Ministry of Health
National Center for Tuberculosis
and Leprosy Control

Kingdom of Cambodia
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Report

Second National Tuberculosis Prevalence Survey Cambodia, 2011

December 2012

National Tuberculosis Control Program

Ministry of Health

National Center for Tuberculosis and Leprosy Control

FOREWORD

The National Tuberculosis Prevalence Survey 2011 is the second of its kind conducted in the Kingdom of Cambodia after the first survey organized in 2002. It is the result of excellent collaborative efforts among the major partners and staff of the National Tuberculosis Control Program (NTP).

The results of the two surveys show a 4.2% annual decline of the smear positive TB cases between 2002 and 2011, bigger than anticipated. As stated in the WHO Global TB Report 2012, the result demonstrates that in low income and high burden country like Cambodia big prevalence reduction could be achieved. This reflects how much hard work that has been done in TB control in the kingdom by the NTP together with its partners including local authorities and communities.

Since reliable information for the NTP has been a long felt need, the findings of the survey are not only useful for looking at the trend of TB epidemiology in the country but also for re-affirming the achievements in TB control during the last ten years. The information will also be of great significance for the overall management of the National TB Control Program, particularly in planning, monitoring and evaluation in the future.

More particularly, the findings will guide the NTP in gearing its efforts towards definitely reaching the Millennium Development Goals. Furthermore, they will assist the NTP in shaping its futures policy and strategy after 2015.

The successful completion of the survey also highlights the tremendous commitment of the Ministry of Health of the Kingdom of Cambodia, the National Centre for Tuberculosis and Leprosy Control (CENAT) and various partners concerned to jointly combat the disease in this high TB burden country.

Phnom Penh, 14 December, 2012

Minister of Health

Dr. Mam Bun Heng

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The Cambodia National Tuberculosis Prevalence Survey 2011 was conducted by the National Center for Tuberculosis and Leprosy Control (CENAT) of the Ministry of Health of the Kingdom of Cambodia together with partners under the supervision of the Executive Committee participated by the representatives from the Ministry of Health and the National Tuberculosis Control Project by Japan International Cooperation Agency (JICA).

Major Funding for the survey was provided by JICA through the National TB Control Project and GFATM supplemented with funds from USAID through TB CAP. World Health Organization (WHO), Research Institute of Tuberculosis (RIT) of Japan Anti-Tuberculosis Association and JICA's National Tuberculosis Control Project Team provided technical support to the survey.

Experts from various agencies including WHO, RIT, USAID and US-CDC and as well as concerned international and domestic agencies participated in the review and consensus building activities of the survey. In addition, health workers both at the central and local levels and local communities participated and made great contributions to the survey.

We wish to express our deep thanks and appreciation to all organizations and individuals for their contributions in making this survey successful. We would like to particularly thank Dr. Kosuke Okada, Dr. Ikushi Onozaki and Dr. Norio Yamada of JICA, WHO and RIT for their tremendous contributions from the very beginning of the survey design to the completion of this report. We sincerely hope the survey results will be of great use in bringing a brighter future to those who suffer from Tuberculosis.

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Phnom Penh, 11 December, 2012

National Center for TB and Leprosy Control

Dr. Mao Tan Eang

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List of Abbreviations

AFB	Acid-fast bacillus
ARI	Annual Risk of Infection
ASEAN	Association of South-East Asian Nations
CI	Confidence interval
CXR	Chest X-ray or chest radiography
DOTS	Directly Observed Treatment – Short course
DST	Drug Susceptibility Test
EC	Executive Committee
EMB	Ethambutol
FM	Fluorescence microscopy
GDF	Global Drug Facility
GP	General Practitioner
INH	Isoniazid
JICA	Japan International Cooperation Agency
MDGs	Millennium Development Goals
MDR-TB	Multidrug-resistant TB
MOH	Ministry of Health
MOTT	Mycobacteria other than tuberculosis
MTB	Mycobacterium tuberculosis
NGO	Non-governmental organization
NTP	National Tuberculosis Control Program
NTRL	National TB Reference Laboratory
OPD	Out-Patient Department
OR	Odds ratio
PPM	Public-Private Mix
PPS	Probability proportionate to size
PSU	Primary sampling unit
RIT/JATA	Research Institute of Tuberculosis, Japan Anti-tuberculosis Association
RMP	Rifampicin
SM	Streptomycin
SOP	Standard Operating Procedures
TB	Tuberculosis
USAID	United States Agency for International Development
WHO	World Health Organization
WPR	Western Pacific Region
ZN	Ziehl-Neelsen

EXECUTIVE SUMMARY

The National TB Control Program led by the National Center for TB and Leprosy Control (CENAT), Cambodia, successfully conducted the second National TB Prevalence Survey with the primary objective of determining the prevalence of pulmonary TB and assessing the trend in TB prevalence. The field operation was carried out for a total of 37,417 (92.6%) out of 40,423 eligible subjects aged 15 years or older from December 2010 to September 2011at 62 sites selected by the population proportionate multistage cluster sampling method.

Both symptom and chest X-ray screening were provided for all participants except those exempted from radiological examination to identify those eligible for sputum examinations. As a result, 4,612 (96.5%) of 4,780 subjects eligible for sputum submitted one or two sputum specimens, for which both smear and culture examinations were performed.

The survey identified 103 smear-positive cases and 211 smear-negative, culture-positive cases, totaling 314 bacteriologically positive TB cases. Weighted prevalence rates of smear-positive TB and bacteriologically positive TB were 271 (95%CI: 212-348) and 831 (95%CI: 707-977) per 100,000 population aged 15 years or older, respectively. With the assumption of no smear-positive TB in children under the age of 15 years, the smear-positive prevalence rate was 183 (95%CI: 142-234) per 100,000 population for all ages. Male to female ratio was 1.5 in both smear-positive TB and smear-negative, culture-positive TB. The subjects aged 45 years or older accounted for 75% in smear-positive TB and 63% in smear-negative, culture-positive TB.

Comparing the results between the first (2002) and second survey (2011) in the population aged 15 years or older of the 20 surveyed provinces, a statistically significant decline of 38% was observed in the smear-positive prevalence rate (4, 2% annual reduction) ; and 45% in bacteriologically positive prevalence rate. The prevalence rates of both smear-positive TB and bacteriologically positive TB were reduced at any age group, though not all were statistically significant.

The proportion of the subjects with symptoms of cough 2 weeks or longer, or haemoptysis among the survey TB cases were only 44% (62% in the first survey) of the smear-positive TB cases and 23% (30% in the first survey) of the smear-negative, culture-positive TB cases. The ratio of the prevalence rate to the notification rate (P/N ratio) by age group showed a drastic change between the first and second survey; the age group of 15-24 years showed the smallest ratio below 0.5, and the ratio increased with age as a whole, exceeding 1.5 in the age group of 55 years or older in both males and females. Furthermore, the survey found that nearly 90% of TB patients were previously treated or are currently treated in public sector.

These great achievements in reducing TB burden have been accomplished by the tremendous efforts made by the Cambodia NTP and the partners concerned. The significant reduction of 38% prevalence among population aged 15 years or older during the period 2002-2011 between the two surveys may be attributable to nationwide DOTS expansion to health centers from 1999 to 2004 and its sustaining during the years after together with the introduction of such specific activities as community DOTS, TB/HIV and PPM-DOTS along the line of the DOTS expansion.

To maintain the achievement momentum and further improve the TB situation in the country, the NTP needs to continue the current activities and increase efforts in the future, because Cambodia has still the highest prevalence among the 22 high burden countries of Tuberculosis. This requires more resources for the NTP.

The survey result presents three big challenges to the NTP in case detection. First, smear-negative TB cases, which can't be diagnosed by smear microscopy, are more than twice as prevalent as smear-positive TB cases, similarly to the first survey. Second, asymptomatic (those without TB suspect symptom) or less symptomatic TB cases, which are less likely to seek medical care by themselves, account for 56% of smear-positive TB and 77% of smear-negative, culture-positive TB. Third, the prevalence rates sharply increase with age and the P/N ratios remains high in the middle-aged and the elderly for both males and females, reflecting the fact that elderly TB patients had less access to TB services. Thus, the current diagnostic procedures which depend on smear microscopy to a large extent should be thoroughly reviewed and the following measures should be considered: active use of chest X-ray (CXR) for any respiratory symptom cases; improving referral system for smear-negative suspects to facility equipped with CXR; expansion of active case finding for high risk and vulnerable populations including elderly; and scale-up of more sensitive, WHO-approved diagnostics such as Xpert MTB/RIF.

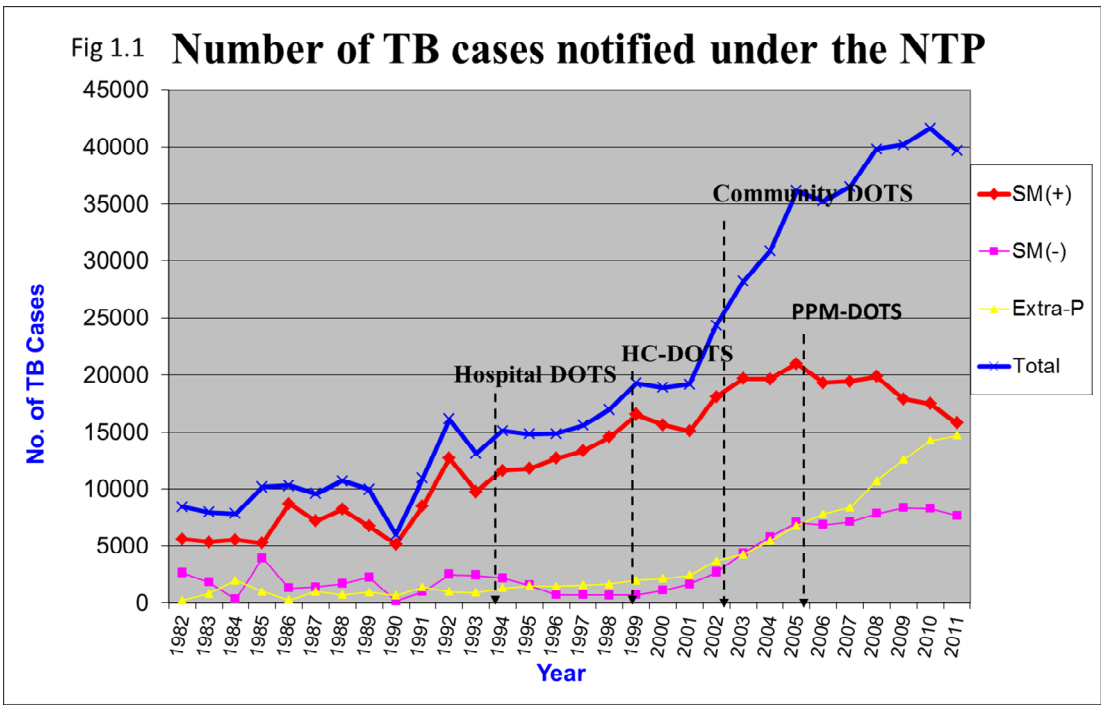
1. INTRODUCTION

1.1 Background of TB control in Cambodia

Cambodia is among the 22 countries in the world with a high burden of tuberculosis (TB). In the Global Tuberculosis Report 2012, the incidence rate and the prevalence rate of all forms of TB for 2011 were estimated 424 (95% CI: 364-489) and 817 (95% CI: 690-954) /100,000 population, respectively and the estimate of the death rate was 63 (95% CI: 29-111) /100,000 population (1). These rates are within the top five of the 22 TB high burden countries.

In response to the need for controlling the disease in the country, the National Tuberculosis Control Program (NTP) has been set up since 1980. From 1980 to 1993, treatment approaches of long duration were applied. In 1994, the Ministry of Health adopted the Directly Observed Treatment, Shortcourse Chemotherapy (DOTS) strategy at hospital level. Due to the collaborative efforts made by all partners concerned, the NTP was able to accomplish its tasks with considerable achievements. For instance, 100% coverage of DOTS services at district hospital and health center level was attained by the end of 1998 and 2004, respectively; since 1995 the NTP has been able to maintain high cure rate of over 85%.The program attained the 70% case detection rate by 2005 as planned. Major achievements in recent years include the ability to maintain the proper functioning of DOTS services at health centers, the expansion of Community-DOTS and care services for TB/HIV co-infected persons ; the start of MDR-TB services from 2006; the scale-up of PPM-DOTS to 11 provinces and 37 ODs by the end of 2009; the organization of the Joint Program Review of the NTP in 2006 and 2012 and the two TB drug resistance surveys in 2001 and 2006; and the organization of the HIV sero-prevalence surveys among TB patients in 2003,2005,2007 and 2009. In Cambodia(2), the number of new TB cases seen at public health facilities doubled during the last decade and the number of TB cases of all types were 18,892 in 2000, 36,121 in 2005 and 41,628 in 2010 (Fig 1.1) The decline of new smear positive TB cases notified has been observed since 2006.

Fig 1.1 **Number of TB cases notified under the NTP**



Despite considerable progress made during the past ten years in combating the disease, a number of challenges still remain to be addressed to enable the NTP to reach the Millennium Development Goals. These include the still high TB prevalence and incidence rates; limited resources to maintain the functioning of the current extensive DOTS services; quality assurance issues; lack of resources to embark on more innovative interventions or further expand community DOTS,TB/HIV,PPM-DOTS and MDR-TB; new diagnostics and laboratory strengthening measures; and staff capacity and motivation.

1.2 First National TB Prevalence Survey in Cambodia, 2002

The NTP needs to monitor the size of its TB burden and, more importantly, the trend in TB epidemiology, i.e., how the tuberculosis burden is changing and what is the impact of the current control measures. As the reduction in TB prevalence is included in the Millennium Development Goals (MDGs) and the Global Plan to Stop TB, TB prevalence surveys are an effective tool to monitor the impact of the program. A series of high quality prevalence surveys are expected to show the impact of national and international investments in TB control. The first National TB Prevalence Survey carried out in 2002 showed the smear-positive prevalence rate of 362/100,000 population among population of 10 years old and older; and 269/100,000 population of all ages (3). After 9 years, the second National TB Prevalence Survey was planned to measure both the current prevalence and any change in prevalence since the previous survey. While the first survey suggested the impact of DOTS since 1994, the second survey was expected to show stronger evidence of a downward trend in TB prevalence in Cambodia due to nationwide DOTS expansion to peripheral levels.

TB data in Cambodia are primarily based on case notification under the NTP and WHO's estimation. Although every effort is made by WHO expert groups to develop accurate estimates, there is a considerable range of uncertainty around these figures. A large discrepancy was observed between the WHO estimates and the prevalence rates as measured by the first prevalence survey2002. Therefore, the NTP in Cambodia conducted the second survey in order to provide the program with updated and more accurate information on the current TB burden.

2. OBJECTIVES AND METHODOLOGY OF THE SURVEY

A survey protocol based on the experiences in the first survey (3) and current international recommendations on TB prevalence surveys(4) was drafted with the technical support of RIT/JATA and reviewed by the Executive committee (Annex 1).

The WHO Global Task Force on TB Impact Measurement, which was established to assist and facilitate the implementation of TB prevalence surveys in developing countries, also reviewed the protocol of the second national prevalence survey in Cambodia and provided technical assistance on the survey preparation, implementation and analysis. The external contributions from the Task Force are listed in Annex 2.The board of RIT/JATA also reviewed and endorsed the survey protocol. Approval of the protocol was obtained from the Cambodian National Ethics Committee, Ministry of Health (Annex 3).

The study design of the second survey was preferably to be the same as that of the first survey for comparison purposes. However, a few differences in the survey protocol were made in light of the results of the first survey and the recommendations by WHO (4). The comparison of the methods and results between the two surveys was discussed in Section 4.8.

2.1 Objectives

2.1.1 Primary objectives

(1) To determine the prevalence of pulmonary TB among the population aged 15 years or older at a defined point in time in Cambodia as measured by:

- Smear-positive pulmonary TB
- Culture-positive pulmonary TB
- Bacteriologically-confirmed pulmonary TB
- Symptoms suggestive of TB

(2) To assess the trend in TB prevalence

2.1.2 Secondary objectives

(1) To identify

- Prevalence of TB suspects
- Radiological abnormalities suggestive of pulmonary TB
- Health-seeking behavior as defined by:
  - Health-seeking behavior of TB patients and individuals reporting chest symptoms
  - Use of the private sector for TB care as reflected in the proportion of TB patients under treatment in the private sector
  - Where the NTP is missing TB cases, by service area, demographics, etc.

2.2 Survey design

2.2.1 Target areas

The target area was the whole area of Cambodia. In the first survey, due to serious limitations of access and their relatively small size of population (less than 3% of national population at that time), four provinces (i.e. Mondulkiri, Rattanakiri, PreahVihear and SteungTreng) were excluded. In the second survey, for purposes

of comparison between the two surveys, these four provinces were grouped into a stratum separate from other areas included in the first survey.

2.2.2 Stratification

To maintain the comparability with the first survey, the following stratification was made. Note that strata 1 and 2 were included for the comparison in prevalence between the first and the second survey.

- Stratum-1 (Urban areas): this stratum consisted of areas categorized as urban in the 2008 census with the exception of the four provinces named above.
- Stratum-2 (Rural areas): this stratum consisted of areas categorized as rural in the 2008 census with the exception of the four provinces named above.
- Stratum-3: this stratum consisted of Mondulkiri, Rattanakiri, PreahVihear and Stoeung Treng which were excluded in the first survey.

2.2.3 Study population

The study target population included all persons aged 15 years or older who had resided at the selected survey sites for 2 weeks or longer at the time of survey, except for those meeting the exclusion criteria mentioned below.

