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Research Article

Trends of Tuberculosis Treatment Outcomes of Notified Cases in Three Refugee Camps in Sudan: A Four-year Retrospective Analysis, 2014–2017

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Abstract

Background: Refugees are vulnerable to tuberculosis (TB) infection. Tracking of program performance is needed to improve TB care and prevention. The objective of this study was to assess the trends of TB treatment outcomes of notified cases in three refugee camps in Sudan from 2014 to 2017.

Methods: This study was a historical cohort study. Sex, age, type of TB, TB patient category, and treatment outcome of all TB cases registered in three refugee camps (Al Kashafa, Shagarab, Wadsherify) from January 1, 2014 to December 31, 2017 were collected from the TB register. Multivariable logistic regression was performed to explore factors for unsuccessful TB treatment.

Results: A total of 710 TB cases of which 53.4% were men, 22.1% children (<15 years), and 36.2% extrapulmonary TB (EPTB) were registered. Overall, the TB treatment success rate was 75.7% with a declining trend from 86.2% in 2015 to 63.5% in 2017. On average, 11.4% were lost to follow-up (LTFU), 6.6% died, 5.9% were not evaluated, and in 0.3% the treatment failed. Being 15–24 years old and having EPTB were significantly associated with unsuccessful treatment outcome.

Conclusion: The treatment success rate in the refugee camp in 2017 (63.5%) was far lower than the national treatment success rate (78%) and the End TB global target (≥90%) that needs to be improved. LTFU, died, and not evaluated outcomes were high which indicated the necessity to improve the TB treatment program.

Keywords: refugees, Sudan, treatment outcome, tuberculosis

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1. Introduction

Tuberculosis (TB) is a major public health challenge around the globe. According to the World Health Organization (WHO) report, in 2017, 10 million TB cases and 1.6 million TB deaths (HIV-negative) were recorded worldwide. In Sudan, the estimated TB incidence and mortality rate (HIV-negative) per 100,000 population in 2017 were 77 and 12, respectively [1]. Although, TB burden has been falling in the past 20 years worldwide [1], it still remains a primary cause of death from a single infectious agent since 2011 [1, 2].

TB is more severe among refugees and internally displaced populations (IDPs) who are at risk to acquire and develop active TB infection [3–6], multi-drug-resistant TB (MDR-TB) [7], as well as low TB treatment success [8, 9]. The reasons for higher TB burden in refugees and other key populations are poor shelter, poor nutritional status, and inadequate TB care and prevention [3–6, 10].

By the end of 2018, nearly 71 million refugees and asylum seekers were registered globally [11]. Majority (>86%) of refugees are from and stay within developing countries where the TB burden is higher [12]. Studies have shown an increase in the prevalence of TB [13, 14] and TB case notification [14, 15] when the number of refugee population increases. Thus, key populations such as refugees have been given special focus in the Stop TB [16] and End TB [2] WHO strategic documents so as to achieve the global targets by 2035.

Sudan (with a population size of 41 million in 2017) is among the countries with high TB incidence rates (≥20/100,000 population) in the world [1]. Sudan has a long history of hosting refugees. By the end of 2019, the country had hosted >1.1 million refugees living in camps and out of camps (70%) in over 130 localities across the country's 18 states [17]; 74, 11, and 8.5% of the refugees in Sudan originate from South Sudan, Eritrea, and Syria, respectively, and the remaining are from Ethiopia, Democratic Republic of Congo (DRC), Chad, Somalia, and Yemen. The number of refugees and asylum seekers in Sudan increased continuously during the study period, from 437,518 in 2014 to 924,810 in 2017 [17].

The aforementioned pieces of evidence [13–17] indicate that TB is one of the main health problems in the refugee camps of Sudan. Hence, periodic review of TB program performance in the refugee camps is needed to address the gaps and improve the implementation of TB care and prevention program.

TB treatment outcome is the most important global indicator to assess the overall quality of TB program and the effectiveness of TB treatment program in particular [18, 19].

