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Pulmonary tuberculosis among Sudanese individuals of White Nile state: Prevalence and role of the socio-demographic features and laboratory findings in the assessment of infection

Abstract

Background: Tuberculosis (TB) is a bacterial disease that can be spread through the air. It usually attacks the lungs, but it can also affect and damage the other parts of the body such as the brain, kidneys, or spine. Globally, the disease remains to be a major health problem in countries suffering from poverty and unsettlement like Sudan. Our study aimed to evaluate the prevalence of pulmonary TB and the value of the socio-demographic characteristic of patients and laboratory findings in the assessment of tuberculosis infection. **Methods:** During the period from May 2017 to December 2018, 1434 subjects were included. *M.tuberculosis* infection was examined using Ziehl-Neelsen (ZN) stain and GeneXpert test, and Human immunodeficiency virus infection was checked by the immuno-chromatographic test. **Results:** Out of 1434 participants, 795 (55.4%) were males and 639 (44.6%) were females as well as 670 (46.7%) were suffering from infection relapse. The percentage of HIV infection, MTB detection, and RF resistance among the study contributors was 1.4%, 16.5%, and 15.5%, respectively. Infection relapse was more in females than males. Among the medically suspected new participants (449), the overall reported prevalence for pulmonary TB was 15.8% based on the Gene Xpert test. Furthermore, the percentage of RF resistance was lower in females than males and participants age 1-20 years compared to 21-40, 41-60, and 61-80 age groups. There was a significant difference in the microscopy findings among disease history, bacillary levels and RF susceptibility patterns, P-values less than 0.05. Moreover, the odd of detection of a high bacillary level was significantly less likely in females than males. Whereas, it is higher in case of treatment failure and infection with RF resistant strain, P-values less than 0.05. **Conclusions:** The findings of the current study were illustrated the current prevalence of pulmonary TB and shown the value of socio-demographic features and laboratory findings in the assessment of pulmonary tuberculosis infection.

Keywords: HIV, Pulmonary tuberculosis, Rifampicin, Xpert MTB/RIF, ZN stain

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Introduction

Tuberculosis (TB) is an infectious disease caused by bacilli belong to Mycobacterium tuberculosis complex, usually *M.tuberculosis* (MTB).[1] It is also considered as one of the most serious diseases due to its high risk of a person to person transmission, morbidity, and mortality. Global strategy for TB decline requires country adaptation and prioritization based on the local epidemiology and available TB control resources.[2] According to the World health organization (WHO, 2017), TB caused an estimated 1.3 million deaths (range, 1.2–1.4 million) among HIV-negative people and there were an additional 300 000 deaths from TB (range, 266 000–335 000) among HIV-positive people. The disease situation has become more alarming due to dual infection with HIV and the development of drug-resistant bacteria. The emergence of resistance to drugs used for TB treatment and particularly multidrug-resistant MTB (MDR-MTB), has become a significant public health problem in many countries and an obstacle to effective global TB control.[3] Previously, the high incidence of disease ranks Sudan among the high prevalence countries for TB in the Eastern Mediterranean region and accounts for 14.6% of the total TB burden.[4] In Kosti city (Sudan), Tuberculosis care and treatment is provided by the National Tuberculosis Control Program under the auspices of the Ministry of Health and by several non-governmental organizations (NGOs) who provide care to displaced persons, including those living in refugee camps.[5] Treatment is also provided by the private sector.[6] The modern development of advance diagnostic techniques such as the Xpert MTB/RIF test provides a better understanding of the pathology and epidemiology of TB. Xpert MTB/RIF test is highly automated, which runs in closed systems with one cartilage per sample. Each instrument can process 4 samples or more at one time with a processing time of just under 2 hours. It has a diagnostic sensitivity of 98% in smear-positive and 72% in smear-negative samples. The Xpert MTB/RIF also has a good sensitivity (80%) and excellent specificity (>98%) when performed on cerebrospinal fluid, lymph node material or gastric fluid. WHO recommends GeneXpert as an initial diagnostic test for TB replacing microscopy by 2020.[7] The current study aimed to evacuate the prevalence of pulmonary TB and the value of the socio-demographic characteristic of patients and laboratory findings in the assessment of tuberculosis infection.

Materials and methods

Study design and subjects

This was a cross-sectional comparative study conducted at the TB clinic of Kosti Teaching Hospital during the period from May 2017

to December 2018. This clinic offers consultants and health services about TB for most populations of White Nile state, Sudan. White Nile state is one of 18 states of Sudan. It has an area of 30,411 km^2 and an estimated population of approximately 1.188,707. Since 1994, Rabak is the capital of the state; other important cities are Kosti, El-dueim, and Al-getaina. Study subjects in the current study composed of suspected or confirmed pulmonary TB patients regardless of gender and age.

Ethical issues, informed consent, and confidentiality

Ethical approval for the current study was obtained from the Ethics Review Committee of Kosti Teaching Hospital. The Research Board of the Faculty of Medical Laboratory Sciences, University of Gezira also provides the authorization. Each participant was informed about the aim of the research as well as kindly asked for their enthusiastic participation and sign on the prepared consent form. Personal information of the study participants was kept confidentially and anonymously.

Data collection

Participant's socio-demographic and clinical presentation information (relapse, loss of follow up, contact with MDR patient or failure of treatment) were collected by researchers using a structured questionnaire.

