

Age Transition of Tuberculosis Patients in Taiwan, 1957–2001

Ming-Chih Yu, Kuan-Jen Bai, Jer-Hwa Chang, Chun-Nin Lee*

Background: The incidence of tuberculosis (TB) has been falling in many developed countries; however, there is a trend of an increasing proportion of TB among the elderly. The aim of this study was to evaluate the age transition of patients with TB in Taiwan from 1957 to 2001.

Methods: Data on the number of TB cases and patient age were collected from the National Tuberculosis Registry for three different 5-year periods: 1957–1961, 1977–1981, and 1997–2001. The distribution of TB cases in these three different periods was analyzed.

Results: The age distributions of TB patients were different among the 1957–61 ($n = 26,000$), 1977–81 ($n = 31,363$) and 1997–2001 ($n = 71,447$) groups. During the 1957–61 period, the most common age group was 25–44 years (50.9%). During 1977–81, the most common age group was 45–64 years (44.9%). In 1997–2001, the most common age group had shifted to people aged 65 years or older (43.7%). For the whole period from 1957 to 2001, after adjusting for age shifts in the general population, the proportion of TB patients had significantly increased in persons 65 years or older, slightly increased in persons aged 0–14 years, and decreased in the 15–24, 25–44, and 45–64-year-old age groups. For the period 1977–2001, age-specific registered case rates increased with age.

Conclusion: The age of TB patients in Taiwan showed a rising trend from 1957 to 2001. A high index of suspicion and prompt investigation of elderly patients with signs and symptoms characteristic of TB may allow earlier diagnosis and treatment. [*J Formos Med Assoc* 2006;105(1):25–30]

Key Words: age, Taiwan, tuberculosis

Tuberculosis (TB), a major cause of morbidity and mortality throughout the world, is also one of the most important health problems in Taiwan. Since the implementation of TB control programs in the 1950s, the TB mortality rate in the general population of Taiwan decreased from 91.2 cases per 100,000 in 1952 to 5.8 cases per 100,000 in 2001. Although the prevalence of pulmonary TB in adults decreased from 5.15% in 1957 to 0.65% in 1993, the incidence of TB in 2001 remained high at 64.8 cases per 100,000.¹

Although the incidence of TB has been falling in many developed countries, there is a trend of an increasing proportion of TB among the elderly.^{2–5}

Taiwan, like other developed countries, has become an aging society in recent years. In order to implement adequate public health measures to address this change in demographics, it is important to understand the age transition in TB patients over several decades. This study aimed to evaluate the age transition of patients with TB in Taiwan from 1957 to 2001.

Methods

Central registration system

Cases of TB have been notified and centrally reg-

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Department of Internal Medicine, Taipei Medical University–Municipal Wan Fang Hospital, Taipei, Taiwan, R.O.C.

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*Correspondence to: Dr. Chun-Nin Lee, Department of Internal Medicine, Taipei Medical University–Wan Fang Hospital, 111, Hsin-Long Road, Section 3, Taipei, Taiwan, R.O.C.
E-mail: cnlee@wanfang.gov.tw

istered in Taiwan since 1957. However, the definition of a case requiring National Tuberculosis Registry notification has periodically changed over this period. In 1957, only bacteriologically confirmed pulmonary cases were registered. Cavitary pulmonary TB was included in the register from 1969, cases with extensive parenchyma involvement were included in 1974, pleural TB cases in 1978, pathologically confirmed extrapulmonary TB cases in 1981, moderately advanced pulmonary TB cases in aboriginal and high incidence areas in 1984, and minimal pulmonary TB cases in aboriginal areas in 1988. Only since 1991 have all TB cases been included in the national register in Taiwan.^{6,7}

Case inclusion criteria

Official reports of TB in Taiwan have been intermittent, especially between 1966 and 1996. However, we did find several reports of data that could be used for the evaluation of the age transition of patients with TB from 1957 to 2001 in Taiwan. The available data from these reports, including number of cases and age of TB patients, were classified into three different 5-year periods at 20-year intervals: 1957–61, 1977–81 and 1997–2001.

The data for the period 1957–61 were obtained from annual reports of the Tuberculosis Control Committee of the Taiwan Provincial Health Department.⁸ The data for 1977–81 were obtained from a review of reports of the Taiwan Provincial Tuberculosis Control Bureau, which was the institute responsible for TB control in Taiwan during that period.^{9,10} The data for 1997–2001 were obtained from the National Tuberculosis Registry.

