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A retrospective Study of Lifestyle Risk Factors Associated with Tuberculosis Infection in *El-Obeid, North Kordofan State, Sudan*

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Abstract

Background and Objectives: Sudan is ranked as the third worst country in the world for tuberculosis transmission. A lack of family income, coupled with the constant displacement from war zones, overcrowding, illiteracy, ignorance, lack of awareness, smoking practice and poor housing conditions contribute to increasing the incidence of this disease. At present, tuberculosis infection is mainly found in eastern states, such the Red Sea, Kassala, and Gedaref. The present study investigated factors related to tuberculosis infection among patients were under follow-up at the Department of Respiratory Tract Diseases in El-Obeid Teaching Hospital, North Kordofan State.

Materials and Methods: The facility-based retrospective cross-sectional descriptive study was conducted between February and December 2018. 101 TB patients were included in the study using a simple random sampling technique. Self-administered questionnaires with closed questions were distributed to the patients to collect data. Data was entered, processed, and analyzed using the SPSS version (16.0) and Microsoft Excel (2010) software. Factor analysis and cross-tab were used for result interpretation.

Results: More than two-thirds (73.3%) of the patients were male, and 27.7% were female. TB peaked between the ages of 16 - 30 years old with 30.7%, followed by 31 - 45 years old with 29.7%, and more than 45 years old with 28.7%. Therefore, 97.7% of them boil milk before drinking it. 55.4% of patients were vaccinated with BCG vaccine. The study indicates that (28.7%) of TB patients live in houses made of straw and mats, (36.6%) of them have mud houses. There was a highly significant relationship between socio-demographic factors (gender, age group and education level) and practices of TB patients towards BCG vaccine ($p\text{-value} = 0.001$, $p\text{-value} = 0.000$ and $p\text{-value} = 0.000$). There was a highly significant relationship between socio-demographic factors (gender, age group, and education level) and practices of TB patients towards smoking ($p\text{-value} = 0.008$, $p\text{-value} = 0.000$ and $p\text{-value} = 0.000$).

Conclusion: A birth certificate is not issued until a baby has been vaccinated against tuberculosis using the BCG vaccine, thus it's important for people to spread the word about the need of doing so through health education programmes in the community and with individual patients.

Keywords: Risk factors, Tuberculosis, Socio-demographic, Hospital, El-Obeid

Introduction

Tuberculosis (TB) is one the biggest public health challenges facing the world today. It is one of the oldest diseases known to mankind ^[1]. It caused by *Mycobacterium tuberculosis*. ^[1, 2]. Which belongs to the genus *Mycobacterium*, family Mycobacteriaceae and Order Actinomycetales ^[1]. The *M. Tuberculosis* complex includes *M.tuberculosis* and *M.africanum*, primarily from humans, and *M.bovis*, primarily from cattle ^[3]. The organism can infect practically any organ of the body. However, pulmonary tuberculosis accounts for over 80% of the total cases suffering from tuberculosis.

The other common forms of tuberculosis are meningeal, bone and joint, renal, genital, abdominal or mesenteric and tubercular lymphadenopathy ^[1]. The disease primarily affects lungs and causes pulmonary tuberculosis, ^[2]. Nearly one-third of the world's population is infected with tuberculosis ^[2, 4]. TB is currently second only to AIDS as an infectious cause of death worldwide ^[1]. The annual risk of tuberculosis infection in high burden countries is estimated to be 0.5-2% ^[2]. In 2005, there were over 8.8 million new cases and nearly 1.6 million deaths. During 2005, new cases of TB included 3.0 million in Southeast Asia and 2.5 million in Africa, where HIV disease has become the leading comorbidity and risk for TB mortality ^[4]. More than one third of the TB-related deaths between 35 and 44 years were associated with the Human Immunodeficiency Virus (HIV) infection and 46.9% were younger than 55 years, including economically active age groups ^[5]. The 2008 Global Tuberculosis Control Report reported 9.2 million new cases in 2006 including 400,000 new cases of multidrug-resistant TB ^[4].

During the year 2013, an estimated 9 million people developed TB, which is equivalent to 126 cases per 100,000 population ^[2], with 1.5 million deaths per annum worldwide ^[6].

Tuberculosis is a major health problem in Sudan, a country that carries 11–15% of the tuberculosis burden in the Eastern Mediterranean Region ^[14]. In Sudan, the incidence of TB is 77 per 100,000, including TB in human immunodeficiency virus (HIV)-positive individuals, and the total number of new and relapsed TB cases was 20,438 in 2017 ^[15].

The risk of progression from exposure to tuberculosis bacilli to the development of active disease is a two-stage process governed by both exogenous and endogenous risk factors. Exogenous factors play a key role in accelerating the progression from exposure to infection, whereas endogenous factors lead in progression from infection to active TB disease ^[7]. Within the developing world, the reasons proposed for the increase in disease are environmental and social factors associated with tuberculosis such as; Overcrowding ^[2, 3, 8, 9, 10], population explosion/high population density, ^[2, 9, 11] population movement/migration, ^[10, 8] food shortages, poor access to health services ^[8], poverty, ^[2, 10, 12] malnutrition, ^[2, 10, 11, 12] tobacco/smoking, alcohol abuse/alcoholism, ^[2, 10, 13] economic recession, poor housing, lack of education, large families, early marriages, lack of awareness, indoor air pollution, ^[2] Diabetes, ^[2, 13] poor ventilation, and poor hygiene habits ^[13].

