THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF HEALTH AND SOCIAL WELFARE

Utafiti wa Kwanza wa Kitaifa wa kutathmini kiwango cha TB nchini Tanzania.

The First National Tuberculosis Prevalence Survey in the United Republic of Tanzania Final Report

September 2013

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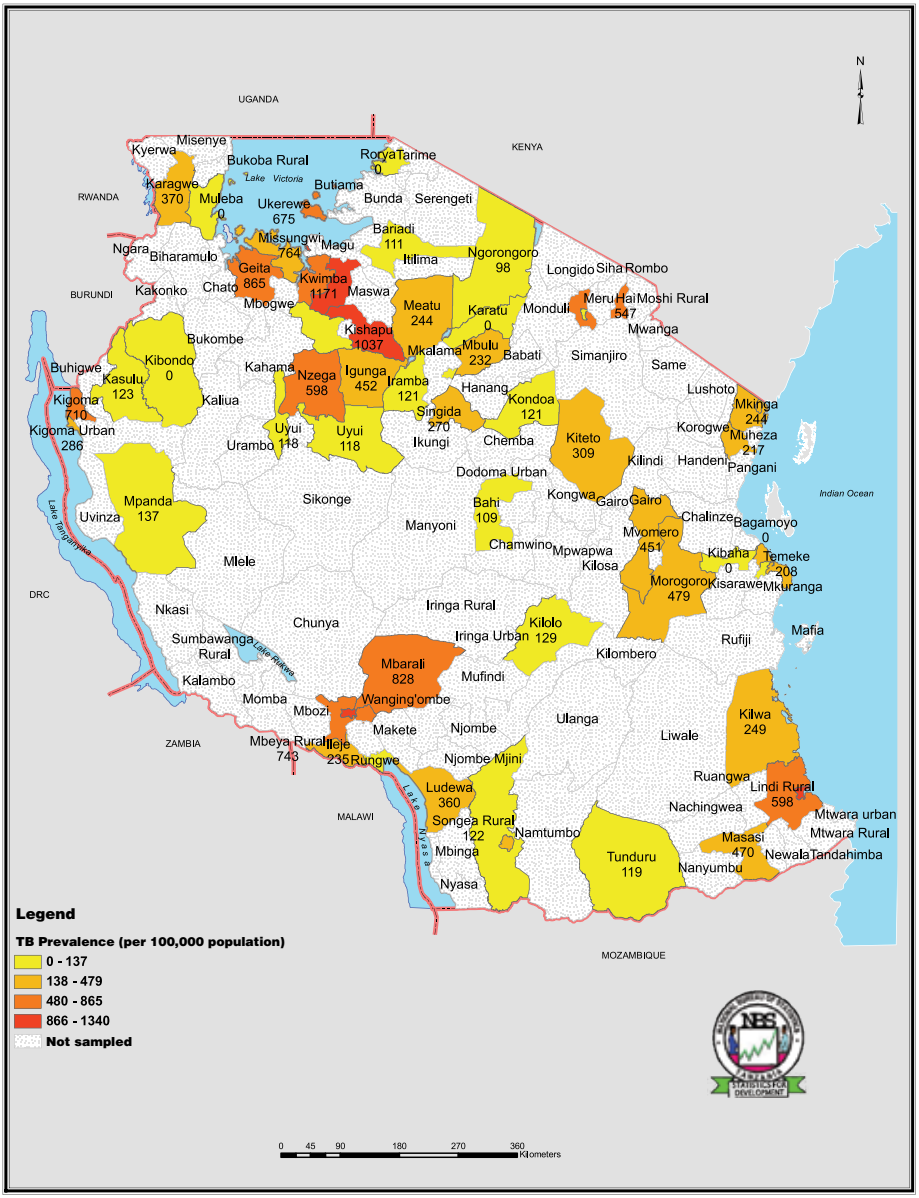
Map showing TB Prevalence by Cluster/District (per 100,000 population)



Source: First National TB Prevalence Survey Preliminary Report

Table of Contents

Acknowledgements

The implementation and completion of the First National TB Prevalence Survey, and the information collected will contribute to the improvement of TB control and prevention interventions in Tanzania through the provision of current and reliable data on the disease burden. The data is indispensable for strategic planning, policy formulation, as well as for monitoring and evaluating national and international strategic frameworks.

The success of the survey depended on the cooperation with and the contributions by the government, development partners, various institutions, and the public at large. A special word of thanks should go to the government leaders at all levels particularly, authorities from the Ministry of Health and Social Welfare (MoHSW) both in the mainland and Zanzibar, regional secretariats, district and council authorities, regional and council health management teams, TB and leprosy coordinators, local leaders, heads of households and the all the people who devoted their time to participate in the survey.

The Ministry of Health and Social Welfare (MOHSW), through the National TB and Leprosy Programme (NTLP), in collaboration with the National Institute of Medical Research (NIMR) wishes to extend sincere gratitude to all those who made this important work possible. The appreciation goes to both NTLP and NIMR staff for their work and coordination: Dr. S.M. Egwaga – Principal Investigator (PI), Dr S.G. Mfinanga – Co-PI, Dr B.F. Njako – NTLP manager, Dr. Ahmed Khatib – Programme Manager – ZTLP, Dr. D.V. Kamara – National Survey Coordinator, Dr. M. Senkoro – Assistant Coordinator, Dr. N.S Range – Principal Research Scientist-NIMR, Dr. F. Lwilla – Principal Research Scientist-IHI/NTLP, Dr. A. Kahwa – Research Scientist-NIMR, Ms. B. Doulla – Head CTRL-NTLP, Mr R. Shirima – Project Data Manager-NTLP, Dr. R. Mtandu – Programme Officer-NTLP, Dr. J. Lyimo – Coordinator GFATM for NTLP, Mr. B.S. Msuya – Programme Accountant-NTLP, Mr. M. Kapufi – Financial Administrator-NIMR, Mr. N. Mazengo – Project Accountant-NIMR, Ms N. Mwaigwisya – Project Administrator-NIMR and Mr J. Kiwuye – Logistic Officer-NIMR.

A special gratitude we give to KNCV Tuberculosis Foundation of The Netherlands for full time technical support and to our technical adviser Dr. Frank van Leth, whose expertise and contribution in stimulating suggestions and encouragement, helped us to coordinate this project and write this report.

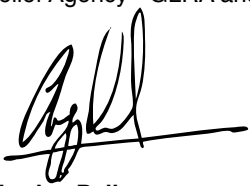
Furthermore I would like to acknowledge the members of the steering committee for managing this important national responsibility; Dr. P. Mbuji – Acting Director of Preventive Services-MoHSW, Dr N.G. Simkoko (WHO-CO), Dr. M. Makame – Country Programme Leader-PATH, Dr. Z. Mkomwa – Project Director-PATH, Mr. T.M. Chonde – Lab Specialist-PATH, Dr. R. Kazema and Dr. L. Fundikira (MUHAS), Mr. A.A. Msuya (NBS), Mr E.. Bandio and C.J. Semkundi (MoHSW),

The MOHSW also recognizes the role of Dr. Katherine Floyd (WHO- HQ), Dr. Ikushi Onozaki (WHO- HQ), Dr Rufaro Chatora (WHO Representative, Tanzania) and Dr. Wilfred Nkhoma (WHO-AFRO) for their technical guidance towards the successful completion of survey operations.

I would like to acknowledge the vital contributions and important role played by the team leaders (Drs J.A. Msaki, M. Ringo, L. Mtafya and Mr. R. Ishumi) and all survey team members for the field work. It is not possible to mention each individual, but I extend similar thanks to all those involved.

Furthermore I would like to acknowledge the crucial role of our partners; Muhimbili University of Health and Allied Sciences, Muhimbili National Hospital, National Institute for Medical Research, Ifakara Health Institute, The UNION, Tuberculosis Surveillance and Research Unit, National Bureau of Statistics, Mokasi-Phillips Services Ltd and Tanzania Atomic Energy Commission for facilitating the conduct of this survey.

Last but not least, I would also like to recognize the financial support provided to the project. In particular, I would like to commend the support from the following; Government of the United Republic of Tanzania, The Global Fund to fight AIDS, Tuberculosis and Malaria, USAID support through PATH - Programme for Appropriate Technology in Health, NTLP Joint account supported by The Royal Netherland Embassy - RNE, Confederation Swiss International - CSI, Irish Aid, Germany Leprosy and Tuberculosis Relief Agency - GLRA and the World Health Organization.



Charles Pallangyo

Permanent Secretary

September 2013

Financial support

This study was financially supported by:

1. The Government of the United Republic of Tanzania
    a. Personnel
    b. Premises
    c. Preliminary work
2. The Global Fund to Fight AIDS, Tuberculosis, ad Malaria (GFATM)
    a. Personnel
    b. Operations
3. Partners in Appropriate Technology in Health (PATH)
    a. Consumables
    b. Supplies
4. Joint account National Tuberculosis and Leprosy programme, supported by Royal Netherlands Embassy, Confederation Swiss International, Irish Aid, German Leprosy and Tuberculosis Relief Agency, World Health Organisation
    a. Trucks and X-Ray equipment

Abbreviations used

CI	Confidence Interval
CTRL	Central Tuberculosis Reference Laboratory
CXR	Chest X-ray
DTLC	District Tuberculosis and Leprosy Coordinator
DTHO	District TB/HIV Officer
MoHSW	Ministry of health and Social Welfare
MUHAS	Muhimbili University of Health and Allied Sciences
NIMR	National Institute of Medical Research
NBS	National Bureau of Statistics
NTLP	National Tuberculosis and Leprosy Programme
PI	Principal Investigator
SC	Survey Coordinator
SEP	Socio-Economic Position
SI	Symptom Interview
SOP	Standard Operating Procedure
TB	Tuberculosis
WHO	World Health Organization

Executive summary

Background

Tanzania is classified as one of the 22 high burden countries for tuberculosis (TB). It was the first country in the world to use the now standard Direct Observed Treatment Short Course to treat tuberculosis. The National Tuberculosis and Leprosy Programme (NTLP) was established in 1977. Although the routine TB surveillance data are consistent over the years, there are still areas of uncertainty, which makes that these routine data cannot be translated easily into an approximation of TB incidence as an indicator for the burden of disease. This lack of information on the true burden of TB disease in the country justified the conduct of a national TB prevalence survey to provide the much-needed context in which all other available data can be re-assessed.

Methods

The survey was designed as a nation-wide population-based survey in the adult population, in which districts were randomly selected, followed by a random selection of a single ward (denoted as cluster) within each district. A set number of participants in each ward was invited to participate in the survey. Participants were screened for being suspect of having TB by a simple symptom questionnaire and a chest X-ray (CXR). Identified TB-suspects were requested to submit three sputum specimens, of which two were assessed by microscopy in a field laboratory and the third was transported to the CTRL for culture.

Key findings

The prevalence of bacteriological confirmed TB was 295 per 100,000 adult populations. Prevalence was higher in mainland Tanzania compared to Zanzibar, rural compared to urban populations, men compared to women, older compared to younger participants and in participants with lower compared to higher socio-economic position. The prevalence of HIV-infection in identified TB cases was 6.8%. Case Detection of new smear-positive adult TB patients was estimated to be between 42 and 54%. The majority of identified TB cases were 54 years or older, indicating a shifting epidemic from young HIV-infected patients.

Facilitators to the implementation

The survey was conducted to high standards as acknowledged by external monitors from KNCV Tuberculosis Foundation (provided Technical Consultant from the start of the study design) and the WHO Task Force on Impact Measurements. The detailed protocol and SOPs facilitated the implementation of the survey. The support by the Ministry of Health and Social Welfare, the close cooperation with community leaders and local NTLP staff, and the assistance of Community Health Workers, facilitated the

implementation of the survey.

Limitations

The survey was conducted in the adult population only, which makes it impossible to assess the burden of childhood TB. Data analysis was hampered by missing data due to recording errors and misplacement of survey records, especially for the central laboratory. However, formal imputation analyses to account for this situation did not change the conclusions of the survey

Conclusions and recommendations

The prevalence of bacteriological TB in the adult population of Tanzania is higher than expected; the case detection of new smear-positive adults is markedly lower than previously reported. There is an urgent need to assess patient identification and the conduct of laboratory procedures in the diagnostic centres. This can be achieved by intensifying supportive supervision in the country which has been decreased in frequency and intensity during the last few years.

Introduction

Background

Tanzania is classified as one of the 22 high burden countries for tuberculosis (TB). It was the first country in the world to use the now standard Direct Observed Treatment Short Course to treat tuberculosis. The National Tuberculosis and Leprosy Programme (NTLP) was established in 1977. Its vision is a Tanzania where TB and leprosy are no longer a public health problem. The mission of the NTLP is to provide quality TB and leprosy control services with the focus on universal access, equity, and affordability. The goal of the NTLP is to reduce the morbidity and mortality of TB and leprosy by 50% in 2015, as compared to 2009.

The burden of TB is monitored through a routine notification system. There are no data from national surveys on incidence or prevalence of disease. Up to 2007, the case detection (number of cases identified as percentage of the estimated incidence of disease) of TB was consequently estimated to be below 50%, indicating a gross under-detection of TB cases, an overestimation of TB incidence, a poor reporting system, or any combination of these factors. Although the routine TB surveillance data are consistent over the years, there are still areas of uncertainty, which makes that these routine data cannot be translated easily into an approximation of TB incidence as an indicator for the burden of disease.

Tanzania has collected a wealth of information on the prevalence of TB-infection through repeated national Tuberculin Skin Test (TST) surveys in schoolchildren. The surveys showed a decline in the Annual Risk of Tuberculous infection (ARTI) in both the younger (aged 5-9), and the older children (10-14)[1]. However, it is not possible to estimate the TB incidence from these data because the often-used Styblo rule does not apply in a setting with TB-control activities[2, 3]. After an in-depth assessment of the notification system and additional data sources in 2008 by a team of the World Health Organization, the case detection was corrected upwards to 70%, despite the fact that a proper insight in the TB incidence and prevalence in the country was still lacking.

This lack of information on the true burden of TB disease in the country justified the conduct of a national TB prevalence survey to provide the much-needed context in which all other available data can be re-assessed. In addition, it will contribute information to the evaluation of the Millennium Development Goals as formulated by The United Nations and signed by 189 countries in the year 2000[4]. Goal number 6 refers to TB and is formulated as halting and beginning to reverse the incidence of TB[5].

Time lines of major activities

Initial discussion on the design and conduct of the survey started in 2004. In July 2005, there was a first stakeholders meeting including representatives of the NTLP, the National Institute for Medical Research (NIMR), Muhimbili University of Health and Allied Sciences (MUHAS), KNCV Tuberculosis Foundation (The Netherlands), and the London School of Hygiene and Tropical Medicine (United Kingdom). The meeting resulted in a broad plan, which was formed into a detailed study protocol by May 2006.

