Quest Journals
Journal of Medical and Dental Science Research
Volume 7~ Issue 4 (2020) pp: 21-29
ISSN(Online) : 2394-076X ISSN (Print):2394-0751
www.questjournals.org

Research Paper

Social Determinants in Household Contacts and Index Cases of Tuberculosis in Lima, Peru

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Abstract
Introduction: Lima has the highest reported incidence of TB cases in Latin America. Social determinants have an impact on health care outcomes. The purpose of this study was to determine the social determinants of health associated with developing TB of household contacts who share living spaces in diagnosed index cases identified by the Healthcare facility of the Ministry of Health in Peru. Methods: The study is descriptive, analytical, and cross-sectional, the sample surveyed is a census of household contacts (n = 51) of the index cases (n = 51) who were recruited from a Healthcare facility that belongs to the Ministry of Health between April and June 2019. The social determinants of health were measured as sociodemographic, clinical and environmental risk factors.Results: sociodemographic, basic housing services were partial (p = 0.04), overcrowding (p = 0.02), poor ventilation (p = 0.01) and exposure to the index case (p = 0.02) were significant findings. Of the 51 household contacts, 7.8% (n = 4) developed pulmonary TB and all were under the age of 15. None of the household contacts received preventive medications (ISZ). TB is a global health threat to all. Social determinants of health must be improved to prevent the continued increase and spread of TB in Peru. It is essential that poverty and inequality in social determinants should be identified to improve health care for all.
Key Works: *Tuberculosis, Household Contacts, Social Determinants of Health*

Received 04 September, 2020; Accepted 19 September, 2020 © the Author(S) 2020.
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I. INTRODUCTION

In 2017, the World Health Organization (WHO) reported new cases of tuberculosis (TB) were up to 11 million people with 1.6 million deaths reported. TB has reemerged as a threat to public health in the world. Even with treatment, it is estimated that one third of the world's population has latent TB and are infected. In Peru, is evident that TB is clearly associated with poverty. The country is identified as a part of the low-income and middle-income countries (LMIC) with 21.8% of people living in extreme poverty.In the highlands of Peru, extreme poverty reaches 32.5%. Although the unemployment rate is 4.2%, the average wage is $ 4.00 per hour in the formal sector and $ 1.80 per hour in the informal sector (PAHO, 2017). Peru has 14% of estimated cases of TB in the Region of the Americas with metropolitan Lima and Callao reporting 64% of TB cases in the country. More concerning, 79% of cases are multidrug-resistant TB (MDR-TB) and 70% of cases are extensively resistant TB (XDR-TB). Lima city, is the one that concentrates the highest burden of tuberculosis, MDR-TB and XDR-TB and the highest incidence(PAHO, 2019), this area includes the district of San Juan de Lurigancho (scene of this study).In the last 2 years, five regions in Peru (Madre de Dios, Ucayali, Loreto, Lima and Ica) reported incidence of TB above the national level. These regions reported 72% of the new cases in Peru. Despite effective treatments and control measures carried out by the World Health Organization (WHO) together with the UNION (International Union Against Tuberculosis and Lung Disease) is reported the highest percentage of deaths (45%), Metropolitan Lima (11.9%) and Callao (15.1%) (MINSA, 2016).

Failure of TB treatment results in high costs, loss of follow-up, recurrence, and death. Treatment can be financially catastrophic to families who are already impoverished. In families receiving socioeconomic support, health outcomes improve. This includes household contacts to begin prevention therapy that is very expensive (Wingfield, et al., 2017).Social determinants of health are strong indicators of health outcomes. In a meta-analysis, reported that the social determinants of health identified with the failure of TB therapy include low income, lack of education and alcohol abuse(Di Gennaro, et al., 2017).A model of the social and structural determinants of tuberculosis was developed and included factors related to the sociodemographic factor, clinical factors and environmental factors, referring to the home internal environment (ventilation), which are indicators

of poverty, similar to those that report wealth / poverty, indoor air pollution (ventilation), overcrowding, and macroeconomic influences (Pedrazzoli, 2017).