The WHO has set International Standards for Tuberculosis Care. These standards are intended to facilitate the effective engagement of all care-providers in delivering high-quality care for patients of all ages, including those with smear-positive, smear-negative, extra-pulmonary tuberculosis, drug-resistant tuberculosis, and tuberculosis combined with HIV infection ^[2]. The five elements of the DOTS strategy are sustainable government commitment, quality assurance of sputum microscopy, standardized short-course treatment (including direct observation therapy), regular supply of drugs, and establishment of reporting and recording systems ^[4]. The national tuberculosis control programme in Sudan is working on many aspects of control, including the care and management of patients and the reduction of risk for others ^[14]. The diagnosis and treatment of cases of tuberculosis is

carried out in accordance with the Sudan National TB Management Guideline (2018).

This guideline recommended that; all patients should be monitored to assess their response to therapy, all patients should be supported and monitored daily while taking Anti-TB drugs by treatment supporter by the family or treatment supporter (family DOT) and Patient weight should be monitored each month, and dosages should be adjusted if weight changes ^[16].

In Sudan, the data about lifestyle risk factors associated with tuberculosis infection in Sudan especially El-Obeid city is limited. Therefore, the assessment of lifestyle risk factors for TB is an important step to identify which risk factors contributory risk factors for TB among patients.

Materials and Methods

A retrospective cross-sectional descriptive hospital-based study of all patients who had TB admitted to the department of respiratory tract diseases at the El-Obeid Teaching Hospital from February to December 2018. El-Obeid Teaching Hospital was established in the forties of the last century and is one of the oldest hospitals in Sudan since the era of the first colonialism. It was established in the year 1992. The area of the hospital is 66 thousand meters. The hospital has about 40 wards that differ in their clinical capacity. El-Obeid Teaching Hospital is the first public hospital located in the centre of El-Obeid city. It has a dedicated emergency room and receives referrals from all Kordofan States of Western Sudan.

Sample Techniques

All TB patients attending during February to December 2018 were included. Sample size taken was (101) patient. A simple random sampling (SRS) technique was implemented. This is the most basic scheme of random sampling. Each unit in the sampling frame has an equal chance of being selected.

Data Collection

The data for this study was obtained from basic data sources. A self-administrated questionnaire (closed-coded) was prepared by researchers and checked for consistency. The self-administrated questionnaire is used to collect data on basic information about factors associated with tuberculosis disease. The final questionnaire included information about demographic characteristics of the patients, including age, gender. In addition, the final questionnaire included information relating to factors associated with tuberculosis disease; general status of rooms conditions, how to drink milk, vaccination against tuberculosis, smoking, taking medication, chronic diseases and behavioral factors.

Data Processing and Analysis

After collecting samples, completing the questionnaire, and cleaning the data,

The Statistical Package for the Social Sciences (SPSS) version (16.0) and Microsoft Excel software (2010) are used to enter and analyse the data.

Results

All patients under follow-up in the Department of respiratory diseases started taking treatment immediately after diagnosis and confirmation of their disease; this means

all TB patients who tested positive under treatment. The study comprised (n = 101) TB patients were admitted during period (February to December 2018).

Table 1: Socio-demographic characteristics of TB Patients, in El-Obeid Teaching Hospital; (n= 101)

Variables	Frequency (%)	P-value
Gender		
Male	74 (73.3%)	0.000
Female	27 (26.7%)	
Age group in years		
1 – 15	10 (9.9%)	0.006
16 – 30	31 (30.7%)	
31 – 45	30 (29.7%)	
More than 45	29 (28.7%)	
Education level		
Illiteracy	45 (44.5%)	0.000
Basic	24 (23.8%)	
Secondary	19 (18.8%)	
University graduate	13 (12.9%)	
Marital status		
Married	57 (56.4%)	0.000
Single	38 (37.6%)	
Widow	26 (25.7%)	
Resident		
Urban	35 (34.7%)	0.853
Rural	35 (34.7%)	
From other city	31 (30.7%)	

Table [1], shows the demographic characteristics of the study group, among the total admissions there was (73.3%) male and (26.7%) female. About (9.9%) of patients fall in 1 – 15 years, (30.7%) of them in the 16 – 30 years, while (29.7%) in 31 – 45 years, and (28.7%) more than 45 years. (44.5%) of TB patients had not education qualified, (23.8%) had education qualified basic, (18.8%) were secondary, (12.9%) were university graduate. (56.4%) of TB patients married, (37.6%) were unmarried, and (25.7%) were widowed. (34.7%) of patients were from urban and rural, and (30.7%) from outside of El-Obeid city.

Table 2: Socio-economic characteristics of TB Patients in El-Obeid Teaching Hospital; (n= 101)

Variables	Frequency/ (%)	P-value
Occupation		
Officeholder	8 (7.9%)	0.000
Unemployed	24 (23.8%)	
Student	20 (19.8%)	
House wife	10 (9.9%)	
Free work	39 (38.6%)	
Monthly income		
Less than 1000 SDG	11 (10.9%)	0.000
1000 – 2000 SDG	16 (15.8%)	
More than 2000 SDG	29 (28.7%)	
Undefined	45 (44.6%)	
Family size (number of family members)		
1 – 4	24 (23.8%)	0.000
5 – 9	62 (61.4%)	
10 or more	15 (14.9%)	

As illustrated in table [2], according occupation of TB patients, (7.9%) were officeholder, (23.8%) unemployed, (19.8%) students, (9.9%) house wife and (38.6%) free work. (10.9%) of patients have a monthly income of less than 1000 SDG, (15.8%) of them have (1000-2000 SDG), (28.7%) of them have more than 2000 SDG, and (44.6%) of them their monthly income is not specified. family size of one to four persons was (23.8%) and five to nine persons was (61.4%) and ten or more was (14.9%).