Between 2006 and 2010, the preparation for the survey was slow due to a lack of directly available funds. As a result, it was not possible to have staff from NTLP work full-time on the project. Due to the cooperation with the WHO Taskforce on Impact Measurements (founded in 2007) [6], funds from the Global Fund for AIDS, Tuberculosis and Malaria could be secured in 2010. This provided the needed input to revitalize the project. The key activities after this period are summarized in Table 1.

The time between the start of the survey field operations and the first formal dissemination of the first results was 18 months.

Objectives

Primary

The primary objective of the survey was to estimate in a nationwide representative survey the prevalence of bacteriologically confirmed pulmonary tuberculosis among the adult population of the United Republic of Tanzania as a basis for estimation of the burden of TB.

Secondary

The secondary objectives were:

1. To assess the prevalence of symptoms suggestive of pulmonary TB.
2. To assess the prevalence of radiological abnormalities suggestive of pulmonary TB.
3. To assess health seeking behaviour in TB suspects
4. To estimate the prevalence of HIV infection in TB cases
5. To assess the prevalence of risk factors for pulmonary TB in the population of TB suspects.

Table 1: Time lines

Period	Activity
2010	Updated study protocol
	Obtained updated sampling frame from NBS
	Finalised sampling for survey
May 2011	Finalised protocol (through workshop all participating institutions)
	Finalised Standard Operating Procedures for the survey
July 2011	Finalised training manual
October 03-07, 2011	Training of all staff in 1-week workshop
October 23-29, 2011	Pilot study
December 04, 2012	Official launch of the survey
December 07, 2011	Start survey activities in first cluster
March 4-14, 2012	Monitoring visit Technical Consultant during 16th cluster
May 14-18, 2012	Mid-term review WHO Task Force Impact Measurements
October 29 -November 08, 2012	Monitoring visit Technical Consultant, field and central activities
November 17, 2012	Finished survey field activities in last cluster
February 18-28, 2013	Monitoring visit Technical Consultant, data management
April 22-30, 2013	Monitoring visit Technical Consultant, data analysis
July 5, 2013	Formal dissemination initial findings

Methodology

Design

The survey was designed as a nation-wide population-based survey in which districts were randomly selected, followed by a random selection of a single ward (denoted as cluster) within each district. A set number of participants in each ward was invited to participate in the survey. Participants were screened for being suspect of having TB by a simple symptom questionnaire and a chest X-ray (CXR). Identified TB-suspects were requested to submit three sputum specimens, of which two were assessed by microscopy in a field laboratory and the third was transported to the CTRL for culture.

Population

The target population was the adult population (15 years of age or older) of the United Republic of Tanzania. The study population was the adult population of the 62 selected

clusters, while the study sample consisted of the participants who were visited during the census, judged to be eligible, presented to the field site, and provided informed consent.

Case definitions

The case definition followed the recommendation of the WHO Task Force on Impact Measurements that oversees the design and implementation of multiple TB prevalence survey. In addition, we used the definitions used in the NTLP of Tanzania

1. Survey definitions
    a. Definite case
        i. Positive culture for TB regardless of smear result.
    b. Probable case
        i. At least one smear-positive sputum specimen AND
            1. Negative culture AND
            2. Evidence of TB on the diagnostic CXR.
    c. Survey case
        i. Definite or probable case
2. NTLP definitions
    a. Smear-positive case (restricted)
        i. At least two smear-positive specimens OR
        ii. One smear-positive specimen AND
            1. Evidence of TB on diagnostic CXR
    b. Bacteriological confirmed case
        i. Positive culture for TB AND / OR
        ii. Smear positive case

Sample size

The survey was designed on an expected prevalence estimate of 145 smear-positive TB cases per 100,000 total population (261 per 100,000 in adults). This number was provided by the WHO Task Force on Impact Measurements at the time of the sampling. With a relative precision of 25%, a level of statistical significance of 5%, a power of 80%, and an anticipated participation rate of 80%, the survey needed to have a sample size of 29,384. Adjustment for the cluster design increased the effective sample size to 46,792 (intra-class correlation coefficient 0.55). To be able to perform all field activities within a single week, the maximum number of participants for each cluster was set at 750, leading to 62 clusters to be included.

Sampling strategy

The sampling frame for the cluster selection was obtained from the National Bureau of Statistics. The frame contained information on age-specific population sizes of each district and ward in the United Republic of Tanzania as projected for 2010 based on the latest census of 2002. The selection of the clusters followed a stratified proportional-to-population-size approach including four steps.

In step 1, the total number of clusters (62) was divided proportionally over four different strata based on setting, being (i) rural, (ii) urban, (iii) semi-urban, and (iv) Zanzibar. The allocated number of clusters was 37, 9, 14, and 2, respectively. In step 2, a separate sampling frame for each stratum was drawn that contained the districts with the total sample size of the population of 15 years and older. From these frames, the districts for the allocated number of clusters for the stratum were selected proportional-to-population-size. In step 3, a single ward within each sampled district was selected by simple random sampling. In step 4, the actual survey site within the selected ward was selected randomly in a ceremony with local authorities.

Ethical clearance

The study protocol was approved by the National Medical Research Coordinating Committee. For the activities in Zanzibar, a separate approval was obtained from the Zanzibar Medical Research and Ethics Committee (ZAMREC).

Field activities

Summary

All eligible adults were screened for TB symptoms and an abnormal CXR. Persons with symptoms and/or abnormal CXR submitted 3 sputum specimens: spot, morning, and spot. The two spot specimens were examined microscopically for acid-fast bacilli by using LED fluorescence microscopy with Auramine phenol staining in a field laboratory at the survey site. The morning specimens were left untouched and sent to CTRL, where smear, culture and identification of the specimens took place. Harvested strains of M. tuberculosis were tested for drug-sensitivity for first-line TB drugs. Initially, all screening x-rays classified abnormal and 20% of those classified as normal were assessed at the central radiology unit of MUHAS to make a final diagnosis of TB. After the midterm review it was decided that in addition to this re-reading, the x-rays of all identified TB suspects were re-read.

Pre-survey visit and population listing

Two to four weeks prior to the field activities, the Survey Coordinator and team leaders visited the selected ward to assess if the infrastructure was adequate to host the survey

team and to conduct the survey. This assessment was done in close cooperation with the district authorities. During this visit, local health workers were selected to perform the pre-survey census by house-to-house visits. The purpose of this was to prepare a population listing of all residents of the selected area of the ward, to gather general information of these residents (age, gender), and to sensitize the residents to the upcoming survey. The residents were provided with information leaflets discussing the purpose of the survey and the activities that would take place.

Site preparation

The survey site was prepared by the survey team after arrival in collaboration with regional and district TB and leprosy coordinators. This included housing the staff, identifying an adequate position for the X-ray truck and field laboratory, and ensuring proper ways of waste disposal. Tents, tables, and chairs were hired from within the local communities. Preparations were done in close cooperation with the district authorities and ward or shehia leaders.

Census

The census activities were carried out by a multitude of small teams consisting of survey staff and a local health worker. The work was guided by the information gathered by the local health workers during the pre-survey visit. Through house-to-house visits, the population list was checked and updated (with deletions or additions) where needed. Information on history of previous TB and current TB treatment was recorded. The residents were explained the purpose of the survey and the activities that would take place. The survey team answered all outstanding questions to the best of their knowledge. All eligible residents were provided with an invitation card with an individualized registration number.

During the census, the socio-economic position (SEP) of the household was assessed through the use of an asset list. This approach, which captures the presence of certain goods in the household, the construction of the house, and the access to services (water, electricity), is validated for the rapid assessment of SEP and recommended to be used in large-scale surveys [7–9].

The geographical coordinates of the household were assessed by the use of GPS, after which the household was identified through a visible household number, to facilitate later return visits if needed.

Registration and consents

Invited residents reporting to the field site were briefed in small groups on the purpose and activities of the survey. At this briefing, the informed consent form was explained, and all outstanding questions were addressed. Formal individual written informed

consent was obtained at the registration of participants. At this 1-on-1 encounter with survey staff, residents could still ask personal questions with regards to the survey before providing consent.

Symptom screening

All participants were screened for the presence of symptoms suggestive of TB. The questionnaire consisted of five sort questions (cough for more than 2 weeks, haemoptysis, fever for more than 2 weeks, weight loss, and excessive sweating). The interviewer was trained to probe for correct answers based on own observations.

X-ray screening

All participants were invited for a CXR. This was conducted in a specially-designed truck that was approved by the Atomic Energy Agency of Tanzania. All women were offered a gonad protection apron for preventive purposes. X-rays were produced with conventional equipment, while imaging was done using digital techniques. As such, X-ray images could be corrected directly on screen, preventing loss of images or the need for repeat exposure.

Initial assessment for screening purposes was solely based on the image showing any abnormality or not in the lung fields or mediastinum. All X-ray images were digitally stored for future reference and selected re-reading.

Field laboratory

Participants identified with any symptom of TB and/or any abnormality of the CXR were identified as a TB suspect. TB suspects were requested to produce three sputum specimens. The first spot specimen was requested directly after the identification of the being a suspect. The second spot specimen was requested the following day when the participant returned with the morning specimen collected directly after waking-up.

Spot specimens were collected in a designated area of the survey site where there was no chance of transmission through an aerosol to other participants, or specimens being processed. Spot specimens were fixated, stained with Auramine for 15 minutes, decolorized with 0.5% acid/alcohol solution (3 minutes), counter-stained with methylene blue for 1 minute, after which the slides were left to dry. The specimens were examined by LED-microscopy at the survey site using a 40x objective.

The morning sputum specimen was collected the day after the TB-suspect visited the screening activities. The participant received a pre-labelled sputum container, information on the importance of this specimen, the method to collect the specimen, and the need for returning to the survey site for handing-in the morning specimen. When

TB-suspects did not return to hand-in the morning specimen (and provide the second spot specimen), they were traced by the local health workers and persuaded to finalize the survey activities. All slides were stored in slide boxes and transferred back to CTRL. Sputum containers were incinerated at the field site at the end of each day.

Specimen transport to CTRL took place twice a week by using either the public mail courier or survey car or public transport. CTRL was informed by SMS that a transport was initiated and specimens could be expected. This was to prevent that specimens were left unattended at bus depots. This strategy was found to be very effective in the previously conducted Drug Resistance Survey some years earlier[10].

When a specimen was found to be smear-positive, the participant was referred to the field team leader, who informed the District Tuberculosis and Leprosy Coordinator (DTLC) or District TB/HIV Officer (DTHO). The participant was offered further clinical assessment and treatment in the nearest diagnostic centre.

Second interview

A second interview was conducted with a TB-suspect. Purpose of this interview was to obtain information on demographics (marital status, education, profession), the presence of risk factors for TB (smoking, alcohol use, diabetes, low Body Mass Index), the knowledge of TB (transmission, diagnosis, treatment, prevention), and health seeking behaviour.

HIV testing

All TB suspects were offered HIV testing. The diagnosis of HIV followed national guidelines. In the initial clusters the sequence of rapid tests was SD Bioline, followed by Determine. The diagnosis was made if both the initial test and the conformation test were positive. If still indeterminate after two tests, the final diagnosis was made by Unigold. During the survey, the national guideline changed. Accordingly, the diagnosis of HIV in the survey was made by the successive use of Determine and Unigold. Again, HIV was diagnosed when both rapid test were positive.

HIV-testing was also performed when non-suspects requested it. Results of these tests were not formally analysed because self-referral introduces bias in prevalence estimates.

Close-out

At the end of the day field activities, the team leader informed the participant on the follow-up activities. These were either none (no TB suspect, TB suspect who returned for the second day), return the next day (TB suspect who needs to produce a morning sputum specimen), or referral to the DTLC (TB suspect with a smear-positive spot sputum specimen).

The cluster close out meeting was also used to answer outstanding questions from the survey participants including medical queries. When needed, the participant was provided with a referral letter to the general health service when judged as needed by the team leader (all Medical Doctors).

Field Data entry

The data from the census, symptom interview and screening CXR were entered into an electronic database during the field activities. A prepared statistical script in STATA provided output for those participants who needed to be actively traced (those invited but not enrolled, TB suspects without sputum specimens). After the midterm review, the data from the field laboratory were added to this list of expedited data to have a direct check on the appropriateness of suspect identification.

Central activities

Central laboratory

All morning sputum specimens were received at CTRL for processing. After LED smear microscopy without a concentration procedure, specimens were prepared for culture on Lowenstein-Jensen medium according to routine procedures. In short, an equal amount of 4% NAOH was added to the specimen (at least 2 ml), after which the mixture was centrifuged at 3000g for 15 minutes. The supernatant was disposed after which the material was suspended in 1 ml of distilled water. The suspension was inoculated on two slopes of egg-based Lowenstein-Jensen medium, and incubated for 8 weeks at 370C. Slopes were inspected weekly for growth. Contamination was handled by sub-culturing. Negative slopes were only identified after 8 weeks. Cultures were identified for TB by using the paranitrobenzoic acid (PNB) colour test.

Positive cultures were processed for drug sensitivity testing for the first-line anti-tuberculosis drugs isoniazid (0.2 µg/ml), rifampicine (µg/ml), ethambutol (2 µg/ml), and streptomycin (5µg/ml), using the modified proportion method.

X-ray diagnosis

The central radiology department of MUHAS read the CXRs from all TB suspects in the field (and not only from suspects by abnormal screening CXR). Purpose of this was to make a final verdict on the presence of abnormalities consistent with pulmonary TB. The assessment used a pre-specified form on which specific lesions and abnormalities were recorded.

Data entry

All data forms were sent to the central data unit located at the NIMR Muhimbili Centre.

Two independent teams entered the data twice in an electronic database. For those forms with expedited data entry in the field, the central data unit entered the data a second time. For the non-expedited forms, the central team entered all data twice.

Data management

A central data manager was responsible for the completeness and storage of all survey data. The data manager assessed consistency between the two data entry files. Inconsistencies were resolved by returning to the source data. Double data entry for the census was stopped after 72% of the data was double entered. The decision was made to free human resources to attend to the other data forms. The decision was justified because at that point in time all primary variables (gender, age, history of previous TB, and current use of TB treatment) had an error rate below 0.5%. At database closure, all primary variables of the other forms had error rates below 0.3% between the two data entry files.

Special groups

General population

A random sample of the general populating with a negative screen (no TB symptoms and no abnormalities on the screening CXR) was invited for the follow-up survey activities intended for TB suspect, including sputum collection. The reason for this was to obtain detailed information needed to calculate the population attributable risk for the TB-risk factors as assessed in the second interview.