As defined in the End TB strategy, the 2020 TB treatment success rate target is at least 90% [2]. Generally, TB treatment success in the refugee population can be affected by factors including less adherence to treatment, death, noncompletion due to lost to follow-up (LTFU), malnutrition, and other coexisting illnesses such as HIV coinfection [8, 20, 21]. Studies showed lower treatment success rate among refugees in Ethiopia (75.1%) [22] and in refugees hosted in different countries (ranging from 63.6 to 77.5%) [23–28].

The TB program in Sudan including in the refugee camps is guided by the National TB Program (NTP), under the Communicable and Non-Communicable Disease Department, in the Ministry of Health (MOH) [22]. The NTP in Sudan has a surveillance system but it largely focuses on the government-owned health facilities run by Federal and State Minsters of Health. However, there is no specific study on the trends of treatment outcome and factors associated with unsuccessful treatment outcome in the refugee camps. Hence, this study aimed to investigate trends of TB treatment outcomes of notified TB cases and assess factors for unsuccessful treatment outcomes in three refugee camps in Sudan from 2014 to 2017.

2. Materials and Methods

2.1. Study settings and participants

In Sudan, TB program in the refugee camps is led and coordinated by the NTP and is implemented according to the national TB guideline [22]. The data collection for the TB surveillance system occurs at TB management units (TBMUs) that utilize patient cards and registers [22].

This study was a refugee health facility based which used Unit TB registers in the refugee camps as data source. According to the inclusion criteria, all refugee health facilities which provided TB diagnosis and treatment at least since January 2017 were included. Thus, three health facilities which fulfilled the inclusion criteria in three refugee camps (Al Kashafa, Shagarab, Wadsherify) located in White Nile and Kassala states were included. The study participants were all TB cases registered in these three refugee camps from January 1, 2014 to December 31, 2017.

2.2. Study design and data collection

This study was a historical cohort study. Variables included in the Unit TB register such as sex, age, type of TB, TB patient category, and treatment outcome of all TB cases registered in three refugee camps (Al Kashafa, Shagarab, Wadsherify) were collected.

Data collection tool was developed and pretested. Nurses and program officers were recruited as data collectors and supervisors, respectively, and received training on data collection tools including practical exercise. Data were collected from January to April 2019.

Data quality was assured through provision of training to data collectors and supervisors and undertaking daily field supervision by the field supervisors. In addition, 10% of the data collected were randomly selected and recollected by the field supervisors and checked page by page.

2.3. Data analysis

Epi-info statistical software version 7 was used for data entry, and data were exported to STATA version 13 (Stata Corp, College Station, TX, USA) for analysis. Frequencies, proportions, and ratios were calculated to describe treatment outcome variables. Bivariate and multivariable logistic regression analysis were done to assess factors associated with unsuccessful treatment outcome. The independent variables used were age, sex, baseline weight, type of TB, category of TB patient, refugee camps, year of treatment, and HIV infection. Odds ratios (OR) with 95% confidence interval was used to assess the strength of association between variables. Statistical significance level was considered at a *P*-value < 0.05.

2.4. Operational definitions

The operational definitions of TB cases and TB treatment outcome categories in this study are based on the National TB management guideline in Sudan [29] and the WHO document [30] included in Supplement 1.

3. Results

3.1. General characteristics

Table 1 shows the general characteristics of the study participants. During the study period, 710 TB cases of all forms were notified in Al Kashafa, Wadsherify, and Shagarab refugee camps. More specifically, the notified TB cases in Al Kashafa, Shagarab, and Wadsherify refugee camps were 334, 206, and 170, respectively.

Of these TB cases, 377 (53.4%) were males and 329 (46.6%) females. The male-to-female ratio (M: F) of the notified cases increased from 1:1 in 2014 to 1.7:1 in 2016 and then declined to 1.1:1 in 2017. The mean (standard deviation, SD) age was 34.1 (21.4) years. Among the notified cases, children aged <15 years and adults aged ≥15 years constituted 22.1 and 77.9%, respectively. By refugee camp, majority, 334 (47.0%), of the TB cases were from Al Kashafa, 206 (29.0%) were from Shagarab, and 170 (23.9%) were from Wadsherify.