Table 3: Assessment of the general conditions of patients' home in El-Obeid Teaching Hospital; (n= 101)

Variables	Frequency (%)	P-value
Building structure		
Unstable (straw and mat)	29 (28.7%)	0.598
Mud/Clay	37 (36.6%)	
Burnt bricks	35 (34.7%)	
Having rooms in the house		
Yes	81 (80.2%)	0.000
No	20 (19.8%)	
The area of rooms in the house (n= 81)		
4*4 m ²	69 (85.1%)	0.000
3*3 m ²	12 (14.9%)	
There are private bedrooms in house (n= 81)		
Yes	73 (90.1%)	0.000
No	8 (9.9%)	
Number of rooms in the house (n= 81)		
One room	5 (6.2%)	0.000
Two rooms	33 (40.7%)	
Three rooms	32 (39.5%)	
More than three rooms	11 (15.6%)	
The number of people who use the room to sleep (n= 73)		
1 – 3 persons	58 (79.5%)	0.000
4 – 6 persons	15 (20.5%)	
Adequate natural ventilation in the rooms (n= 81)		
Sufficient	74 (91.4%)	0.000
Insufficient	7 (8.6%)	

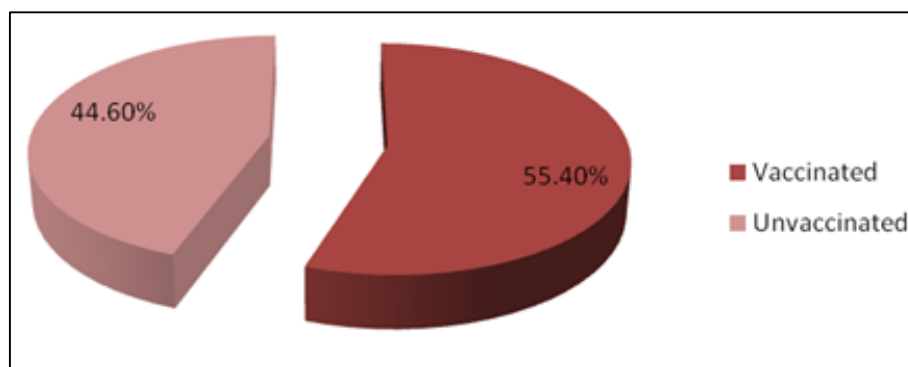
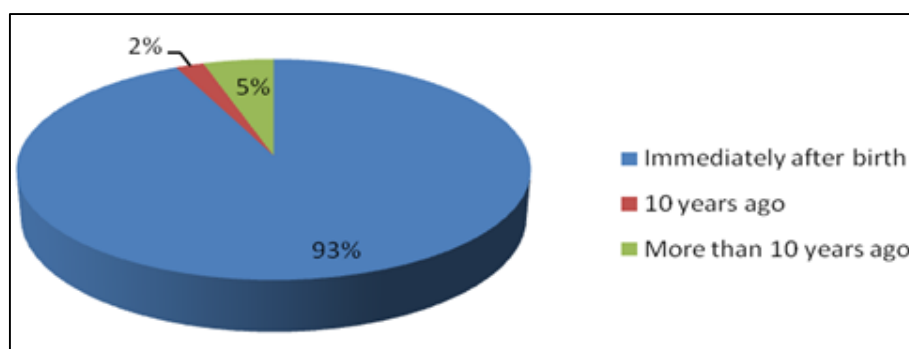
Table [3], indicates that (28.7%) of TB patients live in houses made of straw and mats, (36.6%) of them have mud houses, and (34.7%) of them live in houses structured from burnt bricks. (80.2%) of them have rooms in their home. (90.1%) of TB patients have private bedrooms in house. (85.1%) of rooms have an area of 4*4 m² and (14.9%) have an area of 3*3 m². According to ventilation, adequate natural ventilation was sufficient in (91.4%) of rooms. Also, the above table shows that (6.2%) of patients' homes consist of one room, (40.7%) have two rooms (39.5%) have three rooms, and (15.6%) have more than three rooms. (79.5%) of TB patients reported that the number of family members who sleep in one room were (1-3), and (20.5%) of them reported that family members who sleep in one room (4- 6).

Table 4: Assessment of tuberculosis patients' practices towards healthy nutrition in El-Obeid Teaching Hospital; (n= 101)

Variables	Frequency (%)	P-value
Do you eat a variety of food?		
Yes	46 (45.5%)	0.371
No	55 (54.5%)	
What kind of food do you prefer? (n= 46)		
Legumes	18 (39.1%)	0.004
Carbohydrates	23 (50%)	
Starch	5 (10.9%)	
Do you drink milk?		
Yes	86 (85.1%)	0.000
No	15 (14.9%)	
Do you boil milk before drinking it? (n= 86)		
Yes	84 (97.7%)	0.000
No	2 (2.3%)	
Can you buy enough healthy food?		
Yes	42 (41.6%)	0.091
No	59 (58.4)	

Table [4], shows that (45.5%) of TB patients eat variety foods. (39.1%) of them eat legumes as their favorite food, (50%) had eat carbohydrates, and (10.9%) had eat starches.

