HHS Public Access

Author manuscript

Int J Tuberc Lung Dis. Author manuscript; available in PMC 2019 October 28.

Published in final edited form as:

Int J Tuberc Lung Dis. 2019 July 01; 23(7): 858–864. doi:10.5588/ijtld.18.0526.

Second nationwide anti-tuberculosis drug resistance survey in Namibia

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SUMMARY

SETTING—Namibia ranks among the 30 high TB burden countries worldwide. Here, we report results of the second nationwide anti-TB drug resistance survey.

OBJECTIVE—To assess the prevalence and trends of multidrug-resistant TB (MDR-TB) in Namibia.

METHODS—From 2014 to 2015, patients with presumptive TB in all regions of Namibia had sputum subjected to mycobacterial culture and phenotypic drug susceptibility testing (DST) for rifampicin, isoniazid, ethambutol and streptomycin if positive on smear microscopy and/or Xpert MTB/RIF.

RESULTS—Of the 4124 eligible for culture, 3279 (79.5%) had *Mycobacterium tuberculosis* isolated. 3126 (95%) had a first-line DST completed (2392 new patients, 699 previously treated patients, 35 with unknown treatment history). MDR-TB was detected in 4.5% (95%CI 3.7–5.4) of new patients, and 7.9% (95%CI 6.0–10.1) of individuals treated previously. MDR-TB was significantly associated with previous treatment (OR 1.8, 95%CI 1.3–2.5) but not with HIV infection, sex, age or other demographic factors. Prior treatment failure demonstrated the strongest association with MDR-TB (OR 17.6, 95%CI 5.3–58.7).

CONCLUSION—The prevalence of MDR-TB among new TB patients in Namibia is high and, compared with the first drug resistance survey, has decreased significantly among those treated previously. Namibia should implement routine screening of drug resistance among all TB patients.

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Conflicts of interest: none declared.

RÉSUMÉ

La Namibie fait partie des 30 pays du monde très affectés par la tuberculose (TB). Nous rapportons les résultats de la deuxième enquête nationale de la résistance aux médicaments anti-TB.

Evaluer la prévalence et les tendances de la TB multirésistante (MDR-TB) dans le pays.

De 2014 à 2015, les patients atteints de TB présumée dans toutes les régions de Namibie ont eu un examen de crachats par culture mycobactérienne et preuves de résistance aux médicaments (DST) phénotypique pour la rifampicine, l'isoniazide, l'éthambutol et la streptomycine s'ils étaient positifs à la microscopie de frottis et/ou à l'Xpert® MTB/RIF.

Sur les 4124 patients éligibles à la culture, 3279 (79,5%) ont eu un isolement de *Mycobacterium tuberculosis*; 3126 (95%) ont eu un DST de première ligne (2392 patients nouveaux, 699 déjà traités, 35 ayant des antécédents thérapeutiques inconnus). Une MDR-TB a été détectée chez 4,5% (IC 95% 3,7–5.4) patients nouveaux et 7,9% (IC 95% 6,0–10,1) patients déjà traités. La MDR-TB a été significativement associée avec un traitement préalable (OR 1,8; IC 95% 1,3–2,5), mais pas avec l'infection à virus de l'immunodéficience humaine, le sexe, l'âge ou d'autres facteurs démographiques. Parmi les patients déjà traités, l'échec du traitement antérieur a démontré l'association la plus forte avec la MDR-TB (OR 17,6; IC 95% 5,3–58,7).

La prévalence de la MDR-TB parmi les nouveaux patients TB en Namibie est élevée et comparée à la première enquête nationale de la résistance aux médicaments anti-TB, a significativement diminué parmi les patients déjà traités. La Namibie devrait mettre en œuvre un dépistage de routine de la pharmacorésistance parmi tous les patients TB.

RESUMEN

Namibia está clasificado entre los 30 países con carga de morbilidad por tuberculosis (TB) más alta en el mundo. Se presentan los resultados de la segunda encuesta nacional sobre TB farmacorresistente.

Evaluar la prevalencia y las tendencias de la TB multirresistente (MDR-TB) en el país.