In Peru, National TB programs must be adapted to be inclusive for all people who are at risk of infection including all household contacts.These programs must include improving health outcomes for persons with TB, decreasing poverty, and food security (Wingfield, Tovar, Datta, Saunders, & Evans, 2018).

TB treatment in Peru, is developed through dyads of care providers and patients, entitled as household contact and index case, respectively. The household contact is the person who lives and has contact with the patient and is exposed to the index case on a daily basis, which places this person at risk for developing TB.The purpose of this study was to determine the social determinants of health associated with developing TB of household contacts who share living spaces in diagnosed index cases identified by the Healthcare facility of the Ministry of Health in Peru.

Sensitive tuberculosis. Is the case that demonstrated sensitivity to all first-line drugs by conventional sensitivity tests.

Index case: It is the person who has been diagnosed with TB.

Risk based on exposure to risk factors: is the knowledge of the risk implies the exploration of the factors that condition it. (Colimon, K., 2018)

Exposure time: it is the risk implied by the presence or frequency of a characteristic or factor that increases the probability of adverse consequences.

Home contact: is the person who lives in the home of the index case with tuberculosis. People who share or shared the same address with the index case with TB.

Symptomatic Respiratory (S.R.): is any person who presents cough with expectoration for more than 15 days.

Exposure time to the index case. It is the frequency per day of coexistence between the household contact and the index case.(MINSA, 2018)

The 3 research questions were:

RQ1: Is there an association between the sociodemographic factors of age, sex, and relationship with the index case; education, occupation of contacts, exposure time, housing area, contacts over 15 years old and under 14 years old who share the house and the development of TB in the household contacts of index cases?

RQ2: Is there an association between the clinical risk factors that developed pulmonary TB, admission, height, weight, respiratory symptoms, Isoniazid preventive therapy (IPT); TB comorbidity and TB development in index case household contacts?

RQ3: Is there an association between the environmental factors of housing, basic services, overcrowding, sanitation and ventilation and the development of TB in the household contacts of index cases?

II. METHODS

Design

The study is descriptive, analytical and cross-sectional, the population of index cases was 51 (patients with pulmonary tuberculosis) registered at the time of the study in the tuberculosis program of the San Juan de Lurigancho healthcare facility, 1 household contact was selected of each index case.The field work was carried out at the Healthcare facility and at the patients' homes, to obtain information on the index case and household contacts, through two pre-established instruments. The first instrument, obtained information of the index case diagnosed with Pulmonary TB, data obtained from the Healthcare facility records, and the second, to obtained contact information through a survey applied to the contact who was at home. In under-age contacts, the oldest person in charge who was at the time with the child was surveyed.The instrument of the household contacts consisted of three social factors: a) Sociodemographic factors: which obtained the diagnostic data of the index case, age, sex, relationship with the index case; education, occupation, exposure time (Daily, 2 to 3 times per week, 4 to 5 times per week); housing area (rural, urban, and human settlement); contacts under 14 years old and over 15 years old who share the home. b) Clinical risk factors: contact that developed pulmonary TB, type of admission made up of categories of new, recovered abandonment, relapse, and failure; height, weight; respiratory symptoms; Isoniazidpreventive therapy (IPT); comorbidity associated with TB (data obtained from the clinical records). c) Environmental risk factor: information obtained from contacts and home's observation, basic services (water, electricity, sewerage), overcrowding (number of people / room); health (hygiene), and ventilation (good, fair, bad).The data were processed using SPSS version 23. The participation of the contacts was voluntary, anonymous, upon acceptance by informed consent and commitment to respond to all inquiries made.

Sample

The sample consisted of 51 household contacts of TB index cases. One contact for each index case was selected to be interviewed. Participants of the study were identified through the Healthcare facility of the Ministry of Health between April - June 2019.

Setting

The study took place in Lima, Peru. The index cases were registered at the time of the study in the TB program of the San Juan de Lurigancho Healthcare facility.The interviews took place in the patients' homes. Human settlements are groups of houses of any type or size where people live, in Peru, on the hills around Lima. See image 1.

For this study, social determinants of health were measured as sociodemographic, clinical, and environmental factors. The information was generated from the index cases and from the household contacts, through two pre-established surveys.