At each cluster, 10 participants were sampled by inviting each 10th non-suspect for these extra assessments. To avoid clustering, four non-suspects were invited on day 1 of the screening, on day 2 another four, and at day 3 of the field activities the final two non-suspects were invited.

TB patients

In each cluster, the six latest TB-patients passively detected through routine services and registered at the nearby diagnostic center were visited at home for interview and assessment of SEP. The reason for this was to obtain data on TB knowledge and health-seeing behaviour that could be used to provide context to these same topics assessed in TB-suspects (and confirmed actively detected TB cases).

Training

Workshop

A central 4-day training workshop was conducted for all staff involved in any of the survey activities in October 2011. The workshop consisted of plenary sessions (TB epidemiology, rationale for survey, role of SOPs) as well as specialised sessions for each group of survey staff (interviewers, team leaders, radiologists, laboratory technicians, data entry clerks, data managers, and supporting staff). The specialist session were facilitated by experts. All activities were simulated in role plays in which all staff participated. A final mock census was conducted using actual households and residents in a community.

The workshop was monitored by the Technical Consultant who also acted as the facilitator for selected sessions. The findings of the training were discussed with the team organizing the survey after which some adjustments of the data capture forms and questionnaires were implemented. A formal report of this training was shared with the NTLP, NIMR, KNCV Tuberculosis Foundation, and WHO.[1]

Pilot study

Proposed field activities for the survey were piloted in October 2011 in a rural setting. This pilot study was monitored by the Technical Consultant. Recommendations derived from the pilot study were reported to the NTLP, NIMR, KNCV Tuberculosis Foundation, and WHO in Tanzania and Switzerland. After the pilot study, final adjustments were made to the survey implementation plan, after which formal implementation of the activities could start.

Supervision

A flow chart of the supervision structure of the survey in reported in Figure 1.

Central supervision

At central level, the responsibility for the survey was with the Steering Committee which was chaired by Dr. Peter Mmbuji, the assistant director Department of Preventive Medicine, MoHSW. A full list of the members of the Steering committee is reported in Appendix 1. The Steering Committee monitored and advised the survey management team lead by the Principal Investigator (PI) and co-PI. The Survey Coordinator and his assistant served as a link between the (co-)PI and the field teams.

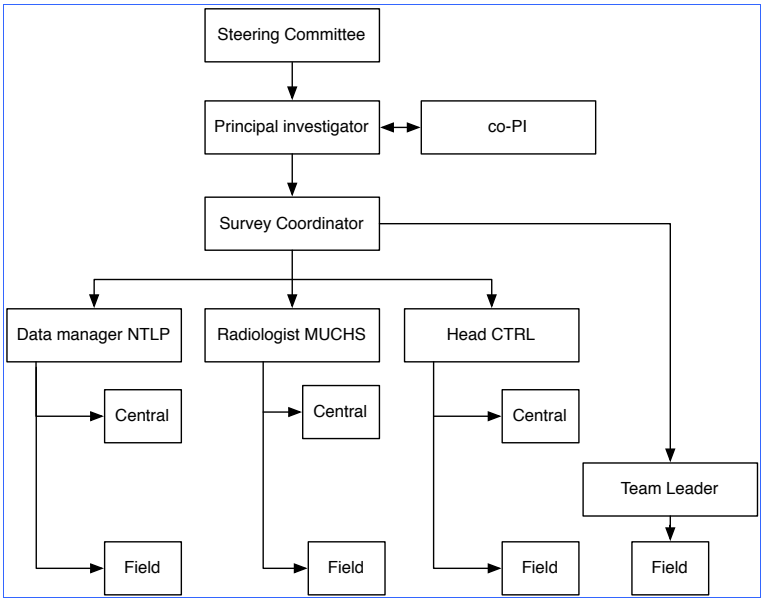
1 Mission to support epidemiological and operational research of the National Tuberculosis and Leprosy Programme, Tanzania. 20 September – 30 September 2011. Report no. 22

The respective Heads of Department supervised the specialised activities of laboratory and radiology. The appointed data manager supervised central data handling activities.

Field supervision

Overall supervision of the field activities was the responsibility of the (assistant) Survey Coordinator. The same persons who supervised the central parts of these activities supervised the field activities of the laboratory, radiology, and data management. The team leaders, who acted as the link between the field staff and the survey coordinator, oversaw the daily running of the survey site.

Figure 1: Supervision structure



Data analysis approach

With the invited population being a representative sample of the general population, we corrected the survey population for potential selection bias by using survey weights that reflect different sampling probabilities in the strata, and selective enrolment in each of the clusters.

A sampling weight to correct for differential sampling between the strata was derived for each stratum separately. It was calculated as the inverse of the ratio between invited population and total sample size adults >= 15 years in the stratum. An attrition weight to correct for non-response was calculated for each cluster separately. This weight was calculated as the inverse of the probability of being enrolled in the group of invited individuals. The probability of enrolment was derived by a logit analysis using the variables gender, age (six groups), previous diagnosis of TB (yes/no), current TB medication (yes/no), and SEP (three groups). The overall survey weight was the product of the sampling weight and the attrition weight. The survey weights were rescaled to the size of the enrolled population to arrive at the correct degrees of freedom in the statistical analyses. The sampling and attrition weights used are reported in Appendix 2.

The number of invitees, participants, TB-suspects, and identified TB-cases is reported in a flow chart as crude frequencies in Appendix 3. Crude refers to the actual frequencies observed during the survey activities, ignoring the survey design. For all tables that report frequencies in sub-populations for comparison, the frequencies are weighted for the survey design.

The prevalence of definite, survey, smear-positive, and bacteriological confirmed TB-cases is reported per 100,000 population with a 95% confidence interval (CI), using three different models.

1. Crude analysis
    a. Eligible population
    b. Missing outcomes ignored (unknown TB status is set to zero [no TB])
    c. Sampling design ignored (no weighting)
2. Survey analysis
    a. Eligible population
    b. Missing outcomes ignored (unknown TB status is set to zero [no TB])
    c. Full adjust for sampling design (stratification and attrition)
3. Missing imputation analysis
    a. Eligible population
    b. Missing outcomes imputed based on existing information
        i. Imputation for smear, culture and diagnostic CXR

ii. Based on census, SEP, and screening results
    1. Augmented logit model
iii. Conditional on being suspect
iv. TB case definition variables treated as “passive”

c. Full adjustment for sampling design (stratification and attrition)

Case detection is estimated by using the Patient Diagnostic Rate (PDR), which denotes the speed with which prevalent TB cases are detected by the TB programme[11]. This method uses the prevalence of disease as a denominator rather than incidence. The PDR is well described for new smear-positive TB patient. We restrict the calculation of case detection therefore to this group.

The PDR is calculated as the ratio of new smear-positive patients notified in 1 year per 100,000 population and the prevalence of new smear-positive TB patients per 100,000 population. The CDR is calculated as PDR / (PDR + 1 survival[years]). Survival refers to undetected and untreated TB patients. We assume this to be between 3 and 6 months for HIV-positive TB cases, and 2 to 3 years for HIV-negative TB cases. Since this is highly driven by HIV-status, the PDR and CDR are stratified by HIV status. An overall CDR is estimated by a weighted average of the two strata.

Quality control

SOPs and field monitoring

All field activities were carried out according to Standard Operating Procedures (SOPs).

The team leaders and the heads of departments made sure that there were no systematic deviations from the SOPs by frequent monitoring of field work. The head of the radiology team frequently visited the field site to inspect the quality of the CXR taking and CXR reading

Central laboratory

All positive slides from the morning specimens were re-read by an independent laboratory technician, just as was the interpretation of sputum culture results.

External monitoring

The TA-consultant conducted external monitoring visits in March 2012 (16-17th cluster), and in October 2012 (58th cluster). The TA-consultant joined an external midterm review in May 2012 conducted by members of the Taskforce of Impact Measurements.[iii, iv, v.]

- Report of the first monitoring visit for the TB prevalence survey in Tanzania; 4 – 16 March 2012
- Report of the second monitoring visit for the TB prevalence survey in Tanzania; 29 October – 8 November 2012
- Report of a mid-term review of the Tanzania National TB Prevalence Survey; 14 - 18 May 2012

Results

Participation rate

The pre-survey population listing recorded 137,547 individuals in the selected clusters, of whom 57,081 (41.5%) were below the age of 15 years. Of the 80,466 adults, the survey teams invited in total 65,664 (81.6%) eligible individuals to participate. Of those 50,447 (76.8%) were included as survey participant, with which the projected sample size was reached. The participation rate in 22 clusters was below 80%. In the initial clusters, the number of invitees was too high resulting in a low participation rate. This was corrected after the first international monitoring visit (17th and 18th cluster). The participation rate in the first period was 53.1% and increased to 87.4% after corrective measures in the second period (Figure 2).

Survey population

The invited and enrolled population differed by gender, age, history of previous tuberculosis, current use of tuberculosis medication, and (SEP) (Table 2). Eighty percent of the invited women were enrolled compared to 73% of the men. The inclusion by age increased from 71% of those invited in the lowest age group (15 – 24 years), to 86% in those invited form the highest age group (65 years and over). Invitees from the lowest SEP tertile were enrolled more frequent (85%) compared to those in the middle (82%) or highest SEP tertile (64%).

After applying the survey weights, the distribution of the different variables in the survey population, mimicked the distribution seen in the invited population (Table 2). With the invited population being a random sample of the total population of Tanzania (due to the sampling strategy), the survey population is a valid representation of the total population of Tanzania.

Screening results

All survey participants were screened for tuberculosis using both a symptom questionnaire and a chest X-ray When either or both of these screening tools were abnormal (at least 1 symptom, any abnormality in the lungs or mediastinum), the participant was identified as a suspect. Due to some breakdowns of the X-ray equipment during the field activities, not all participants were screened with both tools. Out of the 50,376 participants 46,455

(94.1%) had both screening tools performed, while 2,383 (4.7%) had only information on the symptom interview, and 609 (1.2%) had only information on the chest X-ray. To be able to compare subgroups of the study population as a random sample from the total population of Tanzania, all frequencies reported hereafter are weighted for sampling design and attrition unless stated otherwise.

Of all participants, 49,742 (98.6%) were screened for symptoms of whom 45,423 (91.3%) had no symptoms at all reported (Table 3). The remaining 8.7% of the screened participants were identified as a suspect based on the reporting of a least one TB-related symptom. This did not differ markedly between the different strata and gender. There was a clear association with age, in which the percentages of participants reporting no symptoms decreased from 95.2% in the youngest age group (15-24 years) to 82.7% in the oldest.

Coughing for 2 weeks was by far the most frequently reported symptom (6.5%) (Table 4). Females reported cough less often than men (5.9% and 7.2% respectively). The percentage of participants reporting cough increased by age from 3.5% in the youngest age group (15-24 years) to 14.6% in the oldest age group (65 years and older). Coughing was more often reported in the two lowest SEP groups (7.6% and 6.2%, respectively) compared to the highest SEP group (5.6%).

Figure 2: Participation rate

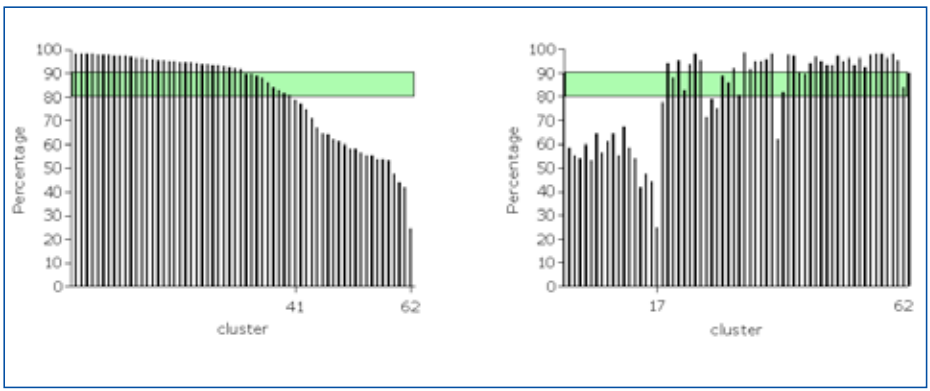


Table 2: Characteristics of the invited and enrolled participants

	Invited		Enrolled			
			Crude		Weighted	
	N = 65,664	%	N = 50,447	%	N = 50,447	%
Stratum						
Zanzibar	1,637	2.5	1,592	3.2	1,338	2.7
Mainland	64,027	97.5	48,855	96.8	49,109	97.3
Urban	11,549	17.6	6,340	12.6	7,259	14.4
Semi-urban	15,623	23.8	11,626	23.0	11,373	22.5
Rural	36,855	56.1	30,889	61.2	30,477	60.4
Gender						
Female	37,181	56.6	29,701	58.9	28,597	56.7
Male	28,467	43.4	20,735	41.1	21,841	43.3
Missing	16	0.0	11	0.0	10	0.0
Age group						
15 - 24	19,673	30.0	14,001	27.8	15,065	29.9
25 - 34	14,449	22.0	10,561	20.9	11,001	21.8
35 - 44	11,595	17.7	9,082	18.0	8,922	17.7
45 - 55	8,316	12.7	6,832	13.5	6,343	12.6
55 - 64	5,514	8.4	4,718	9.4	4,356	8.6
65 and older	6,117	9.3	5,253	10.4	4,761	9.4
SEP						
Low	21,886	33.3	18,560	36.8	17,466	34.6
Middle	21,650	33.0	17,638	35.0	17,046	33.8
High	22,128	33.7	14,249	28.2	15,935	31.6
Previous TB						
Yes	950	1.4	740	1.5	727	1.4
No	64,176	97.7	49,192	97.5	49,274	97.7
Missing	538	0.8	515	1.0	420	0.8
Current TB treatment						
Yes	353	0.5	88	0.2	170	0.3
No	64,777	98.6	49,844	98.8	49,831	98.8
Missing	534	0.8	515	1.0	418	0.8

Table 3: Symptom screening (weighted frequencies)