According to drink milk and boil it, (85.1%) of TB patients drink milk, of them (97.7%) boil milk before drinking it. (58.4%) of them could not buy their food because there is not enough money.

**Fig 1:** Practices of TB patients towards BCG vaccine in El-Obeid Teaching Hospital; (n= 101)**Fig 2:** When to take the tuberculosis vaccine in El-Obeid Teaching Hospital; (n= 101)

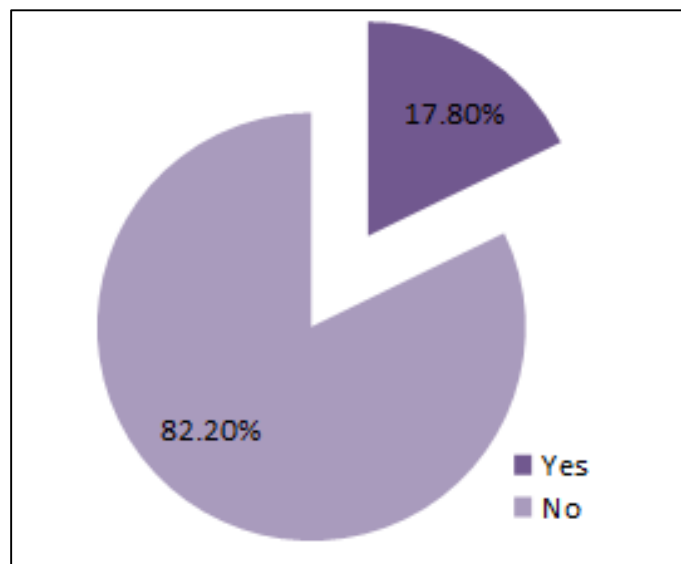


Fig 3: The distribution of TB patients according their family history of tuberculosis in El-Obeid Teaching Hospital; (n= 101)

Table 5: Assessment of health status of tuberculosis patients in El-Obeid Teaching Hospital; (n= 101)

Variables	Frequency (%)	P-value
Is this your first infection with tuberculosis? (n= 101)		
Yes	90 (89.1%)	0.000
No	11 (10.9%)	
If (No), What are the causes of the relapse? (n= 11)		
Discontinuation of treatment	6 (54.4%)	0.307
The treatment center away from home	3 (27.3%)	
Lack adherence to the therapist's instructions	2 (18.2%)	
When did you feel relapsed? (n= 11)		
3 month ago	2 (18.2%)	0.103
6 month ago	2 (18.2%)	
A year ago	7 (63.6%)	
Do you suffer from chronic diseases?		
Yes	1 (0.1%)	0.000
No	100 (99.9%)	
Do you suffer from malnutrition diseases?		
Yes	8 (7.9%)	0.000
No	93 (92.1%)	

Table [5], indicated that (89.1%) of patients had their TB infection for the first time, while (10.9%) have relapse. (60%) of them relapsed was due to discontinuation of treatment, (20%) due to the distance of the treatment unit from home away, (20%) due to their non-compliance with the doctor's instructions. (18.2%) of TB patients had relapse

before three months ago, (18.2%) before 6 months ago, (63.6%) of them a year ago. (0.1%) of TB patients suffer from chronic diseases (kidney failure), while (99.9%) do not suffer from any of the chronic diseases. (7.9%) of them suffer from malnutrition diseases,

Table 6: Assessment of behavioral factors among tuberculosis patients in El-Obeid Teaching Hospital; (n= 101)

Variables	Frequency (%)	P-value
Do you spit directly on the ground?		
Yes	91 (90.1%)	0.000
No	10 (9.9%)	
Do you sleep with others in one room?		
Yes	55 (54.5%)	0.371
No	46 (55.5%)	
Do you use a tissue when sneezing?		
Yes	21 (20.8%)	0.000
No	80 (79.2)	
Do you smoke?		
Yes	16 (15.8%)	0.000
No	85 (84.2%)	
If (yes), what kind of smoke do you smoke?		
Cigarettes	14 (87.5%)	0.005
Hookah	2 (12.5%)	

As indicated in Tables [6], (90.1%) of TB patients spit directly on the floor, (54.5%) of them sleep with others in one room, (20.8%) use a tissue when sneezing, (15.8%) of them smokers, according to the type of smoke, (87.5%) of them smoke cigarettes and (12.5%) hookahs.

Table 7: Measuring the influence of total factors associated with tuberculosis infection in El-Obeid Teaching Hospital; (n= 101)

The factor	Relative importance	P-value
Socioeconomic and demographic factors	30%	0.166
Physical environment factors	22%	0.000
Clinical factors	21.6%	0.051
Behavioral factors	12.7%	0.000
Chronic diseases	4.2%	0.000

The above table indicates the factors associated with tuberculosis infection and explain the total variance was (90.4%). Therefore, we conclude the most influential factors on the incidence of tuberculosis are socio-economic and demographic factors were 30%, followed by natural environment factors were 22%, clinical factors were 21.6%, and then behavioral factors were 12.7%. The least influential factor is the incidence of chronic diseases.