1. The first data collection was demographic information on record to describe the index case (patient) with TB diagnosis.
2. The second data collection was on the household contacts through a home interview on sociodemographic, clinical, and environmental factors including the following.

a) Sociodemographic factors: age, gender, education, employment, relationship with the index case.

b) Clinical factors of household Contacts who developed TB: contacts that developed new cases of TB, time of exposure, abandoned recovery, relapse, failure of treatment, height, weight, respiratory symptoms, Isoniazid preventive therapy (IPT) and TB associated diseases.

c) Environmental factors: basic housing services, number of people living at home (overcrowding), ventilation, and housing areas including not only rural and urban but human settlements.

Process

Permission was obtained from the Ministry of Health Program to carry out the study. There were 51 index cases in the database and 208 household contacts (an average of 4 contacts per index case). The index cases were patients who had been in the Ministry of Health Program for TB treatment and management. In each of these cases, an adult contact who was at home was the interviewed, in under-age contacts, an adult was the person who gave the information, so that underage can be the household contact. When the household contact was selected, this person was not diagnosed with tuberculosis, but was a contact of a diagnosed case prior the visit.Nursing students collected data for the study and had a 2-day (6-hour) training about the project. Nursing students notified participants about the study. At the scheduled visit, nursing students obtained consent and collected data.

Surveys

The researcher developed a survey to collect data about the social determinants of health.The structure of the content corresponds to the theoretical model of pulmonary TB.The instruments enclosed 52 items. The validity of internal consistency was measured through a pilot test in 10 household contacts in a similar healthcare facility of the Ministry of Health and with similar characteristics of the study population.After the pilot, adjustments were made in the 1) variables sociodemographic risk factors in relation to age groups, and the 2) indicators range in relation to the frequency of household contacts who share housing with case index at the time of data collection.From this review, the variables of social determinants were divided into area of sociodemographic, clinical and environmental risk factor dimensions associated with household contacts and pulmonary TB diagnosis.The validity of the household contacts instrument was tested in 10 participants (pilot) from another healthcare facility, similar to the study population. The internal consistency of the instrument was measured as a reliability test through the Cronbach's alpha coefficient, the value obtained was 0.82, (high reliability).

Data Analysis

Data was processed through SPSS version 23. All variables were coded and placed in the database. Simple and cumulative frequencies of all variables were calculated. To determine the association of the variables sociodemographic risk factors, the following were considered: index case diagnosis, age, sex, relationship with the index case; education, occupation, exposure time (daily, 2 to 3 times per week, 4 to 5 times per week); housing area (rural, urban, and human settlement); contacts over 15 years old and under 14 years old.Environmental, considered: home basic services (water, electricity, and sewerage), overcrowding (number of people per room); sanitation (hygiene), and ventilation (good, fair, bad); and for pulmonary TB development variable, Chi-square statistical test was used, with $P < 0.05$. For clinical risk factors, the following were considered: contacts who developed TB, admission type (new, recovered abandonment, relapse, and failure); height, weight; respiratory symptoms; Isoniazid preventive therapy (IPT); comorbidity associated with TB, T Student test was used, with $P < 0.05$, the most relevant results of the risk factors were analyzed.

Ethics Review

The participation of the household contacts was voluntary and anonymous. Nursing students obtained informed consent from the household contacts. The study was approved by María Auxiliadora University Research Ethics Review Board.

III. RESULTS

There were 51 index cases. The study participants were household contacts who lived with the patients diagnosed with sensitive TB (78.4%) and multidrug-resistant TB (MDR-TB) (21.6%).4 household contacts were diagnosed with pulmonary TB all of them were under age. Of these, 2 with comorbidity of HIV and DM. See Table 1.

RQ1: Is there an association between the sociodemographic risk factors and the development of TB in the household contacts of index cases?