	Screened	Number of symptoms											
		0		1		2		3		4		5	
	N = 49,742	N	%	N	%	N	%	N	%	N	%	N	%
Stratum													
Zanzibar	1,329	1,229	92.5	61	4.6	25	1.9	11	0.8	2	0.2	1	0.1
Mainland	48,413	44,194	91.3	2,702	5.6	1,031	2.1	338	0.7	109	0.2	39	0.1
Urban	7,079	6,581	93.0	366	5.2	101	1.4	16	0.2	5	0.1	10	0.1
Semi-urban	11,163	10,204	91.4	603	5.4	264	2.4	67	0.6	22	0.2	4	0.0
Rural	30,170	27,408	90.8	1,733	5.7	666	2.2	256	0.8	82	0.3	25	0.1
Gender													
Female	28,212	25,909	91.8	1,519	5.4	569	2.0	151	0.5	53	0.2	10	0.0
Male	21,521	19,505	90.6	1,244	5.8	486	2.3	198	0.9	58	0.3	30	0.1
Missing	9	8	92.0	1	8.0	0	0.0	0	0.0	0	0.0	0	0.0
Age group													
15 - 24	14,847	14,134	95.2	458	3.1	198	1.3	37	0.3	11	0.1	8	0.1
25 - 34	10,814	10,059	93.0	461	4.3	209	1.9	59	0.5	18	0.2	8	0.1
35 - 44	8,792	8,024	91.3	497	5.7	168	1.9	67	0.8	26	0.3	10	0.1
45 - 55	6,262	5,567	88.9	434	6.9	171	2.7	68	1.1	20	0.3	3	0.0
55 - 64	4,308	3,734	86.7	377	8.7	136	3.1	40	0.9	16	0.4	5	0.1
65 and older	4,719	3,904	82.7	537	11.4	175	3.7	77	1.6	21	0.5	4	0.1
SEP													
Low	17,313	15,621	90.2	1,067	6.2	418	2.4	146	0.8	50	0.3	13	0.1
Middle	16,837	15,427	91.6	856	5.1	366	2.2	129	0.8	45	0.3	14	0.1
High	15,591	14,376	92.2	840	5.4	272	1.7	74	0.5	17	0.1	13	0.1

Table 4: Participants reported symptoms (weighted frequencies)

	Screened	Cough		Haemoptysis		Fever		Weight loss		Sweating	
	N = 49,742	N	%	N	%	N	%	N	%	N	%
Stratum											
Zanzibar	1,329	78	5.9	6	0.4	32	2.4	8	0.6	32	2.4
Mainland	48,413	3,142	6.5	555	1.1	921	1.9	586	1.2	1,203	2.5
Urban	7,079	383	5.4	69	1.0	65	0.9	65	0.9	101	1.4
Semi-urban	11,163	681	6.1	134	1.2	229	2.1	105	0.9	289	2.6
Rural	30,170	2,078	6.9	352	1.2	627	2.1	416	1.4	813	2.7
Gender											
Female	28,212	1,675	5.9	293	1.0	513	1.8	249	0.9	644	2.3
Male	21,521	1,545	7.2	267	1.2	441	2.0	346	1.6	591	2.7
Missing	9	1	8.0	0	0.0	0	0.0	0	0.0	0	0.0
Age group											
15 - 24	14,847	524	3.5	131	0.9	138	0.9	99	0.7	160	1.1
25 - 34	10,814	537	5.0	108	1.0	185	1.7	137	1.3	202	1.9
35 - 44	8,792	540	6.1	101	1.2	178	2.0	115	1.3	253	2.9
45 - 55	6,262	503	8.0	80	1.3	154	2.5	92	1.5	243	3.9
55 - 64	4,308	430	10.0	55	1.3	121	2.8	78	1.8	177	4.1
65 and older	4,719	687	14.6	86	1.8	177	3.8	74	1.6	201	4.3
SEP											
Low	17,313	1,310	7.6	232	1.3	380	2.2	233	1.3	448	2.6
Middle	16,837	1,036	6.2	206	1.2	346	2.1	190	1.1	447	2.7
High	15,591	874	5.6	123	0.8	227	1.5	171	1.1	340	2.2

The relative contribution of the five screening symptoms differed between the 62 clusters, indicating the absence of systematic error in interviewing (Figure 3).

The reported symptoms occurred in a large number of combinations (Figure 4). Cough was most often accompanied with excessive sweating (21.0%), followed by fever (15.4%), weight loss (9.3%) and haemoptysis (12.0%).

Screening by chest X-ray was performed in 47,850 (94.9%) of the participant (Table 5). In one clusters there was no X-ray screening at all, while in two other clusters there was limited X-ray screening due to the breakdown of equipment. In total 2,736 (5.7%) participants screened with X-ray were identified with abnormalities in the lung fields or mediastinum. There was a marked difference in X-ray abnormalities between mainland Tanzania (5.8%) and Zanzibar (2.3%). Also men were more often having X-ray abnormalities (7.3%) compared to women (4.5%). X-ray abnormalities increased with

age and were identified in 21.9% in the oldest age group. Participants from the lowest SEP group had most frequently X-ray abnormalities (6.7%) compared to the other SEP groups (5.2%-5.1%).

The screening process identified 6,302 suspects, which relates to 6,271 (12.4%) after applying the survey weights (Table 5). This was in line with the expected 10-20% suspect rate that was assumed for the planning of the survey. TB-suspects were less frequently identified in Zanzibar, in females, in younger participants, and in the higher SEP groups.

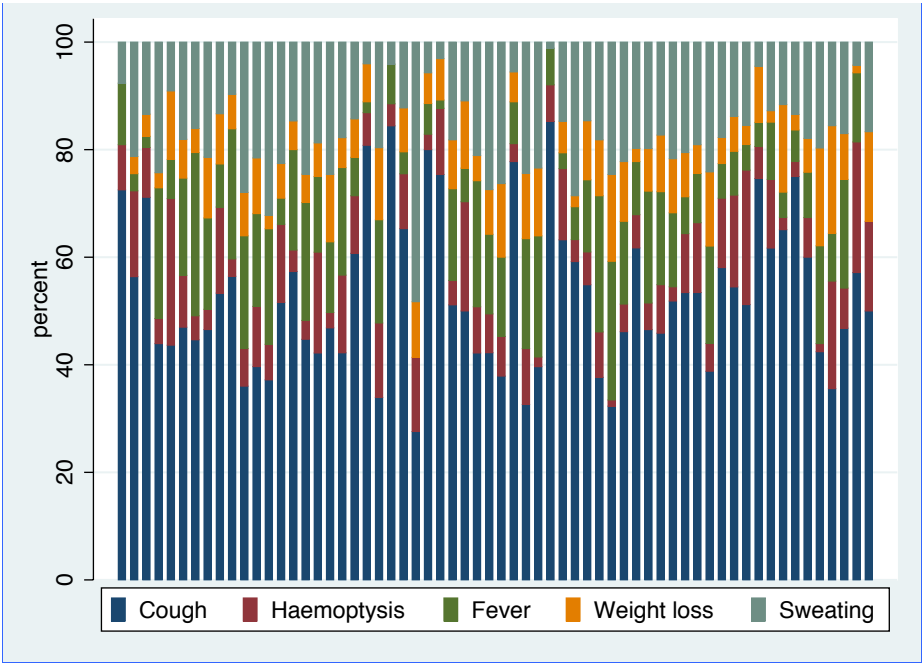


Figure 3: Relative prevalence of symptoms by cluster

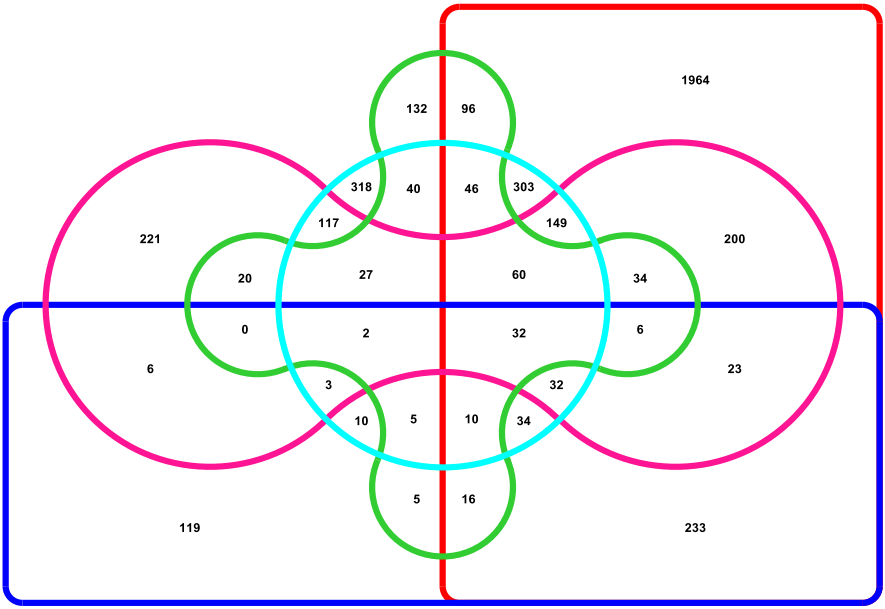


Figure 4: Combination of symptoms reported Red: cough; Blue: haemoptysis; Purple: fever; Green: weight loss; Aqua: sweating.Numbers represent responses of participants with at least 1 symptom. Non-overlapping boxes: symptom not combined with other symptom (e.g 1964 persons report cough without any other symptom [right upper corner], 221 report only fever [left middle]) Overlapping boxes: combination of symptoms (e.g. Of those 3220 who cough [all in red box], 386 also report haemoptysis with or without other symptoms as well [all in red and blue box, regardless of other boxes], while 223 report haemoptysis as the only accompanying symptom [in red and blue box only])

Table 5: TB suspect identification (weighted frequencies)

	Enrolled	Symptom screen		Suspect symptoms		X-ray screen		Suspect X-ray		TB suspect	
	N = 50,447	N	%*	N	%#	N	%*	N	%	N	%
Stratum											
Zanzibar	1,338	1,329	99.3	100	7.5	1,319	98.6	31	2.3	116	8.7
Mainland	49,109	48,413	98.6	4,219	8.7	46,592	94.9	2,705	5.8	6,155	12.5
Urban	7,259	7,079	97.5	498	7.0	7,006	96.5	391	5.6	789	10.9
Semi-urban	11,373	11,163	98.2	959	8.6	11,006	96.8	643	5.8	1,420	12.5
Rural	30,477	30,170	99.0	2,762	9.2	28,580	93.8	1,671	5.8	3,946	12.9
Gender											
Female	28,597	28,212	98.7	2,303	8.2	27,251	95.3	1,226	4.5	3,201	11.2
Male	21,841	21,521	98.5	2,016	9.4	20,651	94.6	1,509	7.3	3,069	14.1
Missing	10	9	93.2	1	8.0	9	91.5	1	8.2	1	7.5
Age group											
15 - 24	15,065	14,847	98.5	713	4.8	14,136	93.8	166	1.2	837	5.6
25 - 34	11,001	10,814	98.3	755	7.0	10,425	94.8	265	2.5	940	8.5
35 - 44	8,922	8,792	98.5	768	8.7	8,539	95.7	395	4.6	1,055	11.8
45 - 55	6,343	6,262	98.7	695	11.1	6,062	95.6	411	6.8	976	15.4
55 - 64	4,356	4,308	98.9	574	13.3	4,203	96.5	503	12.0	933	21.4
65 and older	4,761	4,719	99.1	815	17.3	4,546	95.5	996	21.9	1,529	32.1
SEP											
Low	17,466	17,313	99.1	1,693	9.8	16,458	94.2	1,103	6.7	2,469	14.1
Middle	17,046	16,837	98.8	1,410	8.4	16,155	94.8	846	5.2	2,019	11.8
High	15,935	15,591	97.8	1,216	7.8	15,298	96.0	787	5.1	1,782	11.2

* of those enrolled; # of those screened

Tuberculosis suspects

The group of TB-suspect consisted of 51% females, and almost 25% of participants over 65 years of age (Table 6). Suspects were more often from the lower SEP. Thirty-one percent of the subject did not have any formal education, while almost half of the suspect had primary school as the highest level of education. Just over 0.5% of the suspects had an education beyond secondary school. Excessive alcohol intake and current smoking was not very prevalent among the suspects (16% and 13%, respectively). Just over 15% of the suspect was overweight or obese (BMI >25), while 20% of the TB suspects were undernourished (BMI < 18.5). Of all suspects, 4.8% were tested HIV-positive.

Laboratory

Identified TB suspects should have provided three sputum samples for diagnosis. These consisted of two spot specimens for smear microscopy at the field laboratory, and a morning specimen that was sent untouched to CTRL for smear microscopy and culture. The first spot specimen (at the time of the screening procedures) was provided by 89% of the suspects, while the second spot specimen (the next day on return) was provided

by 80% of the suspects. A morning specimen was received at CTRL for 75.6% of the suspects (Figure 5). Of all identified suspects, 5,668 (90.4%) had at least one smear-result recorded.

The provision of sputum was markedly less in urban areas for each of the three specimens, but especially for the specimens that required a return to the field site the next day (Table 7). Men provided slightly less often sputum, as did the younger participants. If sputum was provided by the suspect, this was in the very large majority three specimens (82%) (Figure 5). The main reason for not providing the first spot specimen was an inability to produce it. An additional reason for not having a second spot specimen was not returning to the field site even after being traced by the survey team. The additional loss of a morning specimen was due to specimens not arriving at CTRL and initial problems with the personal identifiers on the specimen cups, precluding linking the specimen to a survey participant.