3.2. TB cases by diagnostic and age categories

Overall, the number of notified TB cases in the camps increased from 143 in 2014 to 341 cases in 2017. We further analyzed the notified cases disaggregated by diagnostic category and gender (Table 1). From 2014 to 2017, the proportion of Extrapulmonary TB (EPTB) increased from 29.3 to 39.3%.

Among the notified TB cases, the proportion of smear-positive PTB remained lower and decreased from 37.8% in 2014 to 24.9% in 2017 (Table 1; Figure **1**). Similarly, the proportion of bacteriologically confirmed cases among new and relapse PTB patients decreased from 52.6% in 2014 to 40.2% in 2017 (Table 1).

Over the study period, the difference in the proportion of notified cases by age was observed (Table 1). From 2014 to 2017, the percentage of TB accounted by children (<15 years) increased from 8.4 to 34.3%, while the share of the younger age group (15–34 years) decreased from 39.9 to 27.3%.

3.3. Notified TB cases by HIV status

Among the 710 notified TB cases in the four-year period, HIV testing was done for 42.7%. The proportion of notified TB cases who did not receive HIV test and results increased from 30% in 2015 to 62.5% in 2017. The TB–HIV coinfection rate decreased

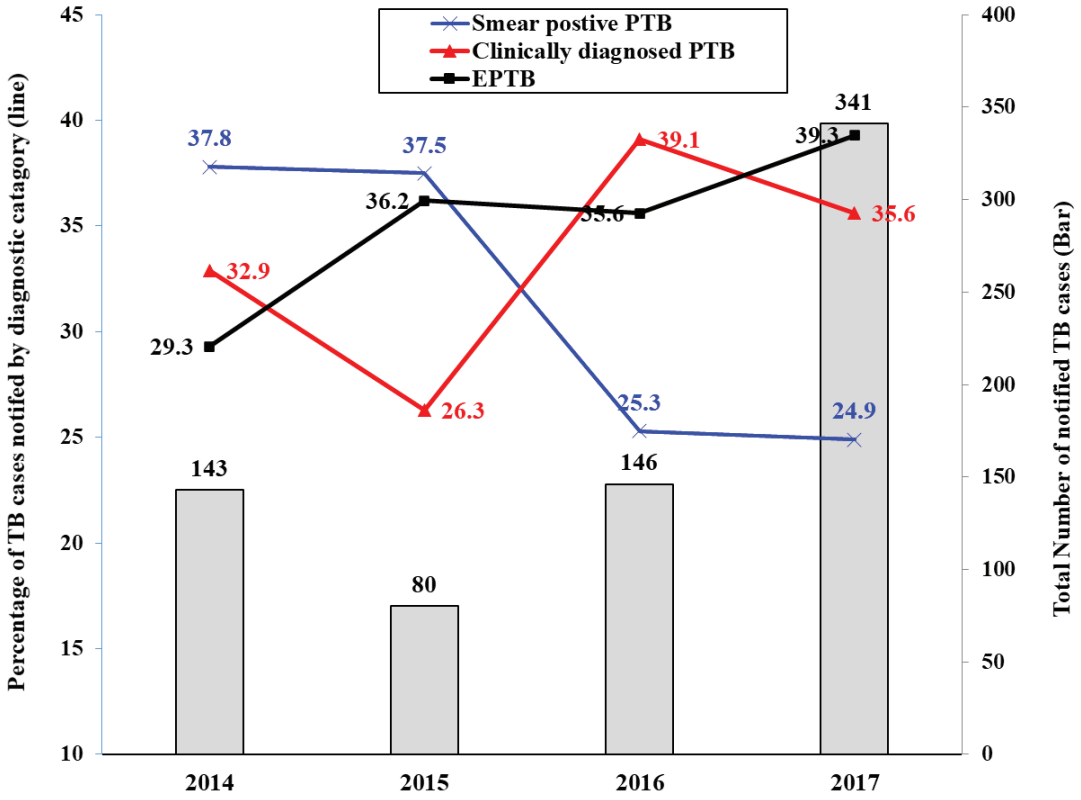

Figure 1: Trends of notified TB cases (bar) by diagnostic category (line) in Al Kashafa, Wadsherify, and Shagarab refugee camps, Sudan, 2014–2017.

from 7.1% (4/56) in 2015 to 4.7% (6/128) in 2017 (Table 1). All identified HIV-positive TB cases in each year were put on ART.