In reviewing the data for registered cases, we assumed that the ratio of possible incompletely registered cases was the same for the different age groups. Under this assumption, the proportion of patients with TB in different age groups might be expected to remain proportionally correct even when using different registration criteria. The registered case rates were only calculated in 1997–2001 because all TB cases in Taiwan have only been included in the register since 1991.

Statistical analysis

General population data for Taiwan were obtained from official publications of the Ministry of the Interior. We used the following methods to adjust for the age shift in the general population when comparing age distributions in patients with TB from 1957 to 2001. First, the percentage of registered cases of TB in each age group and the percentage of the general population in each age group for the three periods, 1957–61, 1977–81 and 1997–2001, were calculated. Then, the percentage of registered TB cases in each age group was divided by the percentage of the general population in each age group for the three time periods to give age-specific likelihood ratios, which were then compared. If the subsequent values were more than that for 1957–61, then the increase in the proportion of TB patients was greater than the increase in the proportion of the general population. If, on the other hand, the subsequent values were less than that for 1957–61, then the decrease in the proportion of TB patients was greater than the decrease in the proportion of the general population.

The age-specific registered case rate (per 100,000 population) was defined as the number of registered TB cases divided by the number of persons in the general population in each age group.

Results

The number of cases and the age distribution of registered TB patients in 1957–61, 1977–81 and 1997–2001 are shown in the Table. In 1957–61, the most common age group was 25–44 years (50.9%). In 1977–81, the most common age group was 45–64 years (44.9%). In 1997–2001, the most common age group was 65 years or over (43.7%). There was an obvious trend of rising age of TB patients from 1957 to 2001 in Taiwan. Meanwhile, the proportion of TB cases in the youngest age group (0–14 years) remained constant during this period (Figure 1). The proportion of the general population that was 65 years or older in 1957–61 was 2.5%, rising to 8.4% in 1997–2001; however, the proportion of TB patients in this age group

Table. Age distribution of patients with tuberculosis from 1957 to 2001 in Taiwan

Year	Total, <i>n</i>	Age, yr					Unknown, <i>n</i> (%)
		0–14, <i>n</i> (%)	15–24, <i>n</i> (%)	25–44, <i>n</i> (%)	45–64, <i>n</i> (%)	≥ 65, <i>n</i> (%)	
1957–61	26,000	197 (0.8)	3260 (12.5)	13,245 (50.9)	7986 (30.7)	1053 (4.1)	259 (1.0)
1957	2457	22 (0.9)	300 (12.2)	1380 (56.2)	668 (27.2)	57 (2.3)	30 (1.2)
1958	4569	29 (0.6)	681 (14.9)	2411 (52.8)	1289 (28.2)	133 (2.9)	26 (0.6)
1959	7012	44 (0.6)	684 (9.8)	3699 (52.7)	2191 (31.2)	313 (4.5)	81 (1.2)
1960	5975	43 (0.7)	829 (13.9)	2909 (48.7)	1877 (31.4)	268 (4.5)	49 (0.8)
1961	5987	59 (1.0)	766 (12.8)	2846 (47.5)	1961 (32.8)	282 (4.7)	73 (1.2)
1977–81	31,363	299 (1.0)	4400 (14.0)	7276 (23.2)	14,077 (44.9)	5126 (16.3)	185 (0.6)
1977	6855	55 (0.8)	1013 (14.8)	1666 (24.3)	3138 (45.8)	963 (14.0)	20 (0.3)
1978	6851	83 (1.2)	1015 (14.8)	1583 (23.1)	3174 (46.3)	971 (14.2)	25 (0.4)
1979	5531	54 (1.0)	831 (15.0)	1296 (23.4)	2736 (49.5)	586 (10.6)	28 (0.5)
1980	5829	41 (0.7)	704 (12.1)	1295 (22.2)	2384 (40.9)	1342 (23.0)	63 (1.1)
1981	6297	66 (1.0)	837 (13.3)	1436 (22.8)	2645 (42.0)	1264 (20.1)	49 (0.8)
1997–2001	71,447	708 (1.0)	5004 (7.0)	14,718 (20.6)	19,802 (27.7)	31,215 (43.7)	
1997	15,386	170 (1.1)	1050 (6.8)	3389 (22.0)	4382 (28.5)	6395 (41.6)	
1998	14,169	129 (0.9)	1031 (7.3)	2957 (20.9)	4029 (28.4)	6023 (42.5)	
1999	13,496	129 (1.0)	979 (7.3)	2726 (20.2)	3759 (27.8)	5903 (43.7)	
2000	13,910	141 (1.0)	1026 (7.4)	2799 (20.1)	3752 (27.0)	6192 (44.5)	
2001	14,486	139 (1.0)	918 (6.3)	2847 (19.6)	3880 (26.8)	6702 (46.3)	