1) Inclusion criteria: Inclusion in TB screening was made only with informed consent. The eligible persons for the survey who did not provide informed consent or did not appear for the interview/TB screening were categorized as non-participants (absentees), but were still counted as eligible individuals (study population) as a denominator in calculating the participation rate. Some individuals were exempted from chest X-ray (CXR) examination (e.g. refusal due to pregnancy or other reasons, difficulty in taking CXR due to disability, or difficulty in showing up at the field operation center for any reason). However, as long as they provided informed consent for participation, they were categorized as participants with missing information.

2) Exclusion criteria: Persons living at military and diplomatic compounds, hospitals and hotels were excluded from the survey at the sampling stage and/or during household census. Residents in dormitories (e.g. school) and temporary settlements (e.g. accommodation facility for construction workers) were not excluded as long as they have resided there for at least 2 weeks prior to the survey.

2.2.4 TB screening methods

Based on the current recommendations by the WHO (4), the following screening strategy was adopted;

- All eligible individuals undergo an individual interview to confirm symptoms of TB and chest X-ray (CXR) examination except those exempted from CXR examination.
- Eligibility for sputum examination was;
  - by symptom screening, cough 2 weeks or longer or haemoptysis, and/or
  - by CXR screening, any abnormal shadow in the lung field or mediastinum other than a single small calcification nodule with a size less than 10 mm or pleural adhesion at costophrenic angle(s)
- All eligible for sputum examination mentioned above were to submit two sputum specimens, one on-the-spot and another, next morning, for smear and culture examination and identification test when culture was positive,.

2.2.5 Sample size

Assuming that prevalence rate fell by 42% from the smear-positive prevalence rate of 441.9 per 100,000 (aged 15 years or older) in the first survey (corresponding to the Western Pacific Regional Target of 50% reduction in prevalence in 10 years), the prevalence rate in 2010 was estimated 256.3 per 100,000. To achieve relative precision of at least 25% for this range, a sample size of 23,932 was required under simple random sampling with 95% confidence level.

After careful consideration of likely changes in TB epidemiology and variation in TB prevalence across the country since 2002, it was conservatively assumed that the intra-cluster correlation co-efficient (ICC) for the second survey would be approximately two times higher than that for the first survey.

The following assumptions were based on findings from the first survey;

- Intra-cluster correlation co-efficient (ICC): 0.000746 (ICC in the first survey x 2)
- Participation rate: more than 90%
- Participants per day:150-180 (max 200) and cluster size: 600-650 a week

Based on the above requirements and assumptions, the most suitable combination of a cluster size with the number of clusters for the survey implementation was considered. As a result, the following total sample size, the cluster size and the number of clusters were adopted for stratum-1 and 2:

- Number of clusters: 60 in stratum-1 and 2
- Cluster size: 640
- Design effect (DEFF): 1.4299, which was estimated from the ICC and the cluster size mentioned above.
- Total sample size of population aged 15 years or older: 38,400

As shown in Tab 2.1, 2 clusters were drawn from stratum-3. Therefore, the total sample size for all strata was 39,680 (62 clusters x 640 subjects per cluster).

Tab 2.1 Cluster distribution by stratum

Stratum	Population aged 15 years or over	%	Number of clusters
Urban (stratum-1)	1,911,597	22.3%	13
Rural (stratum-2)	6,642,678	77.7%	47
sub-total	8,554,275	100.0%	60
Others (stratum-3)	322,481		2

2.2.6 Sampling procedures

In Cambodia, there are 4 levels of administrative units: provinces, districts, communes and villages. Classification of urban and rural areas was made generally at the commune level. The sampling frame was census population with population aged 15 years or over at districts, communes and villages. Sample units were selected by the multistage sampling method with probability proportionate to size (PPS) within each stratum as follows;

1) Primary Sampling Unit (PSU): PSUs were districts the same as in the first survey. Five districts had a higher eligible population than the value of stratum population per number of samples. In case two PSUs

were selected from a district, no replacement would be made.

2) Secondary Sampling Unit (SSU): Considering the hierarchy of sampling units, communes as SSUs were introduced although there was no SSU in the first survey. Sampling of SSUs was also made with PPS. In case a small commune was selected, randomly selected villages within bordering communes were to be included in the same manner as mentioned below.

3) Third sampling stage: One village within the commune selected as SSU was selected randomly. After selecting villages according to the size of the eligible population, the following procedures took place:

- In case the selected village had significantly more than 640 individuals aged 15 years or older (e.g., larger than 800), the village was divided into some household blocks by using existing household groups or natural boundaries such as creeks or paths. The selection was to start with one of the blocks selected randomly, and then to proceed with the next block according to a randomly selected direction (e.g. north or clockwise direction) until the required sample size close to 640 (from 610 to 670) was obtained.
- In case the selected village has significantly less than 640 individuals aged 15 years or older (e.g. 600), additional village(s) were included within the same commune. One of the villages bordering on the originally selected village was to be randomly selected and the survey team continued adding neighboring village(s) in a clockwise manner until the required number of participants was obtained.

2.2.7 Information to be collected

To estimate TB prevalence and identify risk factors for TB, the following demographic data and information on current health status/past history and health-seeking behavior were to be collected by interview;

- Age, sex, and occupation
- Past and current history of TB treatment
- Presence of symptoms (cough, sputum, haemoptysis, chest pain, loss of weight, fatigue, fever, night sweat and other TB related symptoms)
- Health-seeking behavior (e.g. visit to hospitals, health centers, private clinics, pharmacies, traditional healers) for those with symptoms

1) Chest X-ray (CXR) examination results: All participants except those exempted from CXR received the CXR examination to identify eligible subjects for sputum examination and to diagnose bacteriologically negative TB.

2) Bacteriological information: For those eligible for sputum examination by symptom screening and/or CXR screening, and for all subjects who didn't undergo CXR examination, two sputum specimens were collected and examined for smear, culture and identification .

3) Information from TB patients detected by the survey versus TB patients detected from the routine NTP activities: To identify factors for not having been detected by routine NTP activities, detailed information from these TB patients were collected. This protocol was prepared separately.

2.3 Organization

2.3.1 Executive Committee

The Executive Committee (EC), chaired by the Director of the NTP, was established to take overall responsibilities for the survey including performing supervisory tasks. The committee consisted of the survey coordinator and other senior CENAT staff with technical support of the advisers from core partner agencies such as the WHO, JICA, RIT and USAID (Annex1).

2.3.2 Technical Committee

The Technical Committee (TC) was responsible for the planning and execution of the survey work at both the field level and the central level. Under the survey coordinator, it had five sub-committees: Census, Radiology, Bacteriology, Statistics and Administration. In addition to the TC, JICA experts from RIT were involved in the whole survey process for the technical assistance (Annex 4-6).

2.3.3 Bacteriological examination centers

Smear examination and culture examination were carried out in two laboratories, the CENAT as the national reference laboratory and Battambang as a provincial laboratory. Identification test was performed at the CENAT laboratory.

2.3.4 Survey Teams

Three survey teams were established to carry out the field operation within one year. Each team had four units: census/interview, chest X-ray, reception/informed consent and sputum collection. The team was equipped with one portable CXR set and three vehicles. The total number of staff in each team was 15 persons (Tab 2.2). Local volunteers from the village were also involved in the field operation.

Tab 2.2 Staff of survey teams (each team)

Role / Designation	Number	Eligibility
Central Core Team		
Team Leader	1	Senior medical doctors of CENAT
Census & Interview unit	3	CENAT staff
CXR unit	4	Radiologist or Respiratory Disease Doctor x 1 Radiological Technologist x 2 Radiological Assistant x 1
Sputum collection unit	2	Laboratory technologist
Reception and Informed consent	2	CENAT staff
Drivers	3	
Total	15	
Local Supporting Team		
TB coordinator	3	OD TB supervisor and Health Centre Staff
Laboratory	1	
Sputum collection	3	
Local volunteers	6	Village Health Volunteers
Security	2	Local police
Total	15	

2.3.5 Training and pilot testing

All of the central team members were trained prior to the field work. Training for the survey teams included general issues of the survey (e.g. understanding the protocol) and contents specific to each unit based on the standard operating procedures (SOPs). After 5-day training at CENAT, one-day field training in Kampong Speu province was carried out for each unit in September 2010 except for census taking. In addition, pilot tests in Takeo province as a rural setting and Phnom Penh as an urban setting, were conducted as the simulation of the survey in October 2010 in order to identify weaknesses in the SOPs and to revise them by experiencing each step of the survey procedures including laboratory examinations.

2.4 Survey procedures

2.4.1 Procedures before the field operation

- The Executive Committee (EC) selected 62 clusters according to the protocol.
- A few months prior to the commencement of the survey operation, the team leaders and the provincial TB supervisors visited the selected sites and investigated the feasibility of the field work in terms of security and accessibility (the first pre-visit).
- The EC finalized the enumeration areas for the field survey and communicated with the provincial health director and local authorities to cooperate in the survey.
- Household lists were filled in at the local authority office, which was provided for the Census Unit during the second pre-visit.
- Two or three weeks prior to the field work, the team leader and the census unit visited the designated commune (the second pre-visit) to explain the study rationale and procedures to the village chief and the volunteers. The Census unit provided local officials and volunteers with on-the-job training on how to fill out the household lists during the field operation.

2.4.2 Field survey procedures

It was estimated that basically it would take a week to complete the field operation at one cluster (Tab 2.3). The field operation in some urban clusters needed to set up an evening session for more workers to participate in the survey.

Tab 2.3 Basic schedule for field operation

Day		Activities
1st	Sun	Arrival and setting up with local collaborators
2nd	Mon	Census taking
3rd	Tue	Examination-1
4th	Wed	Examination-2 & sputum shipment-1 to culture center
5th	Thu	Examination-3
6th	Fri	Exaimnation-4 mainly for non-attendance (mop-up)
7th	Sat	Sputum shipment-2 and move to another site

1) Census taking

- On the first day, the census group received the household registry from local field workers or commune health workers. (Annex 7.Form-1).
- The census team visited every household to confirm the names of the persons staying there as listed in the household registry, particularly the age and sex of the eligible subjects. To equalize the workload per day, one of the screening days was assigned to each household.
- Every household was given a serial number on the list and the number label was pasted on the door or the gate of the house.
- Census unit member and field workers interviewed the most appropriate person about household information (e.g., size of house) and recorded it in the form.
- Identification number with 7 digits (XX-###-OO: cluster number-house hold number-individual number) was given to each subject regardless of their availability on the survey day. An invitation letter with the names of all the eligible persons was provided to the head of the household.
- Children aged less than 15 years or ineligible persons were also recorded in the household registry, though they were not eligible for the survey.

2) Registration and informed consent

When eligible subjects with invitation letter attended the examination site, a receptionist asked them to provide informed consent. (Form-4).

3) Interview on symptoms, health-seeking behavior and TB history

After the informed consent, the interview was conducted according to the individual survey form (Form-5). When the participant's symptoms met the eligibility criteria for sputum examination, the interviewer ticked on the individual survey form and informed the participant that he/she needed to submit sputum sample after chest X-ray (CXR) examination. All interviewed subjects, except those exempted from CXR, were referred for CXR examination.

4) Chest X-ray (CXR) examination

- CXR examinations were carried out using film size of 350 mm x 350 mm.
- X-ray assistant technician fixed and developed CXR films immediately on the spot.
- The field CXR reader and/or the second reader (the team leader) screened the subjects for eligibility for sputum collection immediately, according to the SOP. The result was recorded on the personal survey card and CXR examination registry (Form-7).
- CXR shadows eligible for sputum collection were defined as any abnormal shadow in the lung field and mediastinum, or pleural effusion except pleural thickness or small single calcification.
- Those with serious disease were advised by the team leader to visit an appropriate medical facility for further follow up in collaboration with the local health authority.
- All the CXR films taken in the field were sent for central reading after the field operation.

5) Sputum collection, storage and shipment

- Two sputum specimens (spot and morning) were collected from each subject eligible for sputum based on either symptoms or CXR screening, or from those exempted from CXR examination irrespective of their symptoms.

- Submitted specimens were immediately kept in an ice box until they reached the designated culture center.
- The identification number of the specimen and other necessary information were recorded in the sputum smear examination forms (Form-8,9).
- Health center staff or volunteers made home visits to trace subjects not having submitted a morning sputum specimen.
- The sputum specimens and sputum smear examination forms were shipped to the designated culture center on Wednesday and Saturday of each week.

2.4.3 Central level procedures

1) Bacteriological examinations

Smear and culture examination were performed on both of the two sputum specimens per subject, according to the SOPs. Laboratory staff recorded the results in the laboratory registries.

- Smear examination:

  First, smear examination was made by fluorescence microscopy (FM), which was adopted to reduce workload and turn-around time. When a reader found a positive slide, another reader confirmed it immediately.

- Culture examination and storage:

  Inoculation on the media was to be done within seven days of sputum collection at the latest though it was strongly recommend that it should be done within five days in order to obtain appropriate recovery rate.

- Shipment of isolates from Battambang to CENAT:

  Primary isolates were shipped to CENAT for further examination (procedures for storage and shipment were described in the SOPs).

- Identification test:

  Identification test (*M. tuberculosis* or Non-tuberculous mycobacteria) was made by Capilia at CENAT.

- Ziehl-Neelsen (ZN) examination to obtain results comparable with the first survey:

  It is recognized that FM has the same or higher sensitivity compared to ZN microscopic examination and that false positives may occur more often than with ZN method. Therefore, in order to maintain the comparability of smear-positive prevalence between the first and the second surveys, ZM method was performed for the slides of the subjects with positive results by FM, those with positive culture and those with bacteriologically negative but CXR suggestive of active TB, and around 5% of specimens with negative results by FM as negative control. This cross-examination by ZN method was made only after completion of re-checking by FM method mentioned above.

- Storage of isolates and smear slides:

  All smear slides and isolates were kept at least until the determination of tuberculosis cases (see next section) was made. Isolates were kept in deep freezers.

2) Central reading and final results of chest X-ray examination:

The central reading for all the CXR films taken in the field was carried out by two Cambodian radiologists, with additional reading by one of the two Japanese experts. The CXR results were

categorized into normal, active TB, healed TB, other lung diseases and findings other than lungs. When a result of CXR interpretation was inconsistent between the Cambodia radiologists and the Japanese expert, the final result was decided by another Japanese expert.

3) Central medical panel

The central medical panel which included international experts established the final diagnostic consensus based on both the CXR findings and the bacteriological examinations as follows;

Smear-positive TB case

- Smear-positive TB (definite: *M. tuberculosis* confirmed by culture)
  - smear-positive and *M. tuberculosis* confirmed by culture
- Smear-positive TB (probable: *M. tuberculosis* NOT confirmed by culture)
  - 2 smear-positive slides only
  - 1 smear-positive slide and CXR suggestive of active TB

Smear-negative, culture-positive TB case

- Smear-negative and culture-positive TB (definite: *M. tuberculosis* confirmed by culture)
  - 5 or more colonies in at least one specimen
  - 1-4 colonies in two specimens
  - 1-4 colonies in one specimen and CXR suggestive of active TB
- smear-negative and culture-positive TB (probable: *M. tuberculosis* NOT confirmed by culture)
  - smear-negative, culture-positive and CXR suggestive of active TB

Bacteriologically positive TB case = Smear-positive TB case + Smear-negative, culture-positive TB case

4) Data management:

The technical sub-committee of statistics at CENAT was responsible for data management with technical support from JICA, WHO and RIT. During the field operation, all individual survey forms were to be checked every evening by the team leader to avoid missing information. Electronic databases on household registry, individual survey form, CXR register, and laboratory register were developed. All the variables were entered using double entry except for the variables from two sources. After matching the databases by survey ID, inconsistent values were detected by comparing values between the databases or between the double entered data. The original forms and two computers protected by specific password for the survey were kept in a locked room accessible only to persons designated by the executive committee.

5) Statistical analysis:

Statistical analysis consisted of the estimation of prevalence, situation analysis of health-seeking behaviors and other risk factors for TB. These included;

- Prevalence of sputum smear-positive pulmonary TB among persons aged 15 years and above
- Prevalence of bacteriologically confirmed pulmonary TB among persons aged 15 years and above
- Prevalence of radiologically confirmed pulmonary TB among persons aged 15 years and above
- Prevalence of TB symptomatic individuals
- Health-seeking behavior of TB symptomatic individuals
- Coverage of health services for TB symptomatic individuals
- Association between TB prevalence and possible risk factors

When prevalence rates were estimated, the weights proportional to the inverse of selection probability were assigned to obtain representative figures. In the sampling method adopted in the survey, selection probability is identical if an actual cluster size (the number of participants) is identical over the clusters. Therefore, the weights which were the inverse of an actual cluster size were given. Prevalence rates were estimated for the whole country and the subgroups (e.g. age, sex or strata) and were compared among the subgroups by the design-based analysis using logistic regression model in which the survey design (stratification, clustering effect and weighting) was incorporated (i.e. svycommad in Stata (StataCorp, Texas)).

As primary analysis, prevalence rates were estimated based on the number of TB cases detected among participants. It was assumed that the participants which were eligible for sputum examination but did not have the decisive results because of no specimen or failure of the examination (e.g. broken slide or contamination) did not have TB and that such participants were representative of the eligible for the survey. The influence of missing data (nonparticipation and missing results of examination) on the results was assessed using weighted analysis and multiple imputations.

6) Follow-up of TB cases identified in the survey:

The TB supervisor responsible for a survey cluster was informed of smear and culture results through team leaders, immediately once positive specimen was detected. For participants who were bacteriologically negative, but had CXR results suggestive of active TB, the supervisor recommended TB treatment or further examination. To confirm whether TB cases identified in the survey were receiving proper care, central team members visited the facility responsible for the TB cases.

