 2000.

The annual number of incident cases of tuberculosis is predicted to increase by 35.6% during 1990-2000 (Table III) while annual mortality is expected to increase by 38.7%. A higher proportional increase in deaths is expected because incidence is predicted to increase most in Africa where treatment rates are lowest and therefore risk of dying highest.

5.1. Total deaths during 1990-1999

During the 10-year period 1990-1999 it is estimated that 30.0 million people will die of tuberculosis, of which 2.9 million will be attributable to HIV infection.

In South-East Asia 12.3 million tuberculosis deaths are forecast for the decade, of which 1.0 million will be attributable to HIV infection. Around 6.0 million tuberculosis deaths are expected in Sub-Saharan Africa, of which 1.5 million will be attributable to HIV infection.

6. Discussion

Nearly 90 million new tuberculosis cases and 30 million tuberculosis deaths are expected to occur through to the end of this decade without more effective intervention. For a disease where intervention is cost-effective (21), this is truly staggering.

These estimates are based on notification data and, because of under reporting of tuberculosis cases, must be considered conservative. This is reflected in our estimated 1990 incidence of 7.5 million new cases being slightly lower than previous estimates which were based on annual risk of infection data (2). Similarly, the estimation of tuberculosis mortality should be considered conservative. This study estimated 2.5 million tuberculosis deaths in 1990, compared with previous estimates of 2.9 million deaths (2). While the exact number of new cases and deaths is not known, the current and previous estimates are consistent in suggesting that between 7.5 and 8.0 million new cases and 2.5-3.0 million tuberculosis deaths occurred in 1990.

Current intervention strategies are expected to result in substantial reductions in age-specific incidence rates in the Eastern Mediterranean region and Central and South America, and to a lesser degree in the Western Pacific and South-East Asian regions. However, the total number of new cases in these regions is predicted to increase in the near future because of population growth.

The impact of the HIV epidemic is most evident in sub-Saharan Africa where the number of new cases per year is forecast to double by the end of the decade. In South-East Asia and other regions there has been little impact, to date, of the HIV epidemic on tuberculosis. However, by the year 2000 over 500,000 new cases and 200,000 deaths in South-East Asia will be attributable to HIV infection.

A number of assumptions were made in these analyses. It was estimated that 5% of all treated cases are not reported to WHO and that 100% of reported cases were treated. Limited global data are available on the completeness and quality of notifications. These levels were chosen as conservative estimates of the global situation. Earlier mortality estimates (2) used a case-fatality rate of 50% for HIV-positive tuberculosis cases, whereas the current estimates did not assume mortality was different between HIV-positive and HIV-negative cases.

Forecasting future incidence and mortality is difficult and can only be based on data available at the time of the modelling. Substantial changes in epidemiological factors, such as greater than expected increases in the seroprevalence of HIV among persons infected with *M. tuberculosis*, would increase the future burden of disease. Conversely, increased availability of treatment, would reduce the forecast number of future cases and deaths.

It has been demonstrated that effective application of short-course chemotherapy in well-managed national tuberculosis programmes produces excellent results, even under the most adverse conditions (21). Short-term chemotherapy of smear-positive tuberculosis cases is one of the most cost-effective health interventions available (22). A higher priority must be given to this disease, both by the countries most severely affected and by donor countries which invest in health care programmes in those countries.

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Table I. Estimated tuberculosis incidence in 1990.

Region	Sudre (2)		New estimates	
	Cases	Rate ¹	Cases	Rate ¹
South-East Asia	2,480,000	195	3,106,000	237
Western Pacific ²	2,557,000	192	1,839,000	136
Africa	1,398,000	265	992,000	191
Eastern Mediterranean	594,000	155	641,000	165
Americas ³	564,000	127	569,000	127
Europe and others ⁴	409,000	34	390,000	31
All regions	8,002,000	152	7,537,000	143

¹Crude incidence rate per 100,000 population

²Excludes Japan, Australia and New Zealand

³Excludes USA and Canada

⁴Independent states of former USSR, USA, Canada, Japan, Australia and New Zealand

Table II. Age distribution of incident tuberculosis cases in 1990/1991, based on data from national tuberculosis programmes.