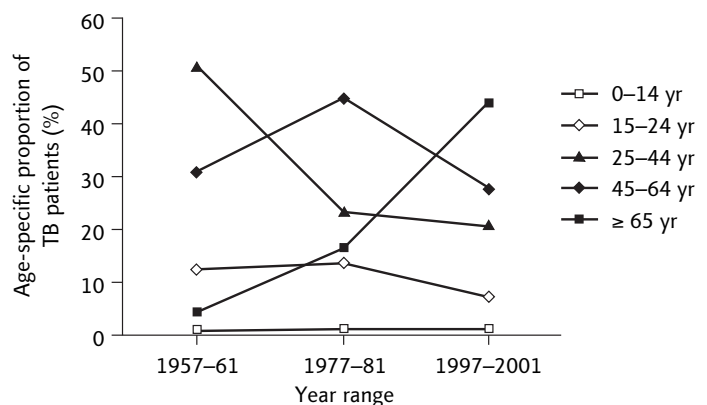
increased from 4.1% in 1957–61 to 43.7% in 1997–2001. The age-specific likelihood ratio in this age group progressively increased from 1957–61 to 1997–2001. This ratio also increased slightly in the age group of 0–14 years from 1957–61 to 1997–2001. On the contrary, the age-specific likelihood ratios of the other age groups all showed a decreasing trend from 1957–61 to 1997–2001, except for a small increase in the 45–64 years age group in 1977–81 (Figure 2).

The age-specific registered case rates for 1997–2001 are shown in Figure 3. Along with rising age, age-specific registered case rates increased during this period. In patients older than 65 years, registered case rates were all above 320/100,000 during this period.

Discussion

This study found a rising proportion of TB in elderly patients from 1957 through to 2001 in Taiwan. Registered TB patients older than 65 years

accounted for 43.7% of all registered TB patients in 1997–2001. Meanwhile, registered case rates among this age group were high, all above 320/100,000, during this period. These findings clearly show that TB in the elderly is becoming an increasingly important public health issue in Taiwan. The proportion of TB patients aged 15–64 years decreased from 94.1% in 1957–61 to 55.3% in 1997–2001, even though the proportion

**Figure 1.** Age trends in tuberculosis (TB) patients in Taiwan, 1957–2001.

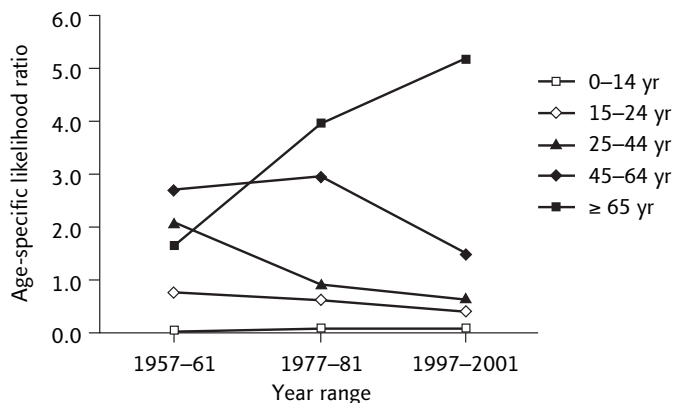


Figure 2. Age shift in tuberculosis patients in Taiwan, 1957-2001.

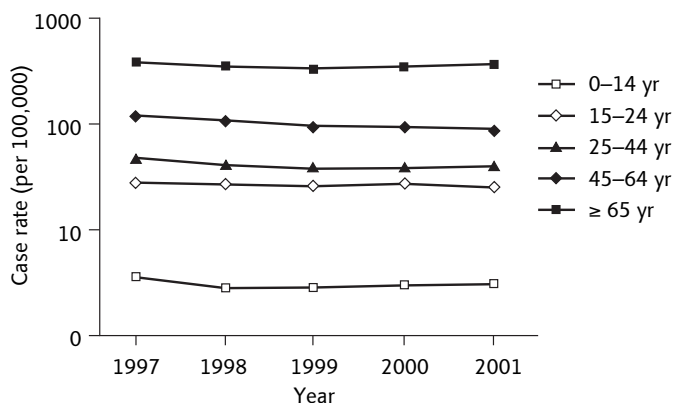


Figure 3. Age-specific registered tuberculosis case rates in Taiwan, 1997-2001.

of the general population in this age group increased from 52.5% to 70.0% during this period. This suggests that the impact of TB in this age group has decreased from 1957 to 2001. The current percentage of TB patients aged 0-14 years in Taiwan is about 1%, which is much lower than that of the United States (6-7%).¹¹ However, as the ratio of the proportion of TB patients to the proportion of the general population in this age group slightly increased from 1957-61 to 1997-2001, epidemiologic monitoring and increased clinical awareness of TB in this age group is needed in Taiwan.