Data on sociodemographic risk factors for age, sex, relationship with the index case, education and employment were measured in household contacts.Household contacts family relationship with index cases were parents (n = 19, 37%), spouses (n = 17, 33%), children (n = 9, 18%), siblings (n = 15, 10 %) and aunts / uncles (n = 1, 2%). Age was a significant factor in the development of TB in household contacts (of those who developed and did not develop). The most associated factors were the daily exposure time with the TB index case, (n = 43, 84.4), living in human settlements areas (of high poverty) (n = 34, 66.7%),> 15 years old living with 1 to 2 people (n = 29, 56.9%), and <14 years old living with 3 to 4 people at home (n = 30, 58.8%) are contacts who developed and did not develop TB, that represent a risk. See table 2.

RQ2: Is there an association between the clinical risk factors and TB development in index case household contacts?

Clinical risk factors data are admission of the household contact, height, weight, respiratory symptoms, preventive therapy with isoniazid (PTI) and comorbidity associated with pulmonary TB, data obtained from the household contacts clinical records who developed TB such as consequence of being in contact with the index case.

Of the household contacts, developed TB (n = 4, 7.8%) in condition of new admission that before did not have pulmonary TB. All of these were under 15 years old, medium height (n = 2.50%), low weight (n = 3.75%), with respiratory symptoms (n = 2.50%), and all contacts with or without TB development, did not receive preventive isoniazid therapy (n = 51, 100%). Associated morbidities in contacts who infected with TB included HIV / AIDS and DM in 50% of household contacts. 7.8% household contacts under 15 years old out of every 100 index cases were infected. See Table 4.

The clinical risk factors of new admission and the clinical assessment of the respiratory symptoms, height, weight, preventive therapy, medical prescription, are those that are significantly associated with a level of significance $\alpha = 0.05$ to developing pulmonary TB in contacts that were infected at home ($p = 0.000$), see Fig. 1.

RQ3: Is there an association between the environmental risk factors and the development of TB in the household contacts of index cases?

Data on environmental risk factors included partial basic housing services (water, electricity, sewerage), number of people at home, overcrowding is 3 to 4 people per room (n = 26, 50.1%), housing with moderate sanitation (n = 28, 54.9%), poor ventilation (n = 30, 58.8%), housing area (human settlement, rural, urban) was measured in the home where the household contact and the index case lived. Basic services were associated with housing ($p = 0.03$), overcrowding ($p = 0.02$) and ventilation ($p = 0.01$) were relevant factors that associate the risk of developing pulmonary TB in household contacts that developed it and if they did not develop pulmonary TB, they are at risk, see table 5.

IV. DISCUSSION

The study included 51 household contacts from index cases. The total number of contacts at risk was 208 people, but only 1 household was interviewed. Of the 51 household contacts, 4 had developed sensitive TB with new admission condition that did not had TB before. Mycobacterium TB or Koch bacillus, are 2 forms of sensitive TB and have the highest risk of contagion (Choi, 2019). Although only 4 of the household contacts were diagnosed with sensitive TB, all household contacts had a risk of developing TB for the time of daily exposure with an index case.

Significantly, household contacts were men (58.8%) between 26 and 45 years, similar results to those found (WHO, 2019). Tuberculosis mainly affects adults in the most productive years of their lives, and does not mean that other age groups are free of risks. More than 95% of cases and deaths are concentrated in developing countries. In relation to education and occupation, it is significant that among the sample they have high school education and work independently (selling food on the streets, gardening, etc.) but they did not work as formal employees, therefore they did not have health insurance. These findings are consistent as the author reports

(Bandera-Jiménez et al., 2018).It was found that the increased risk of lung involvement is for males, from 26 years, which is consistent (Antonio-Bioco, 2016). Is concerning that, 7.8% householdcontacts under 15 years old have being infected for every 100 index cases, if prevention is not applied, those who did not develop TB are at risk of contagion.

According to, National Tuberculosis Program of Peru guidelines recommend that preventive therapy be provided to all contacts under the age of 5 unless they have a TB positive test. In addition, all contacts between 15-19 years old with a positive TB skin test should be on preventive therapy. It is concerning that, none of the household contacts (n = 51) out of 208 did not receive preventive ISZ therapy. Theimplications for practice should address the children needs of living in homes exposed to the risk of a family member with pulmonary TB and provide prevention education programs for children in these homes (Minsa, 2018) / (Minsa, 2019).