Region	AGE 0-14 %	AGE 15-34 %	AGE 35-59 %	AGE 60+ %
South-East Asia	5	30	45	20
Western Pacific ¹	10	30	35	25
China	15	20	30	35
Africa	10	45	35	10
Eastern Mediterranean	10	35	40	15
Americas ²	10	35	40	15
Europe and others ³	10	30	35	25

¹Excludes China, Japan, Australia and New Zealand

²Excludes USA and Canada

³Independent states of the former USSR, USA, Canada, Japan, Australia and New Zealand

Table III. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005.

Region	1990		1995		2000		2005	
	Cases	Rate ¹	Cases	Rate ¹	Cases	Rate ¹	Cases	Rate ¹
South-East Asia	3,106,000	237	3,499,000	241	3,952,000	247	4,454,000	256
Western Pacific ²	1,839,000	136	2,045,000	140	2,255,000	144	2,469,000	151
Africa	992,000	191	1,467,000	242	2,079,000	293	2,849,000	345
Eastern Mediterranean	641,000	165	745,000	166	870,000	167	987,000	170
Americas ³	569,000	127	606,000	123	645,000	120	681,000	117
Eastern Europe ⁴	194,000	47	202,000	47	210,000	48	218,000	49
Western Europe & others ⁵	196,000	23	204,000	23	211,000	24	217,000	24
All regions	7,537,000	143	8,768,000	152	10,222,000	163	11,875,000	176
Increase since 1990				16.3%		35.6%		57.6%

¹Crude incidence rate per 100,000 population²Excludes Japan, Australia and New Zealand³Excludes USA and Canada⁴Includes independent states of former USSR⁵USA, Canada, Japan, Australia and New Zealand

Table IV. Estimated change in tuberculosis incidence due to demographic factors only.

Region	1990			1995			2000			2005		
	Cases	Rate ¹	Rate ¹	Cases	Rate ¹	Rate ¹	Cases	Rate ¹	Rate ¹	Cases	Rate ¹	Rate ¹
South-East Asia	3,106,000	237	241	3,505,000	241	248	3,966,000	248	257	4,477,000	257	257
Western Pacific ²	1,839,000	136	141	2,057,000	141	146	2,281,000	146	153	2,512,000	153	153
Africa	992,000	191	192	1,163,000	192	193	1,370,000	193	195	1,612,000	195	195
Eastern Mediterranean	641,000	165	170	760,000	170	173	907,000	173	180	1,047,000	180	180
Americas ³	569,000	127	131	643,000	131	135	726,000	135	139	812,000	139	139
Eastern Europe ⁴	194,000	47	47	202,000	47	48	210,000	48	49	218,000	49	49
Western Europe & others ⁵	196,000	23	23	204,000	23	24	211,000	24	24	217,000	24	24
All regions	7,537,000	143	148	8,534,000	148	155	9,671,000	155	161	10,895,000	161	161
Increase since 1990					13.2%			28.3%			44.6%	

¹Crude incidence rate per 100,000 population²Excludes Japan, Australia and New Zealand³Excludes USA and Canada⁴Includes independent states of former USSR⁵USA, Canada, Japan, Australia and New Zealand

Table V. Estimated additional cases of tuberculosis, compared with 1990, attributable to changes in demographic and epidemiological factors

Region	1995		2000		2005	
	demographic	epidemiologic	demographic	epidemiologic	demographic	epidemiologic
South-East Asia	399,000	- 6,000	860,000	-14,000	1,371,000	-23,000
Western Pacific ¹	218,000	-12,000	442,000	-26,000	673,000	-43,000
Africa	171,000	304,000	378,000	709,000	620,000	1,237,000
East. Mediterranean	119,000	-15,000	266,000	-37,000	406,000	-60,000
Americas ²	74,000	-37,000	157,000	-81,000	243,000	-131,000
Eastern Europe ³	8,000	0	16,000	0	24,000	0
Western Europe & others ⁴	8,000	0	15,000	0	21,000	0
All regions	997,000	234,000	2,134,000	551,000	3,358,000	980,000
	81.0%	19.0%	79.5%	20.5%	77.4%	22.6%

¹Excludes Japan, Australia and New Zealand²Excludes USA and Canada³Includes independent states of former USSR⁴USA, Canada, Japan, Australia and New Zealand

Table VI. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005:
South-East Asian region.