There were an estimated 8-9 million new cases of TB worldwide in 2000. Most of these (5-6 million) were in people aged 15-49 years.¹² However, the proportion of TB patients among the elderly is increasing in Western countries as well as in Hong Kong and Japan.²⁻⁵ Although the proportion of cases in the elderly increased in Taiwan over the

study period (from 2.5% in 1957-1961 to 8.4% in 1997-2001), the rising proportion of elderly individuals in the general population cannot be the only reason for the marked increase in the proportion of elderly TB patients (from 4.1% in 1957-1961 to 43.7% in 1997-2001) in Taiwan.

The classic theory of the pathogenesis of TB is that, in about 5% of persons, the infection progresses from a latent form to active disease within 2 years of infection, while an additional 5% have active disease at some later point in their lives.¹³ A mass tuberculin survey in Taiwan conducted from 1951-1952 in 26,000 people older than 20 years revealed that 75% had positive tuberculin reaction.¹⁴ With advancing age, these individuals who were infected by *Mycobacterium tuberculosis* may be increasingly susceptible to reactivation of remote latent infection. Underlying acute or chronic diseases, such as diabetes mellitus, malnutrition and biologic changes due to aging, can also contribute to the expected age-associated decline in cellular immune response to *M. tuberculosis*.¹⁵⁻¹⁸

Since the 1950s, Taiwan has implemented several national TB control programs, including vaccination with the Bacillus Calmette-Guérin (BCG) vaccine, and active and passive case finding. Treatment efficacy and reduction of transmission in the community have also been increased. As a result, the annual risk of TB infection, an index of TB transmission within a population, has progressively declined to 1.32% in 1972 and 0.43% in 2001.^{1,19} Thus, the risk of TB infection in younger age groups has progressively declined. The result of an increasing proportion of reactivation in the elderly and a decrease in new infections in younger age groups has been an increase in the proportion of TB cases in the elderly.

At its zenith, TB always claimed its highest toll among young adults. While an epidemiologic shift towards the elderly population may be a sign of the success of TB control programs, the shift may largely be the result of endogenous reactivation of infections acquired years previously when the risk of infection was much higher.^{2,20} In due course, this pool of infected individuals will be depleted, and

currently infected cohorts will successively be replaced by those with a lower infection rate. Therefore, from this point of view, the rising age of patients with TB in Taiwan could be interpreted as a sign of increasing success of TB control.

However, attempts to interpret trends in TB epidemiology in Taiwan based on available data and demographic shifts may be confounded by several factors. Firstly, although TB has been a registered disease since 1957 in Taiwan, it was not until 1991 that all types of TB cases were included in the national TB register. Therefore, even though the prevalence rate of pulmonary TB in adults clearly declined from 5.15% in 1957 to 0.65% in 1993, it is difficult to compare the true incidence trends in these decades because of different registration criteria. Secondly, the reliability of the TB notification rate is limited by completeness and accuracy of reporting due to various reasons, including the related policies of health insurance programs.⁶ Thirdly, data from molecular epidemiology studies and other clinical and epidemiologic studies show that re-infection also plays an important role in the development of TB.^{21–24} TB has also been documented as a nosocomial infection among the elderly in nursing homes.²⁵ Therefore, the view that the age shift of patients with TB indicates success of TB control in Taiwan may be an oversimplified one.

Since the aging of the general population in Taiwan is expected to continue, it can also be expected that the caseload of TB will be increasingly associated with the elderly. The clinical presentation of disease in the elderly is often atypical.^{16,26–28} Diagnosis and treatment are more often delayed in the elderly, and there is a higher incidence of treatment failure.^{1,29} Therefore, physicians should give greater consideration to TB in the differential diagnosis of elderly patients with pulmonary symptoms or obscure fever, and promptly investigate suspected cases to allow earlier diagnosis and treatment.

In summary, this study found a rising age of patients with TB in Taiwan from 1957 to 2001. With the high rate of TB in the elderly and the increasing longevity of the population, there will be

an even larger burden of disease in the elderly in Taiwan. Therefore, a high index of suspicion and prompt investigation of elderly patients with signs or symptoms characteristic of TB may allow for earlier diagnosis and treatment.

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