Samples collection and HIV infection assessment

Under standard bio-safety procedures, sputum samples were collected from each individual and decontaminated by adding a double volume of 4% sodium hydroxide. The pH of the mixture was brought to neutral by the addition of hydrochloric acid and phenol red as an indicator. Samples were then concentrated by centrifugation at 1500–2000 rpm for 20 min. Supernatants were discarded and a double volume of distilled water was added to sediment and centrifuged again for 5 min. Moreover, 2-5 ml of the venous blood sample was also collected from each participant. Subsequently, serum was obtained by centrifugation at 3000 rpm for 5 minutes and tested for Human immunodeficiency virus (HIV) infection by rapid immuno-chromatographic test (Acon, USA).

Ziehl-Neelsen smear and microscopy

Sputum smears were made from the above-prepared specimens. Subsequently, they were air-dried, heat-fixed, and stained by Ziehl-Neelsen (ZN) staining technique. The stained slides were examined under oil immersion (100 × lens objective) and the results were reported as negative when no acid-fast bacilli (AFB) was seen in at least 100 microscopic fields or exact number (positive) when at least 1–9 AFB were seen in 100 fields. Moreover, 10–99 AFB/100 were recorded as 1+, 1–10 AFB/field recorded as 2+, and more than 10 AFB/field after examining at least 20 fields was recorded as 3+.[8] All negative smears were rechecked.

Standard assay procedure of Gene Xpert

GeneXpert test was performed for the examination of *M.tuberculosis*, bacillary level, and Rifampicin(RF) susceptibility. Each Xpert MTB/RIF cartridge was labeled with the sample identity (case number). Using a transfer pipette, 0.5 mL or 1ml of the total re-suspended pellet from each sample was transferred into a conical (screw-capped) tube for Xpert MTB/RIF. Next, sputum sample was liquefied and inactivated by addition of 2:1 of sample reagent, followed by incubation for 10 minutes at room temperature, shacking of the specimen vigorously 10 to 20 times or vortex for at least 10 seconds, and finally incubation of the sample at room temperature for an additional 5 minutes. Afterward, the cartridge lid was opened, and 2ml of the sample was transferred into the sample chamber of the Xpert MTB/RIF cartridge. The sample was dispensed slowly to minimize the risk of aerosol formation. Next, the cartridge lid was closed firmly and the cartridge was loaded into the GeneXpertDx instrument and the test was performed.

Data analysis

Statistical analysis was performed by SPSS version 21.All data were presented as numbers and percentages. Pearson Chi-squared test and Fisher exact test were involved in the evaluation of the statistical difference. Univariate and multivariate logistic regression were assessed the association between dependant and independent variables. A P-value < 0.05 was considered significant.

Results

Table 1 summarizes the socio-demographic characteristics of TB patients. Most of the study participants were males and age 21-40 years old (Table 1). Out of the 1434 subjects included in the current study, 449 (31.3%) were new cases, 670 (46.7%) were suffering from relapses, 157 (11%) were loss of follow up, 46 (3.2%) were cases of failure of treatment and 112(7.8%) have contacted with patients infected by MDR strain. The probability and positivity rate of historical parameters among the study participants were significant differences among age groups. Furthermore, the probability of contact with patients carries multi-drug resistance strains, loss of follow up, and failure of treatment was more in males than females. Whereas, the infection relapses was more in females than males (Table 2).The risk of infection relapses was less in females than males (Table 3). Among the study participants, the percentage of HIV infection, MTB detection using GeneXpert test, and RF resistance were 1.4%, 16.5%, and 15.5%, respectively (Table 4).

Furthermore, HIV infection was statistically linked to loss of follow-up, failure of treatment, and RF resistance (Table 5).Among the TB suspected new participants (449), the overall reported prevalence was 15.8% based on the Gene Xpert test (Table 6). In contrast, 88.6% of participants were negative by ZN stain (Table 7). The probability of MTB detection among the study participants was significantly different among gender, age groups, microscopy finding, bacillary level, and RIF susceptibility patterns, P-values less than 0.05. Moreover, MTB detection was significantly linked to the failure of treatment (Table 6). There was a significant difference in the microscopy findings among disease history, bacillary level, and RF susceptibility patterns, P-values less than 0.05 (Table 7). Moreover, the odd of detecting more than 10 AFB/field (+3) was less in females than males, whereas, it is significantly higher in HIV infected individuals (Table 8). In this study, the percentage of RF was lower in females than males and patient's age 1-20 years compared to 21-40, 41-60, and 61-80 age groups (Table 9). Likewise, logistic regression revealed that females and individuals of 1-20 years old were less likely to develop RF resistance compared to males and many age groups (21-40, 41-60, and 61-80 age groups), respectively (Table 10). Furthermore, bacillary levels were significantly different among gender, disease history and RF susceptibility patterns, P-values less than 0.05 (Table 11). Likewise, regression analysis found that the odd of detection of a high bacillary level was significantly less likely in females than males. Whereas, it is higher in case of treatment failure and infection with RF resistant strain (Table 12).

