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A Socio-Ecological Model to Assess Tuberculosis in Migrant Farmworkers in the US-Mexico Border Region

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Abstract

The migrant and seasonal farmworker toiling in the fields and orchards of the United States of America surmounts innumerable problems daily. Some of these problems pertain to the overall health of the farmworker in addition to the various occupational hazards that he or she faces. This research paper focuses on Tuberculosis infection—both latent and active—in the migrant farmworkers in the United States with a special focus on the US-Mexico border. Using the Socio-Ecological Model as a theoretical framework, the TB health issues faced by this group are studied. The various determinants of health at every level of the Socio-Ecological Model are cogitated upon and culturally appropriate interventions are suggested. This research paper corroborates the fact that health issues facing mobile communities like migrant farmworkers require a synergistic approach by various stakeholders spanning the length and breadth of the Americas.

Keywords

Tuberculosis, Migrant Farmworkers, Socio-Ecological Model, US-Mexico Border

1. Introduction

Migrant farmworkers play a very important role in the sowing, nurturing, and harvesting of the fruits, vegetables, and nuts in the United States [1]. It is, indeed, a quirk of fate that the average migrant farmworker who helps Americans stay nourished and well-fed is him/herself plagued with a suite of medical, social, and economical problems [2]. There is no real estimate of the number of migrant farmworkers in the United States. However, there are approximately 4.2

million migrant and seasonal farmworkers and their families living in the United States and out of these, approximately 1.6 million are classified as migrants [3] [4].

The Office of Migrant Health, Department of Health and Human Services defines migrant workers as: An individual whose principal employment is in agriculture on a seasonal basis, who has been employed within the last 24 months, and who establishes for the purpose of such employment a temporary abode. This definition is based on the United States Public Health Services Act, Section 329 [5]. A seasonal farmworker is defined on the same lines but does not change residence. Estimates by the National Agricultural Workers Survey (NAWS) from 2017-2018, United States Department of Labor suggest that 77% of the farm workers in the United States were born in Mexico [6]. Migrant farmworkers are also among the poorest workers in the United States with their mean individual incomes ranging from $20,000 - $24,499 for the year 2016-2017 [6].

The Economics Research Service of the United States Department of Agriculture has documented that the percentage of unauthorized farmworkers working in the United States has increased considerably from 15 percent in 1989-91 to approximately 55 percent in 1999-2001. However, in recent years about 50% of these farmworkers are unauthorized [7].

2. Etiology of Tuberculosis

Tuberculosis is a disease caused by the bacteria Mycobacterium tuberculosis. It spreads through the air when individuals with active TB cough, sneeze, speak etc. The TB bacteria can remain airborne for many hours and individual who breathes in the bacteria could become infected with latent TB [8]. However, this doesn't mean that the infected person will spread the bacteria to others. This is because the bacterium is inactive [9]. Approximately 5% - 10% of the affected people may end up getting active TB. TB commonly attacks the lungs but may also affect the central nervous system, the lymphatic system, the circulatory system, the genitourinary system, bones, joints, and even the skin [10].

2.1. Signs and Symptoms of TB

The following are the signs and symptoms of an active TB infection [11]:

- Weight loss, and lack of appetite,
- Chest pain,
- Overall fatigue and weakness,
- Night Sweats,
- A cough that persists for three weeks or longer,
- Chills,
- Fever,
- Cough with bloody sputum and bloody phlegm. This usually happens when the TB has already affected the lungs.

2.2. Treatment of Tuberculosis

Active TB treatment can be challenging and requires a dedicated effort toward the treatment on part of the patient and the health care provider. The standard treatment course ranges from six to nine months and is treated with antimicrobials like isoniazid, rifampin, ethambutol, and pyrazinamide [12]. These antimicrobials are the first line of drugs in the fight against TB. The TB bacteria may become drug resistant if the medicines are not taken regularly. This could result in multidrug-resistant TB (MDR-TB) and in rare cases could even turn into drug-resistant TB (XDR-TB) [10]. To treat multidrug-resistant TB, second line of drugs in conjunction with chemotherapy is used. The treatment also has several side effects [10].