2.5 Quality control

2.5.1 Field operation

In January 2012, soon after the field operation in the first 5 clusters, which were supervised, in particular, by the Executive Committee (EC) members and Japanese experts, the first review meeting on field work assessment took place. In April 2012, when nearly half of the clusters were completed, the mid-term review meeting on the quality assessment of field operation, bacteriological examinations and radiological examinations was held inviting international experts. In addition, several supervisory visits to the field were carried out by EC members, Japanese experts or international experts who included the participants from Ethiopia, Ghana, Indonesia, Malawi, Nigeria, Rwanda, South Africa, Tanzania and Uganda in two international training courses on TB prevalence survey.

2.5.2 Bacteriological examination

- Smear examination: smear slides which tested negative by ZN stain but positive by culture examination were re-examined with ZN microscopy by a senior technician.
- Culture examination: contamination rates and recovery rates were carefully monitored.

2.5.2 CXR screening and central reading

Japanese experts attended some of the field operation and checked the quality of CXR films and CXR screening results. All films including normal CXRs were re-interpreted by them and the results of the reading from field screening and central reading were compared with those by the Japanese experts.

2.6 Ethical consideration

The survey was designed and carried out following the internationally established methods for TB screening and diagnosis. The subjects were properly informed of the purposes and methods of the survey through leaflet, and their rights to reject were guaranteed. A written informed consent (Form-4) was obtained from each of the survey participants or his/her parent (or guardian) for minors under 18 years old.

Bacteriologically confirmed subjects and those with CXR suggestive of active TB were informed of the result through the TB supervisor so that they could be treated 'free of charge' under the routine DOTS program.

While the harm due to CXR examination is considered to be minimal, safety measures were taken to reduce unnecessary exposure, including covering the abdomen with lead-material for all female participants. Regardless of pregnancy status, the participants had the right to reject CXR during participation in the survey.

Approval of the protocol was obtained from the Cambodian National Ethics Committee, Ministry of Health (Annex 3).

2.7 Funding and procurement

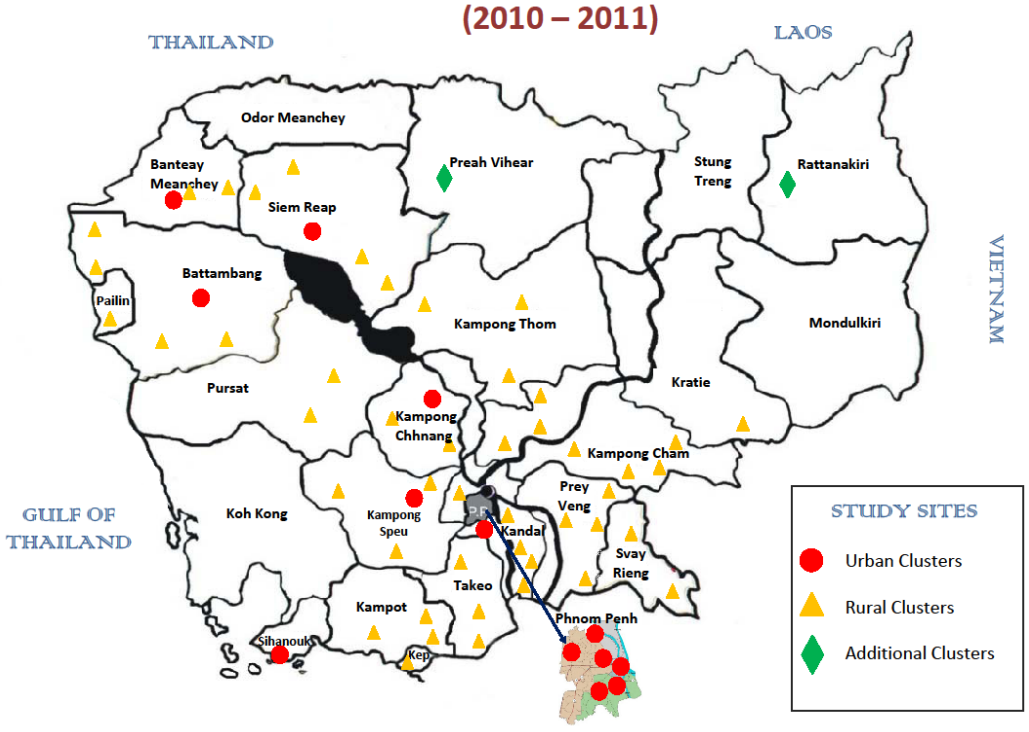
A partnership approach was adopted to cover the whole necessary expenditures for the survey implementation including technical assistance, training, procurement of equipment and consumables and operational cost. Major funding was from JICA and GFATM, supplemented by USAID. The total budget amounted approximately to one million US dollars except for the technical assistance from RIT/JATA and WHO, and salary from the Government. Most of the equipment and the consumables were procured and provided by JICA (Annex 8 and 9).

3. RESULTS

3.1 Summary of the survey

Field operation for the second National TB Prevalence Survey was carried out from December 2010 to September 2011. A total of 68,087 individuals in 62 clusters (Fig 3.1) were enumerated and 40,423 (59.4%) of them were eligible for the survey; 19,681 (28.9%) children under the age of 15 years and 7,983 (11.7%) individuals aged 15 years old or over who did not meet the residential duration criteria were excluded from the survey (Fig3.2).Of the 40,423 eligible subjects, 37,417 (92.6%) persons participated in the survey and were interviewed: 37,221 subjects with CXR examination and 196 subjects without CXR examination because of old age, disability, refusal of the examination or other reasons. Through the field screening by interview and CXR, 4,780 (12.8%) of the participants were regarded as being eligible for sputum examinations, out of which 4,612 (96.5%) subjects submitted at least one sputum specimen.

Fig 3.1 THE 2nd NATIONAL TB PREVALENCE SURVEY IN CAMBODIA (2010 – 2011)



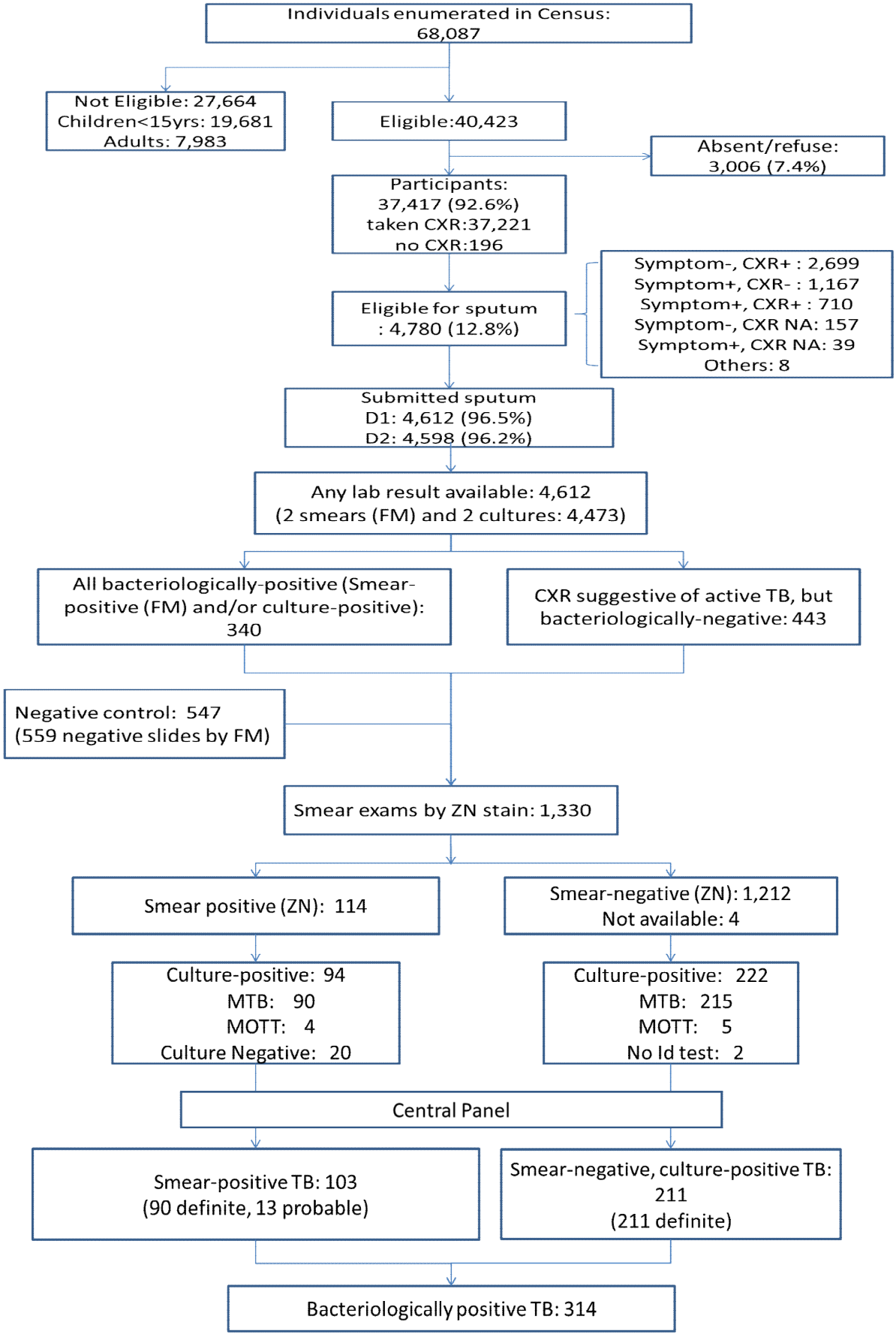
2

To maintain the compatibility of smear results between the first survey and the second survey, a total of 2,108 slides with fluorescent staining (FM) from 1,330 subjects (106 smear-positive subjects, 234 smear-negative, culture-positive subjects, 443 culture-negative subjects with CXR suggestive of active TB and 547 subjects for negative control) were re-examined by conventional smear microscopy with Ziehl-Neelsen staining (ZN). The results of bacteriological examinations were as follows;

- Out of 114 subjects with positive smear on at least one slide, 94 were culture-positive (90 isolated *Mycobacterium tuberculosis* (MTB), 4 isolated Mycobacteria other than tuberculosis (MOTT)) and 20 were culture-negative).
- Out of 1,212 subjects with negative smear by ZN including 4 subjects without slides due to break or loss, 222 subjects were culture-positive (215 identified as MTB, 5 as MOTT and 2 without identification test due to failure in sub-culture).
- In addition to the classification based on laboratory results mentioned above, the definition by the central medical panel classified 103 subjects as smear-positive TB cases (90 definite cases and 13 probable cases) and 211 subjects as smear-negative, culture-positive TB cases (211 definite cases) according to the TB case definition for the survey, based on their final CXR reading.

By the design-based analysis mentioned in the method section, the prevalence of smear-positive TB and bacteriologically positive TB among people aged 15 and above were 271/100,000 survey population (95% CI: 212-348, design effect=1.57) and 831/100,000 survey population (95% CI: 707-977, design effect=2.47), respectively. While this prevalence survey did not aim at estimating prevalence among the country population of all ages, assuming that there was no smear-positive TB among children, a prevalence rate for all age groups was extrapolated by using the observed proportion of national population aged 15 years or over (67.26%) based on the survey census data. The estimated prevalence of smear-positive TB for population of all ages was 183 (142-234) /100,000 population

Fig 3.2 Summary of the 2nd National TB Prevalence Survey, 2011



3.2 Census

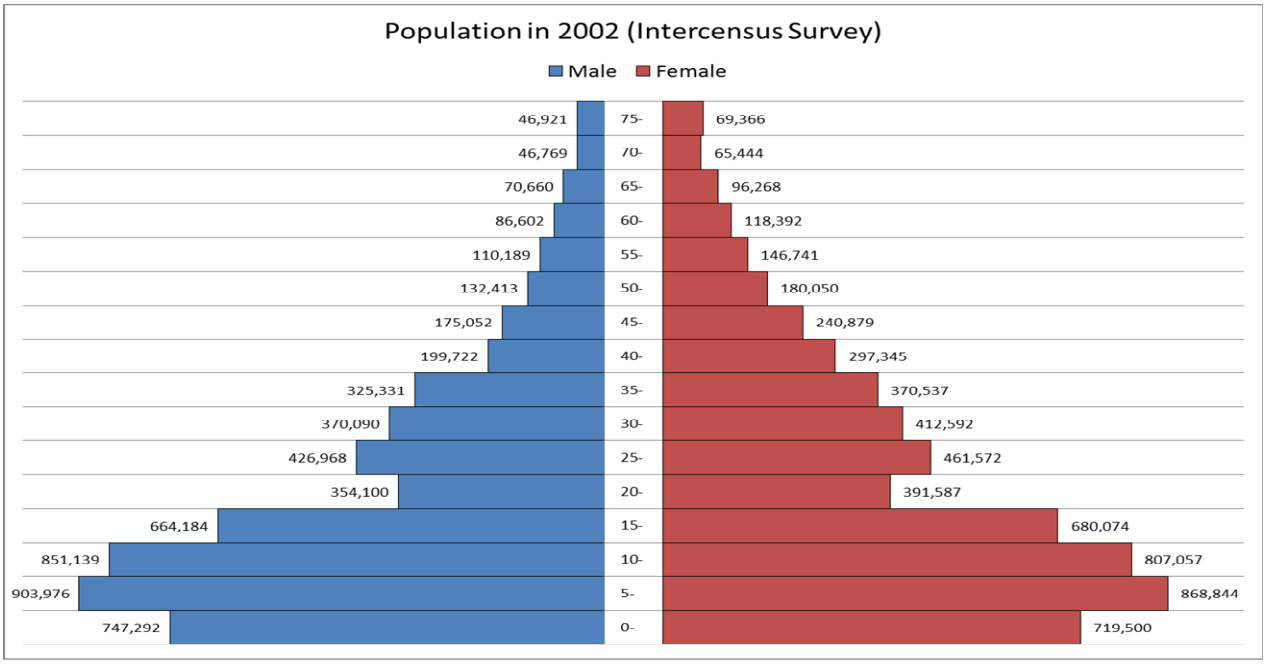
The census team enumerated 68,087 individuals, including 19,681children under the age of 15 (28.9% of the population) who were ineligible for the survey in 62 clusters (Tab 3.1). Among 48,406 individuals aged 15 years and above, 40,423 (83.5%) were registered as eligible survey subjects. While 62.4% of females were eligible for the survey, only 56.2% of males were eligible because there were more children under the age of 15 and more adults who went out of the cluster for job or schooling in the males than in the females. Rural clusters had a lower proportion of eligible subjects than urban clusters because there were more children in rural clusters and more adults who had moved out there.

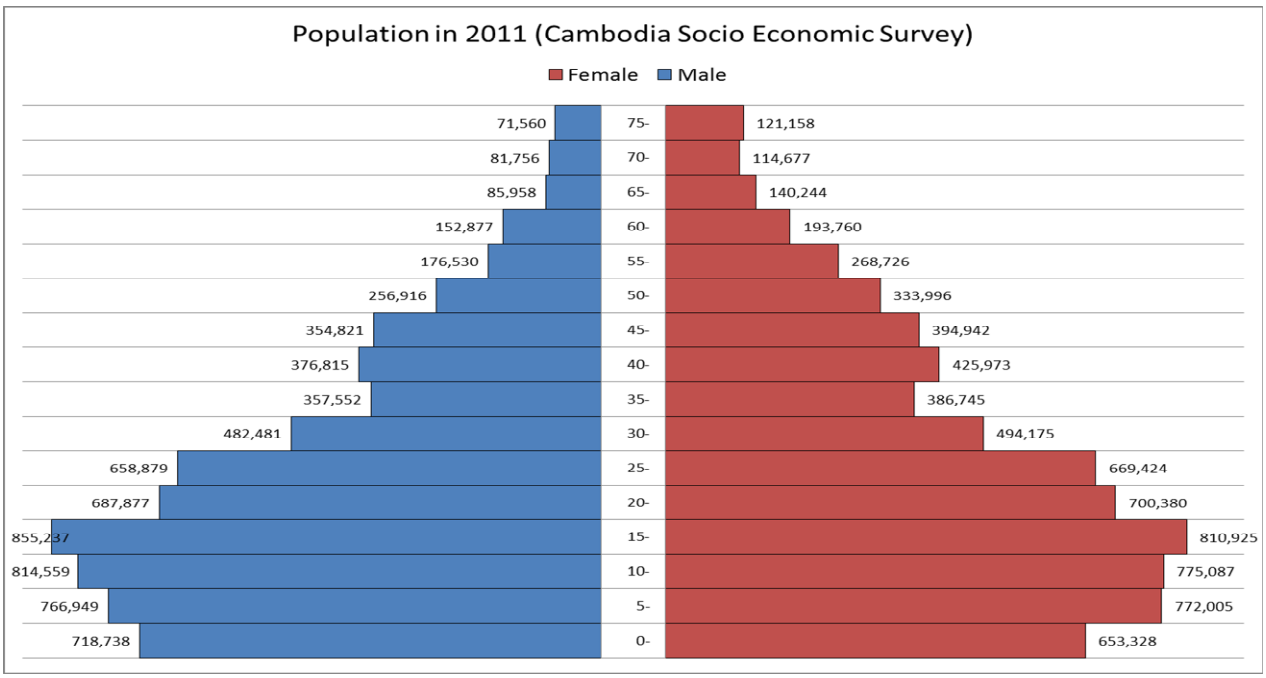
Tab 3.1 Survey census results: Eligible and ineligible subjects

	Total	Eligible		Ineligible aged 15 or over		Ineligible aged under 15	
	Number	Number	%	Number	%	Number	%
Total	68,087	40,423	59.4%	7,983	11.7%	19,681	28.9%
Sex							
Male	33,288	18,718	56.2%	4,424	13.3%	10,146	30.5%
Female	34,799	21,705	62.4%	3,559	10.2%	9,535	27.4%
Age							
0 - 4	6,091	-	-	-	-	6,091	100.0%
5 - 9	6,438	-	-	-	-	6,438	100.0%
10 - 14	7,152	-	-	-	-	7,152	100.0%
15 - 24	15,984	11,800	73.8%	4,184	26.2%	-	-
25 - 34	12,276	9,891	80.6%	2,385	19.4%	-	-
35 - 44	7,132	6,413	89.9%	719	10.1%	-	-
45 - 54	6,212	5,798	93.3%	414	6.7%	-	-
55 - 64	3,747	3,593	95.9%	154	4.1%	-	-
65 -	3,044	2,928	96.2%	116	3.8%	-	-
Unknown	11	0	0.0%	11	100.0%	0	0.0%
Strata							
Urban	12,475	8,629	69.2%	1,174	9.4%	2,672	21.4%
Rural	53,461	30,489	57.0%	6,702	12.5%	16,270	30.4%
Others	2,151	1,305	60.7%	107	5.0%	739	34.4%

A population pyramid based on Cambodia Socio Economic Survey 2011, with children under the age of 15 years accounting for 31.8%, is shown in Fig 3.3. The age group of 15-19 years covers the largest population of all the age groups. The population in Cambodia is aging with its birth rate declining gradually and longer life expectancy.