Table 1 Socio-demographic characteristics of the study participants

Category		Number of participants among age groups No (%)					P value
		1-20 Years	21-40 Years	41-60 Years	61-80 Years	81-100 Years	
Total		312	479	383	237	23	0.000
Gender	Male	180(57.7)	255(53.2)	204(53.3)	136(57.4)	20(87)	
	Female	132(42.3)	224(46.8)	179(46.7)	101(42.6)	3(13)	0.018
	P value	0.000	0.045	0.071	0.001	0.000	

Table 2 Probability and positivity rate of historical parameters among tuberculosis patients

Category Number		History No (%)						
			Relapse	Loss of follow-up	Contact with MDR patients	New patients	Failure of treatment	P value
Total of participants		1434	670(46.7)	157(10.9)	112(7.8)	449(31.3)	46(3.2)	0.000
Age/years	1-20	312(21.8)	90(28.8)	23(7.3)	72(23.1)	119(38.1)	8(2.7)	
	21-40	479(33.4)	259(54.1)	51(10.4)	22(4.9)	131(27.3)	16(3.4)	
	41-60	383(26.7)	196(51.1)	50(13.1)	14(3.7)	108(28.2)	15(3.9)	0.000
	61-80	237(16.5)	117(49.4)	26(10.9)	4(1.7)	83(35.1)	7(2.9)	
	81-100	23(1.6)	8(34.8)	7(30.4)	0(0)	8(34.8)	0.000	
	P value	0.000	0.000	0.009	0.000	0.008	0.876	
Gender	Male	795(55.4)	362(45.5)	93(11.6)	73(9.3)	240(30.2)	27(3.4)	
	Female	639(44.6)	308(48.2)	64(10.1)	39(6.1)	209(32.7)	19(2.9)	0.154
	P value	0.018	0.315	0.311	0.031	0.307	0.652	

Table 3 Association of historical parameters with gender and age of TB patients

Category		Relapse		Loss of follow up		Contact with MDR		New patients		Failure of treatment	
		OR (95%CI)	P value	OR (95%CI)	P value	OR (95%CI)	P value	OR (95%CI)	P value	OR(95%CI)	P value
Gender	Male	1		1		1		1		1	
	Female	.8(.7-1.1)	0.315	1.1(.8-1.6)	0.311	1.5(1.0-2.3)	0.032	.8(.7-1.1)	0.307	1.1(.6-2.0)	0.652
Age	1-20	1		1		1		1		1	
	21-40	.3(.2-.5)	0.000	.6(.3-1.1)	0.124	6.2(3.7-10.2)	0.000	1.6(1.2-2.2)	0.001	.7(.3-1.8)	0.535
	41-60	.3(.2-.5)	0.000	.5(.3-.8)	0.016	7.9(4.3-14.3)	0.000	1.5(1.1-2.160)	0.006	.6(.2-1.5)	0.325
	61-80	.4(.2-.5)	0.000	.6(.3-1.1)	0.145	17.4(6.2-48.6)	0.000	1.1(.8-1.6)	0.453	.8(.3-2.4)	0.782
	81-100	.9(.3-2.3)	0.871	.1(.0-.4)	0.001	9.4(4.2-12.4)	0.000	1.1(.4-2.8)	0.749	0.0 (.0-0.0)	0.000

Citation: Elsafi SSMS, Nour BM, Abakar AD, et al. Pulmonary tuberculosis among Sudanese individuals of White Nile state: Prevalence and role of the socio-demographic features and laboratory findings in the assessment of infection. *J Microbiol Exp.* 2020;8(2):52–63. DOI: 10.15406/jmen.2020.08.00285

Table 4 Percentage of HIV infection, RF susceptibility pattern, MTB detection and the results of microscopy examination among tuberculosis patients

Category		Number	Percentage
HIV	Positive	20	1.4
	Negative	1414	98.6
MTB	Detected	237	16.5
	Not detect	1197	83.5
Microscopy	Negative	1267	88.4
	Exact number	13	0.9
	+1	104	7.3
	+2	37	2.6
	+3	13	0.9
Bacillary level	Negative	1197	83.5
	Very low	29	2
	Low	56	3.9
	Medium	117	8.2
	High	35	2.4
RF susceptibility	Negative	1197	83.4
	Sensitive	224	15.6
	Resistant	14	1

Table 5 Positivity rate and logistic regression model for HIV infection

Category		Number	HIV infection		
			No (%)	OR (95%CI)	P value
Gender	Male	795(55.4)	14 (1.7)	1	
	Female	639(44.6)	6 (0.9)	.5(.2-1.3)	0.194
	P value		0.187		
History	Relapse	670 (46.7)	5 (0.7)	1	
	Loss of follow-up	157(10.9)	2 (1.3)	1.7(.3-8.9)	0.521
	Contact with MDR	112(7.8)	0(0)	2(.0-.0.)	0.998
	New patients	449 (31.4)	13(2.9)	3.9(1.4-11.2)	0.009
	Failed	46(3.2)	0 (0)	2(2.0-2.0)	0.000
	P value		0.02		
MTB	Detected	237(16.5)	7(2.9)	1	
	Not detected	1197(83.5)	13(1.1)	.3(.1-.9)	0.032
	P value		0.025		
Microscopy	Negative	1267(88.4)	16(1.3)	1	
	Exact number	13 (0.9)	0 (0)	4.1(4.1-4.1)	0.000
	+1	104 (7.3)	3(14.4)	2.3(.6-8.1)	0.186
	+2	37 (2.5)	1(2.7)	2.1(.2-16.8)	0.458
	+3	13 (0.9)	0 (0)	4.1(4.1-4.1)	0.000
	P value		0.381		

Citation: Elsafi SSMS, Nour BM, Abakar AD, et al. Pulmonary tuberculosis among Sudanese individuals of White Nile state: Prevalence and role of the socio-demographic features and laboratory findings in the assessment of infection. *J Microbiol Exp.* 2020;8(2):52–63. DOI: 10.15406/jmen.2020.08.00285

Table Continued...