Table 6: Characteristics of TB suspects

	TB suspect	
	N = 6, 271	%
Gender		
Female	3,201	51.0
Male	3,069	48.9
Missing	1	0.0
Age group		
15 - 24	837	13.3
25 - 34	940	15.0
35 - 44	1,055	16.8
45 - 55	976	15.6
55 - 64	933	14.9
65 and older	1,529	24.4
SEP		
Low	2,469	39.4
Middle	2,019	32.2
High	1,782	28.4
Marital status		
Married	740	11.8
Separated	3,412	54.4
Widowed	557	8.9
Cohabitating	790	12.6
Never married	36	0.6
Missing	734	11.7
School level		
None	1,964	31.3
Primary	3,022	48.2
Secondary	524	8.4
Higher education	38	0.6
Missing	723	11.5
Alcohol use		
Never	3,521	56.1

Table 6: *Characteristics of TB suspects (Continued).*

	TB suspect	
Sporadic	137	2.2
Monthly	183	2.9
Weekly	706	11.3
Daily	999	15.9
Missing	724	11.5
Current smoking	819	13.1
Missing	720	11.5
Diabetes	59	0.9
Missing	730	11.6
BMI		
< 18.5	1,262	20.1
18.5 - 24.9	3,289	52.4
25 - 29.9	712	11.4
> 30	249	4.0
Missing	758	12.1
HIV-positive	299	4.8
Missing	1,866	29.8

Figure 5: Sputum specimens produced

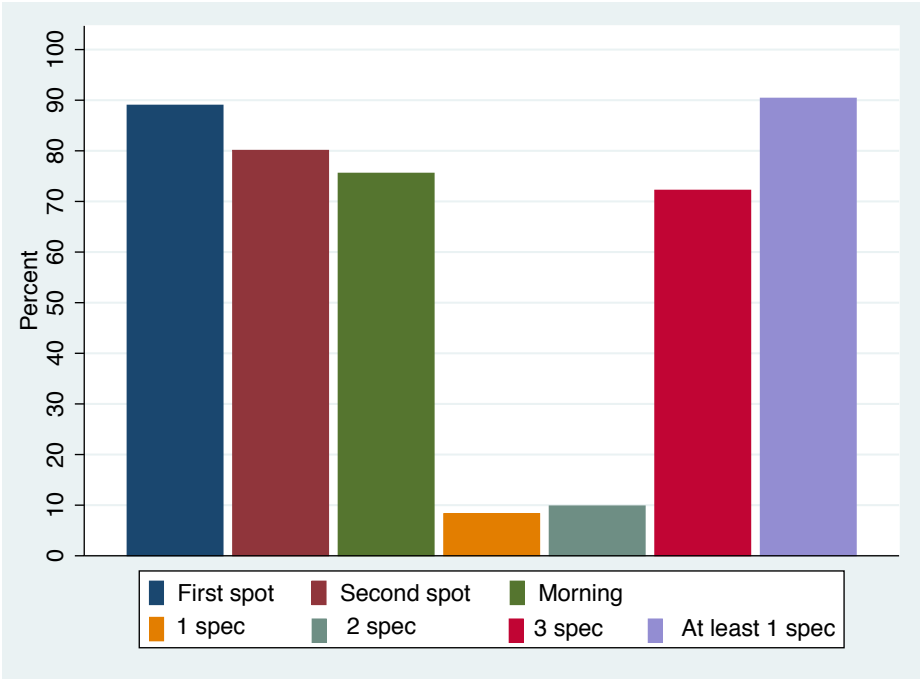


Table 7: Provision and results of sputum specimens

		First spot specimen				Second spot specimen				Morning specimen					
	Suspect	Available		Smear positive		Available		Smear positive		Available		Smear positive		Culture positive	
	N = 6,271	N	%*	N	%#	N	%*	N	%#	N	%*	N	%#	N	%#
Stratum															
Zanzibar	116	107	92.8	0	0.0	98	84.9	0	0.0	92	79.1	0	0.0	2	2.7
Mainland	6155	5474	88.9	96	1.7	4924	80.0	97	2.0	4648	75.5	69	1.5	74	1.6
Urban	789	642	81.4	18	2.8	565	71.7	13	2.4	518	65.7	7	1.3	7	1.3
Semi-urban	1420	1251	88.1	23	1.8	1154	81.3	28	2.5	1076	75.8	17	1.6	13	1.2
Rural	3946	3582	90.8	55	1.5	3204	81.2	55	1.7	3054	77.4	45	1.5	54	1.8
Gender															
Female	3201	2858	89.3	29	1.0	2597	81.1	35	1.3	2439	76.2	30	1.2	35	1.4
Male	3069	2723	88.7	67	2.4	2425	79.0	62	2.6	2300	74.9	39	1.7	42	1.8
Missing	1	1	100.0	0	0.0	0	0.0	97	1.9	1	100.0	0	0.0	0	0.0
Age group															
15 - 24	837	654	78.1	3	0.4	536	64.1	4	0.7	504	60.2	6	1.3	4	0.9
25 - 34	940	806	85.8	22	2.7	708	75.4	21	2.9	644	68.5	13	2.0	15	2.3
35 - 44	1055	938	88.9	26	2.8	839	79.5	23	2.8	784	74.3	12	1.6	11	1.4
45 - 55	976	888	90.9	13	1.5	816	83.5	15	1.8	779	79.8	9	1.2	10	1.3
55 - 64	933	860	92.2	13	1.5	788	84.5	13	1.7	768	82.3	12	1.5	16	2.1
65 and older	1529	1436	93.9	18	1.3	1335	87.3	21	1.6	1260	82.4	17	1.3	20	1.6
SEP															
Low	2469	2242	90.8	39	1.7	2024	82.0	37	1.8	1921	77.8	34	1.8	36	1.9
Middle	2019	1837	91.0	33	1.8	1672	82.8	33	2.0	1591	78.8	23	1.4	26	1.6
High	1782	1503	84.3	24	1.6	1327	74.4	27	2.0	1228	68.9	12	1.0	14	1.2

*of all suspects; # of available specimens

None of the suspects in the two clusters in Zanzibar had a smear-positive sputum specimen (Table 7). In mainland Tanzania, smear-positivity was slightly higher in the semi-urban and urban clusters compared to the rural cluster. Men were more often smear positive than women. Smear positivity was more marked in the young adults (25-44) compared to participants of 45 years and over.

Of all suspects with a valid culture result, 81 (1.7%) had a culture-positive specimen. With the survey weight applied, the frequency was 76 (1.6%) Four of these cultures turned out to be *Mycobacterium Other Than Tuberculosis* (MOTT).

Table 8: Result of morning specimens (unweighted frequencies)•

Smear result		Culture result							
	Suspects	Positive		Negative		Contaminated		Missing	
	N = 6,302	N	%	N	%	N	%	N	%
Positive									
1-9 AFBs	41	31	75.6	8	19.5	2	4.9	0	0.0
1+	21	15	71.4	5	23.8	1	4.8	0	0.0
2+	4	3	75.0	1	25.0	0	0.0	0	0.0
3+	8	4	50.0	4	50.0	0	0.0	0	0.0
Negative	4807	28	0.6	4623	96.2	156	3.2	0	0.0
Missing	1421	0	0.0	1	0.1	0	0.0	1420	100

* excluding the four specimens positive for MOTT

Of all received morning specimens at CTRL, 4,807 (98.5%) were smear negative. Of the smear-positive morning specimens, 40 (54.1%) were scanty (1-9 AFBs), while 12 (16.2%) were 2+ or 3+ positive. Culture positivity was between 70 and 75% for specimens being scanty, 1+ or 2+ smear-positive. This is in contrast to 50% culture positivity for specimens 3+ on smear examination. The contamination rate was 3.3% (Table 8).

Identified TB cases

The weighted frequency of suspects being identified as a definite TB case was 73 (1.2%, while 111 (1.8%) suspect were identified as a survey case. The NTLP definition of smear-positivity identified 100 (1.6%) of the suspects as being a case. The corresponding frequency for bacteriological confirmed TB was 149 (2.4%) (Table 9).

There was no major difference between rural and urban areas in the percentage of suspects that were identified as a TB case. Male suspects were more likely to be a TB case regardless of definition used. The male:female ratio for definite cases was 1.4 and for survey cases 1.6. With the NTLP definitions the ratio was 2.2 for smear-positive, and 1.6 for bacteriological confirmed TB. There was a clear gradient in any TB case definition with respect to SEP. Suspects from the lower SEP were more likely to be a TB case compared to suspects form the middle or high SEP stratum.

Comparing subgroups within the different types of TB cases needs to be done with caution given the small numbers. We therefore focus on survey cases and bacteriological confirmed cases. The group of TB cases identified consisted for 60% of men, and 40% of case over 55 years of age (Table 10). Almost 45% of the identified TB cases derived from households with the lowest SEP. More than 80% of the TB cases had primary education as the highest level of schooling attained. Smoking, problematic alcohol intake, and diabetes were not very prevalent among the identified TB cases. Around 12% of the TB cases were retreatment cases and/or current receiving TB treatment. HIV-positivity was recorded for 6.3% of the survey cases and 5.9% of the bacteriologically confirmed cases.

Table 9: Identified TB cases by suspects screened (weighted frequencies)

	Suspects	Definite		Probable		Survey		Smear positive		Bact. confirmed	
	N = 6,271	N = 73	%	N = 38	%	N = 111	%	N = 100	%	N = 149	%
Stratum											
Zanzibar	116	2	1.4	0	0.0	2	1.4	0	0.0	2	1.4
Mainland	6155	72	1.2	38	0.6	109	1.8	100	1.6	147	2.4
Urban	789	7	0.9	7	0.9	14	1.7	18	2.2	20	2.6
Semi-urban	1420	13	0.9	9	0.6	22	1.6	23	1.6	30	2.1
Rural	3946	52	1.3	22	0.6	73	1.9	59	1.5	96	2.4
Gender											
Female	3201	31	1.0	13	0.4	44	1.4	32	1.0	59	1.8
Male	3069	42	1.4	25	0.8	66	2.2	67	2.2	90	2.9
Missing	1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Age group											
15 - 24	837	4	0.5	1	0.1	5	0.7	4	0.5	6	0.8
25 - 34	940	14	1.5	12	1.3	26	2.8	23	2.4	33	3.5
35 - 44	1055	11	1.0	9	0.9	20	1.9	25	2.4	29	2.7
45 - 55	976	9	1.0	2	0.3	12	1.2	13	1.3	17	1.7
55 - 64	933	15	1.6	8	0.9	24	2.5	16	1.7	29	3.1
65 and older	1529	19	1.3	5	0.3	24	1.6	19	1.2	35	2.3
SEP											
Low	2469	35	1.4	16	0.7	51	2.1	41	1.7	65	2.6
Middle	2019	24	1.2	12	0.6	36	1.8	33	1.6	48	2.4
High	1782	14	0.8	9	0.5	24	1.3	26	1.5	36	2.0

Definite: culture positive regardless of smear; Probable: culture negative, at least 1 smear-positive with CXR suspected for TB; Survey: definite + probable; Smear positive: at least 2 smear positive or 1 smear positive with CXR suspected for TB; bact confirmed: smear-positive + any culture positive.

Table 10: Characteristics TB cases (weighted frequencies)

	Definite		Probable		Survey		Smear positive		Bact. confirmed	
	N = 73	%	N = 38	%	N = 111	%	N = 100	%	N = 149	%
Gender										
Female	31	43.0	13	34.4	44	40.1	32	32.4	59	39.8
Male	42	57.0	25	65.6	66	59.9	67	67.6	90	60.2
Age group										
15 - 24	4	6.1	1	2.6	5	4.9	4	4.0	6	4.2
25 - 34	14	19.0	12	32.6	26	23.6	23	22.8	33	22.4
35 - 44	11	14.6	9	24.6	20	18.0	25	25.4	29	19.3
45 - 55	9	12.9	2	6.6	12	10.8	13	13.2	17	11.1
55 - 64	15	21.0	8	21.8	24	21.3	16	16.0	29	19.7
65 and older	19	26.3	5	11.9	24	21.4	19	18.6	35	23.2
SEP										
Low	35	47.2	16	42.7	51	45.7	41	40.9	65	43.9
Middle	24	33.2	12	32.4	36	32.9	33	32.6	48	32.0
High	14	19.6	9	25.0	24	21.5	26	26.5	36	24.1
Marital status										
Married	12	16.2	8	20.5	20	17.7	20	20.1	25	16.7
Separated	43	58.8	17	44.1	60	53.8	50	50.3	82	55.4
Widowed	9	12.0	6	16.3	15	13.5	12	11.8	17	11.4
Cohabitating	3	4.5	3	9.0	7	6.0	11	11.1	14	9.2
Never married	1	1.2	1	2.2	2	1.6	1	0.8	2	1.2
Missing	5	7.2	3	7.9	8	7.5	6	5.8	9	6.2
School level										
None	31	41.7	12	30.8	42	38.0	29	29.6	54	36.1
Primary	33	45.3	21	54.3	54	48.3	59	58.7	78	52.3
Secondary	3	4.2	4	10.3	7	6.3	7	7.2	8	5.4
Higher education	1	1.5	0	0.0	1	1.0	0	0.0	1	0.8
Missing	5	7.2	2	4.7	7	6.4	5	4.5	8	5.4
Alcohol use										
Never	41	56.3	25	67.4	67	60.1	56	56.0	86	58.0
Sporadic	2	3.0	1	3.2	3	3.1	5	4.7	6	3.8
Monthly	1	1.2	2	4.3	2	2.2	5	4.7	5	3.2
Weekly	8	11.4	4	11.7	13	11.5	13	12.8	17	11.5
Daily	15	20.9	3	8.7	19	16.7	17	17.2	27	18.2
Missing	5	7.2	2	4.7	7	6.4	5	4.5	8	5.4
Current smoking	12	16.6	3	8.7	15	13.9	12	12.0	20	13.2
Missing	5	7.2	2	4.7	7	6.4	5	4.5	8	5.4
Diabetes	3	3.6	0	0.0	3	2.4	3	3.5	3	2.3
Missing	7	9.7	2	4.7	9	8.0	5	4.5	10	6.6
BMI										
< 18.5	21	28.6	16	42.0	37	33.2	45	45.0	51	34.4
18.5 - 24.9	38	51.6	20	53.3	58	52.2	44	44.4	74	50.0
25 - 29.9	6	7.8	0	0.0	6	5.2	5	4.6	10	6.9
> 30	3	3.6	0	0.0	3	2.4	1	1.5	4	2.8
Missing	6	8.4	2	4.7	8	7.1	5	4.5	9	5.9
HIV-positive	4	6.0	3	7.0	7	6.3	7	7.0	9	5.9
Missing	11	14.7	12	32.8	23	20.9	26	25.8	34	23.0
Had TB before	2	3.3	5	13.9	8	6.9	8	8.1	9	5.9
Missing	1	1.5	0	0.0	1	1.0	1	1.1	1	0.7
Current TB treatment	3	3.6	2	6.4	5	4.6	8	8.0	8	5.3
Missing	1	1.5	0	0.0	1	1.0	1	1.1	1	0.7

Definite: culture positive regardless of smear; Probable: culture negative, at least 1 smear-positive with CXR suspected for TB; Survey: definite + probable; Smear positive: at least 2 smear positive or 1 smear positive with CXR suspected for TB; bact confirmed: smear-positive + any culture positive.