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	155,000	31	932,000	207	1,398,000	515	621,000	740	3,106,000	237
1995	170,000	31	1,019,000	207	1,595,000	515	721,000	740	3,505,000	241
2000	180,000	31	1,131,000	207	1,838,000	515	817,000	740	3,966,000	248
2005	186,000	31	1,243,000	207	2,119,000	515	929,000	740	4,477,000	257
----- Demographic and epidemiological factors -----										
1990	155,000	31	932,000	207	1,398,000	515	621,000	740	3,106,000	237
1995	168,000	30	1,016,000	207	1,595,000	514	720,000	740	3,499,000	241
2000	175,000	30	1,126,000	206	1,835,000	514	816,000	739	3,952,000	247
2005	178,000	29	1,235,000	206	2,113,000	514	928,000	739	4,454,000	256

Table VII. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005: Western Pacific region, excluding Japan, Australia and New Zealand

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	248,000	70	423,000	80	579,000	166	589,000	487	1,839,000	136
1995	264,000	70	438,000	80	662,000	166	693,000	487	2,057,000	141
2000	281,000	70	429,000	80	784,000	166	787,000	487	2,281,000	146
2005	274,000	70	414,000	80	947,000	166	877,000	487	2,512,000	153
----- Demographic and epidemiological factors -----										
1990	248,000	70	423,000	80	579,000	166	589,000	487	1,839,000	136
1995	261,000	69	433,000	79	659,000	165	692,000	487	2,045,000	140
2000	274,000	68	420,000	79	776,000	165	785,000	486	2,255,000	144
2005	264,000	68	401,000	79	932,000	164	872,000	486	2,469,000	151

Table VIII. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005:
African region

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	99,000	42	447,000	266	347,000	380	99,000	398	992,000	191
1995	115,000	42	526,000	266	406,000	380	116,000	398	1,163,000	192
2000	133,000	42	623,000	266	479,000	380	135,000	398	1,370,000	193
2005	150,000	42	736,000	266	569,000	380	157,000	398	1,612,000	195
----- Demographic and epidemiological factors -----										
1990	99,000	42	447,000	266	347,000	380	99,000	398	992,000	191
1995	251,000	92	626,000	316	460,000	430	130,000	448	1,467,000	242
2000	447,000	142	857,000	366	606,000	480	169,000	498	2,079,000	293
2005	686,000	192	1,152,000	416	794,000	530	217,000	548	2,849,000	345

Table IX. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005:
Eastern Mediterranean region.

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	64,000	40	224,000	170	257,000	346	96,000	435	641,000	165
1995	73,000	40	261,000	170	311,000	346	115,000	435	760,000	170
2000	81,000	40	307,000	170	380,000	346	139,000	435	907,000	173
2005	86,000	40	350,000	170	452,000	346	159,000	435	1,047,000	180
----- Demographic and epidemiological factors -----										
1990	64,000	41	224,000	170	257,000	346	96,000	435	641,000	165
1995	67,000	37	256,000	167	308,000	343	114,000	432	745,000	166
2000	67,000	33	294,000	164	372,000	340	137,000	429	870,000	167
2005	64,000	30	329,000	161	439,000	337	155,000	426	987,000	170

Table X. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005: American region, excluding USA and Canada.