Del 2014 al 2015, en los pacientes de todas las regiones de Namibia con presunción clínica de TB que obtuvieron un resultado positivo de la baciloscopia, la prueba Xpert® MTB/RIF o ambas, se examinaron las muestras de esputo mediante cultivo de micobacterias y pruebas fenotípicas de sensibilidad a rifampicina, isoniazida, etambutol y estreptomicina.

De las 4124 muestras aptas para el cultivo, en 3279 se aisló el *Mycobacterium tuberculosis* (79,5%). En 3126 casos se completaron las pruebas de sensibilidad a los antituberculosos de primera línea (95%) (2392 casos nuevos, 699 casos previamente tratados y 35 pacientes cuyos antecedentes de tratamiento se desconocían). Se detectó la MDR-TB en el 4,5% de los casos nuevos (IC 95% 3,7–5,4) y en el 7,9% de las personas con antecedente de tratamiento (IC 95% 6,0–10,1). La presencia de MDR-TB se asoció de manera significativa con el tratamiento previo (OR 1,8; IC 95% 1,3–2,5), pero no con la infección por el virus de la inmunodeficiencia humana, el sexo, la edad ni otros factores demográficos. En los pacientes con tratamiento previo, la existencia de un fracaso terapéutico anterior demostró la asociación más sólida con la MDR-TB (OR 17,6; IC 95% 5,3–58,7).

La prevalencia de MDR-TB en los casos nuevos de TB en Namibia es alta y ha disminuido de manera considerable en los pacientes con tratamiento previo, en comparación con los datos de la primera encuesta de farmacorresistencia. Namibia debería introducir la detección sistemática de la farmacorresistencia en todos los pacientes con TB.

Keywords

surveillance; MDR-TB; DRS; report

ACCORDING TO ESTIMATES from the World Health Organisation (WHO), Namibia had the eighth highest estimated incidence of tuberculosis (TB) worldwide in 2015 (489 per 100 000 population).[1] The country introduced programmatic management of drug-resistant TB with systematic recording and reporting in 2008. The first nationwide anti-TB drug resistance survey (DRS) was completed in 2008, which reported a prevalence of multidrug-resistant tuberculosis (MDR-TB) of 6.9% for all TB cases (3.8% and 16.4% among new and previously treated cases, respectively).[2]

According to estimates from the Joint United Nations Programme on HIV/AIDS for 2015, 210 000 (range 200 000–230 000) people were living with human immunodeficiency virus (HIV) infection in Namibia[3] out of a total population of 2.3 million,[4] and the adult prevalence was 13.8%.[3] In the same year, 95% of reported TB patients had an HIV test result and 40% were positive.[5] The prevalence of HIV among patients with drug-resistant TB was even higher (48%). Also, 92% of HIV-infected patients with presumed drug-susceptible TB and 94% of HIV-infected MDR-TB patients were reported as taking antiretroviral therapy.[5]

The aim of Namibia's second national anti-TB DRS was to assess the prevalence and trends of MDR-TB, particularly among bacteriologically positive TB patients not previously treated for TB ("new patients") and those who had received treatment for TB in the past ("previously treated patients"). In addition, the survey sought to evaluate the relationship between HIV and MDR-TB.

METHODS

Patient selection, sample size and sampling strategy

The target population comprised all individuals with presumptive TB (new or previously treated) presenting at all public health facilities in all 14 administrative regions of Namibia between July 2014 and May 2015. Patients with a positive sputum smear using direct fluorescence microscopy (DFM) and/or a positive molecular test using Xpert® MTB/RIF (Cepheid, Sunnyvale, CA, USA) MTB/RIF were eligible to have sputum culture performed for the survey.

The survey sample size was calculated based on the MDR-TB prevalence estimates from the first DRS assuming a similar distribution of sputum smear-positive TB cases as notified in 2012 (4333 new; 1410 retreatment). A sample size of 1910 new and 745 previously treated TB patients (total 2655) was required, with the following considerations at a 95%

confidence interval (CI): 83% participation rate; a sampling design effect of 1.5 (allowing for potential inconsistencies in the recruitment of participants) and a margin of error of ±1% for new cases and ±3% for previously treated cases.