Diseases associated with the development of TB in contacts that were infected are HIV / AIDS and Diabetes Mellitus. HIV infection is a risk factor for pulmonary TB and impacts HIV comorbidity (MINSA, 2016). As the viral load increases and accelerates, AIDS patients are more susceptible to tuberculosis.In HIV infection, CD4-type lymphocytes are affected and, therefore, the risk of reactivation of latent Mycobacterium TB infection increases (Alarcón, et al., 2017) / (Dália-Alvesa, et al., 2019).

The implications for practice would be related to the identification of those patients with comorbidities at high risk of developing TB. None of the household contacts received preventive therapy for TB. Clinical trials have shown that ISZ treatment is effective in slowing the TB progression in 90% of cases. However, due to latent tuberculosis infection, people who could benefit from ISZ are not identified from the beginning. Treatment compliance is also reported to be a problem in people who are the poorest of the poor.The implications for practice would require greater access to preventive treatment for all people despite the social determinants of health and the development of programs to monitor treatment programs to ensure compliance (Wingfield, et al., 2017).

Is not surprising, basic household services, including water, electricity, and sewage, were identified as significant in the study. Most dyads lived in human settlements, in poverty, with at least 4 people living together in a dyad, and with poor ventilation. All of these factors are a perfect storm to develop TB. These are consistent findings with the literature with participants reporting inadequate sewer services and overcrowding (Maldonado-Balanzar and Lagunas-Flores, 2016) / (Hernández-Mahecha, et al., 2017).Health identifies the disparities and social inequalities that generate poverty and therefore impact on health outcomes of tuberculosis (Alarcón, et al., 2017) / (Dália-Alvesa, et al., 2019). The implications for practice include targeting innovative interventions specifically on social determinants that have identified risk factors for pulmonary TB development (Hilary Daniel, Sue S. Bornstein, Gregory C. Kane, 2018).

Environmental control measures aim to reduce the concentration of infectious droplet nuclei. There is a wide variety of environmental control measures, including natural ventilation, mechanical ventilation and ventilation accessories such as air filtration and ultraviolet light. National Tuberculosis Program of Peru guidelines recommend maximizing natural ventilation that is the easiest and cheapest method, the objective is to eliminate and dilute the air in areas of people with tuberculosis away from people without TB, especially in countries with warm weather.This can be done by opening the waiting areas windows, if they do not exist or are not enough, windows or other entryway that communicate with the outside must be installed. When there are ceiling fans it is important that the windows remain open to dilute and exchange air flow. A minimum acceptable condition includes openings at opposite ends of a room (window-window, door-window(Minsade, 2019) / (Álvaro M, Díaz A, Díez J, Resino R, Resino S. 2016) / (Yang X, Zhou H, Pan X. 2017) / (Minsa, 2019).Early patient diagnosis and treatment compliance of the first-line antibiotics for six months, is the formula for people who developed TB to be cured and thus the infection risk can be controlled. The number of cases and annual deaths may be reduce and the social risk factors prevalence such as diabetes and HIV infection, if giving preventive treatment of ISZ, to people with latent TB infection and establishing multisectoral measures in the social determinants of TB development, faced by patients and their families, must be mitigated and intensified, such as poverty, quality of housing and malnutrition described in the Global Tuberculosis Report (WHO, 2019).

V. CONCLUSIONS

The sociodemographic risk factors that stood out the most are the age of a young adult, time of daily exposure to the index case, dwelling area in a human settlement (poverty) and coexistence in the same house are those that were associated with developing pulmonary tuberculosis.

Clinical risk factors were household contacts who developed pulmonary TB, typical TB symptoms are associated with HIV / AIDS and Diabetes Mellitus, lack of ISZ preventive therapy were associated with developing pulmonary tuberculosis.

In environmental risk factors, basic services of water, electricity and sewerage, overcrowding, medium sanitation, and poor ventilation are more relevant, associated with the risk of developing pulmonary TB.

VI. RECOMMENDATIONS

Despite the fact that Peru has many programs for the prevention and treatment of TB, the majority of people who suffer from social determinants of health are poor and do not benefit from these programs, the focus should be on controlling the areas where TB continues to develop, addressing the social determinants of health to improve the health care outcomes of TB patients in Peru. Tuberculosis is at risk of becoming an incurable disease due to drug resistance and poor administration of disease control programs.