2.3. Tuberculosis Etiology in the United States and Mexico

A 2009 report prepared by the United States-Mexico Border Health Commission indicated that in the United States, the Tuberculosis rate is highest among individuals born in foreign nations and racial/ethnic minorities [13]. The CDC reported a total of 26,673 new TB cases in the United States in 1992, 9588 new TB cases in 2013 and 7860 new cases in 2021 [14] [15]. This translates to an incidence rate of 10.4 cases per 100,000 populations in 1992, 3.0 cases per 100,000 populations in 2013, and 2.4 cases per 100,000 in 2021. These figures suggest a downward trend in the tuberculosis infection rates in the United States in the last three decades. Also, in 2013, the TB incidence rate among foreign-born individuals was approximately 13 times greater than the incidence rate among US-born individuals [14] [15]. In the United States, TB rates among Hispanics were 7.4 times higher than among non-Hispanic whites [16]. In addition, most foreign-born individuals with TB in the United States were born in Mexico. 25% of all foreign-born TB cases in the United States were Mexican-born active TB cases. In addition, the National Health and Nutrition Examination Survey, 1999-2000, found that the latent TB infection in Mexican Americans was 9.4% in contrast to 4.2% US born individuals [17]. Furthermore, the World Health Organization reported that foreign born individuals are disproportionately impacted by Multidrug-Resistant (MDR) TB in the United States, accounting for 84.5% of cases in 2007 [13].

2.4. Epidemiology of TB for Agricultural Farmworkers in the United States

Most farmworkers working in the Unites States are foreign born and there is paucity of data on the prevalence of TB in agricultural farmworkers [18]. The CDC reported in one of its MMWR report in 1992 that farmworkers were six times as likely to develop active TB infection in sharp contrast to other individuals employed in other professions in the United States [19]. **Table 1** lists the TB incidence rate for individuals from countries that form the bulk of the foreign farmworkers in the United States. These countries are Haiti, Guatemala, Nicaragua,

Table 1. TB incidence rates for nations of origin for farmworkers working in the United States of America [20].

Country	TB incidence rate per 100,000 population (2013)	TB incidence rate per 100,000 population (2020)
Haiti	206	168
Guatemala	27	27
Nicaragua	57	42
Honduras	42	30
El Salvador	43	55
Mexico	22	24
USA	3.3	2.4

Honduras, El Salvador, Mexico, and the United States. There are various risk factors associated with the high incidences of TB in agricultural farmworkers in the Unites States [20]. For the period 2007-2009, 72% of the farmworkers in the United States were foreign born. Within this sub-group, 15% were Mexicans and Central Americans who can be classified as indigenous Mayans [21].

These groups are more likely to have cases of TB than individuals who are born in the United States. These groups of people also experience varying levels of food insecurity and hunger, and it has been documented that malnutrition can aggravate the chances of the progression of latent TB to active TB [18]. A 2003 study conducted on 100 farmworker families in El Paso County, Texas, and Dona Ana County, New Mexico showed that 82% households were affected by food insecurity and 49% also faced hunger [22]. This confirms that nutrition is very crucial to offset the progression of TB. Also, many Hispanic immigrant communities in the United States consume unpasteurized milk products [23]. Consumption of these products may result in exposure to Mycobacterium bovis—a bovine form of TB that could cause tuberculosis infection in humans [24].

3. US-Mexico Border Region

As per the La Paz agreement of 1983, the United States-Mexico border region is defined as the area of land that is 100 kilometers (62.5 miles) north and south of the international border [25]. This region stretches approximately 2000 from California to the southern tip of Mexico. This border region comprises of four states in the United States (California, Arizona, New Mexico, and Texas) and six states in Mexico (Chihuahua, Coahuila, Nuevo Leon, Sonora, Tamaulipas, and Baja California Norte) [26]. This region, although separated by man-made borders, shares certain environmental, social, cultural, and economic characteristics. The US-Mexico border region also comprises of 44 counties in the United States and 80 municipalities in Mexico. This unique border region also faces certain specific challenges like a growing population that is predominantly Hispanic,

lower educational attainment—especially on the US side, lower income status, high poverty rates, inadequate number of health care providers and higher rates of uninsured individuals [26].