Category		Number	HIV infection		
			No (%)	OR (95%CI)	P value
Bacillary level	Negative	1197(83.5)	13(1.1)	1	
	Very low	29 (2)	2 (6.9)	6.7(1.4-31.3)	0.051
	Low	56 (3.9)	1(1.7)	1.6(.2-12.8)	0.630
	Medium	117 (8.2)	4 (3.4)	3.2(1.034-10.0)	0.044
	High	35 (2.4)	0 (0)	1(1.0-1.0)	0.000
	P value		0.033		
RFsusceptibility	Negative	1197(83.5)	13(1.1)	1	
	Sensitive	224 (15.5)	7(3.1)	2.9(1.1-7.4)	0.023
	Resistant	14 (1)	0 (0)	4.2(4.2-4.2)	0.000
	P value		0.054		

Table 6 Probability and logistic regression model for MTB detection

Category		Number	MTB detection		
			No (%)	OR(95%CI)	P value
Gender	Male	795(55.4)	150(18.8)	1	
	Female	639(44.6)	87(13.6)	.7(.5-2.8)	0.024
	P value		0.008		
Age	1-20	312(21.8)	36 (11.5)	1	
	21-40	479 (33.4)	103(21.5)	1.9(1.2-2.8)	0.002
	41-60	383 (26.7)	64 (16.7)	1.4(.9-2.2)	0.094
	61-80	237 (16.5)	31 (13.1)	1(.6-1.7)	0.866
	81-100	23 (1.6)	3 (13)	1(.3-3.8)	0.903
	P value		0.002		
History	Relapse	670(46.7)	100(14.9)	1	
	Loss of follow-up	157 (10.9)	34(21.6)	1(1.0-2.4)	0.041
	MDR Contact	112 (7.8)	18 (16.1)	1(.6-1.8)	0.754
	New patients	449 (31.4)	71(15.8)	1(.7-1.4)	0.686
	Failed	46 (3.2)	14(30.4)	2.4(1.2-4.8)	0.007
	P value		0.028		
HIV	Positive	20 (1.4)	7 (35)	1	
	Negative	1414(98.6)	230 (16.3)	.3(.1-.9)	0.032
	P value		0.025		
Microscopy	Negative	1267(88.4)	75 (5.9)	1	
	Exact number	13 (0.9)	11 (84.6)	87.4(19.0-401.5)	0.000
	+1	104 (7.3)	101(97.1)	535(165.7-1727.0)	0.000
	+2	37 (2.5)	37 (100)	1708423905(.0-1708423905)	0.99
	+3	13 (0.9)	13 (100)	1708423910(1708423910-1708423910)	0.000
	P value		0.000		

Table Continued...

Category		Number	MTB detection		
			No (%)	OR(95%CI)	P value
Bacillary level	Negative	1197(83.5)	3(0.3)	1	
	Very low	29 (2)	29 (100)	94376544200(94376544200-94376544200)	0.000
	Low	56 (3.9)	55(98.2)	21890(2240.668-213852.326)	0.000
	Medium	117 (8.2)	115(98.3)	22885(3785.1-138363.0)	0.000
	High	35 (2.4)	35(100)	94376543450(94376543450-94376543450)	0.000
	P value		0.000		
RFsusceptibility	Negative	1197(83.5)	2 (0.2)	1	
	Sensitive	224 (15.5)	222(99.1)	66322.5(9293.7-473295.8)	0.000
	Resistant	14 (1)	13 (92.8)	7767.5(662.3-91089.0)	0.000
	P value		0.000		

Table 7 Percentage and probability of microscopy results

Category		Number	Microscopy No (%)					
			Negative	Exact number	+1	+2	+3	P value
Gender	Male	795	688(86.5)	8(1)	64(8.1)	25(3.1)	10(1.3)	0.133
	Female	639	579(90.5)	5(0.8)	40(6.3)	12(1.9)	3(0.5)	
Age	1-20	312	285 (91.3)	4(1.3)	15(4.9)	8(2.5)	0(0)	
	21-40	479	404(84.3)	3(0.6)	47(9.8)	19(4)	6(1.3)	
	41-60	383	343(89.6)	4(1)	25(6.5)	5(1.3)	6(1.6)	0.107
	61-80	237	215(90.7)	2(0.8)	15(6.3)	4(1.7)	1(0.5)	
	81-100	23	20(87)	0(0)	29(8.6)	1(4.5)	0(0)	
History	Relapse	670	604(90.2)	8(1.2)	36(5.4)	13(1.9)	9(1.3)	
	Loss of follow-up	157	129(82.2)	1(0.6)	19(12.1)	8(5.1)	0(0)	
	MDR contact	112	99(88.3)	1(0.9)	8 (7.1)	3(2.5)	1(0.8)	
	New patients	449	398(88.6)	3(0.7)	33(7.4)	13(2.9)	2(0.4)	0.027
	Failed	46	37(80.4)	0(0)	8(17.4)	0(0)	1(2.2)	
HIV	Positive	20	16 (80)	0(0)	3(15)	1(5)	0(0)	0.615
	Negative	1414	1251 (88.5)	13(0.9)	101(7.1)	36(2.5)	13(0.9)	
MTB	Detect	237	75 (31.6)	11(4.6)	101(42.6)	37(15.6)	13(5.6)	
	Not detect	1197	1192(99.5)	2(0.2)	3(0.3)	0(0)	0(0)	0.000
Bacillary level	Negative	1197	1193 (99.6)	1(0.1)	3(0.3)	0(0)	0(0)	
	Very low	29	26(89.7)	0(0)	2(6.9)	0(0)	1(3.4)	0.000
	Low	56	36(64.3)	4(7.1)	16(28.6)	0(0)	0(0)	
	Medium	117	11(9.4)	7(6)	75(64.1)	23(19.6)	1(0.9)	
	High	35	1(2.9)	1(2.9)	8(22.8)	14(40)	11(31.4)	
RFsusceptibility	Negative	1197	1193(99.6)	1(0.1)	2(0.3)	0(0)	0(0)	0.000
	Sensitive	224	73(32.6)	12(5.4)	97(43.3)	31(13.8)	11(4.9)	
	Resistant	14	1(7.1)	0(0)	5(35.6)	6(42.9)	2(14.3)	

