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# RISK OF TUBERCULOSIS INFECTION IN EDIRNE PRIMARY SCHOOLS AND A REVIEW OF ITS EPIDEMIOLOGICAL INDICES*

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**SUMMARY: Saltık A, Sungur İ, Agun K. (Department of Public Health, Trakya University Faculty of Medicine, Edirne, Turkey). Risk of tuberculosis infection in Edirne primary schools and a review of its epidemiological indices. Turk J Pediatr 33: 143-151, 1991.**

**The study population was defined as all first and fifth grade pupils from 17 primary schools located within Edirne Municipality. Of these 3188 pupils, aged 6 - 14 years, 569 had not received the BCG vaccine, and were tested for Tb with strengths of 1,3 or 5 TU PPD, and the reactions were evaluated. The annual risk of infection (AIR), a relatively new indice in Tb epidemiology, was determined in the different subgroups in which age, school grade and sex were taken into consideration. The results of each subgroup were compared with each other and with those reported in foreign countries. Global AIR was found to be 1.54 percent, a relatively very high value when compared with those reported in Syria and Egypt. The relative risk ratio was recorded as 22.4 percent in the Netherlands.**

**Another rate parameter which is almost as important as AIR is the annual variation in AIR. In Turkey this rate has been varying annually by an average of 5 % for over the past 21 years. These figures may be the result only of normal socioeconomic development rather than the effect of campaigns waged in the fight against Tb. We are convinced that under the conditions prevailing in Turkey, widespread, early vaccination with BCG is the best way to control Tb.** *Key words: annual infection risk (AIR), AIR variation rate, Tb epidemiology, Tb immunization, strength of PPD.*

Tuberculosis (Tb) infection is still a major public health problem, particularly in developing countries. A report from the World Health Organization (WHO) released at the end of 1980 estimated that there were 3.5 million new cases and 1 - 2 million deaths each year from Tb in the world[1-4]. In Turkey, because of an efficient and long-term fight against the disease[5], Tb mortality has decreased from a rate that approached 300 per 100,000 in 1940 to 10 per 100,000, a rate that is almost the same as reported in Western countries. But can we really say that the fight against Tb has been won and that the infection is now under control?

Modern health services are of a very broad spectrum and it is therefore impossible to trace the source of diseases or health problems unless the occurrences of illness are taken into consideration on a community - wide basis.

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Thus epidemiological methods must be used for evaluating the past and present situation regarding the fight against Tb and control programs must be established, a task undertaken by the WHO Experts' Committee on Tuberculosis[4, 6, 7].

In Turkey, children and young adults should be screened for Tb. In the United States, however, Tb is becoming more and more a disease of the older non - white male[8-11].

In some countries, the actual mortality rate from Tb is unreliable due to a lack of well - organized recording systems. Patients who acquire chronic conditions resulting from irregular chemotherapy are included in the case rates of Tb which indicates that prevalence rates are not good indices. In addition in countries where health services and documentation are not adequate, a great many new cases of Tb are overlooked, and therefore, incidence rates are not good indices either.

There are two alternatives for determining Tb prevalence rates:

1– Examination of the sputum for the presence of tubercle bacilli.
2– Reactions to purified protein derivative (PPD).

The first method entails mass screening and laboratory facilities, while the second can be executed in a representative sample of a community in a definite region. Using the above - mentioned methods, preschool and primary school children comprise good subjects for the detection of Tb. The risk of infection is a relatively new concept. Classical indices are not very good indicators of Tb epidemiology[8]. The risk of becoming infected with tubercle bacillus in a one - year period has been determined by Styblo[4, 5, 12]. A one percent risk of infection indicates one hundred positive sputum specimens in a population of one hundred thousand. The formula below represents the annual infection risk (AIR) of Tb, which is not a function of socioeconomic conditions of related groups or community - based recording systems.

$$\text{annual infection risk (AIR)} = 1 - N^{1/y}$$

N represents the percentage of PPD (–) children without bacille Calmette-Guerin (BCG) at "y" years of age or "y" age group. For instance, at 7 years of age, let us suppose that the ratio of PPD negativity is 85 %.

$$AIR = 1 - (0.85)^{1/7} = 1 - 9.77 = 0.0229... \quad 2.29 \text{ percent.}$$

According to this logarithmic equation, it can be assumed that 2.9 percent of PPD (–) children might be infected in a one year period.