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	57,000	35	199,000	125	228,000	240	85,000	272	569,000	127
1995	60,000	35	217,000	125	267,000	240	99,000	272	643,000	131
2000	62,000	35	235,000	125	315,000	240	114,000	272	726,000	135
2005	64,000	35	251,000	125	365,000	240	132,000	272	812,000	139
----- Demographic and epidemiological factors -----										
1990	57,000	35	199,000	125	228,000	240	85,000	272	569,000	127
1995	47,000	28	204,000	117	259,000	232	96,000	265	606,000	123
2000	36,000	20	206,000	110	295,000	225	108,000	257	645,000	120
2005	23,000	13	206,000	102	331,000	217	121,000	250	681,000	117

Table XI. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005: Eastern Europe and independent states of the former USSR.

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	19,000	20	58,000	45	68,000	56	49,000	75	194,000	47
1995	20,000	20	56,000	45	75,000	56	51,000	75	202,000	47
2000	19,000	20	55,000	45	81,000	56	55,000	75	210,000	48
2005	19,000	20	56,000	45	86,000	56	57,000	75	218,000	49
----- Demographic and epidemiological factors -----										
1990	19,000	20	58,000	45	68,000	56	49,000	75	194,000	47
1995	20,000	20	56,000	45	75,000	56	51,000	75	202,000	47
2000	19,000	20	55,000	45	81,000	56	55,000	75	210,000	48
2005	19,000	20	56,000	45	86,000	56	57,000	75	218,000	49

Table XII. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005: Western Europe, USA, Canada, Japan, Australia and New Zealand.

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	20,000	10	59,000	22	68,000	27	49,000	37	196,000	23
1995	20,000	10	56,000	22	76,000	27	52,000	37	204,000	23
2000	19,000	10	55,000	22	82,000	27	55,000	37	211,000	24
2005	19,000	10	56,000	22	85,000	27	57,000	37	217,000	24
----- Demographic and epidemiological factors -----										
1990	20,000	10	59,000	22	68,000	27	49,000	37	196,000	23
1995	20,000	10	56,000	22	76,000	27	52,000	37	204,000	23
2000	19,000	10	55,000	22	82,000	27	55,000	37	211,000	24
2005	19,000	10	56,000	22	85,000	27	57,000	37	217,000	24

Table XIII. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005: China.

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	193,000	64	257,000	58	386,000	132	451,000	444	1,287,000	113
1995	204,000	64	264,000	58	437,000	132	527,000	444	1,432,000	117
2000	216,000	64	255,000	58	512,000	132	595,000	444	1,578,000	122
2005	208,000	64	243,000	58	611,000	132	656,000	444	1,718,000	127
----- Demographic and epidemiological factors -----										
1990	193,000	64	257,000	58	386,000	132	451,000	444	1,287,000	113
1995	204,000	64	264,000	58	437,000	132	527,000	444	1,432,000	117
2000	216,000	64	255,000	58	512,000	132	595,000	444	1,578,000	122
2005	208,000	64	243,000	58	611,000	132	656,000	444	1,718,000	127

Table XIV. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005: India.

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	103,000	31	619,000	212	929,000	526	413,000	756	2,064,000	242
1995	113,000	31	677,000	212	1,061,000	526	480,000	756	2,331,000	246
2000	120,000	31	752,000	212	1,222,000	526	543,000	756	2,637,000	253
2005	124,000	31	826,000	212	1,409,000	526	618,000	756	2,977,000	262
----- Demographic and epidemiological factors -----										
1990	103,000	31	619,000	212	929,000	526	413,000	756	2,064,000	242
1995	120,000	33	684,000	214	1,065,000	528	481,000	758	2,350,000	248
2000	135,000	35	766,000	216	1,231,000	530	546,000	760	2,678,000	257
2005	147,000	37	850,000	218	1,425,000	532	623,000	762	3,045,000	268

Table XV. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005: Indonesia.