Table 8 Logistic regression model for microscopy results

Category		Microscopy									
		Negative		Exact number		+1		+2		+3	P value
		OR (95%CI)	P value	OR (95%CI)	P value	OR (95%CI)	P value	OR (95%CI)	P value	OR (95%CI)	
Gender	Male	1		1		1		1		1	
	Female	1.501(1.0-2.0)	0.017	.7(.2-2.3)	0.648	.7(.5-1.1)	0.186	.5(.2-1.1)	0.14	.3(.1-1.3)	0.133
Age	1-20	1		1		1		1		1	
	21-40	.5(.3-.8)	0.005	.4(.1-2.1)	0.346	2.1(1.1-3.9)	0.002	1.5(.6-3.5)	0.318	42957745.9(.0-b)	0.996
	41-60	.8(.4-1.3)	0.427	.8(.2-3.2)	0.627	1.3(.7-2.6)	0.335	.4(.1-1.5)	0.216	54580266.0(.0-b)	0.996
	61-80	.9(.5-1.6)	0.798	.6(.1-3.6)	0.655	1.3(.6-2.7)	0.439	.6(.1-2.1)	0.466	14531610.3(.0-b)	0.996
	81-100	.6(.1-2.2)	0.48	2.7(2.7-2.7)	0.000	1.8(.4-8.7)	0.42	1.6(.2-14.1)	0.629	1(1-1)	0.000
History	Relapse	1		1		1		1		1	
	Loss of follow-up	.6(.4-.9)	0.046	.5(.0-4.2)	0.551	2.4(1.3-4.3)	0.003	2.9(1.1-7151)	0.02	3.0(3.0-3.0)	0.000
	MDR contact	.9(.5-1.6)	0.786	.7(.0-6.0)	0.783	1.3(.6-2.9)	0.453	1.3(.3-4.9)	0.611	.6(.0-5.2)	0.697
	New patients	.9(.6-1.3)	0.737	.5(.1-2.1)	0.389	1.3(.8-2.2)	0.18	1.5(.6-3.2)	0.302	.3(.0-1.5)	0.156
	Failed	.4(.2-.7)	0.008	1(1.0-1.0)	0.000	3.7(1.6-8.5)	0.002	6.4(6.4-6.4)	0.000	1.6(.2-13.1)	0.646
HIV	Negative	1		1		1		1		1	
	Positive	.5(.1-1.5)	0.249	4(4-4.0)	0.000	2.2(.6-7.9)	0.191	2.015(.2-15.4)	0.501	4.0(4-4.0)	0.000
MTB	Detect	1		1		1		1		1	
	Not detect	521.3(207.7-1307.9)	0.000	.0(.0-.1)	0.000	.0(.0-.0)	0.000	2.9(2.9-2.9)	0.000	9.0(9.0-9.0)	0.000
Bacillary level	Negative	1		1		1		1		1	
	Very low	.0(.0-.1)	0.000	3.7(3.1-3.1)	0.000	1(1-1)	0.000	365145.4(.0-1.7)	0.156	34.4(7.3-161.5)	0.000
	Low	.0(.0-.0)	0.000	92(10.1-837.6)	0.000	312(2.8-34038874)	0.543	1(1-1)	0.000	1(1-1)	0.000
	Medium	.0(.0-.0)	0.000	76.1(9.2-624.2)	0.000	4335.7(8.5-2.2)	0.355	1478287614(.0-C)	0.992	.3(.1-.6)	0.001
	High	9.8(1.07-2.1)	0.000	35.1(2.1-574.2)	0.012	1044.7(1.4-73524639783)	0.451	4027798136(.0-C)	0.992	42197368.6(42197368.6-42197368.6)	0.000
RFsusceptibility	Negative	1		1		1		1		1	
	Sensitive	.0(.0-.0)	0.000	67.6(8.7-522.9)	0.000	499.2(121.5-2050.9)	0.000	20875428(20875428-20875428.0)	0.000	578497.0(0.0-0.0)	0.000
	Resistant	.000(1.8-.0)	0.000	6.4(6.4-6.4)	0.000	331.6(56.7-1939.5)	0.000	6.5(6.5-6.5)	0.000	4.6(0.0-0.0)	0.000

b=floating overflow while computing therefore it is set to missing system

Citation: Elsafi SSMS, Nour BM, Abakar AD, et al. Pulmonary tuberculosis among Sudanese individuals of White Nile state: Prevalence and role of the socio-demographic features and laboratory findings in the assessment of infection. *J Microbiol Exp.* 2020;8(2):52–63. DOI: 10.15406/jmen.2020.08.00285