The survey excluded individuals who 1) were sputum smear- and Xpert-negative; 2) did not have a sputum specimen collected or the specimen(s) collected were not sufficient for testing; 3) had extra-pulmonary TB without a pulmonary component, or 4) were already undergoing anti-TB treatment.

Data collection and initial laboratory testing

At enrolment, a DRS laboratory request form was used to record demographic information (age, sex, district name, patient name, date specimen collected), HIV status and history of previous treatment for TB. Two sputum specimens were collected and maintained at 4°C during storage and transportation, and were referred to the laboratory within 48 h of collection. Participating district-level laboratories performed DFM using light-emitting diode fluorescence microscopy, as well as molecular testing with Xpert to identify samples eligible for culture and phenotypic drug susceptibility testing (DST). Eligible specimens were forwarded to the Namibia Institute of Pathology (NIP) Windhoek Central Reference Laboratory (WCRL) for mycobacterial culture, species identification and first-line DST. NIP WCRL also performed DFM and Xpert testing for districts without adequate laboratory capacity. Laboratory results were reported back to the requesting health facility, as per routine, to facilitate patient management.

Mycobacterial culture and drug susceptibility testing

Decontamination of specimens was performed using the conventional 4% *N*-acetyl-L-cysteine-sodium hydroxide (NALC-NaOH) method. The sediments were stained with Auramine-O for fluorescence microscopy and inoculated into liquid medium for mycobacterial growth detection using the BD BACTEC™ mycobacterial growth indicator tube (MGIT™) 960 System (Becton Dickinson, Sparks, MD, USA). Isolates from all positive MGIT tubes were screened using Ziehl-Nielsen (ZN) DM to confirm the presence of acid-fast bacilli. Then, they were inoculated on blood agar plates and incubated for 24 h to screen for contamination. Confirmation of *M. tuberculosis* was performed using the BD MGIT TBc Identification Test (Becton Dickinson) on positive MGIT culture isolates, and isolates positive for *M. tuberculosis* underwent first-line DST. Isolates that tested negative for *M. tuberculosis* on the BD MGIT TBc identification test, but positive on ZN microscopy, were presumed to be mycobacteria other than TB (MOTT). These were referred to the National Institute of Communicable Diseases (NICD) in South Africa for species identification using the GenoType® Mycobacterium CM/AS test (Hain Lifescience, Nehren, Germany). Identification of rods, cocci or fungal elements from blood agar was regarded as contamination, and such specimens were excluded from the survey.

Phenotypic liquid culture-based DST was performed at NIP to determine drug susceptibility and resistance to several first-line anti-TB medicines: isoniazid (H, INH), rifampicin (R, RIF), streptomycin (S, SM) and ethambutol (E, EMB). Drug-resistant samples were limited to those confirmed with phenotypic DST in BD MGIT. DST was performed on pure *M.*

tuberculosis complex cultures only, and mixed cultures were ruled out using ZN DM (for morphology) and an MTBc-specific identification test on positive cultures before DST. All external laboratory quality assurance (EQA) was provided for the survey by NICD (which is an accredited WHO Supranational Reference Laboratory). This included provision of EQA samples for testing and feedback, retesting all RIF-resistant samples and 10% of RIF-susceptible samples, and providing external technical assistance (including backstopping and site visits). If there was any discrepancy between NICD and NIP DST, the NICD result was considered to be the correct result.

Management and analysis of data

The main data collection tool was the laboratory form. Information was collected at the health facility level and laboratory level using the form. Information was double-entered into a database at the central level using Epi Info 7 (US Centers for Disease Control and Prevention, Atlanta, GA, USA). The two databases were merged using SPSS (IBM, Armonk, New York, NY, USA). Duplicate or inconsistent entries were deleted or corrected by checking against the individual databases and completed laboratory form.

Primary analysis was performed with STATA® v12.1 (StataCorp, College Station, TX, USA). Only cases with a known treatment history were included in the analysis. Findings for all key variables were reported individually using descriptive analysis. Univariate analysis and logistic regression were used to explore associations with MDR-TB, and reported odds ratios (ORs) adjusted for age, sex and HIV.