3.4. TB treatment outcomes from 2014 to 2017

Treatment outcome was determined for 143, 80, 146, and 341 TB cases of all forms that were notified in 2014, 2015, 2016, and 2017, respectively (Table 2). The treatment success rate remained lower at a range 63.5–82.9% (increasing gradually from 78.3% in 2014 to 82.9% in 2016 then decreasing to 63.5% in 2017). On average, 18.7% were cured, 57.0% treatment completed, 0.3% treatment failed, 11.4% LTFU, 6.6% died, and 5.9% not evaluated. From 2015 to 2017, there was an increase in the percentage of LTFU (from 3.8 to 15.8%) and dead (3.8 to 8.5%) patients, but a decrease in the percentage of cured patients (from 26.6 to 10.6%).

3.5. Demographic and clinical characteristics associated with unsuccessful TB treatment outcomes in Sudan refugee camps (2014–2017)

Using a simple bivariate logistic regression analysis, age group and type of TB were seen to be associated with unsuccessful treatment outcomes. More specifically, age 15–24 years [OR = 0.4, 95% CI: 0.2–0.8, *P = 0.01*], 25–34 years [OR = 0.5, 95% CI: 0.3–0.9, *P = 0.02*], 45–54 years [OR = 0.5, 95% CI: 0.2–0.96, *P = 0.04*], smear-positive pulmonary TB (PTB+) [OR = 0.5, 95% CI: 0.3–0.8, *P = 0.01*], and EPTB [OR = 0.5, 95% CI: 0.3–0.8, *P = 0.006*] were associated with unsuccessful treatment outcomes.

After adjusting for potential confounders by multivariable modelling, only age groups 15–24 years [adjusted odds ratio (aOR) = 0.4, 95% CI: 0.2–0.9, *P = 0.02*] and being an EPTB case [aOR = 0.5, 95% CI: 0.3–0.9), *P= 0.009*] were associated with unsuccessful treatment outcome (Table 3).

4. Discussion

The findings of this study generate evidence on trends of treatment outcomes of notified case during the study period (2014–2017), which is relevant to improve the quality of TB program in Al Kashafa, Wadsherify, and Shagarab refugee camps in Sudan.

4.1. Notified TB cases

In countries with good TB diagnoses and reporting system, case notifications can be used as a proxy for TB incidence estimates [19]. Moreover, bacteriologic diagnosis of TB allows patients to be correctly diagnosed and started on the most effective treatment regimen. In this study, the absolute number of notified new and relapse cases showed an increment during the study period which could be due to the increment of refugees or new influxes following the conflicts in South Sudan. Similarly, an increase in notified TB cases (from 138 cases in 2014 to 588 in 2017) was reported in refugee population hosted in refugee camps in Ethiopia [22]. In contrast, notified incident TB cases among Syrian refugees in Jordan has declined from 79 cases in 2013 to 58 cases in 2015 [28].

In this study, 45.3% of the new and relapse PTB cases in the refugee camps in 2017 were bacteriologically confirmed, which is lower than the 2018 WHO report for Sudan (49%), African Region (66%), and for the globe (56%) [1], and the End TB global target where 80% of the new and relapse TB patients need to be bacteriologically confirmed

by 2020 [2]. The low proportion of bacteriologically confirmed cases may reflect gaps in capacity for accurate diagnosis.