Table 9 Percentage of RF susceptibility pattern

Category		Number	RF susceptibility pattern No (%)			
			Negative	Sensitive	Resistant	P value
Gender	Male	795(55.4)	645(81.1)	141(17.7)	9(1.1)	
	Female	639(44.5)	551(86.2)	83(12.9)	5(0.9)	0.036
Age	1-20	312(23.2)	276(88.5)	34(10.9)	2(0.6)	
	21-40	479(33.4)	376(78.5)	97(20.2)	6(1.3)	
	41-60	383(58.4)	317(82.8)	63(16.4)	3(0.8)	0.02
	61-80	237(16.5)	207(87.3)	27(11.4)	3(1.3)	
	81-100	23(1.6)	20(87)	3(13)	0(0)	
History	Relapse	670(46.7)	569 (84.9)	93(13.9)	8(1.2)	
	Loss of flow-up	157(10.9)	123 (78.3)	32(20.4)	2(1.3)	
	MDR Contact	112(7.8)	94 (83.9)	16(14.3)	2(1.8)	0.066
	New patients	449((31.3)	378 (84.2)	70(15.6)	1(0.2)	
	Failed	46(3.2)	32 (69.5)	13(28.2)	1(2.1)	
HIV	Positive	20(1.4)	13(65)	7(35)	0(0)	
	Negative	1414(98.6)	1196(84.5)	217(15.3)	14(0.9)	0.052
MTB	Detect	237(16.5)	2(0.8)	222(93.7)	13(5.5)	
	Not detect	1197(83.5)	1194(99.7)	2(0.1)	1(0.08)	0.000
Bacillary level	Negative	1197(83.5)	1196(99.9)	1(0.08)	0(0)	
	Very low	29(2)	0(0)	28(96.6)	1(3.4)	
	Low	56(3.9)	0(0)	54(96.4)	2(3.6)	0.000
	Medium	117(8.2)	0(0)	109(93.2)	8(6.8)	
	High	35(2.4)	0(0)	32(91.4)	3(8.5)	
Microscopy	Negative	1197(83.5)	1193(99.6)	3 (0.3)	1(0.08)	0.000
	Exact number	29(2)	12(41.4)	17 (58.6)	0(0)	
	1	56(3.9)	2(3.6)	49 (87.5)	5(8.9)	
	2	117(8.1)	0(0)	111 (94.9)	6(5.1)	
	3	35(2.4)	0(0)	11 (31.4)	24(68.6)	

Table 10 Logistic regression model for RF susceptibility pattern

Category		Number	RF					
			Negative		Sensitive		Resistant	
			OR(95%CI)	P value	OR(95%CI)	P value	OR(95%CI)	P value
Gender	Male	795	1		1		1	
	Female	639	1.456(1.0-1.9)	0.01	.6(.5-.9)	0.014	.689(.2-2.0)	0.506
Age	1-20	312	1		1		1	
	21-40	479	.4(.3-.7)	0.000	2(1.3-3.1)	0.001	1.9(.3-9.8)	0.41
	41-60	383	.6(.4-.9)	0.036	1.6(1.0-2.5)	0.037	1.2(.2-7.3)	0.826
	61-80	237	.9(.5-1.5)	0.69	1(.6-1.7)	0.855	1.9(.3-11.9)	0.454
	81-100	23	.8(.2-3.0)	0.828	1.2(.3-4.3)	0.752	5.9(5.9-5.9)	0.000

Table Continued...

Category		Number	RF					
			Negative		Sensitive		Resistant	
			OR(95%CI)	P value	OR(95%CI)	P value	OR(95%CI)	P value
History	Relapse	670	1		1		1	
	Loss of follow-up	157	.6(.4-.9)	0.046	1.5(1.0-2.4)	0.042	1(.2-5.0)	0.934
	MDR contact	112	.9(.5-1.6)	0.786	1(.5-1.8)	0.909	1.5(.3-7.1)	0.608
	New patients	449	.9(.6-1.3)	0.737	1.1(.8-1604)	0.427	.1(.0-1.4)	0.112
	Failed	46	.406(.2-.7)	0.008	2.4(1.2-4.8)	0.01	1.8(.2-15.0)	0.57
MTB	Detected	237	1		1		1	
	Not detected	1197	46765(7771.6-281403.0)	0.000	.0(2.5-.0)	0.000	.0(0.0-.1)	0.000
HIV	Positive	20	1		1		1	
	Negative	1414	2.7(1.0-6.9)	0.032	.3(.1-.8)	0.022	249452(24945225-24945225)	0.000
Microscopy	Negative	1267	1		1		1	
	Exact number	13	.0(.0-.0)	0.000	196767(25.2-1534.0)	0.000	4.7(4.7-4.7)	0.000
	+1	104	.0(.0-.0)	0.000	227.2(101.8-507.0)	0.000	63.9(7.3-552.6)	0.000
	+2	37	2.8(0.0-0.0)	0.997	84.7(34.254-209.532)	0.000	245(28.6-2096.8)	0.000
	+3	13	2.8(2.874-011-2.874)	0.000	90.1(19.625-414.434)	0.000	230.1(19.4-2728.7)	0.000
Bacillary level	Negative	1197	1		1		1	
	Very low	29	2.7(2.7-0132.7)	0.001	33488(2042.4-549060)	0.000	4631256531(455445633.1-47093517867)	0.000
	Low	56	2.7 (0.0-0.0)	0.997	32292(2883.2-361662.8)	0.000	4802784551(761358553.9-30296815248)	0.000
	Medium	117	2.7 (0.0-0.0)	0.996	16295.5(2019.4-131495.5)	0.000	9517444615(2384394997-3798940701)	0.000
	High	35	2.7(.2.7-013-2.7)	0.000	12757.3(12915.5-126008.2)	0.000	12157048395(12157048395-2157048395)	0.000

C= cannot compute

Table 11 Percentage of bacillary level

Category		Number	Bacillary level No (%)					P value
			Negative	Very low	Low	Medium	High	
Gender	Male	795	646(81.3)	17(2.1)	30(3.8)	77(9.7)	25(3.1)	0.041
	Female	639	551(86.2)	12(1.9)	26(4.1)	40(6.3)	10(1.5)	
Age	1-20	312	276(88.5)	3(0.9)	9(2.9)	20(6.4)	4(1.3)	
	21-40	479	377(78.7)	14(2.9)	22(4.7)	51(10.6)	15(3.1)	
	41-60	383	317(82.8)	10(2.6)	17(4.4)	27(7)	12(3.2)	0.124
	61-80	237	207(87.3)	2(0.8)	8(3.4)	17(7.2)	3(1.3)	
	81-100	23	20(86.9)	0(0)	0(0)	2(8.8)	1(4.3)	

Table Continued...