Ethical approval

The study protocol was created by the National TB and Leprosy Programme, reviewed by representatives of co-funding agencies, and approved by the Biomedical Research Ethics Committee of Namibia's Ministry of Health and Social Services (MoHSS).

RESULTS

A total of 4124 patients with TB diagnosis confirmed using positive sputum smear microscopy and/or Xpert were enrolled between July 2014 and May 2015. Fifty-five participants (1.3%) had an unknown treatment history; 3100 (75.2%) were new patients and 969 (24.5%) had been treated previously (Table 1).

Among new patients, the median age was 35 years (range <1–106) and 58.0% were male. Among retreatment patients, the median age was 39 years (range 3–96) and 61.5% were male. HIV status was known for 84.2% of new patients and 88.7% of previously treated patients. The prevalence of HIV among the new and previously treated patients who had an HIV test result was respectively 36.6% and 46.9%.

The results for the total number of enrolled patients, samples obtained, culture and DST are summarised in the Figure. Culture using MGIT was performed on 4121 sputum samples. A culture result was recorded for 4092 samples, of which 3279 had *M. tuberculosis* isolated and subjected to first-line DST. DST results were obtained for 95.3% (n = 3126) of these samples. Overall, the survey obtained 2392 samples with DST results from new patients

(125.2% of sample target) and 699 samples from previously treated patients (94.8% of targeted sample size).

Resistance to at least one first-line anti-TB medicine was found in 324 new patients (13.5%, 95% confidence interval [CI] 12.2–15.0) and 127 previously treated patients (18.2%, 95%CI 15.4–21.2). Resistance to H, R, E or S only (any monoresistance) occurred in 163 new patients (6.8%, 95%CI 5.8–7.9) and 45 previously treated patients (6.4%, 95%CI 4.9–8.5) (Table 2). MDR-TB was detected in 108 new patients (4.5%, 95%CI 3.7–5.4) and 55 previously treated patients (7.9%, 95%CI 6.0–10.1).

The odds of having MDR-TB among previously treated patients compared with new patients were 1.8 (95%CI 1.3–2.5, $P < 0.001$). After adjustment for sex, HIV and age group, the adjusted OR (aOR) for MDR-TB among previously treated patients remained 1.8 (95%CI 1.2–2.5). Among the 699 patients with a history of previous treatment, prior treatment failure (11 patients) had the strongest association with MDR-TB (OR 17.6, 95%CI 5.3–58.7), whereas being a relapse case (previous successful treatment, 443 patients) increased the odds of having MDR-TB by 1.8 times (95%CI 1.2–2.6). Having been lost to follow-up while on treatment (62 patients) was not significantly associated with having MDR-TB (OR 2.3, 95%CI 1.0–5.3), nor was having an unknown final outcome (186 patients; OR 1.2, 95%CI 0.6–2.3).

Of the 2671 patients with full DST results and known HIV results, 1021 or 38.2% (95% CI 36.3–40.1) were HIV-positive. The odds of being HIV-positive were higher among previously treated TB patients than among new patients (OR 1.5, 95%CI 1.3–1.8; $P < 0.001$). There was no significant association between MDR-TB and positive HIV status (OR 1.4, 95%CI 1.0–1.9; $P = 0.07$). An association between MDR-TB and demographic characteristics, such as sex, age, education, employment status, place of residence or marital status, was not found.

Laboratory quality indicators for resistance testing (which included tracking the samples that were Xpert MTB-positive/RIF-resistant and *M. tuberculosis* culture-negative) showed a 90.4% concordance. Additional concordance quality indicators were RIF resistance using Xpert compared with MGIT (7.0% vs. 5.8%); RIF resistance using Xpert compared with MGIT at NIP (97.4%); RIF susceptibility at NIP compared with NICD (98.3%).