Primary school children are groups at special risk for Tb infection from many aspects. Clarifying the epidemiological characteristics of Tb in these population groups is therefore quite significant. The aim of this study is to review the indices of the epidemiology of Tb, to assess the risk of infection in five hundred and

sixty - nine children who had not been vaccinated with BCG and to formulate some resolutions. Two papers have been previously presented by the author on vaccination with BCG, and the delineation of allergy to BCG induced by different strengths of PPD[13, 14].

## Material and Methods

The study population was defined as all first and fifth grade pupils from 17 primary schools located within the Edirne Municipality (n = 3188). Junior high school students were excluded from the study because the BCG vaccination programs implemented by the Ministry of Health are restricted to the first and fifth grades[15]. The Mantoux test procedure consisting of strengths of 1, 3 or 5 TU PPD with RT 23 Tween 80 supplied by the RESAMENS - Health Ministry (Refik Saydam Public Health Institute) was administered to three age-randomized sub-groups, respectively who had not received BCG vaccination (n = 569). Teams from the Dispensary for the Fight Against Tuberculosis, The State Chest Hospital and related Departments at Trakya University Faculty of Medicine carried out the tests.

Seventy-two hours later, the diameter of the induration was measured and recorded along with other necessary information like sex, school grade, and age. Pupils with a history of respiratory infection and/or fever within the past fortnight were excluded. PPD reactions and the effectiveness of vaccination with BCG were evaluated in a total 3188 children, 1725 (54.1 %) first graders and 1463 (45.9 %) fifth graders whose ages ranged between 6 - 14 years. In another paper, the author reported on the efficacy of BCG vaccination and its interaction with allergy to tuberculin in 2619 children of the same study population who had been vaccinated at least once with BCG (82.2 %)[13].

The aim of this presentation is basically to assess the risk of infection in the five hundred and sixty - nine children who had not received BCG vaccine. AIR was calculated separately by computer for these subjects according to age and sex as previously illustrated.

## Results

The composition of the study group is presented in TABLE I.

TABLE I: The Distribution According To Age and School - Grade of 569 Children Who Had Not Received BCG Vaccine

| Grades | Girls No. (%) | Boys No. (%) | Total No. (%) |
|---|---|---|---|
| Grade I | 222 (49.2%) | 229 (50.8%) | 451 (100.0%) |
| Grade V | 62 (52.5%) | 56 (47.5%) | 118 (100.0%) |
| Total | 284 (49.9%) | 285 (50.1%) | 569 (100.0%) |

The number of fifth grade pupils in the sample is decreased because of the fact that by the time school - children reach the fifth grade, many have already been vaccinated with BCG. Table II shows, according to sex and school grade, the status of immunization of those subjects vaccinated at least once with BCG. Although there were no significant differences between vaccination ratios of both sexes in the first and fifth grades, there was a significant increase in both sexes of first and fifth graders vaccinated at least once.

TABLE II: Sex and Grade Distribution (%) of 3188 Pupils With Regard To BCG Vaccination Status

| | At Least One BCG Scar | | | |
|---|---|---|---|---|
| Sex | First Grade | Fifth Grade | Total | Without BCG |
| Girls | 73.8 (%) | 91.7 (%) | 81.1 (%) | 18.9 (%) |
| Boys | 73.9 (%) | 92.3 (%) | 83.7 (%) | 16.3 (%) |
| **Total** | **73.9 (%)** | **91.9 (%)** | **82.2** | **17.8** |
| | | | **(n = 2619)** | **(n = 569)** |

In the study subgroups, the average ages for assessing AIRs are represented in TABLE III.

TABLE III: Mean Ages ± SD in Study Subgroups

| PPD (TU) Test applied | First Grade | | Fifth Grade | | Total | |
|---|---|---|---|---|---|---|
| | no. | m.age ± SD | no. | m.age ± SD | no. | m.age ± SD |
| 1 | 82 | 7.1 + 1.1 | 20 | 11.9 ± 1.6 | 102 | 8.0 ± 1.3 |
| 3 | 121 | 7.2 + 0.9 | 34 | 11.3 ± 1.1 | 155 | 8.1 ± 1.0 |
| 5 | 248 | 7.2 + 1.2 | 64 | 11.7 ± 1.4 | 312 | 8.1 ± 1.3 |
| **Total** | **451** | **7.2 ± 1.1** | **118** | **11.6 ± 1.3** | **569** | **8.1 ± 1.2** |

For example when calculating AIR for a given 6 - 10 age group, the age of a related group can be expressed as (6 + 10) / 2 = 8. But, since junior high school students were excluded and also because of the gap between the number of pupils from the first to the fifth grades, (451 and 118, respectively), mean ages were calculated separately for each subgroup. Girl and boy ratios were very similar in both grades, thus no importance was given to sex in the calculations.