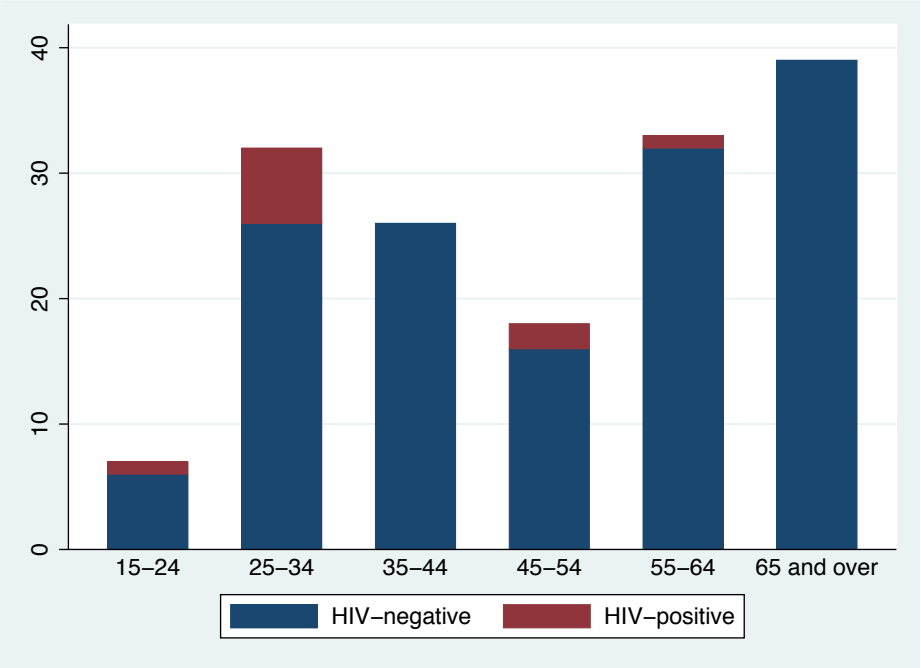


Figure 6: Distribution by age of 155 bacteriological confirmed prevalent TB cases (unweighted frequencies)

The group of bacteriological confirmed TB cases showed a peak in the age group 25-34, where also the majority of HIV-positive TB cases were identified. The number of cases decreased until the age of 55, with the majority of case being in the group of 65 years and over. HIV-positivity was mainly seen in the younger age groups.

Figure 7 depict the screening results of the identified bacteriological confirmed TB cases (n = 155), stratified by HIV status. Just 54% if the HIV-negative cases reported a cough for more than 2 weeks, while this was 70% in the HIV-positive TB cases. Reporting the presence of any of the screening symptoms was done by 63% of the HIV-negative TB cases and 70% of the HIV-positive TB cases. An abnormal screening CXR was seen in 73% of the HIV-negative TB cases and 80% of the HIV-positive TB cases.

Tuberculosis prevalence in adult population

The TB prevalence using different definitions is reported in Table 11. The crude estimate is based on the actual numbers seen, while the weighted estimate is corrected for sampling error and attrition. The weighted prevalence of definite TB is 145 /100,000 population, with a 95% confidence interval (CI) of 98-192/100,000. The relative precision of this estimate is 32,4%, due to the lower than expected number of TB cases identified. Combined with the probable TB cases, the weighted prevalence of survey cases of TB is 220/100,000, with a 95% CI of 165-275/100,000 and a relative precision of 25%. The prevalence by different definitions and estimation methods is depicted in Figure 8.

Figure 7: Screening results of 155 bacteriological confirmed prevalent TB cases (unweighted frequencies)

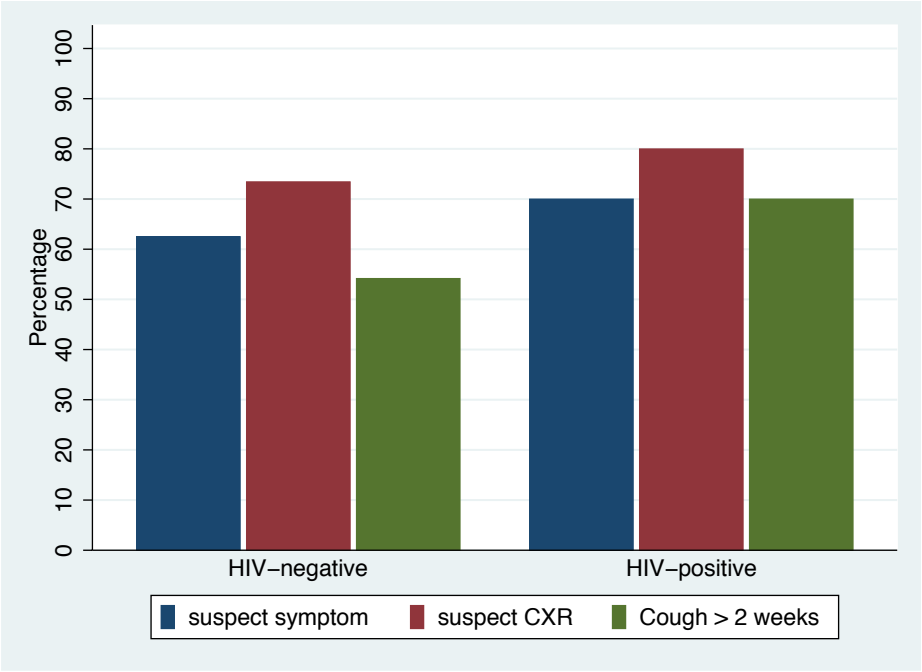


Table 11: TB prevalence per 100,000 adult population

	Crude		Weighted		Imputed	
	estimate	95%CI	estimate	95%CI	estimate	95%CI
Survey definition						
Definite	153	120 - 191	145	98 - 192	164	113 - 214
Probable	81	58 – 110	75	46 - 104	72	43 - 100
Survey	234	194 - 280	220	165 - 275	236	177 - 294
NTLP definition						
Smear positive	200	163 - 243	198	150 - 245	210	158 - 262
Bacteriological confirmed	307	261 - 360	295	229 - 360	316	245 - 387

Definite: culture positive regardless of smear; Probable: culture negative, at least 1 smear-positive with CXR suspected for TB; Survey: definite + probable; Smear positive: at least 2 smear positive or 1 smear positive with CXR suspected for TB; bact confirmed: smear-positive + any culture positive

The primary objective of the NTLP was to assess the prevalence of bacteriological confirmed TB in the adult population. Using the NTLP definition, the weighted prevalence was 295 per 100,000 adult population (95% CI: 229 – 360). Prevalence of bacteriological confirmed TB marked differently by cluster. Each stratum except Zanzibar, had at least one cluster with a prevalence above 750/100.000 (Figure 9).

To accommodate missing data in key laboratory and CXR parameters used for defining the outcome, we performed missing imputation analyses (see methods section). The point estimates for the prevalence did not differ more than 7.5% compared to the weighted estimate for the NTLP definition used, or for the estimate of the survey cases. The 95% CIs are slightly larger, because imputation analyses have to incorporate additional uncertainly for estimates based on imputed values.

As with TB cases identified, comparison of prevalence of TB within subgroups should be done with caution given the power of the survey resulting in very large confidence intervals. We restrict ourselves therefore to the definitions of survey cases and bacteriological confirmed cases. TB prevalence was marked higher in mainland Tanzania compared to Zanzibar (Table 12). TB prevalence was highest in the rural clusters although differences with urban and semi-urban clusters were moderate. TB prevalence was twice as high in men as compared to women, while older age groups showed a higher TB prevalence compared to younger age groups. There was a clear negative correlation between SEP and TB prevalence.

Table 12: TB prevalence by sub-groups (weighted analysis)

	Survey		Bact. confirmed	
	Estimate	95% CI	Estimate	95% CI
Stratum				
Zanzibar	124	122 - 126	124	122 - 126
Mainland	222	166 - 279	300	232- 367
Urban	189	67 - 311	279	114 - 443
Semi-urban	195	88 - 303	267	146 - 389
Rural	241	165 - 316	316	226 - 406
Gender				
Female	156	97 - 214	207	138 - 275
Male	304	219 - 389	410	315 - 505
Age group				
15 - 24	36	7 - 65	42	11 - 73
25 - 34	238	136 - 341	303	183 - 424
35 - 44	224	126 - 322	323	190 - 456
45 - 55	188	77 - 299	260	136 - 385
55 - 64	541	298 - 786	673	403 - 943
65 and older	498	284 - 712	725	461 - 989
SEP				
Low	290	195 - 385	445	307 - 583
Middle	214	138 - 290	342	233 - 452
High	149	71 - 227	268	151 – 384

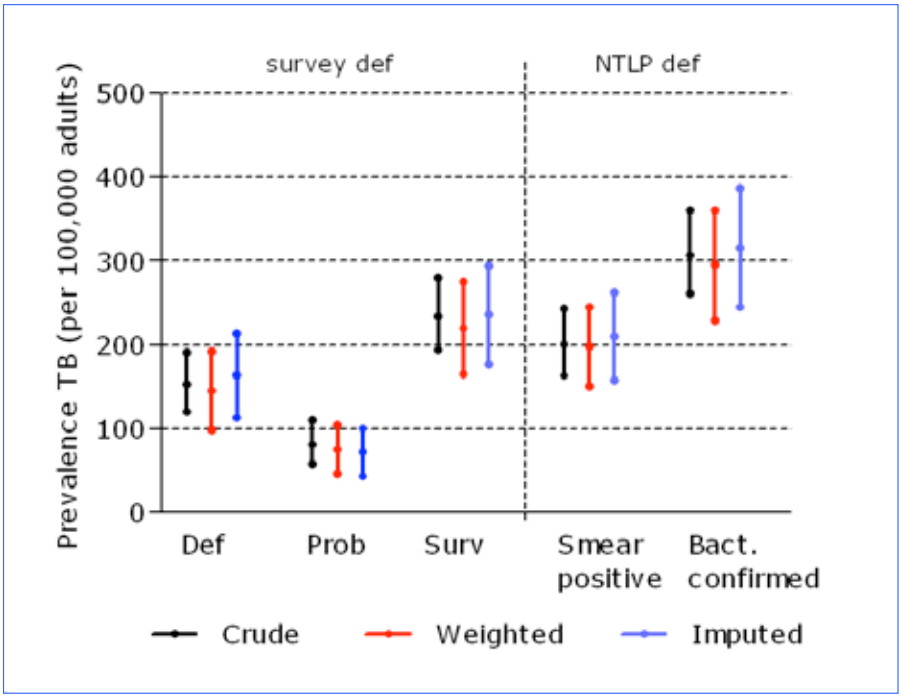


Figure 8: TB prevalence in the adult population

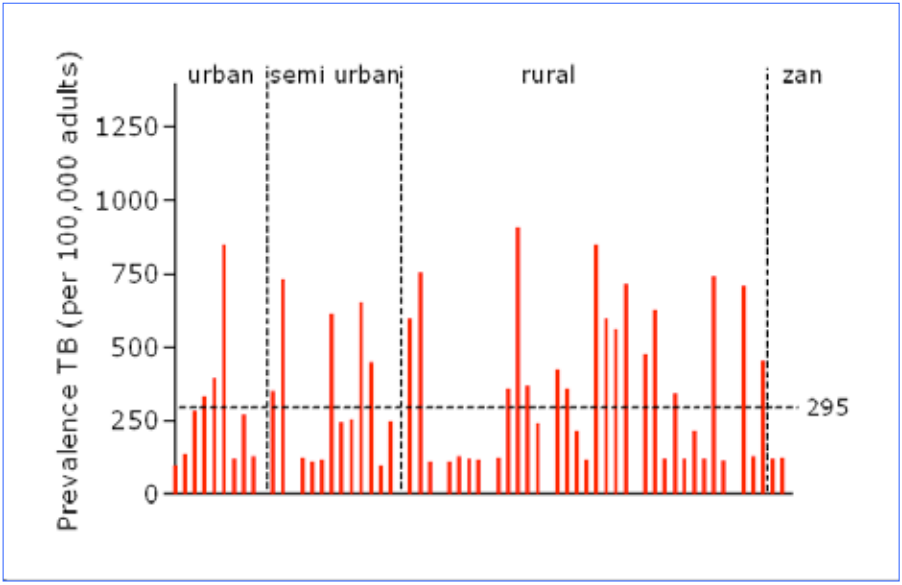


Figure 9: Bacteriological confirmed TB (weighted analysis); 295 is mean estimate per 100,000 in adult population

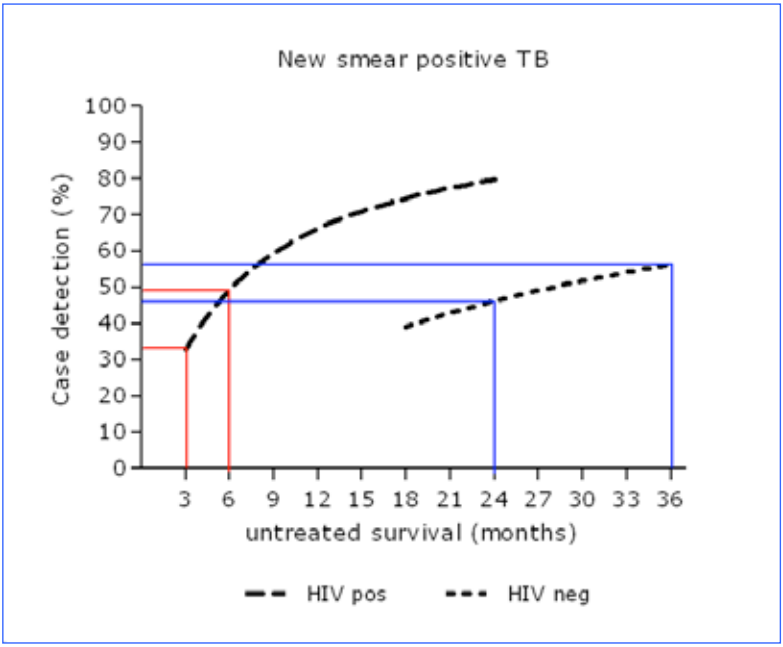
Case detection

The current survey provides a valid estimate of the prevalence and is therefore adequately placed for assessing the CDR through this the PDR approach as described in the Methods section.

The number of new smear-positive cases notified to the NTLP in 2012 was 25,138. Of these, 490 were in individuals below the age of 15, leaving 24,648 new smear-positive patients notified in the adult population. According to the United Nations, the total populating of Tanzania was 44,816,000 of which 55% were 15 years or older. Combing these two estimates, the case notification of new smear-positive adult patients was 100 per 100,000 adult population. The unweighted frequency of smear-positive TB cases was 101, of which 12 had a previous diagnosis of TB or were currently on TB treatment, leaving 89 new smear-positive cases detected.

Using a range for the assumptions on survival of undetected and untreated TB cases by HIV status provides a CDR for HIV-positive patients between 32% (3 months survival) and 49% (6 months survival), and a CDR of 46% (2 years survival) and 56% (3 years survival) for HIV-negative patients (Figure 10). A weighted average based on prevalence of HIV-positivity in notified new smear-positive TB patients (31%) estimates an overall CDR between 42% and 54%.

Figure 10: Case detection of new smear-positive TB patients



Discussion

The primary objective of the First National Tuberculosis Prevalence Survey of the United Republic of Tanzania was to assess the prevalence of bacteriological confirmed pulmonary tuberculosis in the country in a representative sample. The results show that this burden is 295 per 100,000. Although the survey was not designed to provide cluster-specific estimates of TB-prevalence, it was shown that there were clusters that showed a considerable higher prevalence. The estimated prevalence of smear-positive TB was 198 per 100,000 adult population. The detection of new smear-positive patients was estimated to be between 42% and 54% only. These prevalence estimates are higher than expected before the survey and consequently, the case detection is markedly lower than documented in the yearly WHO report. In this report, the case detection for all TB cases in the total population including children was 77% in 2012 [12].