DISCUSSION

The prevalence of MDR-TB among new patients in this survey was similar to that found in Namibia's first DRS conducted in 2008–2009 (4.5%, 95%CI 3.7–5.4 vs. 3.8%, 95%CI 2.8–5.1, respectively). Simultaneously, a significant decline in the prevalence of MDR-TB among previously treated patients was recorded (16.4% [95%CI 1.2–2.6] in the first survey compared with 7.9% [95%CI 6.0–10.1]). The OR for previously treated patients having MDR-TB, compared with new patients, also dropped from 5.0 in 2009 to 1.8 in 2015. This reduction is an important finding. It may also be related to the country's strengthening of TB case management, as shown by the improved national treatment success rate for new TB cases from 83% to 88% and for MDR-TB from 44% to 70% between 2008 and 2014

respectively.[6–8] Furthermore, there was a documented reduction, from 7.1% to 4.4%, of the proportion of patients categorised as “treatment after failure” (i.e., those with the highest likelihood of developing MDR-TB) in the same period.[5,6] The introduction of rapid diagnostics (including Xpert) in 2013 and rapid scale-up just before this survey may have ensured early diagnosis of RIF resistance, thereby reducing the likelihood of such patients failing initial treatment for susceptible TB and returning as treatment after failure. The fact that 186 (26.6%) of the previously treated cases with a DST had an unknown final outcome, yet were not associated with having MDR-TB, raises the possibility that some new patients with an inaccurate history may have diluted the strength of the association between previous treatment and MDR-TB.

Compared with other countries, the prevalence of MDR-TB in Namibia, as measured among new patients in this survey, is higher than that in South Africa,[10] Malawi,[11] Zambia,[12] and Botswana;[13] comparable with that in Mozambique,[14] Lesotho,[15] and the global average;[1] and lower than that in Swaziland.[16] Similarly, the prevalence of MDRTB observed in previously treated patients in Namibia is higher than that in South Africa, Malawi, Zambia and Botswana; comparable with that in Zambia and Lesotho; but lower than that in Mozambique and Swaziland, as well as the global average (Table 3).

The overall high proportion of patients with INH resistance and SM resistance observed in this survey (12.3% and 7.8% respectively) has implications for the choice of appropriate treatment regimens for TB treatment and TB prevention in Namibia. These findings support an earlier decision of the MoHSS to retain the policy of including EMB as a third medicine in the continuation phase of the standard 6-month first-line TB treatment regimen (2HRZE/4HRE), as well as continuing discussions on the best choice of medication for TB preventive therapy.[17–19]

As in other surveys, previous treatment remained an established risk factor for MDR-TB. This, however, should not mask the higher numbers of MDR-TB cases among new patients. For example, along with using findings from this survey, 186 new TB cases (3.9% of 4784 notified)[8] and 104 previously treated TB cases (7.9% of 1317 notified)[8] were expected to be diagnosed with MDR-TB in Namibia in 2016. The failure of this survey to demonstrate conclusively an association between HIV and MDRTB is not new; other studies have also demonstrated variable and/or inconclusive associations.[20] Even in sub-Saharan African settings where HIV prevalence is high, HIV has not been found consistently to be a significant driver of MDR-TB.[21]

This survey had several limitations. First, there was potential for a selection bias because specimens for the survey were collected mainly from state-run health facilities, and excluded patients undergoing investigation for TB in the private sector. However, the impact of this effect may be minimal because (i) the burden of TB in the private sector is understood to be low (contributing only 1.9% of national notifications[8]); (ii) private health providers are advised to refer all presumptive or diagnosed TB patients to state facilities to access free diagnosis and/or treatment. Second, for 32% of previously treated patients, the treatment history could not be verified from the medical records due to the difficulty in accessing prior records. History of prior TB treatment was therefore largely self-reported, which constituted

a risk of recall bias and which was exacerbated by failure to contact patients by telephone to verify some information due to poor network coverage. Finally, the number of specimens lost before reaching the central laboratory could not be quantified due to inadequate tracking procedures for specimen shipment, particularly from peripheral facilities, which reported a lack of dedicated transport as a major challenge. However, the proportion of specimen losses is believed to be minimal given that Namibia's public sector laboratory system has been evaluated as "robust".[22]

CONCLUSION

The prevalence of MDR-TB remains high in Namibia although, among previously treated patients, it is below the 2016 global average. Findings from this survey are comparable with those in other countries in sub-Saharan Africa. Previous TB treatment was the only risk factor found to be significantly associated with MDR-TB. The INH resistance patterns observed in this survey support the WHO recommendation and MoHSS policy to include EMB in the continuation phase of Namibia's first-line TB regimen. Universal screening for drug resistance is strongly recommended for new and previously treated TB patients in Namibia.