TABLE IV, shows the percentages of PPD (+) children without BCG vaccination which were used for calculating AIRs in the study subgroups. As is seen,

increased doses of PPD result in a greater possibility of the occurrence of natural infection allergy (Fig. 1).

TABLE IV: Percentages of PPD Positivity in 569 Pupils Without BCG Who Were Administered 1, 3 or 5 TU PPD

| PPD Test Applied | First Grade | | | Fifth Grade | | | Grand Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Girls | Boys | Total | Girls | Boys | Total | Girls | Boys | Total |
| 1 TU | 9.09 | 13.16 | 10.98 | 0.00 | 25.00 | 10.00 | 7.14 | 15.22 | 10.78 |
| 3 TU | 12.96 | 7.46 | 9.92 | 6.25 | 22.20 | 14.71 | 11.43 | 10.59 | 10.97 |
| 5 TU | 15.32 | 8.06 | 11.69 | 20.59 | 20.00 | 16.95 | 16.46 | 10.39 | 13.46 |
| **Total*** | **13.51** | **8.73** | **11.09** | **14.55** | **21.43** | **15.13** | **13.38** | **11.23** | **12.30** |

* Total percentages are determined according to the number of cases in each TU sub-group. For example for 1, 3 and 5 TU sub-groups, respectively [(102x10.78)+(155x10.97)+(312x13.46)]/569=12.30.

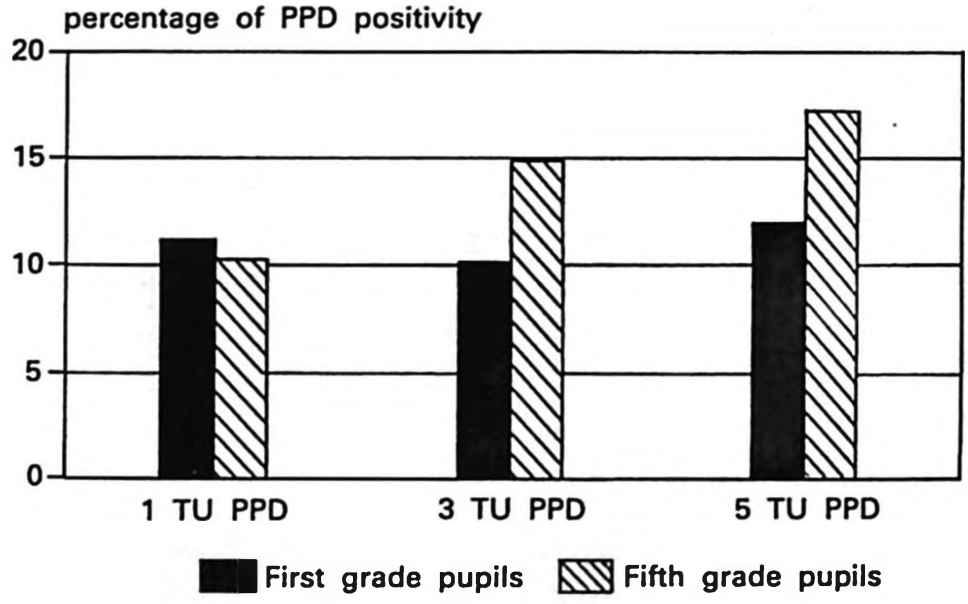


Fig. 1: Percentages of PPD positivity in 569 pupils who had not received BCG vaccine and were given 1, 3, and 5 TU PPD.

According to these data, PPD reactions are not dependent on the school grade, in other words, age and sex of pupils, with the exception of subjects given dosages of 5 TU. Table V shows AIR values for both first and fifth graders who received three different PPD dosages in order to determine the changes in AIR values according to dose (Fig. 2).