Fig 3.3 Population pyramids





3.3 Participants

3.3.1 Survey participation

Among the 40,423 eligible adults aged 15 years or over, 37,417 (92.6%) subjects participated in the survey and received the symptom screening interview (Tab 3.2). The overall participation rate exceeded the 90% anticipated by the survey design. The average number of survey participants per cluster was 604, ranging from 343-672 (Tab 3.3). The participation rate in females (94.0%) was higher than that in males (90.9%). The younger age groups between the age of 15-34 years had relatively lower participation rates than other age groups. Rural clusters showed a higher participation rate (94.8%) than urban clusters (84.6%). Of the 62 clusters, only 4 recorded participation rates lower than 80%, all of which were from urban clusters.

Tab 3.2 Survey participation rates

Age and sex	Eligible	Participants		Interviewed		CXR taken	
		Number	%	Number	%	Number	%
Total	40,423	37,417	92.6%	37,417	100.0%	37,221	99.5%
15 - 24	11,800	10,568	89.6%	10,568	100.0%	10,543	99.8%
25 - 34	9,891	9,035	91.3%	9,035	100.0%	9,016	99.8%
35 - 44	6,413	6,012	93.7%	6,012	100.0%	6,003	99.9%
45 - 54	5,798	5,527	95.3%	5,527	100.0%	5,515	99.8%
55 - 64	3,593	3,448	96.0%	3,448	100.0%	3,432	99.5%
65 -	2,928	2,827	96.6%	2,827	100.0%	2,712	95.9%
Male	18,718	17,007	90.9%	17,007	100.0%	16,946	99.6%
15 - 24	5,914	5,252	88.8%	5,252	100.0%	5,242	99.8%
25 - 34	4,752	4,225	88.9%	4,225	100.0%	4,221	99.9%
35 - 44	2,911	2,683	92.2%	2,683	100.0%	2,681	99.9%
45 - 54	2,584	2,402	93.0%	2,402	100.0%	2,400	99.9%
55 - 64	1,387	1,317	95.0%	1,317	100.0%	1,312	99.6%
65 -	1,170	1,128	96.4%	1,128	100.0%	1,090	96.6%
Female	21,705	20,410	94.0%	20,410	100.0%	20,275	99.3%
15 - 24	5,886	5,316	90.3%	5,316	100.0%	5,301	99.7%
25 - 34	5,139	4,810	93.6%	4,810	100.0%	4,795	99.7%
35 - 44	3,502	3,329	95.1%	3,329	100.0%	3,322	99.8%
45 - 54	3,214	3,125	97.2%	3,125	100.0%	3,115	99.7%
55 - 64	2,206	2,131	96.6%	2,131	100.0%	2,120	99.5%
65 -	1,758	1,699	96.6%	1,699	100.0%	1,622	95.5%
Strata	40,423	37,417	92.6%	37,417	100.0%	37,221	99.5%
Urban	8,629	7,302	84.6%	7,302	100.0%	7,272	99.6%
Rural	30,489	28,916	94.8%	28,916	100.0%	28,753	99.4%
Others	1,305	1,199	91.9%	1,199	100.0%	1,196	99.7%

Tab 3.3 Cluster summary

Surveyed cluster			Census data				Participants			TB history		Screening process					No of TB cases			Crude prevalence rate (/100,000)		
				ineligible																		
Cluster	Strata	Distance (km)	Census population	ineligible >=15yrs	Children <15 yrs	Eligible	Attendee	Absentee	Participation rate	Current TB	Previously TB	TB symptomatic	CXR taken	Eligible by CXR	Eligible for sputum	Taken sputum	Smear+	S-Culture+	Bac-CXR active	Smear+	S-Culture+	Bac-CXR active
1	U	0.5	1,248	271	313	664	639	25	96.2%	0	26	35	636	65	83	83	0	1	7	0	156	1,095
2	U	1	948	11	227	710	562	148	79.2%	0	21	2	561	21	24	24	2	1	3	356	178	534
3	U	3	896	52	190	654	607	47	92.8%	2	15	6	602	40	49	44	0	3	6	0	494	988
4	U	4	1,103	149	294	660	618	42	93.6%	0	8	22	611	75	96	95	1	8	5	162	1,294	809
5	U	7	1,067	159	273	635	614	21	96.7%	0	20	16	613	42	50	50	3	3	9	489	489	1,466
6	U	2	886	46	180	660	601	59	91.1%	1	23	3	599	24	28	27	0	0	5	0	0	832
7	U	1	967	118	170	679	614	65	90.4%	2	21	24	611	55	76	75	1	5	6	163	814	977
8	U	3	908	53	197	658	586	72	89.1%	0	13	8	586	43	45	45	0	1	8	0	171	1,365
9	U	3	714	15	52	647	542	105	83.8%	0	12	1	542	12	13	13	0	3	2	0	554	369
10	U	2	817	75	101	641	343	298	53.5%	0	12	5	343	21	25	23	0	0	4	0	0	1,166
11	U	2	909	75	165	669	473	196	70.7%	1	12	15	471	47	59	58	1	6	3	211	1,268	634
12	U	2	868	58	155	655	546	109	83.4%	1	11	2	543	29	34	33	0	2	4	0	366	733
13	U	2	1,144	92	355	697	557	140	79.9%	0	18	11	554	20	32	29	2	1	3	359	180	539
14	R	3.5	1,009	120	249	640	631	9	98.6%	2	55	55	630	82	114	112	1	7	12	158	1,109	1,902
15	R	13	1,267	282	354	631	616	15	97.6%	3	81	57	615	94	127	126	4	6	8	649	974	1,299
16	R	1	1,502	404	463	635	624	11	98.3%	2	81	51	616	101	129	127	6	6	14	962	962	2,244
17	R	14	1,325	38	581	706	672	34	95.2%	4	35	68	672	73	118	114	1	5	18	149	744	2,679
18	R	1	1,010	35	328	647	599	48	92.6%	2	24	8	599	39	44	43	4	7	11	668	1,169	1,836
19	R	5	1,407	255	438	714	672	42	94.1%	2	51	84	669	78	138	124	3	8	12	446	1,190	1,786
20	R	3	1,015	78	273	664	625	39	94.1%	1	17	34	624	73	96	95	0	3	5	0	480	800
21	R	5	1,213	99	480	634	596	38	94.0%	2	15	59	587	71	122	113	2	3	10	336	503	1,678
22	R	5	985	76	276	633	579	54	91.5%	0	8	12	579	51	61	61	0	5	3	0	864	518
23	R	10	1,054	57	376	621	577	44	92.9%	0	13	89	571	114	168	157	2	0	4	347	0	693
24	R	4	1,081	87	352	642	597	45	93.0%	0	7	21	597	13	29	23	0	1	3	0	168	503
25	R	10	1,085	135	278	672	643	29	95.7%	0	15	13	635	21	40	40	1	0	6	156	0	933
26	R	0	1,150	198	310	642	638	4	99.4%	1	22	27	634	44	62	62	3	2	7	470	313	1,097
27	R	4	961	120	215	626	617	9	98.6%	2	11	23	615	31	48	46	3	0	7	486	0	1,135
28	R	29	1,035	23	375	637	571	66	89.6%	0	5	41	569	48	76	73	1	0	3	175	0	525
29	R	12	1,032	33	363	636	614	22	96.5%	2	28	27	614	62	71	71	1	1	9	163	163	1,466
30	R	11	1,086	61	410	615	535	80	87.0%	1	13	28	534	61	78	74	3	2	1	561	374	187
31	R	2	1,113	164	308	641	617	24	96.3%	0	13	21	617	31	47	47	0	3	5	0	486	810
32	R	5	1,235	144	421	670	631	39	94.2%	3	17	33	631	63	81	80	1	7	6	158	1,109	951

Tab 3.3 Cluster summary

Surveyed cluster			Census data				Participants			TB history		Screening process					No of TB cases			Crude prevalence rate (/100,000)		
				ineligible																		
Cluster	Strata	Distance (km)	Census population	ineligible >=15yrs	Children <15 yrs	Eligible	Attendee	Absentee	Participation rate	Current TB	Previously TB	TB symptomatic	CXR taken	Eligible by CXR	Eligible for sputum	Taken sputum	Smear+	S-Culture+	Bac-CXR active	Smear+	S-Culture+	Bac-CXR active
33	R	4	1,083	145	278	660	651	9	98.6%	0	12	29	646	48	73	71	3	0	2	461	0	307
34	R	4	1,148	142	366	640	622	18	97.2%	2	16	40	619	52	83	73	3	5	12	482	804	1,929
35	R	3	1,214	244	335	635	609	26	95.9%	0	9	15	607	28	38	38	0	1	8	0	164	1,314
36	R	3	1,271	151	478	642	618	24	96.3%	1	20	35	610	34	68	58	0	1	10	0	162	1,618
37	R	0.5	1,245	307	314	624	594	30	95.2%	0	16	21	592	25	41	37	1	3	3	168	505	505
38	R	0.5	1,361	210	489	662	600	62	90.6%	0	23	64	593	58	106	96	1	3	13	167	500	2,167
39	R	1.5	1,141	155	347	639	593	46	92.8%	1	10	14	587	22	35	32	1	1	2	169	169	337
40	R	8	1,090	66	402	622	575	47	92.4%	4	50	75	570	116	159	153	0	9	19	0	1,565	3,304
41	R	4	1,309	231	416	662	661	1	99.8%	3	26	20	659	48	65	65	0	8	7	0	1,210	1,059
42	R	11	1,034	50	325	659	645	14	97.9%	3	34	11	644	54	62	62	2	1	5	310	155	775
43	R	2.4	1,040	124	268	648	622	26	96.0%	0	15	9	615	24	35	34	1	1	3	161	161	482
44	R	5	1,085	78	345	662	625	37	94.4%	0	30	27	623	42	62	57	3	1	6	480	160	960
45	R	3	968	68	241	659	600	59	91.0%	1	25	16	598	85	99	98	1	2	5	167	333	833
46	R	2	1,124	156	318	650	630	20	96.9%	1	12	29	628	70	89	89	0	2	6	0	317	952
47	R	2	1,001	54	286	661	598	63	90.5%	1	19	16	593	49	68	68	1	6	11	167	1,003	1,839
48	R	0	1,071	127	303	641	611	30	95.3%	4	23	81	609	69	134	131	3	7	15	491	1,146	2,455
49	R	6	1,288	268	367	653	632	21	96.8%	4	31	107	628	66	145	145	3	4	12	475	633	1,899
50	R	4	1,217	210	349	658	641	17	97.4%	2	36	65	640	113	146	143	4	3	15	624	468	2,340
51	R	3	1,072	165	264	643	631	12	98.1%	3	36	33	628	74	98	97	1	2	7	158	317	1,109
52	R	3	1,210	232	323	655	634	21	96.8%	4	42	66	631	59	110	96	1	5	7	158	789	1,104
53	R	4	1,161	133	346	682	613	69	89.9%	2	39	76	611	91	143	139	8	1	11	1,305	163	1,794
54	R	6	1,126	157	337	632	591	41	93.5%	0	27	26	571	90	127	127	0	5	10	0	846	1,692
55	R	0	1,132	177	309	646	626	20	96.9%	3	51	49	619	94	118	116	6	8	17	958	1,278	2,716
56	R	0	1,030	145	249	636	607	29	95.4%	0	34	10	602	58	66	65	3	3	15	494	494	2,471
57	R	4	1,040	95	306	639	575	64	90.0%	0	20	10	575	56	58	56	1	7	4	174	1,217	696
58	R	1	1,058	74	347	637	580	57	91.1%	1	11	13	572	42	57	56	3	0	6	517	0	1,034
59	R	3	1,219	177	376	666	628	38	94.3%	1	22	18	625	54	65	59	1	4	4	159	637	637
60	R	5	1,158	152	336	670	650	20	97.0%	4	40	13	650	67	73	73	3	7	7	462	1,077	1,077
61	O	1	948	83	254	611	588	23	96.2%	1	25	22	585	37	52	49	1	8	3	170	1,361	510
62	O	18	1,203	24	485	694	611	83	88.0%	0	1	5	611	40	42	42	2	3	5	327	491	818
Total			68,087	7,983	19,681	40,423	37,417	3,006	92.6%	80	1,478	1,916	37,221	3,409	4,780	4,612	103	211	459	275	564	1,227

3.3.2 Occupation

All participants received a structured interview by a trained interviewer of the central survey team, covering basic demographic factors, TB-related symptoms, health-seeking behavior and TB history.

The most common occupation among the participants was agriculture/forestry and fisheries (60.5% of males and 60.7% of females) (Tab 3.4). Unemployed including students were 16.2% of males and 20.8% of females. In the urban clusters, the service sector accounted for 39.2%, while in rural clusters, agriculture/forestry and fisheries were the most common occupations (71.1%).

Tab 3.4Occupation of participants

Age and sex	Participants	Agriculture, Forestry and		Industry		Service sector		Unemplyed		Unknown	
	N	N	%	N	%	N	%	N	%	N	%
Total	37,417	22,675	60.6%	1,852	4.9%	5,874	15.7%	7,015	18.7%	1	0.0%
15-24	10,568	4,560	43.1%	868	8.2%	1,311	12.4%	3,828	36.2%	1	0.0%
25-34	9,035	5,875	65.0%	736	8.1%	1,850	20.5%	574	6.4%	0	0.0%
35-44	6,012	4,338	72.2%	176	2.9%	1,161	19.3%	337	5.6%	0	0.0%
45-54	5,527	4,216	76.3%	57	1.0%	881	15.9%	373	6.7%	0	0.0%
55-64	3,448	2,516	73.0%	12	0.3%	474	13.7%	446	12.9%	0	0.0%
65-	2,827	1,170	41.4%	3	0.1%	197	7.0%	1,457	51.5%	0	0.0%
Male	17,007	10,281	60.5%	665	3.9%	3,298	19.4%	2,762	16.2%	1	0.0%
15-24	5,252	2,180	41.5%	285	5.4%	705	13.4%	2,081	39.6%	1	0.0%
25-34	4,225	2,792	66.1%	260	6.2%	1,066	25.2%	107	2.5%	0	0.0%
35-44	2,683	1,929	71.9%	71	2.6%	664	24.7%	19	0.7%	0	0.0%
45-54	2,402	1,842	76.7%	35	1.5%	491	20.4%	34	1.4%	0	0.0%
55-64	1,317	978	74.3%	11	0.8%	256	19.4%	72	5.5%	0	0.0%
65-	1,128	560	49.6%	3	0.3%	116	10.3%	449	39.8%	0	0.0%
Female	20,410	12,394	60.7%	1,187	5.8%	2,576	12.6%	4,253	20.8%	0	0.0%
15-24	5,316	2,380	44.8%	583	11.0%	606	11.4%	1,747	32.9%	0	0.0%
25-34	4,810	3,083	64.1%	476	9.9%	784	16.3%	467	9.7%	0	0.0%
35-44	3,329	2,409	72.4%	105	3.2%	497	14.9%	318	9.6%	0	0.0%
45-54	3,125	2,374	76.0%	22	0.7%	390	12.5%	339	10.8%	0	0.0%
55-64	2,131	1,538	72.2%	1	0.0%	218	10.2%	374	17.6%	0	0.0%
65-	1,699	610	35.9%	0	0.0%	81	4.8%	1,008	59.3%	0	0.0%
Strata (total)											
Urban	7,302	1,095	15.0%	993	13.6%	2,863	39.2%	2,351	32.2%	0	0.0%
Rural	28,916	20,570	71.1%	858	3.0%	2,979	10.3%	4,508	15.6%	1	0.0%
Others	1,199	1,010	84.2%	1	0.1%	32	2.7%	156	13.0%	0	0.0%
Strata (male)											
Urban	3,323	549	16.5%	344	10.4%	1,629	49.0%	801	24.1%	0	0.0%
Rural	13,138	9,283	70.7%	320	2.4%	1,649	12.6%	1,885	14.3%	1	0.0%
Others	546	449	82.2%	1	0.2%	20	3.7%	76	13.9%	0	0.0%
Strata (female)											
Urban	3,979	546	13.7%	649	16.3%	1,234	31.0%	1,550	39.0%	0	0.0%
Rural	15,778	11,287	71.5%	538	3.4%	1,330	8.4%	2,623	16.6%	0	0.0%
Others	653	561	85.9%	0	0.0%	12	1.8%	80	12.3%	0	0.0%

3.3.3 TB history

A total of 80 participants (0.21%), 46 males (0.27%) and 34 females (0.17%), reported that they were receiving TB treatment at the time of the survey. Of these, 12 (15%) were receiving treatment at public hospital, 60 (75%) at health center or health post and 4 (5.0%) at private hospital and 2 (2.5%) at private clinic.