Analyzing the notified TB cases by type of TB is important for targeted interventions. In this study, proportion of EPTB increased from 29.4% in 2014 and reached 39.3% by 2017. This is higher than the proportion of EPTB among new cases in Darfur conflict zone in Sudan (2004–2014) (35%) [31], in the globe (14%), and in Sudan (26%) in 2017 [1]. The higher proportion of EPTB in the refugee settlements can be due to demographic factors (age, sex), origin of refugee population, host factors (immune status due to comorbidities such as HIV coinfection) [32, 33], or due to pathogen factor (phenotypes of the *tubercle bacilli*) [34]. Thus, operation research aimed to investigate the factors attributed to the higher and increased trend in EPTB in the refugee settlements is recommended.

TB largely affects productive age groups. Similar to 2018 WHO TB report [1] and studies done in other developing countries [35, 36], our study findings also showed that the highest notified cases were in the age groups 15–34 (30.4%) and 35–54 (26.0%) years (Table 1). Thus, TB programs should strengthen case-finding efforts focusing on these age groups.

High childhood TB is an indication of high missed cases among adults and continuity of TB transmission [23]. According to the 2018 WHO report, 14.1% of TB cases notified in Sudan were of children (<15 years) [1]. In the refugee camps the contribution of children to total notified TB cases increased from 8.4% in 2014 to 34.3% in 2017. The remarkable increment in childhood TB in 2017 in the refugee camps was largely due to the availability of Gene Xpert in Al Kashafa. It is expected that childhood TB is misdiagnosed, overestimated, and/or underreported [2].

4.2. Treatment outcomes

TB treatment outcome is a good indicator for the overall quality of TB program and in particular the TB treatment program [19]. According to the WHO End TB global plan, at least 90% of all TB cases on treatment need to achieve treatment success rate by 2020 [2]. In the refugee camps, on average 75.7% (range 63.5–86.2%) of the TB cases achieved treatment success during the study period.

By 2017, the treatment success rate in the refugee camps (63.5%) was lower than that of the national/Sudan achievement in 2017 (78%) [1] and the WHO global target (≥90%) [1]. Overall, the treatment success rate in the three refugee camps (range 63.5–86.2%) was comparable to the findings among smear positive pulmonary TB (65–66%) in Darfur

conflict zones in Sudan over 10 years (2004–2014) [24], and to treatment success rate among refugees in different parts of the world (63.6 to 77.5%) [23–28].

The declining trend in treatment success rate in the refugee camps started in 2016, and this was probably due to the increase in influx of new refugees in 2016 and 2017 and high mobility of the refugees. This was due to high LTFU, mortality, and unevaluated treatment outcomes, which called for action by the refugee health and NTP. Overall, the mean treatment failure (0.3%), LTFU (11.4%), and died (6.6%) in the refugee camps (Table 3) were comparable to the reports from other refugee camps in different countries which showed 4.6–10.9% death rate, 7.1–27.3% LTFU, and 1.3–2.0% treatment failure [8, 26, 27]. In summary, the low TB treatment success rate in the refugee health facilities indicated the need to improve the TB treatment program, which includes improving documentation, provision of training to healthcare workers, supportive supervision, follow-up sputum smear and culture examination, supplementary nutritional support, and racing of LTFU cases through the engagement of community health workers.

5. Conclusion

The proportion of EPTB (from 29.4 to 39.3%) and TB <15 years (from 8.4 to 34.3%) increased over the study period. TB treatment success rate was at a range 63.5–86.2%. The 2017 treatment success rate in the refugee camps (63.5%) was lower than the report for Sudan (78%) and the End TB target for 2020 (≥90%), which needs to be addressed. There was a high LTFU, mortality, and non-evaluation, which showed that there was a gap in the TB treatment program in the refugee heath facilities. Future research is recommended to investigate the increase in EPTB.

The study has generated useful evidence of treatment outcomes of notified TB case from 2014 to 2017 that will support to plan effective TB care and prevention programs in the refugee camps in Sudan. However, as this study was conducted retrospectively based on secondary data, it had some limitations. Although, socioeconomic factors (occupation, education, and income level), health system factors, and patient-related factors were reported to be associated with unsuccessful treatment outcome in other studies, we were not able to include these variables in our analysis as we used secondary data. We used only independent variables available in the Unit TB register to assess factors associated with unsuccessful treatment outcomes.