Acknowledgements

The authors acknowledge the important contributions by the following colleagues during various stages of this survey: A Dean, A Dreyer, N Ismail, H Mungunda, S Nafuka, T Uutsi and E Sagwa.

We thank the MoHSS management and staff at health facility, district, regional and national levels, as well as the National TB and Leprosy Programme team, for their support in making this survey possible. The authors are grateful to all patients who agreed to participate in the survey.

The survey was co-funded by The Global Fund, US Centers for Disease Control and Prevention (CDC), KNCV, MoHSS, US Agency for International Development and the World Health Organization. This survey was supported in part by the President's Emergency Plan for AIDS Relief (PEPFAR), through the CDC, under the terms of CGH-HSR 2014–146.

Disclaimer: The findings and conclusions detailed in this report are those of the authors and do not necessarily represent the official position of the funding agencies.

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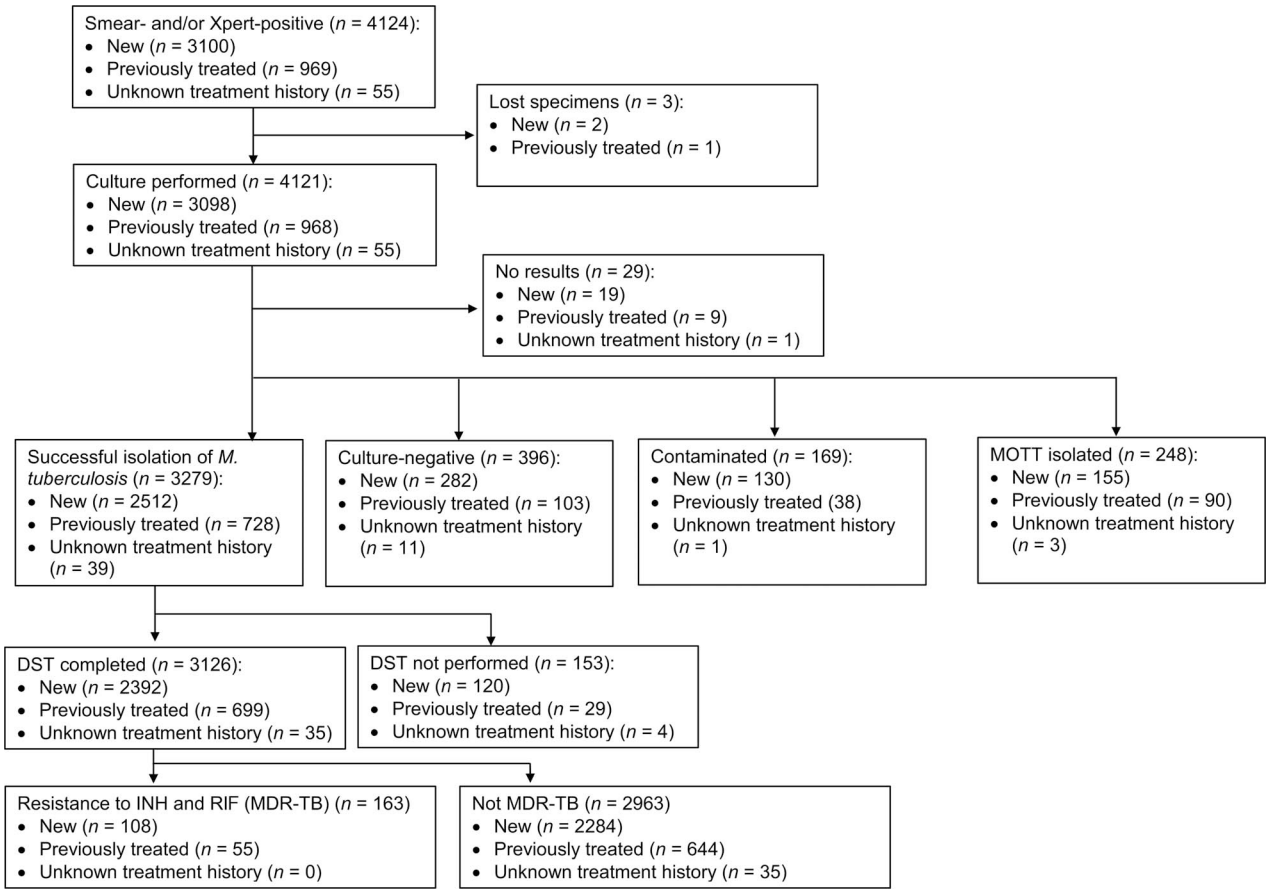