A previous TB treatment history was reported by 1,478 participants (3.95 %). Among them, 480 (32.5%) had received treatment at government hospitals, 851 (57.6%) at health centers, 61(4.1%) at private hospitals, 48 (3.2%) at private clinics (Tab 3.5).

Tab 3.5 TB treatment history and care providers

Previously treated	Total		Sex				Strata of clusters					
			Male		Female		Urban		Rural		Others	
Care provider	N	%	N	%	N	%	N	%	N	%	N	%
Government hospital	480	32.5%	259	35.7%	221	29.3%	118	55.7%	359	29.0%	3	11.5%
Health center	851	57.6%	388	53.5%	463	61.5%	64	30.2%	765	61.7%	22	84.6%
Private clinic	48	3.2%	24	3.3%	24	3.2%	11	5.2%	37	3.0%	0	0.0%
Private hospital	61	4.1%	31	4.3%	30	4.0%	12	5.7%	49	4.0%	0	0.0%
Pharmacy	6	0.4%	4	0.6%	2	0.3%	5	2.4%	1	0.1%	0	0.0%
Traditional healer	1	0.1%	1	0.1%	0	0.0%	0	0.0%	1	0.1%	0	0.0%
Others	31	2.1%	18	2.5%	13	1.7%	2	0.9%	28	2.3%	1	3.8%
Total	1,478	100.0%	725	100.0%	753	100.0%	212	100.0%	1,240	100.0%	26	100.0%

On treatment	Total		Sex				Strata of clusters					
			Male		Female		Urban		Rural		Others	
Care provider	N	%	N	%	N	%	N	%	N	%	N	%
Government hospital	12	15.0%	4	8.7%	8	23.5%	4	57.1%	8	11.1%	0	0.0%
Health center	60	75.0%	37	80.4%	23	67.6%	1	14.3%	58	80.6%	1	100.0%
Private clinic	2	2.5%	1	2.2%	1	2.9%	1	14.3%	1	1.4%	0	0.0%
Private hospital	4	5.0%	2	4.3%	2	5.9%	1	14.3%	3	4.2%	0	0.0%
Pharmacy	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Traditional healer	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Others	2	2.5%	2	4.3%	0	0.0%	0	0.0%	2	2.8%	0	0.0%
Total	80	100.0%	46	100.0%	34	100.0%	7	100.0%	72	100.0%	1	100.0%

3.4 Field screening

3.4.1 TB-related symptoms

All the survey participants were interviewed about TB-related symptoms within the past month for symptom screening. The proportions of the participants who answered to have had cough of any duration, 1 week or longer, and 2 weeks or longer were 57.6%, 24.2% and 4.8%, respectively. The participants who had haemoptysis were 0.9%. Those eligible for sputum examinations (having had cough 2 weeks or longer, or haemoptysis) were 1,916 (5.1%) of all the participants (Tab 3.6).

Tab 3.7 shows interview results of TB-related symptoms by sex and age. The proportions of those eligible for sputum examinations significantly increased with age from 1.2% at the age of 15-24 years to 15.7% at the age of 65 years or above. They were 5.3% in males and 5.0% in females.

Tab 3.6 TB-related symptoms within a month

Symptoms	Number (a)	%
Cough any duration	21,555	57.6%
1 - 6 days	12,515	33.4%
7 - 13 days	7,236	19.3%
14 - 20 days	1,339	3.6%
21 days -	465	1.2%
Sputum	15,698	42.0%
Haemoptysis	319	0.9%
Chest pain	11,405	30.5%
Loss of weight	8,834	23.6%
Fatigue	15,727	42.0%
Fever	17,811	47.6%
Night sweat	5,957	15.9%
Others	389	1.0%
Cough >= 2 wks or heamoptysis	1,916	5.1%
Any symptom	29,536	78.9%
No symptom	7,881	21.1%
Total	37,417	100.0%

Tab 3.7 Interview results of TB-related symptoms

	Interviewed	Cough: any days		Cough: 1-13 days		Cough: 14-20 days		Cough: 21 days-		Sputum		Haemoptysis		Chest pain		Loss of weight		Fatigue		Fever		Night sweat		Other symptoms		Eligible for sputum		Any symptom		No symptom	
Age/sex	N	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Total	37,417	21,555	57.6%	19,751	52.8%	1,339	3.6%	465	1.2%	15,698	42.0%	319	0.9%	11,405	30.5%	8,834	23.6%	15,727	42.0%	17,811	47.6%	5,957	15.9%	389	1.0%	1,916	5.1%	29,536	78.9%	7,881	21.1%
15-24	10,568	5,179	49.0%	5,074	48.0%	75	0.7%	30	0.3%	3,675	34.8%	40	0.4%	2,278	21.6%	1,860	17.6%	3,224	30.5%	4,183	39.6%	1,043	9.9%	40	0.4%	131	1.2%	7,338	69.4%	3,230	30.6%
25-34	9,035	5,037	55.7%	4,830	53.5%	163	1.8%	44	0.5%	3,778	41.8%	56	0.6%	2,771	30.7%	1,911	21.2%	3,578	39.6%	4,371	48.4%	1,352	15.0%	80	0.9%	236	2.6%	7,172	79.4%	1,863	20.6%
35-44	6,012	3,597	59.8%	3,308	55.0%	214	3.6%	75	1.2%	2,616	43.5%	67	1.1%	2,020	33.6%	1,416	23.6%	2,518	41.9%	3,017	50.2%	1,055	17.5%	84	1.4%	309	5.1%	4,864	80.9%	1,148	19.1%
45-54	5,527	3,505	63.4%	3,076	55.7%	322	5.8%	107	1.9%	2,520	45.6%	77	1.4%	1,997	36.1%	1,544	27.9%	2,681	48.5%	2,869	51.9%	1,142	20.7%	92	1.7%	447	8.1%	4,672	84.5%	855	15.5%
55-64	3,448	2,276	66.0%	1,939	56.2%	245	7.1%	92	2.7%	1,661	48.2%	45	1.3%	1,267	36.7%	1,050	30.5%	1,869	54.2%	1,789	51.9%	733	21.3%	43	1.2%	350	10.2%	2,950	85.6%	498	14.4%
65-	2,827	1,961	69.4%	1,524	53.9%	320	11.3%	117	4.1%	1,448	51.2%	34	1.2%	1,072	37.9%	1,053	37.2%	1,857	65.7%	1,582	56.0%	632	22.4%	50	1.8%	443	15.7%	2,540	89.8%	287	10.2%
Male	17,007	10,098	59.4%	9,261	54.5%	629	3.7%	208	1.2%	7,717	45.4%	160	0.9%	5,244	30.8%	3,576	21.0%	6,196	36.4%	7,263	42.7%	2,446	14.4%	125	0.7%	897	5.3%	13,232	77.8%	3,775	22.2%
15-24	5,252	2666	50.8%	2,610	49.7%	39	0.7%	17	0.3%	1927	36.7%	22	0.4%	1165	22.2%	842	16.0%	1445	27.5%	1934	36.8%	487	9.3%	17	0.3%	70	1.3%	3639	69.3%	1613	30.7%
25-34	4,225	2488	58.9%	2396	56.7%	77	1.8%	15	0.4%	1945	46.0%	27	0.6%	1401	33.2%	820	19.4%	1447	34.2%	1826	43.2%	585	13.8%	27	0.6%	106	2.5%	3326	78.7%	899	21.3%
35-44	2,683	1690	63.0%	1552	57.8%	108	4.0%	30	1.1%	1284	47.9%	34	1.3%	941	35.1%	579	21.6%	988	36.8%	1225	45.7%	428	16.0%	25	0.9%	151	5.6%	2168	80.8%	515	19.2%
45-54	2,402	1593	66.3%	1382	57.5%	161	6.7%	50	2.1%	1223	50.9%	36	1.5%	854	35.6%	603	25.1%	1025	42.7%	1103	45.9%	450	18.7%	31	1.3%	219	9.1%	2005	83.5%	397	16.5%
55-64	1,317	891	67.7%	747	56.7%	102	7.7%	42	3.2%	724	55.0%	22	1.7%	485	36.8%	347	26.3%	626	47.5%	608	46.2%	261	19.8%	11	0.8%	152	11.5%	1108	84.1%	209	15.9%
65-	1,128	770	68.3%	574	50.9%	142	12.6%	54	4.8%	614	54.4%	19	1.7%	398	35.3%	385	34.1%	665	59.0%	567	50.3%	235	20.8%	14	1.2%	199	17.6%	986	87.4%	142	12.6%
Female	20,410	11,457	56.1%	10,490	51.4%	710	3.5%	257	1.3%	7,981	39.1%	159	0.8%	6,161	30.2%	5,258	25.8%	9,531	46.7%	10,548	51.7%	3,511	17.2%	264	1.3%	1,019	5.0%	16,304	79.9%	4,106	20.1%
15-24	5,316	2513	47.3%	2464	46.4%	36	0.7%	13	0.2%	1748	32.9%	18	0.3%	1113	20.9%	1018	19.1%	1779	33.5%	2249	42.3%	556	10.5%	23	0.4%	61	1.1%	3699	69.6%	1617	30.4%
25-34	4,810	2549	53.0%	2434	50.6%	86	1.8%	29	0.6%	1833	38.1%	29	0.6%	1370	28.5%	1091	22.7%	2131	44.3%	2545	52.9%	767	15.9%	53	1.1%	130	2.7%	3846	80.0%	964	20.0%
35-44	3,329	1907	57.3%	1756	52.7%	106	3.2%	45	1.4%	1332	40.0%	33	1.0%	1079	32.4%	837	25.1%	1530	46.0%	1792	53.8%	627	18.8%	59	1.8%	158	4.7%	2696	81.0%	633	19.0%
45-54	3,125	1912	61.2%	1694	54.2%	161	5.2%	57	1.8%	1297	41.5%	41	1.3%	1143	36.6%	941	30.1%	1656	53.0%	1766	56.5%	692	22.1%	61	2.0%	228	7.3%	2667	85.3%	458	14.7%
55-64	2,131	1385	65.0%	1192	55.9%	143	6.7%	50	2.3%	937	44.0%	23	1.1%	782	36.7%	703	33.0%	1243	58.3%	1181	55.4%	472	22.1%	32	1.5%	198	9.3%	1842	86.4%	289	13.6%
65-	1,699	1191	70.1%	950	55.9%	178	10.5%	63	3.7%	834	49.1%	15	0.9%	674	39.7%	668	39.3%	1192	70.2%	1015	59.7%	397	23.4%	36	2.1%	244	14.4%	1554	91.5%	145	8.5%
Strata																															
Urban	7,302	3,761	51.5%	3,619	49.6%	115	1.6%	27	0.4%	2,953	40.4%	21	0.3%	1,739	23.8%	1,277	17.5%	2,703	37.0%	3,037	41.6%	957	13.1%	81	1.1%	150	2.1%	5,402	74.0%	1,900	26.0%
Rural	28,916	17,135	59.3%	15,500	53.6%	1,205	4.2%	430	1.5%	12,236	42.3%	294	1.0%	9,251	32.0%	7,247	25.1%	12,635	43.7%	14,235	49.2%	4,922	17.0%	304	1.1%	1,739	6.0%	23,180	80.2%	5,736	19.8%
Others	1,199	659	55.0%	632	52.7%	19	1.6%	8	0.7%	509	42.5%	4	0.3%	415	34.6%	310	25.9%	389	32.4%	539	45.0%	78	6.5%	4	0.3%	27	2.3%	954	79.6%	245	20.4%

3.4.2 Chest X-ray examination

A total of 37,221 (99.5%) of the 37,417 participants received chest X-ray (CXR) examination (Tab 3.8). There were196 participants (61 males and 135females)who were exempted from CXR examination due to their difficulties in walking old age, refusal for possible pregnancy or being busy. Among those examined with CXR, 3,409 (9.2%) were eligible for sputum examinations due to abnormal findings. More males (10.7%) had abnormal lung findings in CXR than females (7.9%), and the proportion also increased significantly with age from 1.7% in those aged 15-24 years to 34.8% in those aged 65 years or older.

Tab 3.8 Field screening by Chest X-ray

Age and sex	Participants	CXR taken		CXR not taken	Eligible for sputum	
	N (a)	N (b)	% (b/a)	N	N (c)	% (c/b)
Total	37,417	37,221	99.5%	196	3,409	9.2%
15-24	10,568	10,543	99.8%	25	183	1.7%
25-34	9,035	9,016	99.8%	19	326	3.6%
35-44	6,012	6,003	99.9%	9	505	8.4%
45-54	5,527	5,515	99.8%	12	731	13.3%
55-64	3,448	3,432	99.5%	16	720	21.0%
65-	2,827	2,712	95.9%	115	944	34.8%
Male	17,007	16,946	99.6%	61	1,813	10.7%
15-24	5,252	5,242	99.8%	10	109	2.1%
25-34	4,225	4,221	99.9%	4	202	4.8%
35-44	2,683	2,681	99.9%	2	290	10.8%
45-54	2,402	2,400	99.9%	2	411	17.1%
55-64	1,317	1,312	99.6%	5	339	25.8%
65-	1,128	1,090	96.6%	38	462	42.4%
Female	20,410	20,275	99.3%	135	1,596	7.9%
15-24	5,316	5,301	99.7%	15	74	1.4%
25-34	4,810	4,795	99.7%	15	124	2.6%
35-44	3,329	3,322	99.8%	7	215	6.5%
45-54	3,125	3,115	99.7%	10	320	10.3%
55-64	2,131	2,120	99.5%	11	381	18.0%
65-	1,699	1,622	95.5%	77	482	29.7%
Strata						
Urban	7,302	7,272	99.6%	30	494	6.8%
Rural	28,916	28,753	99.4%	163	2,838	9.9%
Others	1,199	1,196	99.7%	3	77	6.4%

3.5 Central reading and final reading of CXR

After the field screening, all the CXR films were interpreted by two Cambodian doctors (central reading) and one of the two Japanese experts. For CXR films with discrepant results between the central reading and the Japanese expert reading, the final reading was decided by another Japanese expert. Tab 3.9 shows the comparison of CXR reading results between the central reading and the final reading. There were 735 (2.0%) subjects with CXR suggestive of active TB, 1,462 (3.9%) with healed TB and 633 (1.7%) with other lung diseases on CXR after the final results of CXR reading. The concordance rates of the central reading to the final reading were 47.5% in CXR suggestive of active TB, 55.5% in healed TB, and 98.1% in other lung diseases. The overall concordance rate was 97.0% of the 37,221 films.

Tab 3.9 Comparison of CXR results between central and final reading

Final CXR reading results	Central reading results							
	Normal	Active TB-suggestive	Healed TB	Other lung diseases	Findings other than lung	No CXR taken or missing	Total	%
Normal	34,185	1	0	58	0	0	34,244	91.5%
Active TB-suggestive	14	349	221	147	4	0	735	2.0%
Healed TB	32	22	812	594	2	0	1,462	3.9%
Other lung diseases	10	1	0	621	1	0	633	1.7%
Findings other than lung	0	0	0	1	145	0	146	0.4%
No CXR taken or missing	0	0	0	0	0	197	197	0.5%
Total	34,241	373	1,033	1,421	152	197	37,417	100.0%
%	91.5%	1.0%	2.8%	3.8%	0.4%	0.5%	100.0%	

Tab 3.10 shows the comparison between the field screening results and the final reading results of CXR. The proportions of positive results based on the field CXR screening were 97.4% in those with CXR suggestive of active TB, 90.5% in those with healed TB and 68.6% in those with other lung diseases, but combining the CXR screening with symptom screening resulted in a small increase to 97.7%, 91.1% and 72.0%, respectively. Although those without CXR were to submit sputum specimens regardless of the presence of symptoms, only 165 (84.2%) of the 196 subjects without CXR submitted their sputum specimens.

Tab 3.10 Results of field screening and final reading by CXR

Final CXR reading	Total	Eligible for sputum by CXR		All sputum specimens submitted	
	N	N	%	N	%
	37,417	3,409	9.1%	4,612	12.3%
Normal	34,244	877	2.6%	1,870	5.5%
Active TB-suggestive	735	716	97.4%	718	97.7%
Healed TB	1,462	1,323	90.5%	1,332	91.1%
Other lung diseases	633	434	68.6%	456	72.0%
Findings other than lung	146	59	40.4%	71	48.6%
missing film	1	0	0.0%	0	0.0%
No CXR taken	196	0	0.0%	165	84.2%

3.6 Summary of screening results

A total of 4,780 (12.8%) of the 37,417 participants were eligible for sputum examinations (Tab 3.11): 710 (14.9%) eligible by both symptoms and CXR, 2,699 (56.5%) eligible by CXR only, 1,167 (24.4%) eligible by symptoms only, 196 (4.1%) without CXR (39 eligible and 157 ineligible by symptoms) and 8 (0.17%) for other reasons.