Acknowledgements

None.

Ethical Considerations

Individual consent was not required as the data used were secondary, collected from the TB register in the refugee camps. Ethical approval and permission were obtained from the National Research Ethics Review Committee, Health Research council, Ministry of Health, Republic of Sudan (proposal no 1-1-19).

Competing Interests

The authors declare that they have no competing interests.

Availability of Data and Materials

All analyzed data were included in this manuscript. However, patient-level data, which were analyzed, can be received with permission of NTP, Communicable and Non-Communicable Disease Department, in the Ministry of Health (MOH), Sudan.

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Supplement 1

Operational Definitions

TB case notification: TB is diagnosed in a patient and is reported within the national TB surveillance system.

TB cases: A patient in whom TB has been diagnosed. A TB case is defined as:

(i) **A bacteriologically confirmed TB case:** is one from whom a biological specimen is positive by smear microscopy, culture, or WHO-approved rapid diagnostics (such as Xpert MTB/RIF).

(ii) **A clinically diagnosed TB case:** is one who does not fulfil the criteria for bacteriological confirmation but has been diagnosed with active TB by a clinician or other medical practitioner who has decided to give the patient a full course of TB treatment.

Bacteriologically confirmed or clinically diagnosed cases of TB are also classified according to anatomical site of disease, history of previous treatment, drug resistance, and HIV status.

Classification based on anatomical sites:

(i) **Pulmonary tuberculosis (PTB):** any bacteriologically confirmed or clinically diagnosed case of TB involving the lung parenchyma or the tracheobronchial tree.

(a) Pulmonary TB positive (PTB+): bacteriologically confirmed PTB cases using available confirmatory diagnostic.

(b) Pulmonary TB negative (PTB–): clinically diagnosed PTB cases.

(ii) **Extrapulmonary tuberculosis (EPTB):** any bacteriologically confirmed or clinically diagnosed case of TB involving organs other than the lungs

Classification based on history of previous TB treatment (patient registration group):

(i) **New TB patients:** are those who have never been treated for TB or have taken anti-TB drugs for less than one month.

(ii) **Previously treated TB patients:** are those who have received one month or more of anti-TB drugs in the past. They are further classified by the outcome of their most recent course of treatment as follows:

(a) **Relapse patients:** are those who have previously been treated for TB, were declared cured, or the treatment was completed at the end of their most recent course of treatment but and are now diagnosed with a recurrent episode of TB (either a true relapse or a new TB caused by reinfection).

(b) **Treatment after failure patients:** are those who have previously been treated for TB and whose treatment failed at the end of their most recent course of treatment.

(c) **Treatment after loss to follow-up patients:** are those who have previously been treated for TB and were declared LTFU at the end of their most recent course of treatment. *(These were previously known as treatment after default patients.)*

(d) **Other previously treated patients:** are those who have previously been treated for TB but whose outcome after their most recent course of treatment is unknown or undocumented.

(e) **Transfer in:** a patient who started treatment in one health facility (reporting unit) and was then transferred to another health facility (reporting unit) to continue treatment.

Classification based on TB treatment outcomes for drug sensitive-TB:

(i) **Cured:** a pulmonary TB patient with bacteriologically confirmed TB at the beginning of treatment who was smear- or culture-negative in the last month of treatment and on at least one previous occasion.

(ii) **Treatment completed:** a TB patient who completed treatment without evidence of failure **BUT** with no record to show that sputum smear or culture results in the last month of treatment and on at least one previous occasion were negative either because tests were not done or because results are unavailable.

(iii) **Treatment failed:** a TB patient whose sputum smear or culture is positive at month 5 **OR** later during treatment.

(iv) **Lost to follow-up (LTFU):** a TB patient who did not start treatment **OR** whose treatment was interrupted for two consecutive months or more.

(v) **Died:** a TB patient who dies for any reason before starting **OR** during the course of treatment.