Figure.

Flow chart of specimens undergoing culture and DST in the second national anti-tuberculosis drug resistance survey in Namibia. MOTT = mycobacteria other than tuberculosis; DST = drug susceptibility testing; INH = isoniazid; RIF = rifampicin; MDR-TB = multidrug-resistant tuberculosis.

Table 1

Characteristics of patients with positive sputum smear and/or molecular identification of *M. tuberculosis* enrolled in the Second Drug Resistance Survey, Namibia (*n* = 4124)

	New *n* (%)	Previously treated *n* (%)	Unknown treatment history *n* (%)	Row total *n* (%)
Total, *n*	3100	969	55	4124
Sex				
Male	1797 (58.0)	596 (61.5)	31 (56.4)	2424 (58.8)
Female	1283 (41.4)	369 (38.1)	22 (40.0)	1674 (40.6)
Unknown	20 (0.6)	4 (0.4)	2 (7.7)	26 (0.6)
Age group, years				
0–4	19 (0.6)	1 (0.1)	0	20 (0.5)
5–14	78 (2.5)	10 (1.0)	2 (3.6)	90 (2.2)
15–24	480 (15.5)	67 (6.9)	7 (12.7)	554 (13.4)
25–34	927 (29.9)	248 (25.6)	10 (18.2)	1185 (28.7)
35–44	747 (24.1)	310 (32.0)	18 (32.7)	1075 (26.1)
45–54	391 (12.6)	173 (17.9)	10 (18.2)	574 (13.9)
55–64	195 (6.3)	86 (8.9)	5 (9.1)	286 (6.9)
≥65	193 (6.2)	64 (24.7)	2 (3.6)	259 (6.3)
Unknown	70 (2.3)	8 (0.8)	1 (1.8)	79 (1.9)
Median age, years	35	39	39	36
Area of residence				
Rural	1346 (43.4)	384 (39.6)	14 (25.5)	1744 (42.3)
Semi-rural	268 (8.7)	79 (8.2)	2 (3.6)	349 (8.5)
Urban	657 (21.2)	249 (25.7)	12 (21.8)	918 (22.3)
Unknown	829 (26.7)	257 (26.5)	27 (49.1)	1113 (27.0)
HIV				
Positive	954 (30.8)	403 (41.6)	11 (20.0)	1368 (33.2)
Negative	1656 (53.4)	456 (47.1)	18 (32.7)	2130 (51.7)
Unknown	490 (15.8)	110 (11.4)	26 (47.3)	626 (15.2)
Nationality				
Namibian	3023 (97.5)	953 (98.4)	55 (100.0)	4031 (97.7)

	New *n* (%)	Previously treated *n* (%)	Unknown treatment history *n* (%)	Row total *n* (%)
Non-Namibian	76 (2.4)	14 (1.4)	0	90 (2.2)
Unknown	1 (0.0)	2 (0.2)	0	3 (0.1)

HIV = human immunodeficiency virus.