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	22,000	31	134,000	212	201,000	526	89,000	756	446,000	242
1995	24,000	31	145,000	212	226,000	526	102,000	756	497,000	246
2000	25,000	31	158,000	212	257,000	526	114,000	756	554,000	253
2005	25,000	31	170,000	212	290,000	526	127,000	756	612,000	262
----- Demographic and epidemiological factors -----										
1990	22,000	31	134,000	212	201,000	526	89,000	756	446,000	242
1995	20,000	26	141,000	206	225,000	521	101,000	753	487,000	241
2000	17,000	21	150,000	201	252,000	516	113,000	746	532,000	243
2005	13,000	16	158,000	197	282,000	511	124,000	741	577,000	247

Table XVI. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005: Pakistan.

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	31,000	61	107,000	257	122,000	523	46,000	658	306,000	250
1995	35,000	61	124,000	257	147,000	523	55,000	658	361,000	254
2000	38,000	61	144,000	257	178,000	523	65,000	658	425,000	262
2005	41,000	61	165,000	257	213,000	523	75,000	658	494,000	269
----- Demographic and epidemiological factors -----										
1990	31,000	61	107,000	257	122,000	523	46,000	658	306,000	250
1995	35,000	61	124,000	257	147,000	523	55,000	658	361,000	254
2000	38,000	61	144,000	257	178,000	523	65,000	658	425,000	262
2005	41,000	61	165,000	257	213,000	523	75,000	658	494,000	269

Table XVII. Estimated tuberculosis incidence in 1990, 1995, 2000 and 2005: Brazil.

	AGE 0-14		AGE 15-34		AGE 35-59		AGE 60+		ALL AGES	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
----- Demographic factors only -----										
1990	19,000	35	67,000	125	76,000	240	29,000	272	191,000	127
1995	20,000	35	73,000	125	90,000	240	33,000	272	216,000	130
2000	21,000	35	78,000	125	105,000	240	38,000	272	242,000	135
2005	21,000	35	83,000	125	121,000	240	44,000	272	269,000	139
----- Demographic and epidemiological factors -----										
1990	19,000	35	67,000	125	76,000	240	29,000	272	191,000	127
1995	16,000	28	68,000	117	87,000	233	32,000	264	203,000	123
2000	12,000	20	69,000	110	98,000	224	36,000	257	215,000	120
2005	8,000	13	68,000	102	110,000	218	40,000	248	226,000	117

Table XVIII. Estimated number of HIV-attributable tuberculosis cases in 1990, 1995 and 2000.