Table 8: Practices of TB patients towards BCG vaccine in El-Obeid Teaching Hospital; (n= 101)

Factors	Vaccination with BCG		Total	X ²	P-value
	Vaccinated	Unvaccinated			
Gender					
Male	41	33	74 (73.3%)	45.859	0.000
Female	15	12	27 (26.7%)		
Age group in years					
1 – 15	5.5	4.5	10 (9.9%)	70.640	0.000
16 – 30	17.2	13.8	31 (30.7%)		
31 – 45	16.6	13.4	30 (29.7%)		
More than 45	16.6	13.4	30 (28.7%)		
Education level					
Illiteracy	25	20.0	45 (44.5%)	76.881	0.000
Basic	13.3	10.7	24 (23.8%)		
Secondary	11.1	8.9	19 (18.8%)		
University graduate	6.7	5.3	13 (12.9%)		

There was a highly significant relationship between socio-demographic factors (gender) and practices of TB patients towards BCG vaccine ($p\text{-value} = 0.000$, $X^2 = 45.859$). There was a highly significant relationship between socio-demographic factors (Age group) and practices of TB patients towards BCG vaccine ($p\text{-value} = 0.000$, $X^2 = 70.640$). There was a highly significant relationship between socio-demographic factors (gender, age group and education level) and practices of TB patients towards BCG vaccine ($p\text{-value} = 0.000$, $p\text{-value} = 0.000$ and $p\text{-value} = 0.000$).

Table 9: Practices of TB patients towards smoking in El-Obeid Teaching Hospital; (n= 101)

Variables	Cigarette smoking		Total	X ²	P-value
	Yes	No			
Gender					
Male	11.7	62.3	74 (73.3%)	6.937	0.008
Female	4.3	22.7	27 (26.7%)		
Age group in years					
1 – 15	1.6	8.4	10 (9.9%)	64.706	0.000
16 – 30	4.9	26.1	31 (30.7%)		
31 – 45	4.8	25.2	30 (29.7%)		
More than 45	4.8	25.2	30 (28.7%)		
Education level					
Illiteracy	7.1	37.9	45 (44.5%)	23.659	0.000
Basic	3.8	20.2	24 (23.8%)		
Secondary	3.2	16.8	19 (18.8%)		
University graduate	1.9	10.1	13 (12.9%)		

According to above table, there was a highly significant relationship between socio-demographic factors (gender, age group, and education level); ($p\text{-value} = 0.008$, $p\text{-value} = 0.000$ and 0.000), respectively and practices of TB patients towards smoking.

Discussion

The study comprised (101) of TB patients were admitted during period (February to December 2018). All patients under follow-up in the Department of respiratory diseases started taking treatment immediately after diagnosis and confirmation of their disease; this means all TB patients who tested positive under treatment.

The current study showed that socio-economic and demographic factors play a major role in the incidence of tuberculosis, such as occupation, Marital status, number of people who use the room, monthly income, sufficient healthy food and educational level have been found to be significant risk factors of TB; as the relative importance of it was (30%) of the total variance. This is the main factor for explaining the correlations between the variables.

The current study observed that males seriously suffered (73.3%) from the Tuberculosis infection than females (26.7%). Parks's mentioned that about 60% of TB cases and deaths occur among men [2]. Our finding is comparable to the study conducted in Sudan, where males (70%) were more prone to have pulmonary tuberculosis than females (30%) [28]. This finding is in disagreement with studies conducted in different parts of the world such as Eritrea, showed that females (8.2%) were more predisposed to have a positive TB smear than males (7.4%) [29]. A similar study conducted in Bab El Sharia University hospital indicated that (53.6%) of females have prone to TB than males (46.4%) [30].

Tuberculosis infection was predominant among the 16 – 30 age group with (30.7%) followed by 31 – 45 age group with (29.7%) and more than 45 age group with (28.7%), which is comparable to the study conducted in Sudan, where TB reached its peak at the age 21 – 40 years with (44.3%), followed by 41 – 60 years with (22.5%) [28]. A previous

study conducted in Babol, Iran, showed that the majority of patients with TB were age groups of 18-40 with (39%) and over 60 years old with (31.5%) [33]. WHO reported that 75% of TB cases in developing countries are in the economically productive age group of 15 - 50 years [32]. Agrawal *et al*, stated that the prevalence of infection has been found to be increasing with age. The peak age for males is 45 - 54 years and that for females is 35 years [1].

This study revealed that a marital status, family size, occupation, number of rooms relating to tuberculosis ($P=0.000$). This result is in line with the study conducted in South India, based on data collected through a questionnaire survey pertaining to religion, marital status, household size, occupation, employment, number of rooms in houses, separate kitchens [17]. The current study revealed that the marital status, a previous family histories, smoking and number of people who use the room to sleep have been found to be significant risk factors of TB ($P=0.000$). Our findings are consistent with the study by Fielding *et al* conducted study in three African countries Guinée, Guinea Bissau, and The Gambia, and highlighted the risk factors as marital status, family history, smoking, and crowding [18].

In this study, gender, age group, marital status and occupation shown an association with TB ($P=0.000$). Our findings are in disagreement with a study conducted in Ethiopia, where was sex, different age groups, residence, marital status, and occupation had not shown an association with developing TB [13].