Category		Number	Bacillary level No (%)					P value
			Negative	Very low	Low	Medium	High	
History	Relapse	670	569(84.9)	12(1.8)	28(4.1)	46(6.8)	15(2.2)	0.000
	Loss of follow-up	157	123(78.3)	1(0.6)	7(4.5)	19(12.1)	7(4.5)	
	MDR Contact	112	94(83.9)	4(3.6)	3(2.7)	9(8)	2(1.8)	
	New patients	449	379(84.5)	6(1.3)	17(3.8)	36(8)	11(2.4)	
	Failed	46	32(69.6)	6(13)	1(0.2)	7(1.5)	0(0)	
HIV	Positive	20	13(65)	2(10)	1(5)	4(20)	0(0)	
	Negative	1414	1184(83.7)	27(1.9)	55(3.9)	113(8)	35(2.5)	0.33
MTB	Detect	237	3 (1.3)	29(12.2)	55(23.2)	115(48.5)	35(14.8)	
	Not detect	1197	1194(99.7)	0(0)	1(0.1)	2(0.2)	0(0)	0.000
Microscopy	Negative	1197	1193(99.5)	2(0.2)	1(0.1)	1(0.1)	1(0.1)	
	Exact number	29	26(89.7)	0(0)	2(6.9)	0(0)	1(3.4)	
	+1	56	36(64.3)	4(7.1)	16(28.6)	0 (0)	0(0)	
	+2	117	11(9.4)	7(6)	75(64.1)	23(19.7)	1 (0.8)	0.000
	+3	35	1(2.9)	1(2.9)	8(22.9)	14(40)	11(31.3)	
RF susceptibility	Negative	1197	1193(99.6)	1(0.1)	2(0.2)	1(0.1)	0(0)	
	Sensitive	224	1 (0.4)	28(12.5)	54(24.1)	109(48.6)	32(14.3)	0.000
	Resistant	14	1(7.1)	0(0)	5(35,7)	6(42.9)	2(14.3)	

Table 12 Logistic regression model for bacillary level

Category		Bacillary level									
		Negative		Very low		Low		Medium		High	
		OR(95%CI)	P value	OR(95%CI)	P value	OR(95%CI)	P value	OR(95%CI)	P value	OR(95%CI)	P value
Gender	Male	1		1		1		1		1	
	Female	.6(.4-.8)	0.002	1.1(.5-2.4)	0.728	.9(.5-1.5)	0.774	1.6(1-2.3)	0.019	2(.9-4.2)	0.019
Age	1-20	1		1		1		1		1	
	21-40	.4(.3-.7)	0.000	3.1(.8-10.8)	0.077	1.6(.7-3.5)	0.23	1.7(.0-2.9)	0.044	2.4(.8-7.5)	0.108
	41-60	.7(.4-1.1)	0.185	2.7(.7-10.1)	0.125	1.5(.6-3.5)	0.287	1.1(.6-2.0)	0.739	2.4(.7-7.8)	0.117
	61-80	.9(.5-1.5	0.69	.8(.1-5.2)	0.886	1.1(.4-3.0)	0.742	1.1(.6-2.3)	0.625	.9(.2-4.4)	0.987
	81-100	.8(.2-3)	0.828	2.8(2.8-2.8)	0.000	7.1(7.1-7.1)	0.000	1.3(.3-6.3)	0.671	3.5(.3-32.6)	0.272
History	Relapse	1		1		1		1		1	
	Loss of follow-up	.0(.0-.1)	0.000	.3(.0-2.7)	0.317	1(.4-2.4)	0.876	1.8(1-3.2)	0.03	2.0(.8-5.0)	0.127
	MDR contact	.1(.0-.2)	0.000	2(.6-6.4)	0.227	.6(.1-2.1)	0.455	1.1(.5-2.4)	0.654	.7(.1-3.5)	0.761
	New patients	.1(.0-.2)	0.000	.7(.2-2.0)	0.586	.9(.4-1.6)	0.737	1.1(.7-1.8)	0.469	1.0(.4-2.4)	0.818
	Failed	.0(.0-.1)	0.000	8.2(2.9-23)	0.000	.5(.0-3.8)	0.512	2.4(1-5.7)	0.042	5.5(5.5-5.5)	0.000
HIV	Positive	1		1		1		1		1	
	Negative	.3(.1-.9)	0.032	5.7(1.2-25.8)	0.024	1.3(.1-9.8)	0.8	2.8(.9-8.7)	0.062	.0(.0-.0)	0.998
MTB	Detect	1		1		1		1		1	
	Notdetect	.0(.0-.0)	0.000	225234476.3(.0-.0)	0.994	361.4(49.7-2627.8)	0.000	561.8(137.1-2301.7)	0.000	279909011.2(.0-.0)	0.987

Citation: Elsafi SSMS, Nour BM, Abakar AD, et al. Pulmonary tuberculosis among Sudanese individuals of White Nile state: Prevalence and role of the socio-demographic features and laboratory findings in the assessment of infection. *J Microbiol Exp.* 2020;8(2):52–63. DOI: 10.15406/jmen.2020.08.00285

Table Continued...