3.1. TB along the US-Mexico Border Region

Table 2 shows the incidence rates of TB in the four southern border states of the United States and the six northern states of Mexico. These incidence rates are from the year 2009 and as is obvious from the table, California has the highest incidence rate of TB per 100,000 populations (6.7) in contrast to New Mexico (2.4), which was the least [27]. On the Mexican side of the border, the rates were much higher with Baja California recording an incidence rate of 38.3 per 100,000 populations compared to the state of Coahuila, which recorded the least at 16.7 per 100,000 populations. These figures showcase the importance of TB as a major public health concern along this border region.

3.2. Tuberculosis and Migrant Farmworkers Literature Review

A study conducted on Latino migrant farmworkers in Connecticut suggested a high percentage of asymptomatic latent tuberculosis infections [28]. The researchers recruited seventy-nine male farmworkers and out of these fifty-seven consented to the first-step tuberculin test (TST). Out of this sub-group 26% tested positive and the authors also documented that 96% of the 57 tested farmworkers were from Mexico. In another population-based study of 543 migrant farmworkers in North Carolina study, Ciesielski *et al.* discovered active TB in 0.47% of Hispanics and found a 37% prevalence of TB infection—as measured by the positive tuberculin skin tests in Hispanics [29]. Another study to ascertain the risk of TB among 842 migrant farm workers on the Delmarva peninsula found that thirty-seven of the migrants tested positive for TB [30]. This study was conducted in 1982 on migrant workers living in 33 camps on the Delmarva Peninsula—a peninsula shared by the states of Delaware, Maryland, and Virginia.

A TB study conducted on migrant farm workers in Pennsylvania indicated

Table 2. Incidence Rates of TB per 100,000 populations along the ten states of the US-Mexico border region.

United States		Mexico	
Border States	**Incidence Rates per 100,000 populations**	**Border States**	**Incidence Rates per 100,000 populations**
California	6.7	Baja California	38.3
Texas	6.1	Tamaulipas	32.4
Arizona	3.5	Sonora	26.1
New Mexico	2.4	Chihuahua	18.4
		Nuevo Leon	18.1
		Coahuila	16.7

that out 509 workers from 15 migrant camps who were tested for TB, 14.8% had a positive TB reaction [31]. Most of the subjects in this study were Mexicans (77%), and 13% of this subgroup tested positive for TB. A 2008 cross-sectional study conducted in a migrant agricultural community in San Quintin, Baja California, Mexico, documented that out of 133 participants, 39.8% tested positive for latent TB [32]. The authors also indicated that over 90% of the residents of the camp were migrant residents from southern Mexico, more specifically from the state of Oaxaca. One third of these migrant farmworkers also reported of previous US travel. This is of great public health concern especially for US-Mexico border regions because the lifetime risk of the progression of latent TB to active TB is about 10% [33]. These findings also warrant joint surveillance strategies for TB between the United States and Mexico public health officials especially regarding mobile populations like migrant farmworkers.

4. The Socio-Ecological Model

The Socio-Ecological model conceptualizes that health behaviors are an outcome of the interactions between individuals and their environment. This environment encompasses several factors and domains—individual factors, interpersonal, organizational, community and policy level factors [34]. The Socio-Ecological Model helps toward the understanding of the cultural and social issues facing a given community or sub-group and aids toward the preparation of more effective health promotion strategies. Public health issues should not be considered in isolation of the cultural, socio-economical and other factors. The Socio-Ecological model is the prevalent general framework in public health understanding of human behavior. Health promotion programs should also be developed in the context of a Socio-Ecological model. The Socio-Ecological model, therefore, is an effective tool or mechanism to address issues pertaining to TB in the US-Mexico Border region.

There are various determinants of health that comprise the various levels of the Socio-Ecological Model. The five levels of the model are individual, interpersonal, organizational, community, and political level. Healthy People 2020 categorizes the determinants of health into various categories [35]. These are as follows:

- Biological and Genetics—age, sex, family history of diseases.
- Individual Behavior—Diet, nutrition, substance abuse, general hygiene.
- Health Services—Availability of medical care, insurance etc.
- Social Factors—poverty, social unrest, racism.
- Policy making—laws in sovereign nations and international treaties.

