

Associations Between Socio-Environmental Determinants and the Risk of Pulmonary Tuberculosis in Guilan, Iran

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Abstract

Background: Certain social determinants may influence host susceptibility to tuberculosis (TB) infections, and increase the risk of developing the disease.

Objectives: The present study aimed to evaluate the effects of several host and environmental factors on the risk of TB in northern Iranian households.

Patients and Methods: This case-control study was conducted for one year between 2010 and 2011 in the Guilan province in Iran. Eighty-seven confirmed TB positive cases, based on convenience sampling, were included in this study. A patient positive for TB was confirmed by a positive sputum smear, chest X-ray, and clinical manifestations as diagnosed by a physician. The data were collected using observational methods, and were analyzed by SPSS software.

Results: The average mean age of the TB cases was 51 ± 22 years old, and 40.2% (35/87) of the TB cases were male and 59.8% (52/87) were female. The majority of TB cases were from rural areas (71.3%, 62/87), while 28.7% (25/87) were from urban areas. Significant differences ($P < 0.001$) were observed between the geographical conditions and distribution of the disease. The room density of the individuals was significantly different (2.9 ± 1.2 vs. 2.2 ± 1.9 , $P < 0.002$) among the TB cases and control group, respectively. A statistical difference was observed between the groups in terms of the building materials ($P < 0.05$), while significantly inadequate UV irradiation was seen in the houses of the TB patients, compared to the control group (82.8% vs. 14.9%, $P < 0.001$). The hygiene of the houses seemed to be a significant risk factor ($P < 0.001$) for TB infection.

Conclusions: The results suggest that in the studied region several host and environmental factors were associated with higher risks of TB infection.

Keywords: Tuberculosis, Risk Factors, Social Medicine, Case-Control Studies

1. Background

Tuberculosis (TB) is one of the oldest human life threatening diseases, and has been recorded in various ancient civilizations (1). It remains one of the most important causes of morbidity and mortality among the infectious diseases of humans (1, 2). Pulmonary TB has been described using different terms, such as consumption and phthisis, with both conditions describing the severe wasting and coughing up of blood, followed by later stages of the disease (1). This disease is frequently engaged with the pulmonary system; however, it can affect any other organ, which is called extra-pulmonary TB (3).

The world health organization (WHO) has reported that approximately 2 billion of the world's population have latent infections, 8 million are affected with the active dis-

ease, and 2-3 million die annually due to tuberculosis (3). According to the WHO reports, the estimated incidence rate of TB for Iranians in 2012 was 21 cases per 100,000 individuals in the population (4). One of the fundamental problems with the control of TB is that many people are infected with multidrug-resistant TB (MDR-TB), and most of them are from developing countries (5, 6). Previously published data from Iran has described the outcomes of MDR-TB and extensively drug-resistant TB (XDR-TB) among TB infected individuals (7-9). Iran neighbors Afghanistan, Pakistan, Azerbaijan, and Iraq, which all suffer high burdens of TB, which makes preventing TB particularly challenging, and should be considered (5).

TB usually occurs after prolonged close contact with

infected persons, and any condition modifying the balance established between the hosts' physiology and TB can have an impact on the risk of developing the disease (5). In addition, some social determinants may influence the hosts' susceptibility to TB infection, including the indoor air quality, overcrowding in homes and workplaces, poverty, and malnutrition (10-12). For example, vitamin D helps macrophages function and destroy TB bacteria, so a lack of vitamin D could increase the risk of TB infection (13). Significant social and economic obstacles, such as difficulties in obtaining transportation to health care facilities, can delay treatment in individuals with TB symptoms, and increase the chance of uninfected individuals being exposed (10).

The control strategies introduced by the WHO emphasize clinical solutions in the form of drugs, vaccines, and access to health care; but, despite the success of these programs, TB incidence and mortality have not decreased (13). Knowledge of the obstacles and identifying the risk factors can improve the health care policy.

2. Objectives

The present study was performed with aims to evaluate the effects of some of the host and environmental factors on the risk of TB in northern Iranian households.

3. Materials and Methods

3.1. Study Design and Setting

This case-control study was conducted for one year, from 2010 to 2011, in Siahkal, Guilan, Iran. The population of Siahkal city is divided into two parts, urban (17,848 inhabitants covered by health care centers) and rural (30,332 inhabitants covered by health care centers). In the rural area, many of the houses were made of mud bricks and thatched roofs.

3.2. Study Population

The study subjects were made up of patients recorded

in the district databases (health care centers), who had TB as a primary diagnosis. A positive TB infection was confirmed by a positive sputum smear, chest X-ray, and clinical manifestations as diagnosed by a physician.