Tab 3.11 Field screening summary

CXR screening	Interview screening: Eligible	Interview screening: Not eligible	sub-total
Eligible	**710**	**2,699**	3,409
Not eligible	**1,167**	32,637	33,804
sub-total	1,877	35,336	37,213
no CXR	39	157	**196**
Others	0	8	**8**
Total			37,417
Number of subjects eligible for sputum =			**4,780**

3.7 Laboratory examinations

3.7.1 Sputum collection and available laboratory results

A total of 4,780 subjects were considered eligible for sputum examinations and were asked to submit two sputum specimens. Of these, 4,612 (96.5%) subjects submitted at least one specimen. Tab 3.12 shows how many subjects obtained a complete set of laboratory examinations, which ideally consists of 2 smear and 2 culture results. However, in reality, some laboratory results were incomplete due to no submission of specimens, broken smear slides, contamination of culture examination, etc. Consequently, out of the 4,780 subjects eligible for sputum examinations, 4,473 (93.6%) had 2 smear and 2 culture results.

The combined results based on symptom and CXR screening are shown in the upper part of Tab 3.12; 132 subjects with positive symptom and normal CXR had no sputum submission, because some respiratory symptoms were overlooked or wrongly recorded in the form. Thirty one subjects without CXR taken were also overlooked.

Tab 3.12 Screening / final CXR reading and laboratory results (FM and culture)

Field screening by symptoms and CXR	Eligible	Laboratory results (FM and culture): 2 smear/ 2		2 smear/ 1		2 smear/ 0		1 smear/ 1		1or 0 smear/ 2		No sputum	
	N	N	%	N	%	N	%	N	%	N	%	N	%
Total	4,780	4,473	93.6%	108	2.3%	10	0.2%	14	0.3%	7	0.1%	168	3.5%
Symptom- / CXR+	2,699	2,612	96.8%	65	2.4%	6	0.2%	9	0.3%	2	0.1%	5	0.2%
Symptom+ / CXR-	1,167	1,013	86.8%	16	1.4%	0	0.0%	5	0.4%	1	0.1%	132	11.3%
Symptom+ / CXR+	710	678	95.5%	25	3.5%	4	0.6%	0	0.0%	3	0.4%	0	0.0%
Symptom+ / no CXR	39	37	94.9%	1	2.6%	0	0.0%	0	0.0%	1	2.6%	0	0.0%
Symptom- / no CXR	157	125	79.6%	1	0.6%	0	0.0%	0	0.0%	0	0.0%	31	19.7%
Others	8	8	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Final CXR reading													
Total	4,780	3,942	82.5%	108	2.3%	10	0.2%	14	0.3%	7	0.1%	168	3.5%
Normal	2,000	1824	91.2%	36	1.8%	1	0.1%	7	0.4%	2	0.1%	130	6.5%
Active TB-suggestive	718	162	22.6%	20	2.8%	2	0.3%	1	0.1%	2	0.3%	0	0.0%
Healed TB	1,335	1287	96.4%	34	2.5%	5	0.4%	4	0.3%	2	0.1%	3	0.2%
Other lung diseases	460	438	95.2%	14	3.0%	2	0.4%	2	0.4%	0	0.0%	4	0.9%
Findings other than lung	71	69	97.2%	2	2.8%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
No CXR	196	162	82.7%	2	1.0%	0	0.0%	0	0.0%	1	0.5%	31	15.8%

3.7.2 Smear examination by fluorescence microscopy

The results of smear examinations by fluorescence microscopy (FM) are shown in Tab 3.13. In total, there were 106 subjects with at least one positive smear: 100 with 2 positive slides from both spot and morning specimen and 6 with 1 positive slide (5 spot and 1 morning specimens). Ninety nine (93%) of the smear-positive subjects had abnormal CXR findings: 81 (76%) subjects with CXR suggestive of active TB, 13 (12%) with healed TB and 4 (3.8%) with other lung diseases. There were 7 (6.6%) smear-positive subjects with normal CXRs, of whom 6 subjects had negative culture and one had positive culture with *Mycobacterium tuberculosis* (MTB).

Tab 3.13 Screening / final CXR reading and FM smear results

Field screening by symptoms and CXR	Eligible	Smear results by FM (spot/morning)															
		S+/S+		S+/S-		S-/S+		S-/S-		S-/NA		NA/S-		NA/NA		Any S+	
	N	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Total	4,780	100	2.1%	5	0.1%	1	0.0%	4,485	93.8%	17	0.4%	3	0.1%	169	3.5%	106	2.2%
Symptom- / CXR+	2,699	54	2.0%	3	0.1%	1	0.0%	2,625	97.3%	10	0.4%	0	0.0%	6	0.2%	58	2.1%
Symptom+ / CXR-	1,167	5	0.4%	1	0.1%	0	0.0%	1,023	87.7%	6	0.5%	0	0.0%	132	11.3%	6	0.5%
Symptom+ / CXR+	710	40	5.6%	1	0.1%	0	0.0%	666	93.8%	1	0.1%	2	0.3%	0	0.0%	41	5.8%
Symptom+ / no CXR	39	0	0.0%	0	0.0%	0	0.0%	38	97.4%	0	0.0%	1	2.6%	0	0.0%	0	0.0%
Symptom- / no CXR	157	1	0.6%	0	0.0%	0	0.0%	125	79.6%	0	0.0%	0	0.0%	31	19.7%	1	0.6%
Others	8	0	0.0%	0	0.0%	0	0.0%	8	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Final CXR reading																	
Total	4,780	100	2.1%	5	0.1%	1	0.0%	4,485	93.8%	17	0.4%	3	0.1%	169	3.5%	106	2.2%
Normal	2,000	5	0.3%	2	0.1%	0	0.0%	1,854	92.7%	9	0.5%	0	0.0%	130	6.5%	7	0.4%
Active TB-suggestive	718	81	11.3%	0	0.0%	0	0.0%	634	88.3%	1	0.1%	1	0.1%	1	0.1%	81	11.3%
Healed TB	1,335	10	0.7%	3	0.2%	0	0.0%	1,313	98.4%	5	0.4%	1	0.1%	3	0.2%	13	1.0%
Other lung diseases	460	3	0.7%	0	0.0%	1	0.2%	450	97.8%	2	0.4%	0	0.0%	4	0.9%	4	0.9%
Findings other than lung	71	0	0.0%	0	0.0%	0	0.0%	71	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
No CXR	196	1	0.5%	0	0.0%	0	0.0%	163	83.2%	0	0.0%	1	0.5%	31	15.8%	1	0.5%

3.7.3 Smear examination by conventional smear microscopy

To maintain the compatibility with other survey results, especially with the first prevalence survey in 2002, we re-examined smear slides from any bacteriologically positive (smear-positive or culture-positive) subjects, the bacteriologically negative subjects with CXR suggestive of active TB and some negative control slides by the conventional smear microscopy with Ziehl-Neelsen stain (ZN). The number of subjects for re-examination with ZN method and the number of those who were actually re-examined are shown in Tab 3.14. In total, 2,108 slides from 1,330 subjects were re-examined including 340 bacteriologically positive subjects and 443 bacteriologically negative subjects with CXR suggestive of active TB. Due to broken or missing smear slides, 9 (1.1%) subjects (7 bacteriologically positive subjects and 2 bacteriologically negative subjects with CXR suggestive of active TB) were re-examined for one slide only and 4 (0.5%) subjects (1 bacteriologically positive subject and 3 bacteriologically negative subjects with CXR suggestive of active TB) were not re-examined.

Tab 3.14 Subjects for reexaminations with ZN method

by fluorescent microscopy, culture and CXR	by conventional microscopy with Ziehl-Neelsen method						
	Total	2 smears		1 smear only		no smear	
	N	N	%	N	%	N	%
Bac+	340	332	97.6%	7	2.1%	1	0.3%
Bac-/Active TB	443	438	98.9%	2	0.5%	3	0.7%
Negative control	547	12	2.2%	535	97.8%	0	0.0%
sub-total	1,330	782	58.8%	544	40.9%	4	0.3%

Total number of slides reexamined = 2,108

Tab 3.15shows the results of re-examined subjects from the field screening (symptoms and CXR) or from the final CXR reading. Many of the re-examined subjects were selected from the subjects with abnormal CXR: 33.5% of the subjects with negative symptom and abnormal CXR and 36.8% of the subjects with positive symptom and abnormal CXR. Tab 3.16 shows the number of specimens available by ZN method and culture examination. Of the 1,330 re-examined subjects, 782 (58.8%) subjects had 2 smear-slide results, while the remaining subjects, most of whom were negative controls with two negative slides by FM, had only one slide available.

Smear results by ZN method are shown in Tab 3.17. There were a total of 114 subjects with positive smear: 81 subjects with two positive slides and 33 with one positive slide (11 spot and 22 morning specimens). Of these, 106 (93%) subjects had abnormal CXR: 91 (80%) with CXR suggestive of active TB, 10 (8.8%) with healed TB and 3 (2.6%) with other lung diseases. Nine subjects with positive smear had normal CXRs, of whom 8 subjects had negative culture and one had positive culture with MTB. Tab 3.18 shows the association of ZN smear results between spot and morning sputum. Smear positivity in morning specimens was greater than that in spot specimens (7.7%v.s. 6.9%).

Tab 3.15 Comparison of subjects between fluorescent microscopy (FM) and Ziehl-Neelsen method (ZN)

Field screening by symptoms and CXR	Fluorescent microscopy	Subjects for Ziehl-Neelsen method							
		Bac+ (S+ and/or C+)		Bac-/ active TB		Negative control		Re-examined (total)	
	N	N	%	N	%	N	%	N	%
Total	4,780	340	7.1%	443	9.3%	547	11.4%	1,330	27.8%
Symptom- / CXR+	2,699	230	8.5%	351	13.0%	323	12.0%	904	33.5%
Symptom+ / CXR-	1,167	16	1.4%	0	0.0%	132	11.3%	148	12.7%
Symptom+ / CXR+	710	91	12.8%	92	13.0%	78	11.0%	261	36.8%
Symptom+ / no CXR	39	0	0.0%	0	0.0%	2	5.1%	2	5.1%
Symptom- / no CXR	157	3	1.9%	0	0.0%	11	7.0%	14	8.9%
Others	8	0	0.0%	0	0.0%	1	12.5%	1	12.5%
Final CXR reading	4,780	340	7.1%	443	9.3%	547	11.4%	1,330	27.8%
Normal	2,000	16	0.8%	0	0.0%	246	12.3%	262	13.1%
Active TB-suggestive	718	275	38.3%	443	61.7%	0	0.0%	718	100.0%
Healed TB	1,335	38	2.8%	0	0.0%	216	16.2%	254	19.0%
Other lung diseases	460	8	1.7%	0	0.0%	62	13.5%	70	15.2%
Findings other than lung	71	0	0.0%	0	0.0%	10	14.1%	10	14.1%
No CXR	196	3	1.5%	0	0.0%	13	6.6%	16	8.2%

Tab 3.16 Screening / final CXR reading and available lab results (ZN and culture)

Laboratory results	Number of subjects	2 smear/ 2 culture		2 smear/ 1 culture		2 smear/ no culture		1 smear/ 2 culture		1 smear/ 1 culture		1 smear/ no culture		No smear (0 or 2 culture)	
Screening	N	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Total	1,330	757	56.9%	23	1.7%	2	0.2%	531	39.9%	12	0.9%	1	0.1%	4	0.3%
Symptom- / CXR+	904	562	62.2%	16	1.8%	0	0.0%	317	35.1%	8	0.9%	0	0.0%	1	0.1%
Symptom+ / CXR-	148	18	12.2%	0	0.0%	0	0.0%	127	85.8%	2	1.4%	0	0.0%	1	0.7%
Symptom+ / CXR+	261	174	66.7%	7	2.7%	2	0.8%	73	28.0%	2	0.8%	1	0.4%	2	0.8%
Symptom+ / no CXR	2	0	0.0%	0	0.0%	0	0.0%	2	100.0%	0	0.0%	0	0.0%	0	0.0%
Symptom- / no CXR	14	3	21.4%	0	0.0%	0	0.0%	11	78.6%	0	0.0%	0	0.0%	0	0.0%
Others	1	0	0.0%	0	0.0%	0	0.0%	1	100.0%	0	0.0%	0	0.0%	0	0.0%
Final CXR reading															
Total	1,330	757	56.9%	23	1.7%	2	0.2%	531	39.9%	12	0.9%	1	0.1%	4	0.3%
Normal	262	21	8.0%	1	0.4%	0	0.0%	235	89.7%	4	1.5%	0	0.0%	1	0.4%
Active TB-suggestive	718	686	95.5%	20	2.8%	2	0.3%	6	0.8%	1	0.1%	0	0.0%	3	0.4%
Healed TB	254	37	14.6%	2	0.8%	0	0.0%	211	83.1%	4	1.6%	0	0.0%	0	0.0%
Other lung diseases	70	10	14.3%	0	0.0%	0	0.0%	58	82.9%	1	1.4%	1	1.4%	0	0.0%
Findings other than lung	10	0	0.0%	0	0.0%	0	0.0%	8	80.0%	2	20.0%	0	0.0%	0	0.0%
No CXR	16	3	18.8%	0	0.0%	0	0.0%	13	81.3%	0	0.0%	0	0.0%	0	0.0%

Tab 3.17 Screening / final CXR reading and smear results (ZN)

Field screening by symptoms and CXR	Number of subjects	Smear results by ZN (spot/morning)																	
		S+/S+		S+/S-		S+/NA		S-/S+		S-/S-		S-/NA		NA/S-		NA/NA		Any S+	
	N	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Total	1,330	81	6.1%	7	0.5%	4	0.3%	22	1.7%	674	50.7%	292	22.0%	246	18.5%	4	0.3%	114	8.6%
Symptom- / CXR+	904	42	4.6%	6	0.7%	2	0.2%	12	1.3%	519	57.4%	172	19.0%	150	16.6%	1	0.1%	62	6.9%
Symptom+ / CXR-	148	1	0.7%	0	0.0%	2	1.4%	4	2.7%	14	9.5%	74	50.0%	52	35.1%	1	0.7%	7	4.7%
Symptom+ / CXR+	261	37	14.2%	1	0.4%	0	0.0%	6	2.3%	139	53.3%	39	14.9%	37	14.2%	2	0.8%	44	16.9%
Symptom+ / no CXR	2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	50.0%	1	50.0%	0	0.0%	0	0.0%
Symptom- / no CXR	14	1	7.1%	0	0.0%	0	0.0%	0	0.0%	2	14.3%	5	35.7%	6	42.9%	0	0.0%	1	7.1%
Others	1	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	100.0%	0	0.0%	0	0.0%	0	0.0%
Final CXR reading																			
Total	1,330	81	6.1%	7	0.5%	4	0.3%	22	1.7%	674	50.7%	292	22.0%	246	18.5%	4	0.3%	114	8.6%
Normal	262	1	0.4%	0	0.0%	3	1.1%	5	1.9%	18	6.9%	129	49.2%	105	40.1%	1	0.4%	9	3.4%
Active TB-suggestive	718	72	10.0%	5	0.7%	1	0.1%	13	1.8%	618	86.1%	4	0.6%	2	0.3%	3	0.4%	91	12.7%
Healed TB	254	5	2.0%	2	0.8%	0	0.0%	3	1.2%	29	11.4%	122	48.0%	93	36.6%	0	0.0%	10	3.9%
Other lung diseases	70	2	2.9%	0	0.0%	0	0.0%	1	1.4%	7	10.0%	25	35.7%	35	50.0%	0	0.0%	3	4.3%
Findings other than lung	10	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	6	60.0%	4	40.0%	0	0.0%	0	0.0%
No CXR	16	1	6.3%	0	0.0%	0	0.0%	0	0.0%	2	12.5%	6	37.5%	7	43.8%	0	0.0%	1	6.3%

Tab 3.18 Comparison of ZN smear results between spot and morning sputum

Spot sputum (ZN)	Morning sputum (ZN)							
	Negative	Scanty	1+	2+	3+	NA	sub-total	%
Negative	674	16	2	2	0	292	986	74.1%
Scanty	7	26	5	2	2	4	46	3.5%
1+	0	11	11	2	1	0	25	1.9%
2+	0	1	2	4	1	0	8	0.6%
3+	0	0	2	2	9	0	13	1.0%
NA	246	2	0	0	0	4	252	18.9%
sub-total	927	56	22	12	13	300	1,330	100.0%
%	69.7%	4.2%	1.7%	0.9%	1.0%	22.6%	100.0%	

3.7.4 Culture examination

All the sputum specimens from 4,612 subjects were inoculated for culture examination, of which 10 subjects had no culture results due to contamination (Tab 3.19). There were 316 culture-positive subjects: 127 with two positive specimens and 189 with one positive specimen (92 spot and 97 morning specimens). Of these, 302 (96%) subjects had abnormal CXR: 267 (84%) with CXR suggestive of active TB, 30 (9.5%) with healed TB and 6 (1.9%) with other lung diseases on CXR. Ten culture-positive subjects had normal CXR, of whom 5 subjects had positive identification test results for *Mycobacterium tuberculosis*(MTB), 4 had negative test results (Mycobacteria other than tuberculosis: MOTT) and 1 had no test result.

Tab 3.20 shows the relationship between the smear and the culture results in spot specimens (the upper part), morning specimens (in the middle part) and combined results (in the lower part). In the combined results with spot and morning specimens, 114 subjects out of the 1,330 subjects re-examined by ZN method were smear-positive:90 (79%) subjects with MTB identified, 4 (3.5%) with MOTT, 19 (17%) with negative culture and 1 without a result due to contamination. Of the 90 smear-positive subjects with MTB identified, 38 (42%) were scanty-positive and 26 (29%) were grade 1+ positive.

Of 1,212 smear-negative subjects and 4 subjects with no smear results, 222 subjects tested positive by culture: 215 with MTB and 5 with MOTT isolated. There were two subjects with negative smear but positive culture; however, identification tests were not performed since there was no growth from sub-culture.