region	1990				1995				2000				
	HIV +ve TB cases	HIV attributed TB cases (%)	HIV +ve TB cases	HIV attributed TB cases (%)	HIV +ve TB cases	HIV attributed TB cases (%)	HIV +ve TB cases	HIV attributed TB cases (%)					
ADULTS AGED 60+													
All regions	0%	1,588,000	0	0%	1,855,000	0	0%	2,125,000	0	0%	2,125,000	0	0%
ADULTS AGED 15-59													
South-East Asia	3%	2,330,000	66,000 (2.8%)	10%	2,611,000	248,000 (9.5%)	20%	2,961,000	563,000 (19.0%)	20%	2,961,000	563,000 (19.0%)	20%
Western Pacific	2%	1,002,000	19,000 (1.9%)	3%	1,092,000	31,000 (2.6%)	6%	1,196,000	68,000 (5.7%)	6%	1,196,000	68,000 (5.7%)	6%
Africa	25%	794,000	188,000 (23.8%)	35%	1,086,000	361,000 (33.3%)	40%	1,463,000	556,000 (38.0%)	40%	1,463,000	556,000 (38.0%)	40%
Eastern Mediterranean	2%	481,000	9,000 (1.9%)	3%	564,000	16,000 (2.8%)	6%	666,000	38,000 (5.7%)	6%	666,000	38,000 (5.7%)	6%
Americas ²	5%	427,000	20,000 (4.8%)	10%	463,000	44,000 (9.5%)	20%	501,000	95,000 (19.0%)	20%	501,000	95,000 (19.0%)	20%
Eastern Europe ³	1%	126,000	1,000 (0.9%)	2%	131,000	2,000 (1.9%)	5%	136,000	6,000 (4.8%)	5%	136,000	6,000 (4.8%)	5%
Western Europe ⁴	5%	127,000	6,000 (4.8%)	10%	132,000	13,000 (9.5%)	20%	137,000	26,000 (19.0%)	20%	137,000	26,000 (19.0%)	20%
All regions		5,287,000	310,000 (5.9%)		6,079,000	715,000 (11.8%)		7,060,000	1,352,000 (19.2%)		7,060,000	1,352,000 (19.2%)	
CHILDREN AGED 0-14													
East Africa ⁵	20%	25,000	5,000 (19.9%)	25%	63,000	15,000 (23.7%)	30%	113,000	32,000 (28.0%)	30%	113,000	32,000 (28.0%)	30%
Other African	0%	74,000	0	2%	188,000	4,000 (1.9%)	5%	334,000	16,000 (4.8%)	5%	334,000	16,000 (4.8%)	5%
South-East Asia	0%	155,000	0	2%	168,000	3,000 (1.9%)	5%	175,000	8,000 (4.8%)	5%	175,000	8,000 (4.8%)	5%
Americas ²	0%	57,000	0	2%	47,000	1,000 (1.9%)	5%	36,000	2,000 (4.8%)	5%	36,000	2,000 (4.8%)	5%
Other regions	0%	351,000	0	0%	368,000	0	0%	379,000	0	0%	379,000	0	0%
All regions		662,000	5,000 (0.8%)		834,000	23,000 (2.8%)		1,037,000	58,000 (5.6%)		1,037,000	58,000 (5.6%)	
TOTAL		7,537,000	315,000 (4.2%)		8,768,000	738,000 (8.4%)		10,222,000	1,410,000 (13.8%)		10,222,000	1,410,000 (13.8%)	

¹Excludes Japan, Australia and New Zealand

²Excludes USA and Canada

³Includes independent states of the former USSR

⁴Includes USA, Canada, Japan, Australia and New Zealand

⁵Burundi, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe

Table XIX. Estimated proportion of incident cases receiving treatment in 1990.

Region	Notified cases ¹	Expected cases	Percent notified	Case-Fatality treated ²	Case-Fatality Rate ³
South-East Asia	1,510,311	3,176,000	47.6%	50.1%	35.0%
Western Pacific ⁴	875,098	1,839,000	47.6%	50.1%	35.0%
Africa	370,359	1,008,000	36.7%	38.6%	39.6%
Eastern Mediterranean	252,413	660,000	38.2%	40.2%	38.9%

¹Notified cases based on most recent report (WHO/TUB/92.169)

²Calculated assuming 5% of treated patients are not included in notification data

³Calculated assuming 15% mortality among treated cases and 55% mortality among untreated cases

⁴Excludes Japan, Australia and New Zealand

Table XX. Estimated tuberculosis deaths in 1990, 1995 and 2000, assuming regional treatment coverage rates remain at their 1990 level.

Region	1990 Deaths		1995 Deaths		2000 Deaths	
	Total	HIV attributed	Total	HIV attributed	Total	HIV attributed
South-East Asia	1,087,000	23,000	1,225,000	88,000	1,383,000	200,000
Western Pacific ¹	644,000	7,000	716,000	11,000	789,000	24,000
Africa	393,000	77,000	581,000	150,000	823,000	239,000
Eastern Mediterranean	249,000	4,000	290,000	6,000	338,000	15,000
Americas ²	114,000	4,000	121,000	9,000	129,000	19,000
Eastern Europe ³	29,000	<200	30,000	<600	32,000	<900
Western Europe & others ⁴	14,000	<500	14,000	1,000	15,000	2,000
All regions	2,530,000	116,000 (4.6%)	2,977,000	266,000 (8.9%)	3,509,000	500,000 (14.2%)

Increase since 1990

17.7%

38.7%

¹Excludes Japan, Australia and New Zealand

²Excludes USA and Canada

³Includes independent states of former USSR

⁴USA, Canada, Japan, Australia and New Zealand