Table 2

Prevalence of first-line anti-tuberculosis drug resistance in Namibia using phenotypic DST, 2014–2015*

	New		Previously treated		Unknown		Total *n* (%)
	n **(%)**	**95% CI**	***n*** **(%)**	**95% CI**	***n*** **(%)**	**95% CI**	
Total patients with DST results (H+R)	2392 (76.5)	75.0–78.1	699 (22.4)	20.9–23.9	35 (1.1)	0.8–1.6	3126 (100)
Any resistance to INH	268 (11.2)	10.0–12.5	116 (16.6)	13.9–19.6	2 (5.7)	0.7–19.2	386 (12.3)
Any resistance to RIF	115 (4.8)	4.0–5.7	63 (9.0)	7.0–11.4	0	—	178 (5.7)
Any resistance to EMB	84 (3.5)	2.8–4.3	44 (6.3)	4.6–8.4	0	—	128 (4.1)
Any resistance to SM	170 (7.1)	6.1–8.2	69 (9.9)	7.8–12.3	4 (11.4)	3.2–26.7	243 (7.8)
Resistance to H only	109 (4.6)	3.8–5.5	34 (4.9)	3.4–6.7	0	—	143 (4.6)
Resistance to R only	6 (0.3)	0.1–0.5	8 (1.1)	0.5–2.2	0	—	14 (0.4)
Resistance to E only	1 (0.0)	0.0–0.2	0	—	0	—	1 (0.0)
Resistance to S only	47 (2.0)	1.4–2.6	3 (0.4)	0.1–1.2	2 (5.7)	0.7–19.2	52 (1.7)
Any monoresistance	163 (6.8)	5.8–7.9	45 (6.4)	4.7–8.5	2 (5.7)	0.7–19.2	210 (6.7)
H+R	25 (1.0)	0.7–1.5	9 (1.3)	0.6–2.4	0	—	34 (1.1)
H+R+E	7 (0.3)	0.1–0.6	3 (0.4)	0.1–1.2	0	—	10 (0.3)
H+R+S	18 (0.8)	0.4–1.2	14 (2.0)	1.1–3.3	0	—	32 (1.0)
H+R+E+S	58 (2.4)	1.8–3.1	29 (4.1)	2.8–5.9	0	—	87 (2.8)
Any multidrug resistance	108 (4.5)	3.7–5.4	55 (7.9)	6.0–10.1	0	—	163 (5.2)
H+E	6 (0.3)	0.1–0.5	4 (0.6)	0.2–1.5	0	—	10 (0.3)
H+S	35 (1.5)	1.0–2.0	15 (2.1)	1.2–3.5	2 (5.7)	0.7–19.2	52 (1.7)
H+E+S	10 (0.4)	0.2–0.8	8 (1.1)	0.5–2.2	0	—	18 (0.6)
R+E	0	—	0	—	0	—	0
R+S	0	—	0	—	0	—	0
R+E+S	1 (0.0)	0.0–0.2	0	—	0	—	1 (0.0)
E+S	25 (1.0)	0.7–1.5	9 (1.3)	0.6–2.4	0	—	34 (1.1)
Any polyresistance	77 (3.2)	2.5–4.0	36 (5.2)	3.6–7.1	2 (5.7)	0.7–19.2	115 (3.7)

*Rows are not mutually exclusive.

DST = drug susceptibility testing; CI = confidence interval; H, INH = isoniazid; R, RIF = rifampicin; EMB, E = ethambutol; SM, S = streptomycin.

Table 3

Comparison of DRS results in selected settings, 2008–2016

Setting/geographical region	MDR-TB in new patients % (95%CI)	MDR-TB in previously treated patients % (95%CI)	Year of estimate
Namibia DRS 2	4.5 (3.7–5.4)	7.9 (6.0–10.1)	2015
Namibia DRS 1	3.8 (2.8–5.1)	16.4 (13.0–20.8)	2009
South Africa	2.1 (1.5–2.7)	4.6 (3.2–6.0)	2014
Botswana	2.5 (1.5–3.5)	6.6 (2.4–11)	2008
Lesotho	3.2 (2.2–4.1)	7.3 (4.2–10)	2014
Swaziland	7.7 (4.9–10.5)	33.8 (28.3–39.3)	2010
Malawi	0.4 (0.1–1.0)	4.8 (3.2–6.9)	2010
Zambia	0.3 (0.04–1.2)	8.1 (4.1–14)	2008
Mozambique	3.5 (2.2–4.8)	11.2 (0.0–25.2)	2008
Global average	3.9 (2.7–5.1)	21 (15–28)	2016

DRS = drug resistance survey; MDR-TB = multidrug-resistant tuberculosis; CI = confidence interval.