Tab 3.19 Screening / final CXR reading and culture results

Field screening by symptoms and CXR	Number of subjects	Culture results (spot / morning)																			
		C+/C+		C+/C-		C-/C+		C-/C-		C-/		contaminated		2		C-/NA		NA/NA		Any C+	
	N	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Total	4,780	127	2.7%	92	1.9%	97	2.0%	4,170	87.2%	62	1.3%	41	0.9%	10	0.2%	13	0.3%	168	3.5%	316	6.6%
Symptom- / CXR+	2,699	85	3.1%	61	2.3%	75	2.8%	2,398	88.8%	37	1.4%	24	0.9%	6	0.2%	8	0.3%	5	0.2%	221	8.2%
Symptom+ / CXR-	1,167	1	0.1%	5	0.4%	5	0.4%	1,003	85.9%	9	0.8%	7	0.6%	0	0.0%	5	0.4%	132	11.3%	11	0.9%
Symptom+ / CXR+	710	41	5.8%	24	3.4%	16	2.3%	601	84.6%	15	2.1%	9	1.3%	4	0.6%	0	0.0%	0	0.0%	81	11.4%
Symptom+ / no CXR	39	0	0.0%	0	0.0%	0	0.0%	38	97.4%	0	0.0%	1	2.6%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Symptom- / no CXR	157	0	0.0%	2	1.3%	1	0.6%	122	77.7%	1	0.6%	0	0.0%	0	0.0%	0	0.0%	31	19.7%	3	1.9%
Others	8	0	0.0%	0	0.0%	0	0.0%	8	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Final CXR reading																					
Total	4,780	127	2.7%	92	1.9%	97	2.0%	4,170	87.2%	62	1.3%	41	0.9%	10	0.2%	13	0.3%	168	3.5%	316	6.6%
Normal	2,000	1	0.1%	3	0.2%	6	0.3%	1,816	90.8%	20	1.0%	16	0.8%	1	0.1%	7	0.4%	130	6.5%	10	0.5%
Active TB-suggestive	718	121	16.9%	69	9.6%	77	10.7%	433	60.3%	9	1.3%	7	1.0%	2	0.3%	0	0.0%	0	0.0%	267	37.2%
Healed TB	1,335	4	0.3%	14	1.0%	12	0.9%	1,260	94.4%	23	1.7%	10	0.7%	5	0.4%	4	0.3%	3	0.2%	30	2.2%
Other lung diseases	460	1	0.2%	4	0.9%	1	0.2%	432	93.9%	9	2.0%	5	1.1%	2	0.4%	2	0.4%	4	0.9%	6	1.3%
Findings other than lung	71	0	0.0%	0	0.0%	0	0.0%	69	97.2%	0	0.0%	2	2.8%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
No CXR	196	0	0.0%	2	1.0%	1	0.5%	160	81.6%	1	0.5%	1	0.5%	0	0.0%	0	0.0%	31	15.8%	3	1.5%

Tab 3.20 Relationship between smear and culture results (spot and morning sputum)

Culture results	Smear results of spot sputum by ZN						
	Negative	Scanty	1+	2+	3+	NA	sub-total
Negative	821	14	2	2	4	249	1,092
MTB	149	29	21	6	9	0	214
MOTT	2	2	1	0	0	0	5
No identification	0	0	0	0	0	0	0
Contaminated	14	1	1	0	0	3	19
NA	0	0	0	0	0	0	0
sub-total	986	46	25	8	13	252	1,330

Culture results	Smear results of morning sputum by ZN						
	Negative	Scanty	1+	2+	3+	NA	sub-total
Negative	769	11	6	4	3	291	1,084
MTB	140	39	15	8	10	4	216
MOTT	3	3	0	0	0	0	6
No identification	2	0	0	0	0	0	2
Contaminated	12	3	1	0	0	4	20
NA	1	0	0	0	0	1	2
sub-total	927	56	22	12	13	300	1,330

Culture results	Combined results of smear by ZN						
	Negative	Scanty	1+	2+	3+	NA	sub-total
Negative	988	13	2	1	3	4	1,011
MTB	215	38	26	12	14	0	305
MOTT	5	3	1	0	0	0	9
No identification	2	0	0	0	0	0	2
Contaminated	2	1	0	0	0	0	3
NA	0	0	0	0	0	0	0
sub-total	1212	55	29	13	17	4	1,330

3.8 Central medical panel

Based on the survey TB case definitions, the central medical panel categorized 103 subjects (90 definite and 13 probable cases) as smear-positive TB and 211 subjects (211 definite cases) as smear-negative, culture-positive TB.

There were a total of 114 smear-positive subjects; 90 subjects with culture-confirmed TB (definite cases), and 13 culture-negative subjects (probable cases) including 2 cases on TB treatment (10 cases with 2 positive slides, and 3 cases with 1 positive slide and CXR suggestive of active TB). However, 4 subjects with MOTT and 7 subjects with normal CXR were excluded from the cases by the panel.

There were 222 smear-negative, culture-positive subjects; however, the panel excluded 5 subjects with MOTT, 2 subjects lacking either identification results or CXR suggestive of active TB, and 4 subjects who had 4 colonies or less in culture and did not have CXRs suggestive of active TB.

In total, 22 subjects (11 smear-positive subjects and 11 smear-negative, culture-positive subjects) were excluded from the survey TB cases as shown in Tab 3.21.

Tab 3.21 Excluded subjects from TB cases

No	Age	Sex	Smear (ZN)		Culture		ID test	CXR	TB history
			D1	D2	D1	D2			
1	54	F	Neg	Scanty	Neg	Neg		Normal	N
2	23	F	Neg	Scanty	Neg	Neg		Normal	N
3	56	M	Scanty	Scanty	3+	3+	MOTT	Healed TB	N
4	27	F	NA*	Scanty	Neg	Neg		Normal	N
5	25	M	Scanty	NA*	Neg	Neg		Normal	N
6	67	F	Scanty	NA*	Neg	Neg		Normal	N
7	65	F	Scanty	Scanty	1+	Neg	MOTT	Other lung disease	N
8	54	F	1+	Scanty	1+	2+	MOTT	Healed TB	Past
9	63	M	Scanty	NA*	Neg	Neg		Normal	N
10	46	F	NA*	Scanty	Neg	Neg		Normal	N
11	39	M	Neg	Scanty	Neg	1 clolony	MOTT	Other lung disease	N
12	67	M	Neg	Neg	Neg	4 colonies	Mtb	Healed TB	N
13	50	M	Neg	Neg	3 colonies	Neg	Mtb	Other lung disease	N
14	46	M	Neg	Neg	Neg	2 colonies	MOTT	Normal	N
15	23	F	Neg	Neg	Neg	3 colonies	Mtb	Normal	N
16	50	F	Neg	Neg	1+	Neg	MOTT	Other lung disease	N
17	40	F	Neg	Neg	Neg	2 colonies	MOTT	Normal	N
18	21	F	Neg	Neg	Neg	3 colonies	MOTT	Normal	N
19	67	M	Neg	Neg	Neg	6 colonies	NA	Healed TB	N
20	56	F	Neg	Neg	2 colonies	Neg	MOTT	Normal	N
21	75	F	Neg	Neg	1 colony	Neg	Mtb	Other lung disease	N
22	65	F	Neg	Neg	Neg	3+	NA	Normal	N

NA*: smear results by ZN stain are not available, but negative-smear by FM

3.9 TB cases identified in the survey

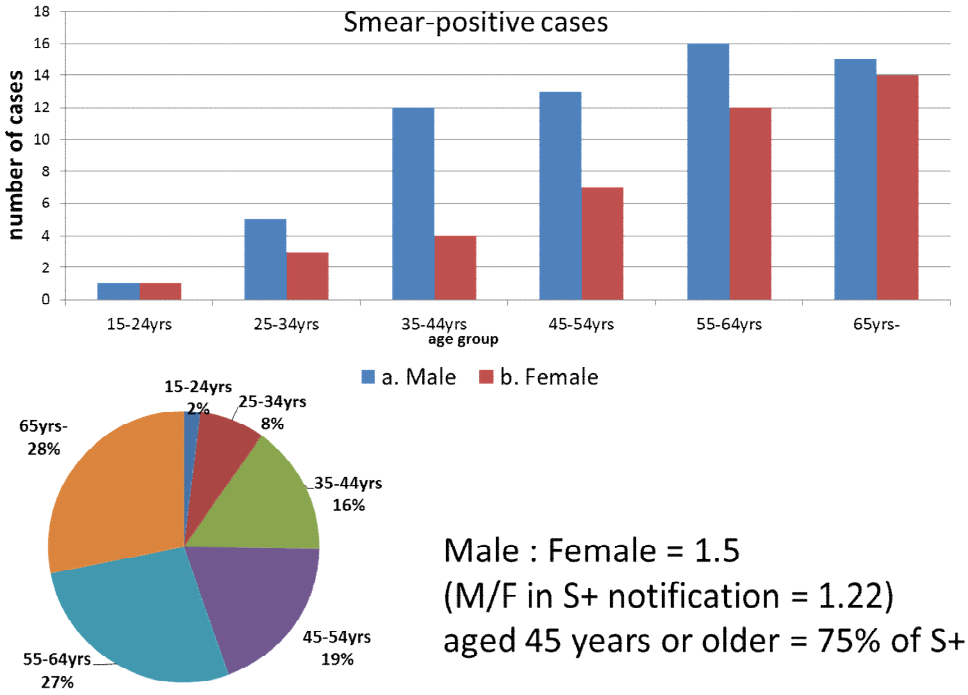
3.9.1 Overview of TB cases identified in the survey

Age distributions by sex among smear-positive TB cases and smear-negative, culture-positive TB cases identified in the survey are shown in Fig 3.4 and Fig 3.5, respectively. The number of TB cases detected increased with age and those aged 45 years or older accounted for 75 % of smear-positive TB and 63 % of smear-negative, culture-positive TB. The ratio of male to female was 1.5 both in smear-positive and smear-negative, culture-positive TB.

The number of TB cases detected in the survey and its crude TB prevalence rate by age, sex, and stratum are shown in Tab 3.22. The crude prevalence rate of smear-negative, culture-positive TB was 2.1 times higher than that smear-positive TB (564 vs. 275 per 100,000). The prevalence rates increased sharply with age and reached approximately 1% in smear-positive TB, 2% in smear-negative, culture-positive TB and 3% in bacteriologically positive TB at the age of 65 years or older. The crude smear-positive prevalence rate in males was 1.8 times higher than that females (365 vs. 201 per 100, 000). The crude smear-positive prevalence rate in rural clusters was 2.3 times higher than that in urban clusters (311 vs. 137 per 100,000).

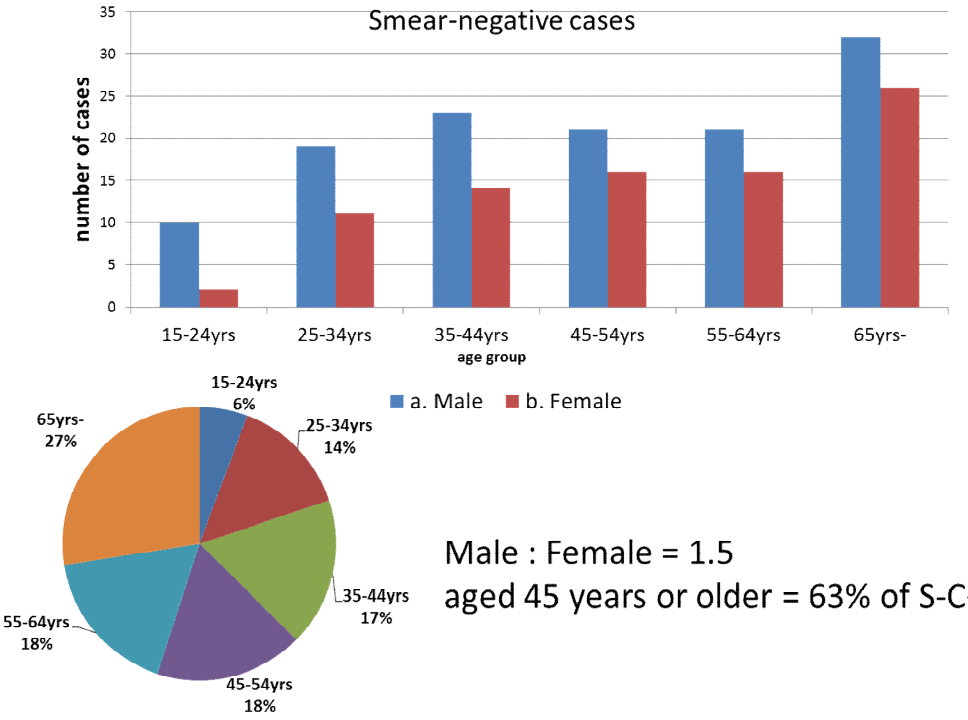
Characteristics of the 314 TB cases including age, sex, symptoms, CXR results, cluster stratum and TB history are shown in Tab 3.23. Ninety eight per cent of all TB cases had some abnormal shadow on CXR: 87.9% with CXR suggestive of active TB, 9.2% with healed TB and 0.3% with other lung diseases. CXR suggestive of active TB was seen in about 88% for both smear-positive TB cases and smear-negative, culture-positive TB cases. There were 5 (1.6%) cases without any abnormality on CXR. Six (1.9%) cases were on treatment and 26 (8.3%) cases had previous treatment history.

Fig 3.4 S(+) age-sex distribution



Male : Female = 1.5
(M/F in S+ notification = 1.22)
aged 45 years or older = 75% of S+

Fig 3.5 S(-)C(+) age-sex distribution



Male : Female = 1.5
aged 45 years or older = 63% of S-C+

Tab 3.22 Summary of TB cases by age and sex, and stratum

	Number of attendees	Number of cases					Crude prevalence rate (100,000)				
		Smear+	S-Culture+	Bac+	Bac-CXR active	Pulmonary TB	Smear+	S-Culture+	Bac+	Bac-CXR active	Pulmonary TB
Total	37,417	103	211	314	459	773	275	564	839	1,227	2,066
15-24	10,568	2	12	14	24	38	19	114	132	227	360
25-34	9,035	8	30	38	55	93	89	332	421	609	1,029
35-44	6,012	16	37	53	98	151	266	615	882	1,630	2,512
45-54	5,527	20	37	57	109	166	362	669	1,031	1,972	3,003
55-64	3,448	28	37	65	74	139	812	1,073	1,885	2,146	4,031
65-	2,827	29	58	87	99	186	1,026	2,052	3,077	3,502	6,579
male	17,007	62	126	188	271	459	365	741	1,105	1,593	2,699
15-24	5,252	1	10	11	15	26	19	190	209	286	495
25-34	4,225	5	19	24	36	60	118	450	568	852	1,420
35-44	2,683	12	23	35	54	89	447	857	1,305	2,013	3,317
45-54	2,402	13	21	34	64	98	541	874	1,415	2,664	4,080
55-64	1,317	16	21	37	48	85	1,215	1,595	2,809	3,645	6,454
65-	1,128	15	32	47	54	101	1,330	2,837	4,167	4,787	8,954
female	20,410	41	85	126	188	314	201	416	617	921	1,538
15-24	5,316	1	2	3	9	12	19	38	56	169	226
25-34	4,810	3	11	14	19	33	62	229	291	395	686
35-44	3,329	4	14	18	44	62	120	421	541	1,322	1,862
45-54	3,125	7	16	23	45	68	224	512	736	1,440	2,176
55-64	2,131	12	16	28	26	54	563	751	1,314	1,220	2,534
65-	1,699	14	26	40	45	85	824	1,530	2,354	2,649	5,003
Total	37,417	103	211	314	459	773	275	564	839	1,227	2,066
Urban	7,302	10	34	44	65	109	137	466	603	890	1,493
Rural	28,916	90	166	256	386	642	311	574	885	1,335	2,220
Others	1,199	3	11	14	8	22	250	917	1,168	667	1,835
male	17,007	62	126	188	271	459	365	741	1,105	1,593	2,699
Urban	3,323	5	19	24	39	63	150	572	722	1,174	1,896
Rural	13,138	56	102	158	229	387	426	776	1,203	1,743	2,946
Others	546	1	5	6	3	9	183	916	1,099	549	1,648
female	20,410	41	85	126	188	314	201	416	617	921	1,538
Urban	3,979	5	15	20	26	46	126	377	503	653	1,156
Rural	15,778	34	64	98	157	255	215	406	621	995	1,616
Others	653	2	6	8	5	13	306	919	1,225	766	1,991

Tab 3.23 TB cases identified in the survey

	S+C+ (definite)	S+C- (probable)	S+ case (total) (a)	%	S-C+ case (b)	%	Bac+ case (a+b)	%
Total	90	13	103	100.0 %	211	100.0 %	314	100.0 %
Sex and age group								
Male	53	9	62	60.2%	126	59.7%	188	59.9%
15-24	1	0	1	1.0%	10	4.7%	11	3.5%
25-34	4	1	5	4.9%	19	9.0%	24	7.6%
35-44	10	2	12	11.7%	23	10.9%	35	11.1%
45-54	12	1	13	12.6%	21	10.0%	34	10.8%
55-64	15	1	16	15.5%	21	10.0%	37	11.8%
65-	11	4	15	14.6%	32	15.2%	47	15.0%
Female	37	4	41	39.8%	85	40.3%	126	40.1%
15-24	1	0	1	1.0%	2	0.9%	3	1.0%
25-34	3	0	3	2.9%	11	5.2%	14	4.5%
35-44	4	0	4	3.9%	14	6.6%	18	5.7%
45-54	6	1	7	6.8%	16	7.6%	23	7.3%
55-64	10	2	12	11.7%	16	7.6%	28	8.9%
65-	13	1	14	13.6%	26	12.3%	40	12.7%
Symptom								
Eligible	35	10	45	43.7%	48	22.7%	93	29.6%
Not eligible	55	3	58	56.3%	163	77.3%	221	70.4%
Field CXR screening								
Eligible	88	12	100	97.1%	206	97.6%	306	97.5%
Not eligible	1	1	2	1.9%	3	1.4%	5	1.6%
No CXR	1	0	1	1.0%	2	0.9%	3	1.0%
Eligible for sputum by both	34	9	43	41.7%	45	21.3%	88	28.0%
Final CXR reading								
Normal	1	1	2	1.9%	3	1.4%	5	1.6%
Active TB-suggestive	82	9	91	88.3%	185	87.7%	276	87.9%
Healed TB	5	3	8	7.8%	21	10.0%	29	9.2%
Other lung diseases	1	0	1	1.0%	0	0.0%	1	0.3%
Findings other than lung	0	0	0	0.0%	0	0.0%	0	0.0%
No CXR	1	0	1	1.0%	2	0.9%	3	1.0%
Strata of clusters								
Urban	8	2	10	9.7%	34	16.1%	44	14.0%
Rural	80	10	90	87.4%	166	78.7%	256	81.5%
Additional	2	1	3	2.9%	11	5.2%	14	4.5%
TB history								
On treatment	2	2	4	3.9%	2	0.9%	6	1.9%
Previously treated	9	1	10	9.7%	16	7.6%	26	8.3%

3.9.2 TB-related symptoms

Each of the TB-related symptoms and its sensitivity are shown in Tab 3.24. The proportions of the subjects who met the symptom criteria- “cough 2 weeks or longer, or haemoptysis”,(TB suspected symptoms) were 5.1% of all participants, 44% of smear-positive TB cases, 23% of smear-negative TB cases and 30% of bacteriologically positive TB cases. The proportions of the subjects without any respiratory symptoms at all were 21.1% of all participants, 5.8% of smear-positive TB cases, 12% of smear-negative, culture-positive TB cases and 10% of bacteriologically positive TB cases. Although any duration of cough, sputum, fatigue and fever indicated a very high sensitivity for bacteriologically confirmed TB disease, it was not very specific. The proportions of TB cases with symptoms (i.e. cough 2 weeks or longer, or haemoptysis) by age are shown in Tab 3.25. The age group of 15-34 years had significantly lower proportion of subjects with symptoms than other older age groups.