In total, 87 confirmed TB positive cases, based on convenience sampling, were included in the present study. The TB positive cases ranged in age from 10 to 87 years old, with a mean age of 51 years old. The controls were selected to be as close as possible to the TB positive subjects in terms of gender and age, with a mean age of 53 years old. The controls had negative TB smears, but were excluded if they reported coughs for more than two weeks (or any other signs of TB), and if any members of their household had TB.

3.3. Measured Risk Factors and Equipment

The data were collected by using a pretested structured questionnaire. Each household was visited by one observer, and the demographic information was collected using face-to-face interviews. The information collected included host factors (sex, age, and weight) and environmental factors (light level, UV level, humidity, ventilation, and building materials). The measured variables, equipment used, and criteria used for measuring the variables is presented in Table 1.

This study was conducted in accordance with the declaration of Helsinki, approved by the regional ethics committee, and informed written consent was obtained from all of the participants. The patients' private details were kept strictly confidential.

3.4. Statistical Analysis

The data analysis was carried out using SPSS™ software, version 19.0 (IBM Corp., Armonk, NY, USA). The frequency of the risk factors was presented as descriptive statistics in terms of relative frequency. Paired t-tests were used to compare the differences between the two groups' means. A value of $P < 0.05$ was considered to be statistically significant.

Table 1. Participant Criteria Considered to be Potential Risk Factors for TB

Criteria	Variable Type	Measurement Method/Units
Age, y	Quantitative	Self questionnaire
Gender	Qualitative	Self questionnaire
Weight, kg	Quantitative	Measurement instrument
Humidity, relative humidity %	Quantitative	WBGT meter
Light, lux (< 300 lux considered a risk factor)	Quantitative	Lux meter
UV irradiation, $Mw/s\text{ Cm}^2$ (> 0.002 $Mw/s\text{ Cm}^2$ considered a risk factor)	Quantitative	UV meter
Ventilation, relative score	Qualitative	Observational
Building materials, type of materials	Qualitative	Observational
Waste disposal system, relative score	Qualitative	Observational
Restroom condition, relative score	Qualitative	Observational

Table 2. Association of Socio-Environmental Factors With the Risk of TB

Environmental Factors	Subjects	Controls	PValue
Age, y			0.5851
Mean \pm SD	51 \pm 22	53 \pm 14	
Range	10 - 87	28 - 80	
Weight, kg			< 0.001
Mean \pm SD	57.9 \pm 12.6	71.3 \pm 11.4	
Range	36 - 93	42 - 90	
Type of building materials			
Wooden-clay	36 (41.4)	16 (18.4)	0.0017
Brick	15 (17.2)	19 (21.8)	0.5663
Cement block	37 (42.5)	53 (60.9)	0.0229
Inadequate housing	57 (65.5)	18 (20.7)	< 0.001
Housing with high humidity	56 (64.4)	35 (40.2)	0.0024
Housing light < 300 Lux	67 (77.0)	10 (11.5)	< 0.001
Inappropriate ventilation	68 (78.2)	16 (18.4)	< 0.001
Inadequate UV irradiation	72 (82.8)	13 (14.9)	< 0.001
Inadequate restroom	61 (70.1)	22 (25.3)	< 0.001
Unsafe waste disposal	66 (75.9)	17 (19.5)	< 0.001

4. Results

Overall, 40.2% (35/87) of the TB cases were male, and 59.8% (52/87) were female. The average weight of the patients in the TB group was 57.9 kg, ranging from a minimum of 36 kg to a maximum of 96 kg, which was significantly ($P < 0.001$) lower than in the control group (71.3 kg). The majority of the cases were from rural areas (71.3%, 62/87), while 28.7% (25/87) were from urban areas. In total, 4.6% of the patients were from the countryside, with the majority coming from the plains region. The statistical analyses have revealed significant differences ($P < 0.001$) between the geographical conditions and distribution of the disease.

In the TB group, the average density of the persons per room (PPR) was 2.9 ± 1.2 , and in the control group it was 2.2 ± 1.9 ; therefore, the density of the PPR was significantly different ($P < 0.002$) between the studied groups. The two groups showed no statistical differences in terms of the family members average (data are not shown). With regard to the heating appliances and drinking water conditions in the home, there were no significant differences between the groups; however, 76.2% of the homes in both groups did not have a proper exhaust pipe.

A significant difference was not observed between the TB group and the control group in terms of the buildings with brick materials; however, the wooden-clay and cement buildings showed significant differences ($P < 0.05$) between the studied groups. A higher proportion (82.8%) of inadequate UV irradiation and, subsequently, lack of UV absorption were seen among the TB cases, compared to the controls. Poor house hygiene seemed to be asso-

ciated with a significant risk for TB infection in the TB group ($P < 0.001$); additionally, the restroom conditions and safe garbage disposal were inadequate in most of the houses (70.1% and 75.9%, respectively). Complete lists of the environmental risk factors for the transmission and development of the disease in both groups, and the clinical relevance, are described in Table 2.