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Image 1
Human Settlements in Lima

Table 1: Household Contacts and Case Indexes demographics		
DEMOGRAPHICS	HOUSEHOLD CONTACTS N = 51	CASE INDEXES N=51
Gender		
Male	n = 30 (57.8%)	n = 33 (64.7%)
Female	n = 21 (41.2)	n = 18 (35.3)
Age		
<5	n = 2 (3.9%)	n = 0
6-14	n = 5 (9.8%)	n = 0
15-25	n = 2 (3.9%)	n = 2 (3.9%)
26-45	n = 28 (54.9%)	n = 35 (68.6%)
>46	n = 14 (27.4%)	n = 14 (27.5%)
Education		
None	n = 4 (7.8%)	n = 3 (5.9%)
Primary	n = 18 (35.3%)	n = 20 (39.2%)
Secondary	n = 27 (52.9%)	n = 25 (49.0%)
Technical	n = 2 (4%)	n = 3 (5.9%)
Work Status		
Dependent	n = 14 (27.4%)	n = 15 (29.4%)
Independent	n = 34 (66.7%)	n = 36 (70.6%)
Do not work (<14 year)	n = 3 (5.9%)	
TB Diagnosis		
Sensitive	n = 4 (7.8%)	n = 40 (78.0%)
MDR Resistant		n = 11 (22.0%)

Table 2 Sociodemographic risk factors associated with developing pulmonary TB in household contacts

Sociodemographic factors	Household contacts						P<0.05
	TB development		No **TB development**		Total		
	n	%	n	%	n	%	

Exposure time to the case Index	Daily	4	7.8	39	76.5	43	84.4	0.016
Home location	Human Settlements	4	7.8	30	58.8	34	66.7	0.016
>15 years old living in the home	1 to 2 people	2	6.9	27	52.9	29	56.9	0.015
<14 years old living in the home	3 to 4 people	2	6.9	28	54.9	30	58.8	0.016

Source: San Juan de Lurigancho Healthcare facility, Peru.
Significant level: *p< 0.05*

Table 3: Sociodemographic determinants of exposure to the case index associated with developing Pulmonary TB in household contacts

Sociodemographic Factors		Household Contact						p value
		Developed TB		Did not develop TB		Total		
		n	%	n	%	n	%	
Case exposure time Index	Daily	4	7.8	39	76.5	43	84.3	0.016
Housing Location	Human settlement	4	7.8	30	58.8	34	66.7	0.016

Source: San Juan de Lurigancho Healthcare facility, Peru.
Significant level: *p< 0.05*

Table 4 Clinical factors associated with developing pulmonary TB in household contacts

Clinical factor		**TB development**		**Total**		**p<0.05**
		%	n	n	%	
Contact admission	New admission	100	4	4	7.8	0.000
Height	Medium height	50	2	2	3.9	
Weight	Underweight	75	3	3	5.9	0.000
Respiratory symptoms	Respiratory symptoms	50	2	2	3.9	0.000
Isoniazid preventive therapy (IPT)	They did not receive ISZ	100	4	47	100	0.000
TB-associated comorbidity	HIV/SIDA	25	1	1	2.0	0.000
	Mellitus Diabetes	25	1	1	2.0	

Table 5: Environmental social determinants associated with developing TB in household contacts

Environmental Factors		Social determinants of household contacts						p value P<0.05
		Developed TB		Did not develop TB		Total		
		n	%	n	%	n	%	
Basic Services	Water and electricity	0	0	30	58.8	30	58.8	0.037
Overcrowding	3 - 4 personas	4	7.8	22	43.1	26	50.1	0.022
Health	Moderately healthy	3	5.9	25	49.0	28	54.9	0.413
Ventilation (Air circulation)	Stuffines	2	3.9	28	54.9	30	58.8	0.012
Total		4	7.8	47	92.2	51	100	

Source: Centro de salud de San Juan de Lurigancho, Perú
Significant level: p< 0.05