The present study showed highly significant between socio-economic factors, overall; natural ventilation ($P=0.000$), occupation; ($P=0.000$), malnutrition diseases ($P=0.000$), family size ($P=0.000$) and tuberculosis. This finding is comparable to the study conducted to investigate the Social Determinants of Tuberculosis, showed that the social determinants are a key risk factors for TB, for example; poor ventilation, malnutrition, overcrowding in homes, workplaces, and communities increase [12].

A similar study was conducted in a high-incidence area for study of tuberculosis transmission patterns revealed that many factors play a role in tuberculosis transmission and they are often interrelated, such as crowding and unemployment, which are all part of the complex socio-economic environment tuberculosis patients live in [19]. While a study conducted in in three countries in West Africa; Guinée, Guinea Bissau and The Gambia showed that the risk of TB increased with the number of households in the compound, and with the number of persons in the household [18]. The results of the current study close to result of a previous study conducted in Gujrat city Pakistan discovered the poverty, smoking, density of population, housing congestion, level of education, malnutrition have been found to be significant risk factors of TB in the current study [20]. Research conducted among Sudanese Patients revealed that the four demographic data gender, BCG vaccination, socioeconomic status and smoking were significant ($P\text{-value}=0.000$) associated with increased risk of novel development of pulmonary tuberculosis [10].

Environmental factors play a major role associated with the incidence of tuberculosis, overall; number of rooms ($P=0.000$), the area of rooms in the house ($P=0.000$), adequate natural ventilation ($P=0.000$), number of people who use the room to sleep ($P=0.000$), a similar study conducted by Kant *et al*, revealed that environmental conditions playing a role in disease development were humidity and number of

people living in the house. Overcrowded housing and poor ventilation increase both the likelihood of exposure to *Mycobacterium tuberculosis* (MTB) and progression to disease [21].

These results are in line with the study conducted by Srivastava *et al* reported that studies in hospitals and health care facilities have shown that poor ventilation design or construction, crowded housing and poor ventilation increase the risk of transmission and malnutrition are recognized risk factors which are confounded with the socioeconomic status of a setting [21]. A study conducted by Madhona *et al*, stated that houses with less ventilation effect on the incidence of pulmonary tuberculosis. Home ventilation function to remove contaminated air (bacteria, CO₂) and replace it with fresh air and clean or for air circulation point of entry of ultraviolet light [22].

The present study showed that (15.8%) of patients were smoked; ($P=0.000$). This study is in line with a similar study carried out among Sudanese patients revealed that 14% of TB patients were smoked ($P=0.000$) [10]. The result indicates that the majority of the patients (75%) were non-smokers [24].

The results of the study showed a strong association between TB and both smoking and the types of tobacco products smoked; ($P\text{-value}; 0.000$ and 0.005) respectively, as one of the third factor variables represented (21.57%) of the total variance. A study carried out in three countries in West Africa; Guinée, Guinea Bissau, and The Gambia showed the risk of TB was found to increase with smoking, with a significant dose-response trend according to duration of smoking ($P=0.001$) [18]. Hassmiller K. stated that findings have suggested that a large part of the tuberculosis burden in India can be attributed to smoking (40%) [24]. Smoking increases the chances of MTB infection, the risk of progression from infection to disease, and the risk of death among TB patients [25].

The percentage of male patients was higher than that of females; 73.3% and 26.7% respectively. This finding is in disagreement with a previous study conducted in Gujrat city Pakistan discovered the percentage of female patients was slightly higher than that of males, i.e., 51.33 % and 48.66% respectively [20]. While the current finding is in line with a previous study conducted among Sudanese populations showed that the male was become more infected (75%) than women (25%) according to many reasons and differences in immune response biological differences in male and female susceptibility to infect by PTB [10].

This analysis found that there were one to three people per room (79.5%) and four to six people per room (20%); ($P=0.000$). A prior study conducted in three West African nations; Guinée, Guinea Bissau, and The Gambia demonstrated that TB was unrelated to the number of occupants per room [18]. Also, a prior study conducted in the Pakistani city of Gujrat revealed that 70.54 percent of patients across all respondents shared housing [20]. The study conducted in the Gambia is in line with the current study whereas showed that the highest category of household crowding, were all found to be associated with TB disease, ($p < 0.0001$) [26].

The study illustrated that (93%) of TB patients were vaccinated with BCG vaccine immediately after birth; This result is highest as compared with a study conducted among Sudanese Patients finding that only 15% of them vaccinated with BCG ($P\text{-value}=0.000$) [10].

The present investigation revealed a highly significant link between tuberculosis and the occupations of TB patients ($P = 0.000$); 7.9% were officeholders, 23.8% were unemployed, 19.8% were students, 9.9% were housewives, and 38.6% performed free work. A prior study conducted in three West African countries; Guinée, Guinea Bissau, and The Gambia revealed that there was no significant variation in the present employment situation between cohorts; 27% were employed, 17% were unemployed, 7% were housewives, 10% were in school, and 39% were retired [18].