5. Discussion

In this study, several host and environmental risk factors among TB patients were investigated in Guilan, Iran. The latest report of the tuberculosis and leprosy control office, department of health and education of Iran in 2011 put Guilan in a delicate situation for TB studies due to its high incidence of TB (24 per 100,000), after the Sistan/Baluchestan and Golestan provinces (14). TB is usually associated with multi-factorial environmental and host related factors (10, 12); therefore, any attempts to understand the respective effects of environmental and host related factors on the development of the disease can have useful implications for TB control and prevention (11). To the best of our knowledge, there is a lack of such a study in our region; therefore, the present study was designed, using a case-control method, to evaluate the probable roles of some host and environmental factors among positive TB smear patients in Guilan.

In the current study, the incidence of TB was slightly higher among females, and TB in the Iranian population overall seems to be more common in females, compared

to other parts of the world, but this may be associated with certain social and genetic factors (5, 15). In support of our finding, Yazdani Charati *et al.* from Kurdistan (western Iran) reported a higher incidence of TB in females (16).

The average age of the positive smear patients was 51 years old, suggesting that TB was more common in the older people in our studied area. Overall, the incidence of TB in developing countries is higher in young adults, but in developed countries, the incidence is higher in older people, which is similar to our findings (5, 17). Although the differences may be due to variations in socioeconomics and lifestyles in different parts of the world (10, 12). Moreover, a loss of weight seems to increase one's risk of being infected with TB, since our results showed significantly lower weights in the TB cases than in the control group.

Demographic data has shown different patterns for the geographical distribution of the disease, which could be reflected by health care service accessibility, lifestyle, genetic factors, and many other social or environmental factors in this region. However, different TB incidences between different parts of the countries around the world are not uncommon (18, 19). A significant correlation between the PPR and TB was seen in the findings of the present study, which was in accordance with a previous study by Clark *et al.* in a Canadian population. They showed that the increasing rates of the PPR in a community were associated with increased cases of TB (20). However, in a hospital survey in Brazil, no significant difference was observed between the PPRs for the TB group and the other studied group (21). Previously, it was shown that large families were at a higher risk of contracting TB, when compared to families with a lower population (16). However, in the current study, it was found that the household size had no influence on the prevalence of a TB infection.

A significant correlation between inadequate housing and TB was seen in the present study, and was directly associated with the household economy. Previously, the association between the household socioeconomic position and prevalence of TB in Zambia was reported (22). In addition, Oxlade *et al.* indicated an association between poverty and the prevalence of TB among Indians (23). An important finding of this study was the suggestion of a higher risk of TB among those living in homes with insufficient sunlight. Moreover, the significantly lower UV radiation level in the TB cases' homes may indicate a correlation between the UV level and TB bacterial survival in the home. This phenomenon may subsequently lead to an increasing risk of exposure to TB infection.

Our results showed that a significantly larger proportion of the TB cases were living in houses made of wooden-clay materials ($P < 0.001$). In addition, the controls were more likely to live in houses made of cement materials ($P < 0.05$). Similar findings were reported by Taha *et al.* in a study from southwestern Ethiopia (24). In ad-

dition, inappropriate ventilation was one of the items in our study which was significantly higher in the TB cases, which was in agreement with the findings of Ho Lin *et al.* who showed that indoor air pollution increased the risk of TB (25). Furthermore, household hygiene plays a principal role in the transmission of disease, so it is not strange that we found a significant association among those who lived in homes with poor sanitation systems (inadequate restroom and unsafe waste disposal) (26, 27).

Our study did have some limitations. First, a larger sample size of cases, along with a wider range of studied regions in our province could strengthen the results. Second, we cannot exclude the possibility of a simultaneous association between the risk factors and risk of active TB. Finally, our TB rates might have been improved if more precise methods, such as cultures and PCR, were employed (28).

In summary, our results support the associations between host and environmental factors with higher risks of TB in the studied region. It seems that the lifestyles of the people living in this region can directly affect their general health. Therefore, any attempts to improve their socioeconomic levels may result in the prevention of TB, which can be much more cost effective when compared to treatment programs. However, since most of these risk factors are closely related to each other, further studies to examine these factors simultaneously, as well in different regions, are recommended.

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Footnotes

Authors' Contribution: Study concept and design: Yosef Taher-Ghasemi, Iraj Nikokar, Ahmad Reza Yazdanbakhsh; acquisition of data: Ahmad Reza Yazdanbakhsh; analysis and interpretation of data: Robabe Vakili Sadeghi, Ahmad Reza Yazdanbakhsh; drafting of the manuscript: Hadi Sedigh Ebrahim-Saraie, Iraj Nikokar; critical revision of the manuscript: Hadi Sedigh Ebrahim-Saraie, Iraj Nikokar; statistical analysis: Abdolhalim Rajabi; study supervision: Iraj Nikokar.

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