4.1. Tuberculosis Health Problems Faced by Migrant Farmworkers in the United States

The migrant farmworkers in the United States surmount a suite of social, environmental, political, and cultural problems which aggravates their TB infection

and impedes their seeking treatment for the same. Some of these challenges facing the migrant farmworkers are elucidated below:

- Language barriers—Majority of the migrant farmworkers are Spanish speakers and may face problems explaining their illnesses to health care providers [4].
- Lack of knowledge about TB—Most of the migrant farmworkers are influenced by Latino cultural aspects and may not understand the etiology or the epidemiological significance of TB [4].
- Fear of Deportation—Undocumented migrant farmworkers have been apprehensive to seek medical care for the fear of deportation [36].
- Paucity of authorized health clinic sites—As per the Public Health Service Act of 1962, the Migrant Health Program was initiated [37]. However, the approximately 400 federally authorized clinic sites cater to only 12% - 15% of the migrant population [38].
- Need for long term treatment or preventive efforts—Most farmworkers are in the transient state moving from one state to another depending on the harvesting schedules and may have difficulty in adhering to the full nine-month TB treatment [4].
- Cost of Treatment and other barriers to health care—Migrant farmworkers make meager salary and are mired in grinding poverty and may not be able to afford the exorbitant cost of TB treatment [4].
- Crowded and insalubrious living conditions—Migrant farmworkers endure difficult living conditions with substandard and unsafe heating, cooking, and electrical systems, inadequate sanitation, and dilapidated structures [39].
- Racism—Most migrant farmworkers are Mexicans and some of them are of indigenous background and may face racism [40].
- Malnutrition—Most farmworkers are undernourished and also suffer from hunger pangs [22] [41].
- Stigma—Farmworkers are apprehensive to seek medical treatment for fear of social ostracism [42].
- Lack of Transportation—Most farmworkers do not have private transportation and may face difficulties seeking medical attention for their TB infection [42].
- Closure of Health Care centers in the evening—Health care clinics are closed in the evenings and migrant farmworkers might not want to avail the medical facilities during the daytime due to wage loss. Also, the farm manager or supervisor may not give the requisite permission to visit the clinic during normal working hours [4].
- Unresponsive health care system—Differences in approach to medical care in the United States and Mexico may hinder the migrant farmworkers from seeking treatment for TB [43].
- Lack of Coordination between the Federal and state agencies of both the United States and Mexico—No joint surveillance data on Latent and Active TB between the two nations may aggravate or complicate the fight against TB in

migrant farmworkers.

- Psychosocial stressors—rigid work demands, and poor working conditions may aggravate the feelings of helplessness, anxiety, and depression with severe repercussions for overall health of the migrant farmworkers [40].

4.2. Various Interventions to Address TB Related Infections

This section of the paper propounds on the various interventions that have been adopted in the United States and Mexico to address TB related infections in the predominantly Hispanic community. These measures could also be utilized and practiced in the US-Mexico border region with great success. These interventions are as follows.

Vivir a Todo PULMON

Vivir a Todo Pulmon is a multiyear innovative and very successful program developed by the Southeastern National Tuberculosis Center and the Rural Women 's Health Project at the University of Florida [44]. This program incorporated the services of community-based organizations and utilized the services of trained community liaisons to develop photo-novellas to gather information and understand the perceptions, cultural beliefs and knowledge of TB, and barriers associated with seeking TB treatment in the Hispanic immigrant community in the Southeast United States. The program developed culturally sensitive education materials for patients and clinicians to launch community awareness campaigns to reduce the stigma associated with TB and to introduce the subject of TB into mainstream discussion.

TB*Net*

The TB*Net* program provides referrals for patients returning to Mexico from the State of Texas. The program is coordinated by the Texas Department of State Health Services and funded by the United States Centers for Disease Control & Prevention (CDC). TB therapy is also administered to individuals diagnosed with active Tuberculosis and who are detained by the Federal Authorities for deportation back to Mexico [13]. The TB*Net* program helps patients complete their TB treatment is three simple ways.