(vi) **Not evaluated:** a TB patient for whom no treatment outcome is assigned. This includes cases “transferred out” to another treatment unit as well as cases for whom the treatment outcome is unknown to the reporting unit.

(a) **Successful treatment:** sum of cured and treatment completed outcomes.

(b) **Unsuccessful treatment:** sum of died, treatment failed, and LTFU outcomes.

TABLE 1: Characteristics of notified TB cases in Al Kashafa, Wadsherify, and Shagarab refugee camps, Sudan, 2014–2017 (*N* = 710).

Characteristic	2014, *N* (%)	2015, *N* (%)	2016, *N* (%)	2017, *N* (%)	Total (2014–2017)
Total TB cases (row, %)	143 (20.1)	80 (11.3)	146 (20.6)	341 (48.0)	710 (100)
Mean age (SD), yr	38.2 (19.1)	42.0 (21.6)	39.5 (19.0)	28.2 (21.4)	34.1 (21.4)
By age groups					
<15	12 (8.4)	8 (10.0)	20 (13.7)	117 (34.3)	157 (22.1)
15–24	30 (21.0)	8 (10.0)	10 (6.9)	50 (14.7)	98 (13.8)
25–34	27 (18.9)	17 (21.3)	30 (20.1)	44 (12.9)	118 (16.6)
35–44	19 (13.3)	12 (15.0)	25 (17.1)	36 (10.6)	92 (13.0)
45–54	20 (14.0)	13 (16.3)	19 (13.0)	40 (11.7)	92 (13.0)
55–64	11(7.7)	5 (6.3)	26 (17.8)	31 (9.1)	73 (10.3)
>=65	24 (16.8)	17 (21.3)	16 (11.0)	21 (6.2)	78 (11.0)
Not recorded	0	0	0	2 (0.6)	2 (0.3)
BY gender					
Male	72 (50.4)	46 (57.5)	81 (55.9)	178 (52.7)	377 (53.4)
Female	71 (49.6)	34 (42.5)	64 (44.1)	160 (47.3)	329 (46.6)
Male to Female ratio	1	1.4	1.7	1.1	1.1
BY type of TB					
PTB	101 (70.6)	51 (63.8)	94 (64.4)	207 (60.7)	453 (63.8)
EPTB	42 (29.4)	29 (36.2)	52 (35.6)	134 (39.3)	257 (36.2)
By diagnostic category					
PTB+	54 (37.8)	30 (37.5)	37 (25.3)	85 (24.9)	206 (29.0)
PTB–	47 (32.9)	21 (26.3)	57 (39.1)	122 (35.8)	247 (34.8)
EPTB	42 (29.4)	29 (36.2)	52 (35.6)	134 (39.3)	257 (36.2)
BY type of TB patients					
New and relapse	138 (96.5)	80 (100)	141 (96.6)	321 (94.1)	680 (95.8)
Treatment after failure	4 (2.8)	0	0	1 (0.3)	5 (0.7)
Lost to follow-up to treatment	1 (0.7)	0	5 (3.4)	15 (4.4)	21 (3.0)
Others	0	0	0	4 (1.2)	4 (0.6)
New and relapse –PTB patients	97 (70.3)	51 (63.8)	89 (63.1)	189 (58.9)	426 (62.6)
Bacteriologically confirmed	51 (52.6)	30 (58.8)	36 (40.4)	76 (40.2)	193 (45.3)
Clinically diagnosed	46 (47.4)	21 (41.2)	53 (59.6)	113 (59.8)	233 (54.7)
By HIV status					
Positive	1 (2.0)	4 (7.1)	3 (4.2)	6 (4.7)	14 (4.6)
Negative	47 (98.0)	52 (92.9)	68 (95.8)	122 (95.3)	289 (95.4)
Not documented	95 (66.4)	24 (30)	75 (52.4)	213 (62.5)	407 (1.6)
BY refugee camps					
Al Kashafa	0	0	60	274	334 (47.0%)
Shagarab	98	41	47	20	206 (29.0%)
Wadsherify	45	39	39	47	170 (23.9%)

PTB+: smear-positive pulmonary TB; **PTB–**: clinically diagnosed PTB, which includes smear-negative pulmonary TB and smear not done/unknown.