TABLE V: The Risk of Tb Infection in 569 Children Who Had Not Received BCG Vaccine in Relation to TU Subgroups

| Grades | Tb Risk of Infection (%) According to Applied PPD Dose | | | In General |
|---|---|---|---|---|
| | 1 TU | 3 TU | 5 TU | |
| First Grade | 1.62 | 1.44 | 1.71 | 1.62 |
| Fifth Grade | 0.88 | 1.40 | 1.57 | 1.40 |
| **Total** | **1.62** | **1.42** | **1.67** | **1.61** |

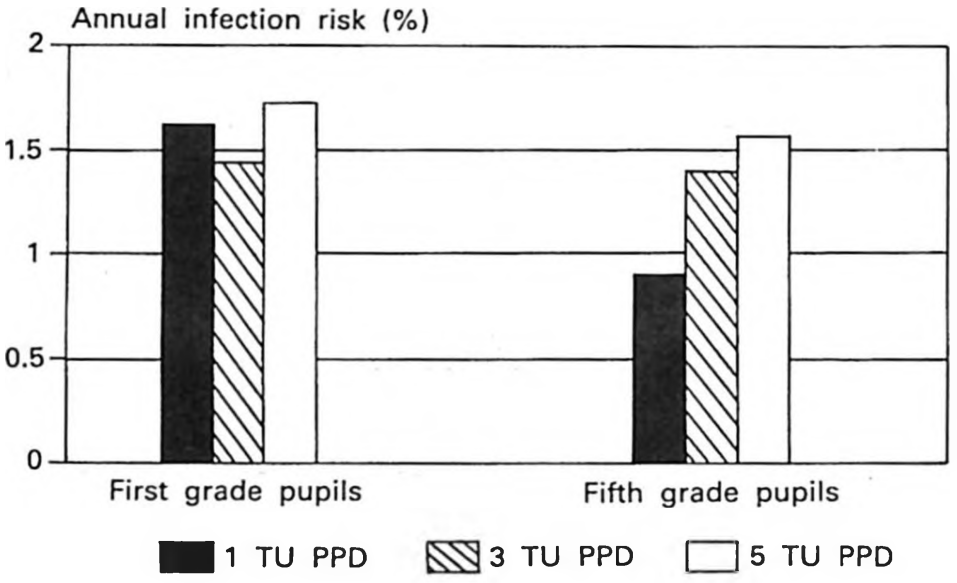


Fig. 2: Risk of Tb infection in 569 pupils who had not received BCG vaccine in relation to TU subgroups (%).

As seen from TABLE V, the AIR value increases according to PPD dosage and the possibility of delineating natural infection allergy rises[12, 14, 16, 17]. AIR is about 1.62 percent in the first grade and 1.40 percent in the fifth grade, which is to be expected because an inverse relationship exists between age and AIR. Additionally, the ratio of PPD (−) pupils without BCG vaccination gradually decreases with time because of natural infection allergy.

The AIR value of 1.61 percent listed in TABLE V for the entire group may be calculated more precisely. Considering the relative magnitude of the first and fifth grades in the total 569 pupils, real or effective AIR can be calculated more precisely as:

$$(1.62 \times 0.79) + (1.40 \times 0.21) = 1.57$$

One can easily assume by this AIR value that there may be 1.57 x 50 = 79 (per 100 thousand) smear (+) patients within a period of a year[4, 5, 12].

In TABLE VI, the AIR values calculated above were compared to the AIR values in other countries using relative risk coefficients.

TABLE VI: AIR Rates in Various Countries and Relative Risk Coefficients

| Country | 1950 - 53 | 1982 - 84 | Relative Risk |
|---|---|---|---|
| Syria | 3.0 % | 0.25 % | 6.28 |
| Egypt | 2.8 % | 0.40 % | 3.90 |
| The Netherlands | – | 0.07 % | 22.40 |
| Turkey: | | | |
| – (0 - 3) age, (1964) | 1.8 % | 0.65 % | – |
| – (0 - 6) age, (1964) | 2.0 % | 0.63 % | – |
| Presented study | – | 1.57 % | 1.0 |

## Discussion

The data obtained are more than striking. In WHO projects, it has been reported that AIR which was three percent in 1950 fell to 0.25 percent in 1983. In the Netherlands it was 10 percent in 1910 and fell to 0.07 percent by the end of 1984[4]. In comparison, the relative risk ratios have been reported as 6.3 in Syria, 3.9 in Egypt, and 22.4 in the Netherlands (Table VI; Fig. 3).