The present study showed that there was no significant correlation between building structure and TB disease (0.598), whereas (28.7%) of TB patients live in houses made of straw and mats, (36.6%) of them have mud houses, and (34.7%) of them live in houses structured from burnt bricks. The study conducted in The Gambia showed that the walls made of mud were found to be associated with TB disease [26]. Previous research in three West African nations; Guinée, Guinea Bissau, and The Gambia found that mud-brick walls and earth/soil floors were associated with a higher risk of tuberculosis than cement walls and concrete floors, although the differences were not statistically significant [18]. Another similar study in the Oromia Region of Eastern Ethiopia found that 92.7% of the homes in that region were constructed from mud and wood [27].

The present study (90.1%) of TB patients has private bedrooms in house. Also a similar study conducted in Oromia Region, Eastern Ethiopia, showed that three hundred sixty sixes (81.2%) of the respondents had separate kitchen room [27].

According to ventilation, adequate natural ventilation was sufficient in (91.4%) of rooms. a similar study conducted in Oromia Region, Eastern Ethiopia, showed that majority 305 (67.6%) of study group houses had good ventilation [27]. This study showed that (17.8%) of TB patients have previous family histories; ($P = 0.000$). Our study is in line with the study conducted in the Gambia showed that a history of TB in another member of the household ($p = 0.0013$) were all found to be associated with TB disease [26].

Conclusion

Occupation, preferred food, marital status, monthly income, educational level, age group, gender, number of rooms, the area of rooms in the house, Adequate natural ventilation, number of people who use the room to sleep, boiling milk before drinking, smoking, use a tissues during sneezing, a previous family histories, malnutrition diseases, family size, spit directly on the ground, drink milk and vaccinated with BCG have been found to be significant risk factors of TB. Health awareness for community and patients through health education programs to eliminate harmful habits and unhealthy behavior that increase the incidence of tuberculosis, linking the issuance of a birth certificate for newborns to immunization with the vaccination of BCG vaccine.

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Ethical Consideration

To obtain agreement to conduct the study is very important for collecting data. Before the study commenced permission was obtained from the appropriate management authority; State Ministry of Health, North Kordofan State and El-Obeid Teaching Hospital. This study was reviewed and approved by the Researches Committee of Department of Public and Environmental Health, University of Kordofan.

References

1. Agrawal Sunil, Bhalwar RajVir, Singh Mandeep, Bhatti Vijay K, Patrikar Seema R, *et al.* Text Book of Public Health and Community Medicine, Department of Community Medicine, Armed Force Medical College, Pune. Gayo Enterprises, Sector No. 28, Plot No. 234, PCNTDA, 2009.
2. K Park-Park's, Banarsidas Bhanot. Park's Textbook of Preventive and Social Medicine 23 Edition, Jabalpur, India, 2015.
3. World Health Organization. Communicable disease control in emergencies; A field manual, ISBN 92 4 154616 6. (2005).
4. Theodore H Tulchinsky, Elena A Varavikova. The New Public Health, Second Edition. Elsevier Academic Press. 525 B Street, Suite 1900, San Diego, California 92101-4495, USA, 2009. <http://textbooks.elsevier.com>
5. Zerbini E, Greco A, Estrada S, Cisneros M, Colombo C, Beltrame S, *et al.* Factors Affecting Tuberculosis-Related Mortality. *Medicina (Buenos Aires)*. 2017; 77:267-273. ISSN 1669-9106.
6. World Health Organization (WHO) report 2014. Global Tuberculosis Control, WHO Report. 2014 Geneva. http://apps.who.int/iris/bitstream/10665/137094/1/9789241564809_eng.pdf.
7. Srivastava K, Kant S, Verma A. Role of Environmental factors in Transmission of Tuberculosis. *Dynamics of Human Health*, 2015, 2(4). ISSN 2382-1019.
8. World Health Organization. Communicable Disease Profile; Afghanistan and Neighboring Countries, 2001, 21.
9. K Tocque, MA Bellis, NJ Beeching, Q Syed, T Remington, PDO. Davies. A case-control study of lifestyle risk factors associated with tuberculosis in Liverpool, North-West England. *European Respiratory Journal*, 2001. DOI:10.1183/09031936.01.00211701.
10. Ali AH, Omer AA, Saeed NS, Mansour EE, Elhassan M. M; Assessment of Different Risk Factors Affecting Pulmonary Tuberculosis among Sudanese Patients. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*. e-ISSN: 2279-0853, p-ISSN: 2279-0861. Volume 17, Issue 2 Ver. 6 February. (2018), PP 86-88. DOI: 10.9790/0853-1702068688. www.iosrjournals.org.
11. Mason PH, Degeling C, Denholm J. Sociocultural Dimensions of Tuberculosis: An overview of key concepts. *International Journal of Tuberculosis and Lung Disease*. 2015; 19(10):1135-1143. Doi: <http://dx.doi.org/10.5588/ijtld.15.0066>.
12. Hargreaves JR, Boccia D, Evans CA, Adato M, Petticrew M, Porter JDH. The Social Determinants of Tuberculosis: From Evidence to Action, *American Journal of Public Health*. 2011; 101:4
13. Diriba K, Awulachew E. Associated risk factor of tuberculosis infection among adult patients in Gedeo