Table 2: TB treatment outcome of all TB cases registered in Al Kashafa, Wadsherify, and Shagarab refugee camps, Sudan, 2014–2017 (*N* = 710).

	Years				Total
Treatment outcome	**2014 (*n* = 143) *N* (%)**	**2015 (*n* = 80) *N* (%)**	**2016, (*n* = 146) *N* (%)**	**2017 (*n* = 341) *N* (%)**	**Total (*n* = 710) *N* (%)**
Cured	38 (26.6)	28 (35.0)	25 (17.1)	42 (10.6)	133 (18.7)
Treatment Completed	74 (51.7)	41 (51.2)	96 (65.8)	194 (56.9)	405 (57.0)
Treatment failed	0	0	1 (0.7)	1 (0.3)	2 (0.3)
LTFU	12 (8.4)	3 (3.8)	12 (8.2)	54 (15.8)	81 (11.4)
Died	6 (4.2)	3 (3.8)	9 (6.2)	29 (8.5)	47 (6.6)
Not evaluated	13 (9.1)	5 (6.2)	3 (2.0)	21 (6.2)	42 (5.9)
Success rate	**112 (78.3)**	**69 (86.2)**	**121 (82.9)**	**252 (63.5)**	**538 (75.7)**

Table 3: Demographic and clinical characteristics associated with unsuccessful TB treatment outcomes among all TB cases in Al Kashafa, Wadsherify, and Shagarab refugee camps, Sudan, 2014–2017.

Characteristics	**Successful outcomes**	**Unsuccessful outcomes**	**X^2, *P*-value**	**Bivariate analysis**		**Multivariable analysis**	
				OR (95%CI)	***P*-value**	**Adjusted OR (95%CI)**	***P*-value**
Gender							
Female	250 (80.7)	60 (19.3)	0.002	1			
Male	285 (80.5)	69 (19.5)	0.9	1.02 (0.7–1.5)	0.9		
Age group							
<15	110 (71.9)	43 (28.1)		1			
15–24	80 (86.0)	13 (14.0)	15.2	0.4 (0.2–0.8)	0.01	0.4 (0.2–0.9)	0.02
25–34	91 (84.3)	17 (15.7)	0.03	0.5 (0.3–0.9)	0.02	0.5 (0.3–1.0)	0.06
35–44	70 (81.4)	16 (18.6)		0.6 (0.3–1.1)	0.1	0.6 (0.3–1.2)	0.2
45–54	69 (84.1)	13 (15.9)		0.5 (0.2–0.96)	0.04	0.5 (0.3–1.0)	0.06
55–64	59 (83.1)	12 (16.9)		0.5 (0.3–1.1)	0.07	0.6 (0.3–1.2)	0.1
>=65	59 (79.7)	15 (20.3)		0.7 (0.3–1.3)	0.2	0.7 (0.3–1.3)	0.2
Pretreatment weight, Kg*							
>40	188 (81.0)	44 (19.0)	1.2	1			
<40	78 (75.7)	25 (24.3)	0.2	1.4 (0.7–2.4)	0.2		
Type of TB							
PTB–	169 (73.8)	60 (26.2)		1		1	
PTB+	162 (83.9)	31 (16.1)	10.1	0.5 (0.3–0.8)	0.01	0.6 (0.4–1.1)	0.07
EPTB	207 (84.1)	39 (15.9)	0.006	0.5 (0.3–0.8)	0.006	0.5 (0.3–0.9)	0.009
HIV status							
Negative	238 (88.5)	31 (11.5)	1.5	1	0.2		
Positive	10 (76.9)	3 (23.1)	0.2	2.3 (0.6–8.8)			

PTB+: smear-positive pulmonary TB; **PTB–**: clinically diagnosed PTB, which includes smear-negative pulmonary TB and smear not done/unknown; OR: odds ratio; CI: Confidence interval; 1:00, Reference; X^2: Chi-square.
*Analysis done for adults aged ≥15 years.

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