The program supplies clinic with wallet-sized patient cards for the patients. These cards are very handy and can be carried by TB patients wherever they go. The card also has toll-free numbers which could be used by clinics to obtain patient's medical records in order to continue the treatment in case of relocations. The program also maintains a central storehouse of patients in the program. This record is obtained via a toll-free number anywhere from United States, Mexico, or Central America. In addition, patients who are in flux from one city to another—in case of migrant farm workers—can call up the toll-free number to locate treatment facilities and health centers at their next place of location or destination [45].

Cure TB Project

Cure TB project is a very successful program based in the San Diego County

[46]. The funding and oversight are provided by the State of California and the United States Centers for Disease Control and Prevention. It helps provide referrals, in term of wallet-sized "binational cards" for patients with active TB moving between the US and Mexico for over ten years. The cards provide toll-free phone numbers for patient referrals and patient treatment information to assure the continuance of the full TB treatment [13]. The program facilitates the exchange of information between health systems and also provides education to patients about TB and methodologies for accessing follow-up care. Till date, over 1000 patients have been sought treatment through.

"Meet & Greet" Program

"Meet & Greet" program is an informal joint initiative between the health department officials of the state of Arizona and Sonora. Health officials from Sonora meet TB patients who are being deported back to Mexico through Sonora and the Sonoran officials assume full responsibility for the completion of the TB treatment [13].

GUAPA Project

The GUAPA project was the first successful, binationally coordinated, epidemiological investigation initiated between the Pennsylvania Department of Health and the Instituto Nacional de Salud Publica of Mexico [31]. The project was supported by the CDC and the Health and Human Services of Minority Health, which assured that Mexican patients were afforded follow-up and medical treatment for TB even if they returned home to Mexico during the course of their treatment. The GUAPA project was a success story between an interior state of the United States—Pennsylvania, and an interior state in Mexico—Guanajuato.

US-Mexico Border—VIDAAI Project

The VIDAAI project is a joint collaborative effort between one Mexican (Universidad Autonoma de Baja California) and two US universities (University of California San Diego and San Diego State University) that provides primary medical care to all residents through semi-annual clinics [32]. During these clinics, clinical, epidemiological, and health promotion services were offered to the patients. Clinics such as the VIDAAI project help understand the binational aspect of TB surveillance and help sustain joint epidemiological research in a US-Mexico border setting.

TB Photovoice

TB Photovoice is a program started to convey the message that TB is curable and there should be no stigma associated either with the diagnosis or the treatment. TB survivors, caregivers, friends, and family members take photographs and these photographs along with the narratives reflect the journey of the survivors and the steps that need to be undertaken to reduce the overall stigma associated with TB [47].

Neustra Casa

Neustra Casa is a truly inspirational and innovative program that involves a three-dimensional movable house augmenting the life stories of individuals af-

fected by TB [47]. Neustra Casa provides the much-needed information in communities of low socioeconomic status and generates awareness among the various stakeholders like TB patients, decision makers, and care givers to reduce the incidences and cases of TB in the US-Mexico border region.

Role of Promotoras

The Promotoras or Community Health workers can play a very crucial role in the fight against TB. In fact, the US-Mexico Border Health Commission elicits the importance of promotoras in health educational activities and behavioral health education. The Promotoras can help create a culture of wellness and prevention in the migrant farmworker communities [48].

Provision of health services closer to the Farmworkers

Similar to the practice adopted in the Jacobson study [30], outreach nurses in the TB program should pay regular visits to the migrant camps to screen symptomatic farmworkers for health problems. This policy is crucial and should be adopted for the US-Mexico border region as well.

Health Fairs

Study by McCurdy and colleagues documented the feasibility of health fairs in migrant housing centers to initiate tuberculosis control measures for farm workers [49]. Such health fairs should also be held during harvesting season near farms on the US-Mexico border region.

4.3. Culturally Sensitive Approaches to Address TB Issues

Public Health nurses should be cognizant of Latino cultural underpinnings while discussing TB related issues with migrant farmworkers. In the Latino culture, it is widely believed that going out in the cold and perspiring will cause TB. Nurses should recognize the cultural belief sets but not negate them as this may vitiate their relationship between the workers and there may be reasons to believe that the farmworkers might not trust the nurse [50].