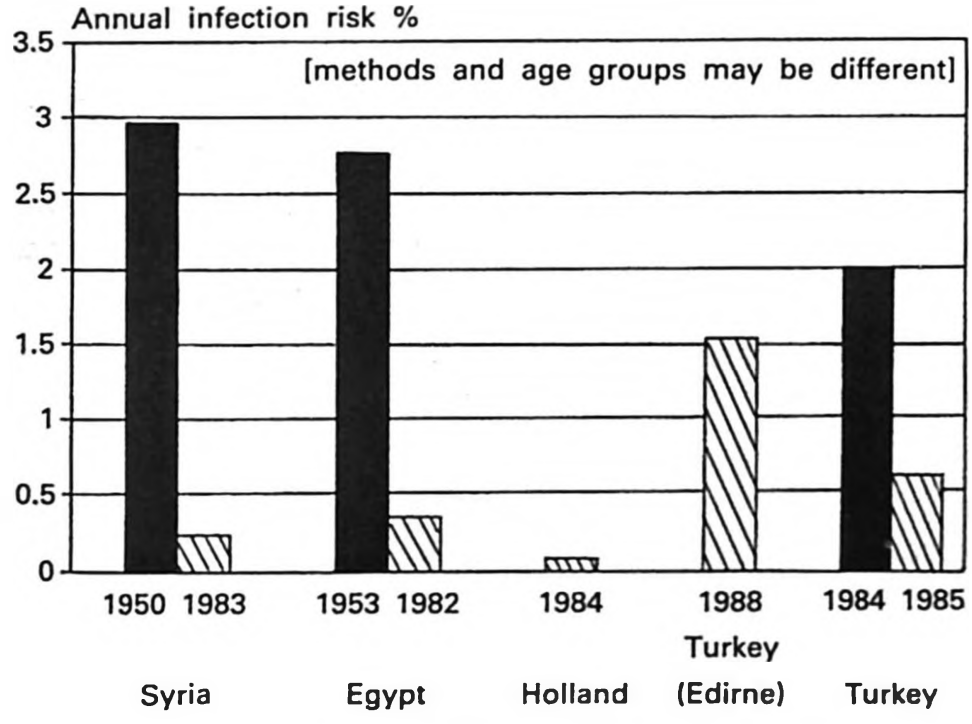


Fig. 3: Annual risk of Tb infection in various countries and in Edirne.

The official statistics on the number of Tb cases in Turkey is much lower than expected, which means that screening programs are limited. Thus, we cannot realistically abandon BCG vaccination programs and substitute them with active patient surveillance, as is implemented in Western countries. In Western countries, the infection reservoir was reduced to the present level only after BCG vaccination programs and other social and economic measures had been strictly implemented[18].

What is even more important than AIR itself, is the fact that the rate of AIR varies annually. An average annual (geometric) drop of 5.3 percent in AIR values has been reported in Turkey over the past twenty - one years[12].

Even though no great strides have been made in combatting Tb in Turkey, some improvement has been observed as a result of socioeconomic development[12]. Rates have been reported to be decreasing at an average of 7 percent in Syria, 13 percent in the Netherlands (1940 - 1984), and from 10 percent (1910 - 1940) to 6 percent (1950 - 1983) in Egypt[4]. In the United States a decreasing average annual rate of 8.5 percent has been noted, and it is envisaged that the rate of incidence might drop to 1 per million towards the year 2010[10]. These rates, which are dropping more than 5 percent annually, indicate the effectiveness of Tb control programs.

When compared to the average in Turkey, Edirne has better socioeconomic parameters. In spite of these relatively good living conditions, even if only present in the urban center, a remarkably high AIR has been reported in this province. Can it be said, therefore, that the average annual decrease of 5 percent in AIR values over the past twenty - one years did not result from campaigns waged to fight against Tb but rather from socioeconomic development? If this assumption is incorrect, then socioeconomic development in Turkey is at a standstill. What is more probable is that both factors equally influenced the drop in AIR.

Early, widespread and efficient vaccination programs should be given precedence, which should be followed by prompt implementation of other recommendations by WHO and adapted to Turkey's needs and conditions.

In conclusion, it is impossible to ignore Winslow's adage: "Tb can be defeated only in countries where poverty has been eliminated and there is adequate nutrition".

We plan further studies to monitor AIR trends in Edirne through longitudinal epidemiological surveys.

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