A case detection below 50% is not new for Tanzania. Up to 2007, this was reported on a yearly basis for all forms of TB. The case detection was adjusted upwards after a re-assessment of TB-control activities in the country through in-depth interviews with programme staff and review of routine data. It is well possible that this adjustment was somehow over-enthusiastic and the resulting re-assessment of the estimates for TB-incidence (as a basis for the WHO case detection estimate) too generous. The current case detection estimate is based on the Patient Diagnostic Rate which has the actually measured prevalence as a denominator rather than the un-measurable incidence. This approach makes it possible to incorporate a stratified assessment of case detection by HIV status and a range of assumptions on survival. With a consistent case notification system in place (which was seen as one of the strong points during the 2008 assessment), both numerator and denominator for the Patient Diagnostic Rate as a basis for a case detection estimate are actually measured. As such the reported 42-54% case detection of new smear-positive cases in this report is a valid estimate. Routine case detection is passive in the sense that individuals with symptoms need to feel the need and have the means to visit a health facility, after which the health system needs to undertake appropriate diagnostic activities. In the survey, these individuals were actively traced. An unknown part of the identified prevalent TB cases might have been identified by the NTLP at a later stage.

In the routine setting, the HIV-negative individuals are screened for TB by asking only about the presence of cough for more than 2 weeks. For HIV-positive individuals, the screening consists of the same questionnaire as used in the survey. Just over 50% of the HIV-negative identified TB cases reported cough, while 70% of the HIV-positive identified TB cases reported at least one symptom. Symptom screening without additional CXR seems therefore inadequate. These findings fit with the results from studies that could formally assess the sensitivity of screening tools. A large individual-data meta-analysis

in HIV-positive individuals showed a superior sensitivity of a the symptom questionnaire containing all 5 questions over any other combination [13]. Although the sensitivity was higher in the clinical setting as compared to the survey setting, it did not exceed 80%. A study in Zambia showed that the sensitivity of any screening tool differed by HIV-status [14]. The findings of the present survey questions the TB-screening strategy currently in use in Tanzania, especially when HIV status is not known at presentation and therefore the screening is restricted to cough without additional CXR.

When TB suspects are identified, there needs to be an appropriate diagnostic procedure in place. In the routine setting in Tanzania, the diagnosis of TB relies on smear microscopy. The conduct of smear microscopy in the peripheral laboratories has been shown to be of inadequate standard in several studies [15, 16]. As expected, this refers mainly to false-negative results leading to missing of patients. Low-grade smear-positivity is associated with HIV.

An inefficient screening procedure combined with sub-optimal diagnostic procedures paves the way for marked under-detection of TB patients. Anecdotal evidence suggests a decrease in frequency and intensity of the supportive supervision of the peripheral health system. Without corrective measures is seems unlikely that case detection will improve.

A striking finding of the survey was that 54% of the identified bacteriological confirmed TB cases was 45 years or older. This points in the direction that prevalent TB is largely driven by progression from a much earlier acquisition of a latent infection. In a setting with marked active transmission, TB will mainly be seen in younger population. In contrast, among notified TB cases in 2012, just 27% was 45 years or older, making the populations of prevalent and notified TB cases rather different. Reasons for this can be many, including differences in health seeking behaviour between younger and older individuals with symptoms, or differences in level of suspicion by health staff between these populations. The latter will lead to differential clinical work-up with a biased identified population as a result. It is very well possible that the strong influence of HIV on the TB-epidemiology in Tanzania has led to over-emphasis of case finding in this population with a general negligence of the elderly HIV-negative TB patient. This finding shows that the NTLP of Tanzania is able to address the burden of TB in the country as it has done in the past, but that there is need to redefine the strategies based on the changing epidemic.

The survey was conducted with a high standard without major or systematic deviations from the survey protocol and SOPs. Internal monitoring of the activities took place as an on-going activity, performed by team leaders, the survey coordinators, and the heads of the departments. External monitoring took place at key points during the implementation of the survey by both the Technical Consultant of KNCV Tuberculosis Foundation, and a

delegation of the WHO Task Force on Impact Measurements. Apart from logistic advice, all three monitoring reports applaud the high quality of implementation of all survey activities.

The results of the survey are in line with general TB-epidemiology which supports the validity of the findings. These include the proportion of participants identified as suspects, and the higher prevalence in males and individuals from the lower SEPs. The observation that the weighted and unweighted estimates (taking into account sampling variation and non-participation) are rather close, points towards the absence of major selection bias. The similarities between the weighted analysis and the analysis after imputation missing data, points towards the absence of major ascertainment bias.

The main limitation of the survey is the amount of missing data for the second spot specimen for smear microscopy at the field site, and the morning specimen for culture at CTRL. There can be several reasons for these missing data. The screening algorithm was designed to identify as many as possible suspects for further assessment. This resulted in suspects with just minor complaints, the absence of cough, and an inability to produce sputum. A second reason is a considerable amount of default from procedures by suspects who did not come back the next day for the second spot specimen and the morning specimen. Although there was a default-tracing strategy in place in which community health worker revisited the household to persuade continuous participation, this strategy was not very effective. Suspect were very unwilling to return once they had decided to default. A final reason for missing data is purely administrative. Survey forms were simply misplaced and could not be traced, while the registration of personal identifiers on forms and specimens did not always match.

With only a single specimen submitted to CTRL for culture makes that results from the field laboratories were an integral part in the TB diagnosis. With the marked number of TB suspects not having a result from CTRL makes that potential diagnostic errors in the field could not be corrected. However, the field laboratory was staffed by experienced technicians from CTRL itself. All positive slides and a selection of negative slides at CTRL were re-read by independent technicians. This did not identify major discrepancies. With smear-microscopy being less sensitive than sputum culture, the results can be seen as a conservative estimate. TB diagnosis in community surveys have to take the effect of potential MOTT into account. For that reason, smear-positive TB cases needed to have at least an additional sign of TB, being a positive culture, an second smear-positive specimen, or a diagnostic CXR suggestive of TB. In this way we reduced the potential effect of smear-positivity solely due to MOTT infection to a minimum.

To account for missing data, we performed imputation analyses in which as much as possible clinical information was used to predict the laboratory status for suspects without all three sputum specimens. The used models all converged and provided

valid estimates. These models assume that the true value of these missing data can be implied from the observed data available for analysis ("missing at random"). If there are reasons for not returning to the field site are related to a lower probability of having TB compared to the probability for those suspects who did return, then these models overestimate the prevalence of TB. We tried to keep this effect as small as possible by including symptoms and CXR findings from the screening in the predictions. The similarities between the crude, the weighted and the imputed analyses indicate that there was no marked selection or ascertainment bias in the survey, underlining the validity of the results.

Conclusions

The prevalence of bacteriological confirmed TB in The United Republic of Tanzania is high. Case finding by the NTLP is low and needs urgent attention. The large proportion of elderly prevalent TB cases points towards a historic positive effect of NTLP control strategies but differences with the notified TB cases makes that the NTLP needs to re assess its screening and diagnostic strategies. The strong emphasis of the NTLP on TB/HIV activities might have taken the attention away from a large unidentified population of elderly HIV-negative TB patients.

Recommendations

From the results and the discussion the following recommendations can be formulated

1) The Ministry and NTLP should intensify TB control activities in order to improve case detection. This can be achieved by
   a) creating awareness in the community to seek care
   b) improving diagnostic procedures at the health facilities

2) Screening algorithms for TB should be re-assessed
   a) Implementing multiple symptom screening for all (not only HIV-positive patients)
   b) Assessing the possibility to include CXR.

3) Supportive supervision should be strengthened regarding
   a) Identification of TB-suspects for further clinical assessment
   b) Smear microscopy
   c) Diagnostic capacity

4) The quality and completeness of the notification system should be assessed
5) The NTLP should perform in-depth analyses of health seeking behaviour by suspects identified in the survey

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Appendix 1: Steering Committee members

Dr Peter Mbuji – Acting Director Preventive Services, MoHSW (chair)

Dr Blasdus F. Njako – Acting Programme Manager, NTLP

Dr Said M. Egwaga – Principal Investigator, NTLP

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Dr Deusdedit V. Kamara – Survey coordinator, NTLP

Dr Senkoro Mbazi – Assistant Survey Coordinator, NIMR Muhimbili Center

Dr Neema G. Simkoko – National Programme Officer TB, World Health Organization

Dr Nyangosa S. Range – Principal Research Scientist, NIMR Muhimbili Center

Dr Lulu Fundikira, MUHAS

Dr Ramadhan Kazema, MUHAS

Mrs Basra Doulla, CTRL

Mr Timothy Chonde, PATH

Dr Zahra Mkomwa, PATH

Dr Amos Kahwa, NIMR

Mr Eunice Bandio – Senior Radiographer, MoHSW

Mr Raymond P. Shirima - Data Analyst, NTLP

Ms Catherine J. Semkudi, MoHSW

Dr Fredi Lwila, NTLP/Ifakara Health Institute

Mr Athumani J. Msuya - Senior Cartographer - NBS

Dr Johnson Lyimo , NTLP

Dr Lugora Mtandu, NTLP

Ms Ntuli Mwaikusya , NIMR (secretary)

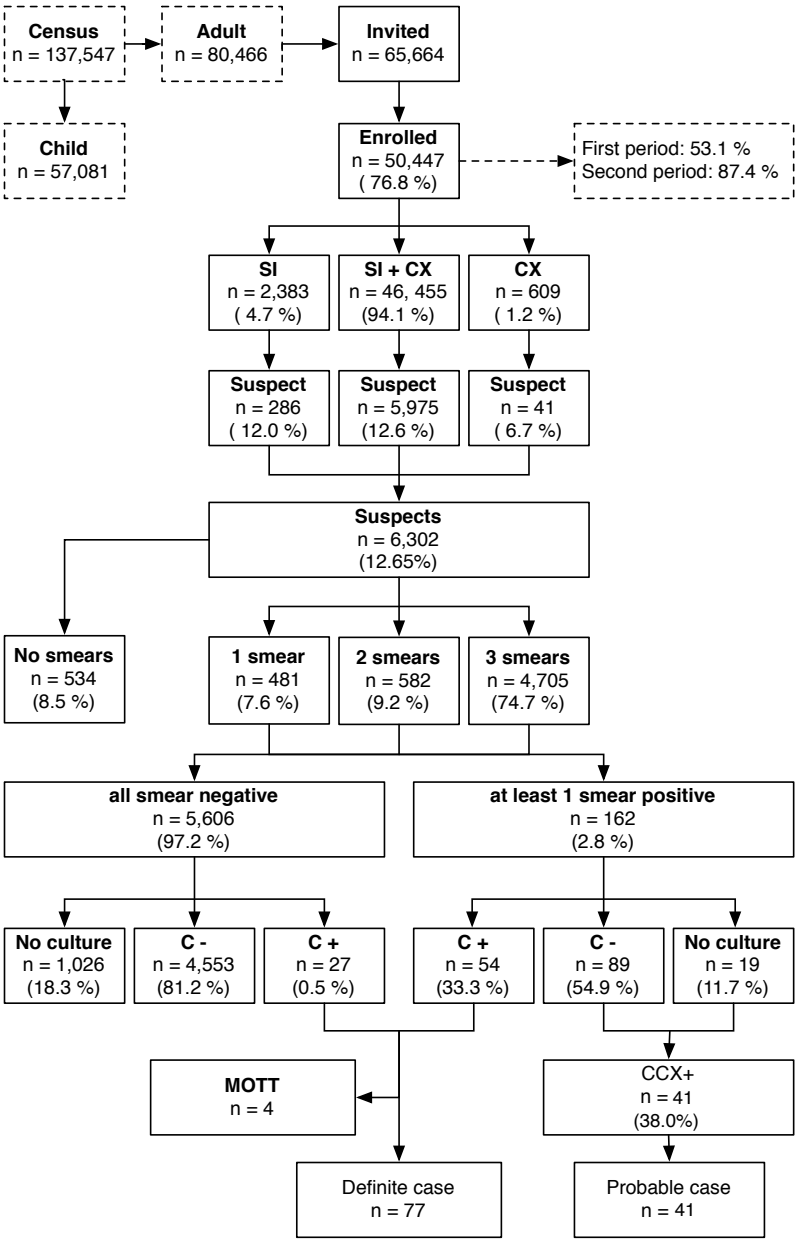
Appendix 2: Survey weights

Cluster			Stratum weight			Attrition weight			Survey weight		
SN	Name	Setting	Median	p25	p75	Median	p25	p75	Median	p25	p75
1	Chiungutwa	Semi urban	347.699	347.699	347.699	1.036	1.013	1.076	0.758	0.742	0.788
2	Itezi		347.699	347.699	347.699	1.052	1.041	1.095	0.770	0.762	0.802
3	Itumba		347.699	347.699	347.699	1.062	1.043	1.076	0.777	0.764	0.788
4	Kasamwa		347.699	347.699	347.699	1.080	1.067	1.161	0.790	0.781	0.850
5	Kimnyaki		347.699	347.699	347.699	1.811	1.686	2.034	1.326	1.235	1.489
6	Kivinje Singino		347.699	347.699	347.699	1.021	1.011	1.040	0.747	0.740	0.761
7	Kiwalala		347.699	347.699	347.699	1.038	1.024	1.077	0.760	0.750	0.788
8	Maramba		347.699	347.699	347.699	1.627	1.384	2.073	1.191	1.013	1.518
9	Masama Rundugai		347.699	347.699	347.699	1.516	1.319	1.596	1.110	0.966	1.169
10	Misasi		347.699	347.699	347.699	1.009	1.002	1.016	0.739	0.733	0.744
11	Mvomero		347.699	347.699	347.699	1.713	1.451	1.974	1.254	1.062	1.445
12	Orgosorok		347.699	347.699	347.699	1.454	1.303	1.649	1.064	0.954	1.207
13	Ruvuma		347.699	347.699	347.699	1.010	1.004	1.018	0.739	0.735	0.745
14	Tumbi		347.699	347.699	347.699	1.688	1.588	1.836	1.236	1.162	1.344
15	Bambi	Zanzibar	389.852	389.852	389.852	1.026	1.016	1.052	0.842	0.834	0.863
16	Mfenesini		389.852	389.852	389.852	1.006	1.003	1.018	0.826	0.824	0.836
17	Bangata	Rural	395.807	395.807	395.807	1.920	1.444	2.147	1.600	1.203	1.789
18	Bukondo		395.807	395.807	395.807	1.046	1.018	1.077	0.872	0.848	0.898
19	Bumera		395.807	395.807	395.807	1.007	1.005	1.021	0.840	0.837	0.851
20	BunyamboW		395.807	395.807	395.807	1.086	1.059	1.153	0.905	0.882	0.961
21	Chikola		395.807	395.807	395.807	1.092	1.045	1.140	0.910	0.871	0.950
22	Gisambalang		395.807	395.807	395.807	1.537	1.400	1.820	1.280	1.167	1.517
23	Goima		395.807	395.807	395.807	1.098	1.040	1.159	0.915	0.867	0.966
24	Ibiri		395.807	395.807	395.807	1.194	1.125	1.278	0.995	0.938	1.065
25	Ibuga		395.807	395.807	395.807	1.256	1.161	1.439	1.047	0.967	1.199
26	Ikama-Kalakala		395.807	395.807	395.807	1.031	1.020	1.050	0.859	0.850	0.875
27	Iwela		395.807	395.807	395.807	1.027	1.012	1.056	0.856	0.843	0.880
28	Kinamapula		395.807	395.807	395.807	1.024	1.012	1.051	0.853	0.843	0.876
29	Kiruruma		395.807	395.807	395.807	1.235	1.166	1.347	1.029	0.971	1.123
30	Kisesa		395.807	395.807	395.807	1.006	1.004	1.009	0.838	0.836	0.841
31	Kisumwa		395.807	395.807	395.807	1.248	1.127	1.308	1.040	0.939	1.090