Honduran farmworkers usually use home remedies for suspected tuberculosis. They prefer these remedies in contrast to the lengthy nine-month treatment as they are concerned about stigma associated with neighbors and family members finding out about their TB infection. They usually use skunk oil, boa constrictor oil, shark oil, and mango [43]. As such, Tuberculosis services and treatments should be developed and tailored taking into consideration the cultural sensitivities of the target population [51].

4.3.1. Provision of Transportation Facilities

In the Wyss study, transportation facilities were used to help the migrant farm workers go to the clinic for the necessary TB Mantoux skin tests. In addition, the health care providers had an understanding with the growers that allowed the farmworkers to visit the clinics. Such practices can also be adopted along the US-Mexico border region [42].

4.3.2. Educational Interventions in Spanish

Spanish language interpreters are also very crucial while working with farm-

workers and educational interventions that are appropriate at the farmworker literacy levels should be incorporated into the TB programs [42]. In the Wyss study, the authors used the Health Belief Model (HBM) and the Social Cognitive Theory to address the issue of tuberculosis and understand the belief sets of the migrant workers in the Midwestern United States. Such practices should also be implemented on the US-Mexico border region.

4.3.3. Role of Public Health Departments in the Border States of United States and Mexico and Binational Organizations like PAHO

The border region can provide evidence-based interventions and prepare a team of border health professionals who will address the needs of the people in this region. It is very crucial and necessary that joint surveillance of data for latent and active TB should be undertaken in the ten border states of the US-Mexico border region. This could be achieved by signing a binational agreement between both the United States and Mexico and would spearhead the fight against TB [15]. Finally, the following **Table 3** is elucidating the determinants and interventions at each level of the Socio-Ecological Model.

Table 3. Study of the determinants and interventions for TB infection at each level of the socio-ecological model.

Levels	Determinants	Interventions
Individual	Social norms, biological norms, cultural norms, individual beliefs	• Individual beliefs of the farmworkers pertaining to TB need to be handled in a culturally sensitive manner • Nutritional aspects need to be taken into account • Sincere efforts need to be undertaken to reduce the social stigma associated with TB
Interpersonal	Interactions with family, colleagues at work, nurses and other health care providers	• Family members may help the TB farmworker to adhere to the treatment regimen. • The farm supervisor should provide facilities for better housing and nutrition so that the TB patients can recover fast • Transportation facilities to the clinic centers need to be incorporated
Organizational	Work environment, Church and faith-based groups	• Faith based groups may provide TB treatment services to the migrant farmworkers. In El Paso, we have clinics like "Clinica Bautista" that provide free medical services to all individuals irrespective of their immigration status (Personal communication—Ms. Gabriella, Phlebotomist, City of El Paso project). • Health camps could be organized by local clinics at the migrant farmworker sites.

Continued

Community	Community Health Services, Medical Health Services, Universities, and other Institutions of Learning	• Universities can team up with local public health departments and organize health fairs to disseminate knowledge about Latent and Active TB. • Issues related to social stigma can be negated via telenovelas, and educational materials sensitive to the needs of the Hispanic migrant farmworkers.
Policy, Law	Government policies, immigration rules and regulations	• Federal authorities like the Department of Homeland Security, Department of Health and Human Services should sign binational agreements with Mexican and Central American sister agencies to address TB related cases in undocumented migrant farmworkers. • Health insurance should be provided for the migrant farmworkers. • Guest worker programs with temporary visas for migrant farmworkers should be instituted so that they can come out of the shadows. • Organizations like PAHO should spearhead the movement of TB elimination from the US-Mexico border landscape and beyond.

5. Conclusion

The Tuberculosis health problems facing the migrant farmworkers in the US-Mexico border region warrant a synergistic approach that involves various stakeholders both on the United States and Mexican side of the border. The overall tacking and amelioration of the TB problem in the migrant farmworker community is not an impossible task but it requires a sincere approach from both sides of the border sans any nationalistic or xenophobic or any hegemonic tendencies—especially from the United States side. As indicated in this social and behavioral research paper, infectious diseases like Tuberculosis can be tackled and handled at various levels of the Socio-Ecological framework. This research paper concurs that infectious diseases recognize no manmade jurisdictions especially in this day and age of globalization.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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