- Zone, Southern Ethiopia. SAGE Open Medicine. 2022; 10:1-10. <https://doi.org/10.1177/20503121221086725>.
14. Elmadhoun WM, Noor SK, Bushara SO, Ahmed EO, Mustafa H, Sulaiman AA, *et al.* Epidemiology of tuberculosis and evaluation of treatment outcomes in the national tuberculosis control programme, River Nile state, Sudan, 2011-2013. (2016).s Eastern Mediterranean Health Journal. EMHJ • Vol. 22 No. 2 • 2016.
 15. Elduma A Hussein, Mansournia M Ali, Foroushani A Rahimi, Ali HM Hamdan, Elegail AMA Salam, Elsony A, Holakouie-Naieni K. Assessment of the risk factors associated with multidrug-resistant tuberculosis in Sudan: A case-control study. *Epidemiology and Health*. 2019; 41(e2019014):9. <https://doi.org/10.4178/epih.e2019014>.
 16. Federal Ministry of Health, Sudan National Tuberculosis Control Programme; Sudan National TB Management Guideline 2018. Khartoum, Sudan, 2018.
 17. Shetty N, Shemko M, Vaz M, D'souza G. An epidemiological evaluation of risk factors for tuberculosis in South India: a matched case control study. *The International Journal of Tuberculosis and Lung Disease*. 2006; 10(1):80-86.
 18. Lienhardt C, Fielding K, Sillah J, Bah B, Gustafson P, Warndorf D, *et al.* Investigation of the risk factors for tuberculosis: a case-control study in three countries in West Africa. *International journal of epidemiology*. 2005; 34(4):914-923.
 19. Z Munch, SWP Van Lill, CN Booysen, HL Zietsman, DA Enarson, N Beyers. Tuberculosis transmission patterns in a high-incidence area: a spatial analysis. *The International Journal of Tuberculosis and Lung Disease, INT J TUBERC LUNG DIS*. 2003; 7(3):271-277.
 20. Miandad M, Anwar M Mushahid, Ahmed S, Rahman G, Khan M Ahmed. Assessment of risk factors associated with spread of tuberculosis in Gujrat city Pakistan. *Journal of Geography*, 2019, (39). <http://jgeography.istanbul.edu.tr>. DOI: 10.26650/JGEOG2019-0023).
 21. Srivastava K, Kant S, Verma A. Role of Environmental factors in Transmission of Tuberculosis. *Dynamics of Human Health*, 2015, 2(4). ISSN 2382-1019. (2015). http://journalofhealth.co.nz/?page_id=982
 22. Madhona R, Ikhwan Z, Aminin F. Physical Environment Home and Incidence of TB Disease in Tanjungpinang District. *Advances in Health Sciences Research*, 2016, 1. DOI: 10.2991/phico-16.2017.77.
 23. Rodriguez F, A Herrera, Agbo S Onoja. An assessment of the risk factors for pulmonary tuberculosis among adult patients suffering from human immunodeficiency virus attending the Wellness Clinic at Themba Hospital. *South African Family Practice*. 2015; 57(2):106-111. <http://dx.doi.org/10.1080/20786190.2014.978105>).
 24. Hassmiller K. The impact of smoking on population level tuberculosis outcomes. *TSRU progress report 2007*. The Hague: KNCV, 2007.
 25. Kant S, Maurya AK, Kushwaha RAS, Nag VL. Multi Drug resistant tuberculosis; an iatrogenic problem. *Biosciences Trends*. 2010; 4:48-53.
 26. Hill PC, Sillah D Jackson, Donkor SA, Otu Jacob, Adegbola RA, Lienhardt C. Risk factors for pulmonary tuberculosis: a clinic-based case control study in The Gambia. *BMC Public Health*. 2006; 6:156. <http://doi:10.1186/1471-2458-6-156>. <http://www.biomedcentral.com/1471-2458/6/156>)
 27. Adane A, Damena M, Weldegebreal F, Mohammed H. Prevalence and Associated Factors of Tuberculosis among Adult Household Contacts of Smear Positive Pulmonary Tuberculosis Patients Treated in Public Health Facilities of Haramaya District, Oromia Region, Eastern Ethiopia. *Tuberculosis Research and Treatment*. Volume 2020, Article ID 6738532, 7 pages. (2020) <https://doi.org/10.1155/2020/6738532>.
 28. Mohammed MAO, Babikir MH. Patterns of Tuberculosis infection in El-Obeid City, North Kordofan State, Sudan, *journal of Medical Sciences*. ISSN; 1682-4474. (2022). DOI: 10.3923/jms.2022.66.72.
 29. Kesete Y. Assessment of the Prevalence of Pulmonary Tuberculosis Patients at Nakfa Hospital from 2014-2019, Eritrea. pp; 1 to 5. (2020) <https://doi.org/10.1101/2020.02.11.20021279>.
 30. Zedan M, Al Wakeel E, *et al.* Pattern of tuberculosis in patients of a university hospital during the period (2004-2011). *Egyptian Journal of Chest Diseases and Tuberculosis*, 2014. <http://dx.doi.org/10.1016/j.ejcdt.2014.09.003>, www.elsevier.com/locate/ejcdt, www.sciencedirect.com).
 31. Nikbakht H Ali, Saber Ghaffari, *et al.* Epidemiological patterns of Tuberculosis disease in the Babol, Iran, *J Anal Res Clin Med*. 2015; 3(3):164-9. Doi: 10.15171/jarcm.2015.026, <http://journals.tbzmed.ac.ir/JARCM>
 32. World Health Organization; WHO Report 2008. *Global Tuberculosis Control; Surveillance, Planning, Financing*. Switzerland, Geneva, 2008.