Cluster			Stratum			Attrition			Survey		
SN	Name	Setting	Median	P25	P75	Median	P25	P75	Median	P25	P75
32	Lugata	Rural	395.807	395.807	395.807	1.020	1.012	1.051	0.850	0.844	0.876
33	Madibira		395.807	395.807	395.807	1.032	1.013	1.059	0.860	0.844	0.883
34	Maghang		395.807	395.807	395.807	1.687	1.533	1.952	1.406	1.277	1.627
35	Mcheshi		395.807	395.807	395.807	1.016	1.010	1.023	0.847	0.841	0.853
36	Mcholi II		395.807	395.807	395.807	1.067	1.049	1.074	0.889	0.874	0.895
37	Mogwa		395.807	395.807	395.807	1.019	1.012	1.025	0.849	0.844	0.855
38	Murutunguru		395.807	395.807	395.807	1.026	1.016	1.047	0.855	0.847	0.873
39	Mwabomba		395.807	395.807	395.807	1.143	1.128	1.295	0.953	0.940	1.079
40	Mwaru		395.807	395.807	395.807	1.009	1.000	1.016	0.841	0.833	0.847
41	Mzumbe		395.807	395.807	395.807	1.730	1.498	1.851	1.441	1.248	1.542
42	Nangaru		395.807	395.807	395.807	1.023	1.014	1.035	0.852	0.845	0.863
43	Ndongosi		395.807	395.807	395.807	1.014	1.010	1.022	0.845	0.842	0.852
44	Nhundulu		395.807	395.807	395.807	1.043	1.023	1.071	0.869	0.852	0.892
45	Ntwike		395.807	395.807	395.807	1.006	1.005	1.024	0.839	0.837	0.853
46	Potwe		395.807	395.807	395.807	1.402	1.257	1.672	1.168	1.048	1.394
47	Rusaba		395.807	395.807	395.807	1.120	1.067	1.205	0.933	0.889	1.004
48	Santilya		395.807	395.807	395.807	1.019	1.007	1.050	0.849	0.839	0.875
49	Sekebugoro		395.807	395.807	395.807	1.030	1.018	1.064	0.858	0.849	0.887
50	Somangira		395.807	395.807	395.807	1.897	1.492	2.158	1.581	1.243	1.798
51	Sunuka		395.807	395.807	395.807	1.064	1.049	1.094	0.887	0.874	0.912
52	Ukwega		395.807	395.807	395.807	1.160	1.110	1.247	0.967	0.925	1.039
53	Ziba		395.807	395.807	395.807	1.027	1.017	1.039	0.855	0.848	0.865
54	Ilembo	Urban	314.768	314.768	314.768	1.014	1.006	1.022	0.672	0.667	0.677
55	Kasimbu		314.768	314.768	314.768	1.185	1.000	1.262	0.786	0.663	0.836
56	Kijitonyama		314.768	314.768	314.768	2.104	1.610	2.403	1.395	1.067	1.592
57	Magomeni		314.768	314.768	314.768	2.235	1.907	2.487	1.481	1.264	1.648
58	Mbugani		314.768	314.768	314.768	1.347	1.310	1.565	0.893	0.868	1.037
59	Miburani		314.768	314.768	314.768	2.393	1.727	3.145	1.586	1.144	2.084
60	Mughanga		314.768	314.768	314.768	1.066	1.031	1.102	0.707	0.683	0.730
61	Mwandet		314.768	314.768	314.768	1.616	1.529	1.815	1.071	1.013	1.203
62	Upanga E		314.768	314.768	314.768	3.802	3.397	4.606	2.519	2.251	3.052

Appendix 3: Flow chart survey activities and findings (unweighted frequencies)

(unweighted frequencies)

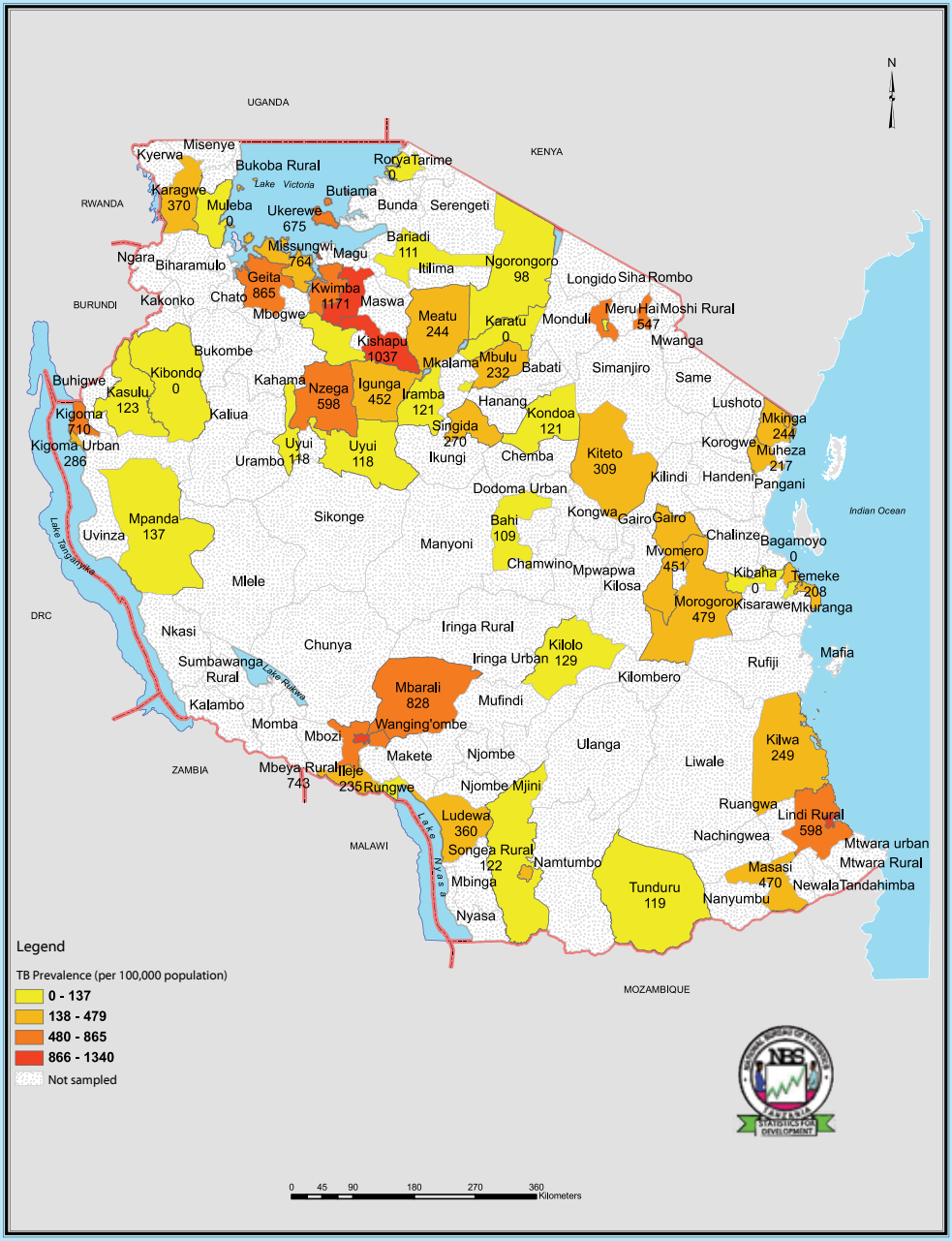


Appendix 4: Cluster summary

SN	Cluster name	Invited	Enrolled	Participation	Definite	Probable	Survey	S-positive (restricted)	Bact. Conf. (restricted)	S-positive (broad)	Bact. conf. (broad)	Prevalence Bact. conf. (broad)
		N	N	%	N	N	N	N	N	N	N	/ 100,000
1	Chiungutwa	876	820	93.6	0	0	0	3	3	4	4	470
2	Itezi	875	812	92.8	3	1	4	3	6	5	8	966
3	Itumba	909	851	93.6	0	0	0	0	0	2	2	235
4	Kasamwa	926	816	88.1	0	1	1	1	1	1	1	126
5	Kimnyaki	1,531	815	53.2	1	0	1	1	1	1	1	111
6	Kivinje Singino	857	814	95.0	0	0	0	1	1	2	2	249
7	Kiwalala	854	804	94.1	4	0	4	1	5	7	7	866
8	Maramba	1,475	815	55.3	0	3	3	3	3	3	3	244
9	Masama Rundugai	1,250	806	64.5	0	1	1	2	2	4	4	547
10	Misasi	940	921	98.0	1	4	5	6	6	7	7	764
11	Mvomero	1,517	840	55.4	3	0	3	1	3	3	3	451
12	Orgosorok	1,259	812	64.5	0	0	0	1	1	1	1	98
13	Ruvuma	812	797	98.2	1	1	2	2	2	2	2	248
14	Tumbi	1,542	903	58.6	0	0	0	0	0	0	0	0
15	Bambi	834	805	96.5	1	0	1	0	1	0	1	123
16	Mfenesini	803	787	98.0	1	0	1	0	1	0	1	125
17	Bangata	1,472	793	53.9	2	0	2	4	5	6	6	689
18	Bukondo	979	923	94.3	3	1	4	5	7	6	8	865
19	Bumera	903	889	98.4	0	1	1	1	1	1	1	111
20	BunyamboW	932	829	88.9	0	0	0	0	0	0	0	0
21	Chikola	923	830	89.9	1	0	1	1	1	1	1	109
22	Gisambalang	1,385	848	61.2	1	0	1	0	1	1	2	232
23	Goima	918	823	89.7	0	1	1	1	1	1	1	121
24	Ibiri	926	758	81.9	1	0	1	0	1	1	1	118
25	Ibuga	1,087	816	75.1	0	0	0	0	0	0	0	0
26	Ikama-TalaTala	846	815	96.3	0	1	1	1	1	1	1	126
27	Iwela	873	833	95.4	2	0	2	2	3	2	3	360
28	Kinamapula	934	888	95.1	7	1	8	1	8	2	9	1037
29	Kiruruma	1,056	833	78.9	1	1	2	2	3	2	3	370

SN	Cluster name	Invited	Enrolled	Participation	Definite	Probable	Survey	S-positive (restricted)	Bact. Conf. (restricted)	S-positive (broad)	Bact. conf. (broad)	Prevalence Bact. conf. (broad)
30	Kisesa	897	823	91.8	1	0	1	1	2	2	2	244
31	Kisumwa	1,116	866	77.6	0	0	0	0	0	0	0	0
32	Lugata	992	949	95.7	0	3	3	4	4	4	4	423
33	Madibira	881	838	95.1	3	0	3	1	3	7	7	828
34	Maghang	1,408	796	56.5	1	0	1	2	2	3	3	309
35	Mcheshi	845	824	97.5	1	0	1	1	1	1	1	119
36	Mcholi II	877	819	93.4	5	1	6	2	7	10	11	1340
37	Mogwa	852	833	97.8	4	1	5	3	5	5	5	598
38	Murutunguru	917	876	95.5	0	1	1	5	5	6	6	675
39	Mwabomba	936	777	83.0	3	2	5	4	6	8	9	1171
40	Mwaru	905	888	98.1	0	0	0	0	0	0	0	0
41	Mzumbe	1,361	796	58.5	2	1	3	3	4	4	4	479
42	Nangaru	828	802	96.9	2	3	5	3	5	6	6	748
43	Ndongosi	834	820	98.3	0	1	1	1	1	1	1	122
44	Nhundulu	906	852	94.0	1	2	3	2	3	3	3	342
45	Ntwike	858	825	96.2	1	0	1	0	1	1	1	121
46	Potwe	1,209	816	67.5	0	0	0	2	2	2	2	217
47	Rusaba	929	801	86.2	0	1	1	1	1	1	1	123
48	Santilya	842	811	96.3	3	0	3	3	6	4	6	743
49	Sekebugoro	906	860	94.9	0	1	1	1	1	1	1	113
50	Somangira	1,627	877	53.9	0	0	0	0	0	0	0	0
51	Sunuka	923	851	92.2	6	0	6	2	6	3	6	710
52	Ukwega	856	720	84.1	1	0	1	0	1	0	1	129
53	Ziba	916	891	97.3	3	1	4	3	4	4	4	452
54	Ilembo	752	733	97.5	1	0	1	1	1	1	1	137
55	Kasimbu	920	743	80.8	1	0	1	1	2	2	2	286
56	Kijitonyama	1,654	789	47.7	2	0	2	3	3	3	3	333
57	Magomeni	1,362	601	44.1	0	2	2	2	2	2	2	396
58	Mbugani	1,173	835	71.2	1	3	4	5	5	7	7	1110
59	Miburani	1,998	831	41.6	0	0	0	1	1	2	2	208
60	Mughanga	1,224	761	62.2	1	1	2	1	2	2	2	270
61	Mwandet	1,244	747	60.0	1	0	1	0	1	1	1	130
62	Upanga E	1,222	300	24.5	0	0	0	0	0	0	0	0

Map showing TB Prevalence by Cluster/District (per 100,000 population)



Source: First National TB Prevalence Survey Preliminary Report