Category		Bacillary level									
		Negative		Very low		Low		Medium		High	
		OR(95%CI)	P value	OR(95%CI)	P value	OR(95%CI)	P value	OR(95%CI)	P value	OR(95%CI)	P value
Microscopy	Negative	1		1		1		1		1	
	Exact number	.0(.0-.0)	0.000	2.3(2.3-2.3)	0.000	15.1(4.4-51.6)	0.000	57.1(.0-51505.5)	0.244	105.5(6.2-1786.8)	0.001
	+1	.0(.0-.0)	0.000	.9(.2-3.9)	0.998	6.217(3.3-11.6)	0.000	506.3(16.0-16004.1)	0.000	105.5(13.0-852.2)	0.000
	+2	2.8(.0-c)	0.997	2.3(.0.0)	0.998	2.2(.0.0)	0.998	144.9(2.4-8640.5)	0.017	770.609(97.2-6108.4)	0.000
	+3	2.8(2.8-2.8)	0.000	3.9(.4-31.7)	0.193	2.2(2.2-2.2)	0.000	33597.6 (1114.4-1012840.3)	0.000	6963(587.3-82545.6)	0.000
RFsusceptibility	Negative	1		1		1		1		1	
	Sensitive	3.7(2.3-6.0)	0.000	46813233808 (5894557033-3.7)	0.000	27722160838 (6015244199-1.2)	0.000	21042695973 (707174765-62614657047)	0.000	10876979264 (2875780667-41139673568)	0.000
	Resistant	5.7(5.7-5.7)	0.011	2527125897 (2527125897-2527125897)	0.000	14545578220 (14545578220-14545578220)	0.000	29601346017 (29601346017-29601346017)	0.000	17798693341 (17798693341-17798693341)	0.000

Discussion

TB is among the most widely spread and serious of all human infectious diseases and there are more cases today than at any previous time in human history.[9] Sudan is currently suffering from poverty and social restlessness, which are factors that seriously may affect the infection rates of the disease. Although health care professionals in Sudan and WHO and its counterparts acknowledge that tuberculosis case rates in the war zone areas are higher than those in the rest of the part of the country, the magnitude of the disease in war and poverty zones of Sudan has been unknown. The revised National Tuberculosis Programme that has adopted the World Health Organization (WHO) recommended strategy of directly observed treatment, short-course (DOTS) that a person with cough of more than three-week duration should have a sputum test done for early diagnosis and treatment of tuberculosis. Commonly used techniques for detecting *M.tuberculosis* are low sensitivity in clinical specimens.[10,11] Molecular techniques, such as GeneXpert systems, have changed the field of diagnosis of TB. This test has high sensitivity and specificity results. In December 2010, the World Health Organization approved the Xpert MTB/RIF diagnostic test for the rapid diagnosis of TB and MDR-TB. Populations included in the study were recruited form TB specialized clinics and their common complaints were cough, fatigue, headache, chest pain, shortness of breath, and loss of weight. In this study, it was found that the probability of MTB detection was higher in males than in females and among the participants age 21-40 years compared to others. Previously, most studies, which contain data on the prevalence of pulmonary tuberculosis in adults or those above 15 years of age, male have a higher prevalence than females overall.[12] The higher frequency of MTB detection among males compared to females in this study might be attributed to the consumption of cigarettes and alcohol by males as oblivious in the community. Previously, many studies[13,14] have revealed that an X-chromosome susceptibility gene may contribute to the high frequency of TB among males. This finding was supported by a study in cows where 90% of TB infected cases occurred in males compared with females that may reflect the effect of sex in disease development and the role of X–chromosome contribution.[15]

In the current study, 0.2% of new cases were infected by RF resistance strains and 5.5% of detected *M.tuberculosis* by GeneXpert was Rifampicin resistant. Furthermore, 2.1% of RF resistance was observed in case of treatment failure. When compared to reports from the other regions, Rasaki et al study reported 7.7% of multi-drug resistant strains in newly diagnosed TB patients.[16] Likewise, 7.2% of RF resistance among TB patients was reported by Idigbe et al.,[17] 8.6% by Friis et al.,[18] 2% by Davis et al.,[19] and 19% by Lawsonetal[20] study. The probable reason for the difference in the prevalence of RF between our study and other studies could be attributed to diverse geographic areas, study populations, and cultural habits. Previously, the variation in the prevalence of resistance across geographic regions was a cause for concern and the suggests was also that sub-optimal treatment has been administered and the reasons given for the interrupted treatment were lack of money, lack of drugs and feeling well, which were more likely linked to our study subjects. Evidence of inadequate treatment is provided by a study of 19 patients attending Abu Anga Teaching Hospital during 2008, who had failed treatment with first-line drugs, where over half (10) reported interrupted treatment. Similarly, of 24 patients taking second-line treatment for MDR-TB, five had interrupted treatment once, and a further thirteen had interrupted treatment on more than one occasion.[21]

As reported in this study, the probability of infection relapse, treatment failure, MTB detection, microscopy findings, HIV infection, and RF susceptibility patterns diverged among the study variables. Likewise, HIV infection was linked to loss of follow-up, failure of treatment and RF resistance. This could reflect the value of the socio-demographic features and laboratory findings in the evaluation of patients and the prognosis of tuberculosis.

Conclusion

The current study was illustrated the current prevalence of pulmonary TB and shown the value of socio-demographic features and laboratory findings in the assessment of pulmonary tuberculosis infection.

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Conflicts of interest

We declare that there was no conflict of interest.

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