Tab 3.24 TB-related symptoms within a month and sensitivity among TB cases identified in the survey

Symptoms	Number of subjects	%	S+ cases	%	S-C+ cases	%	Bac+ cases	%	Bac-/CXR suggestive of TB	%
Cough any duration	21,555	57.6%	90	87.4%	153	72.5%	243	77.4%	340	74.1%
1 - 6 days	12,515	33.4%	13	12.6%	45	21.3%	58	18.5%	140	30.5%
7 - 13 days	7,236	19.3%	32	31.1%	61	28.9%	93	29.6%	112	24.4%
14 - 20 days	1,339	3.6%	30	29.1%	34	16.1%	64	20.4%	70	15.3%
21 days -	465	1.2%	15	14.6%	13	6.2%	28	8.9%	18	3.9%
Sputum	15,698	42.0%	80	77.7%	125	59.2%	205	65.3%	244	53.2%
Haemoptysis	319	0.9%	10	9.7%	7	3.3%	17	5.4%	16	3.5%
Chest pain	11,405	30.5%	46	44.7%	104	49.3%	150	47.8%	229	49.9%
Loss of weight	8,834	23.6%	54	52.4%	92	43.6%	146	46.5%	188	41.0%
Fatigue	15,727	42.0%	75	72.8%	129	61.1%	204	65.0%	273	59.5%
Fever	17,811	47.6%	75	72.8%	119	56.4%	194	61.8%	291	63.4%
Night sweat	5,957	15.9%	40	38.8%	66	31.3%	106	33.8%	128	27.9%
Others	389	1.0%	1	1.0%	5	2.4%	6	1.9%	11	2.4%
Cough >= 2 wks or heamoptysis	1,916	5.1%	45	43.7%	48	22.7%	93	29.6%	91	19.8%
Any symptom	29,536	78.9%	97	94.2%	185	87.7%	282	89.8%	411	89.5%
No symptom	7,881	21.1%	6	5.8%	26	12.3%	32	10.2%	48	10.5%
Total	37,417	100.0%	103	100.0%	211	100.0%	314	100.0%	459	100.0%

Tab 3.25 Symptom and TB cases detected in the survey by age

Age group	S+ TB			S-C+ TB				Bac+ TB				Bac-/CXR suggestive of TB			
	all	symptomatic	%	all	symptomatic	%		all	symptomatic	%		all	symptomatic	%	
15-24	2	1	50.0%	12	1	8.3%	*	14	2	14.3%	*	24	0	0.0%	*
25-34	8	1	12.5%	30	2	6.7%		38	3	7.9%		55	7	12.7%	
35-44	16	7	43.8%	37	9	24.3%		53	16	30.2%		98	20	20.4%	
45-54	20	10	50.0%	37	9	24.3%		57	19	33.3%		109	23	21.1%	
55-64	28	11	39.3%	37	8	21.6%		65	19	29.2%		74	14	18.9%	
65-	29	15	51.7%	58	19	32.8%		87	34	39.1%		99	27	27.3%	
Total	103	45	43.7%	211	48	22.7%		314	93	29.6%		459	91	19.8%	

symptomatic: cough >= 2 weeks or haemoptysis

*: $p < 0.05$ between 15-34 age group and 35-44 age group

3.9.3 CXR abnormality and bacteriological positivity

The final CXR reading results of TB cases including bacteriologically negative TB cases are shown in Tab 3.26. There were a total of 735 cases with CXR suggestive of active TB (91 smear-positive TB, 185 smear-negative, culture-positive TB and 459 bacteriologically negative TB).The relationship between bacteriological positivity and radiological findings among 728 cases with CXR suggestive of active TB are shown in Tab 3.27,excluding 7 cases with pleuritis or hilar lymphadenopathy (2 cases from 185 smear-negative, culture-positive TB and 5 cases from 459 bacteriologically negative TB with CXR suggestive of active TB (Bac-negative TB). Of 155 cases with cavitary lesions on CXR, 90 (58.1%) cases were bacteriologically positive TB, while 184 (32.1%) cases of 573 cases without cavity were bacteriologically positive TB. As the extent of the lesions in the lung field progressed from minimal to moderate and advanced, its bacteriological positivity rate increased from 47.8% to57.4%, and 65.8% in the cases with cavity and from 24.0% to39.0% and 56.8% in the cases without cavity, respectively.

Tab 3.26 Final CXR reading results of TB cases

Final CXR reading	S+ TB	S-C+ TB*	Bac- TB**	total
Normal	2	3	0	5
Active TB-suggestive	91	185	459	735
Healed TB	8	21	0	29
Other lung diseases	1	0	0	1
Findings other than lung	0	0	0	0
No CXR taken	1	2	0	3
sub-total	103	211	459	773

*: smear-negative, culture-positive TB including 2 cases with hilar lymph adenopathy

**: bacteriologically negative TB including 2 cases with pleuritis and 3 cases with hilar lymph adenopathy

Tab 3.27 Bacteriological positivity and CXR reading results among active-TB suggestive cases

TB case	No cavity			sub-total	Presence of cavity			sub-total	Total	
	Minimal	Moderate	Advanced		Minimal	Moderate	Advanced			
S+ TB	7	21	8	36	6	31	18	55	91	
S-C+ TB	67	68	13	148	5	23	7	35	183	*
Bac- TB	234	139	16	389	12	40	13	65	454	**
sub-total	308	228	37	573	23	94	38	155	728	
% of Bac+ TB	24.0%	39.0%	56.8%	32.1%	47.8%	57.4%	65.8%	58.1%	37.6%	

*: 2 with hilar lymphadenopathy

**: 5 with pleuritis or hilar lymphadenopathy

3.10 Prevalence rates of TB

Point estimates and the 95% CIs of prevalence rates using logistic regression model are summarized in Tab 3.28. The prevalence rates of smear-positive TB, smear-negative, culture-positive TB and bacteriologically positive TB per 100,000 aged 15 years or older, were estimated to be 271 (95%CI: 212-348), 560 (95%CI: 458-684) and 831 (95%CI: 707-977), respectively. Assuming that there were no children with smear-positive TB under 15 years of age, the prevalence rate of smear-positive TB for all ages was 183/100,000 (95% CI: 142-234), which declined by 32% from 269/100,000 obtained in the 2002 survey.

Fig 3.6 shows estimated prevalence rates of smear-positive TB and bacteriological TB by stratum and age group. Rural areas had higher prevalence rate than urban areas, although they were not adjusted by age. The proportion of smear-positive TB to bacteriologically positive TB is larger in rural areas than in urban areas (35% vs. 23%). The prevalence rates of both smear-positive and bacteriologically positive TB sharply increased with age. The proportion of smear-positive TB to bacteriologically positive TB also increased with age except for the age group of 65 years or over (14% at the age of 15-24 years, 20% at the age of 25-34 years, 30% at the age of 35-44, 35% at the age of 45-54 years, 43% at the age of 55-64 years and 33% at the age of 65 years or over). Fig 3.7 shows estimated prevalence rates of smear-positive TB and bacteriological TB by age and sex. Males had higher prevalence rates at any age group than females (Table 3.29).

Tab 3.28 Summary of the 2nd National TB Prevalence Survey in Cambodia, 2011

Estimated TB Prevalence, Cambodia, 2011	Rate (per 100,000)		
	Point Estimate	95% C.I.	No. of Cases
(For population aged 15 years or older)			
Smear-positive TB	271	212-348	26,163
Smear-negative, culture-positive TB	560	458-684	54,065
Bacteriologically positive TB	831	707-977	80,228
(For all age*)			
S(+) TB	183	142-234	

*Assuming that there was no smear-positive TB in children aged less than 15 years, and using 67.26% as the proportion of the adults aged 15 years or older based on the survey census data

**Cambodia Socio Economic Survey 2011: the population age 15 years or older of 9,654,382

Fig 3.6

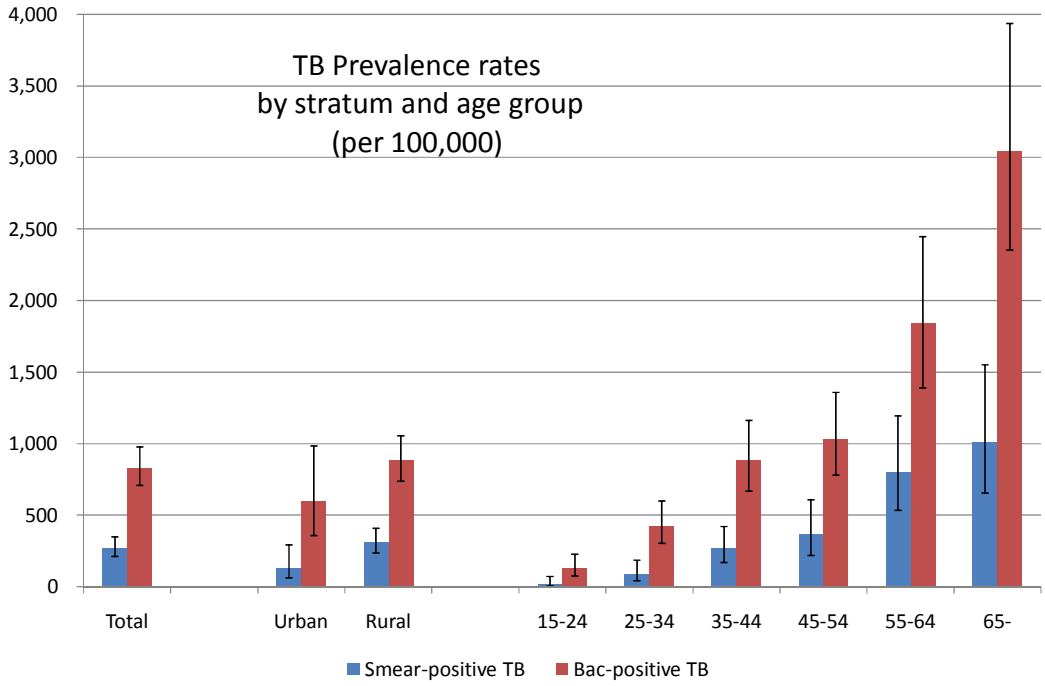
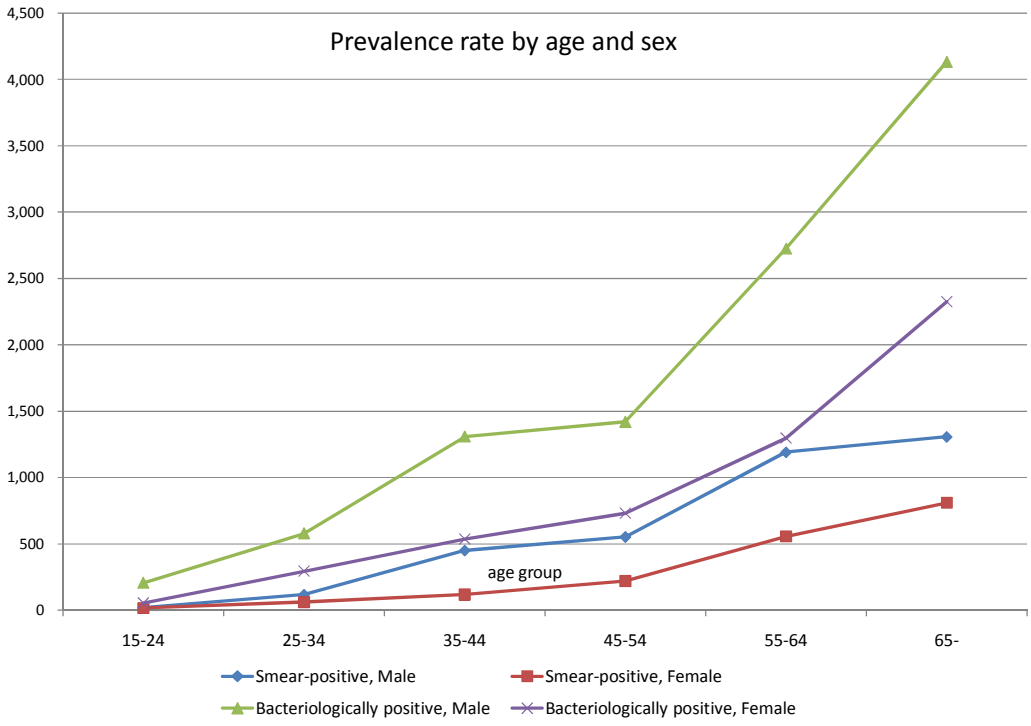

TB Prevalence rates
by stratum and age group
(per 100,000)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Total
Urban
Rural
15-24
25-34
35-44
45-54
55-64
65-
Smear-positive TB
Bac-positive TB

Fig 3.7


Prevalence rate by age and sex
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
age group
15-24
25-34
35-44
45-54
55-64
65-
Smear-positive, Male
Smear-positive, Female
Bacteriologically positive, Male
Bacteriologically positive, Female

Tab 3.29 TB prevalence rates by age/sex and stratum

Age/ Sex / Stratum	Smear-positive TB			Smear-negative, culture-positive TB			Bacteriologically positive TB		
	Point estimate	95%CI		Point estimate	95%CI		Point estimate	95%CI	
		lower	upper		lower	upper		lower	upper
Total	271.4	211.7	347.9	559.6	457.5	684.5	831.1	706.9	976.8
15-24	17.5	4.3	71.2	112.0	62.3	201.1	129.5	74.0	226.6
25-34	87.1	40.9	185.4	339.4	234.5	490.8	426.5	303.8	598.3
35-44	266.2	168.5	420.2	614.9	433.2	872.1	881.1	667.3	1,162.7
45-54	364.3	218.4	607.3	664.9	449.5	982.4	1,029.2	779.6	1,357.7
55-64	798.5	533.5	1,193.8	1,045.5	730.0	1,495.4	1,844.1	1,388.0	2,446.3
65-	1,007.3	653.3	1,550.2	2,038.8	1,528.8	2,714.2	3,046.1	2,352.6	3,935.8
Male	361.2	264.6	492.8	735.9	587.2	921.9	1,097.0	895.1	1,343.9
15-24	18.3	2.5	136.1	188.0	103.0	342.7	206.3	116.7	364.2
25-34	116.7	41.7	326.2	461.8	294.4	723.5	578.5	378.5	883.2
35-44	448.8	269.2	747.5	860.0	561.8	1,314.3	1,308.8	933.6	1,831.9
45-54	551.7	310.0	979.9	867.9	525.2	1,431.0	1,419.6	1,009.1	1,993.6
55-64	1,190.3	684.1	2,063.3	1,536.1	928.6	2,530.7	2,726.4	1,849.1	4,003.0
65-	1,306.7	758.3	2,242.7	2,827.7	2,008.1	3,968.1	4,134.3	3,015.9	5,643.4
Female	196.6	127.4	303.3	412.7	319.3	533.3	609.3	486.2	763.4
15-24	16.8	2.3	122.8	37.1	9.1	151.3	53.9	17.3	167.6
25-34	61.0	19.4	191.7	231.7	128.5	417.4	292.7	175.8	486.8
35-44	118.8	45.1	312.5	417.1	233.1	745.3	535.9	333.6	859.8
45-54	220.3	107.3	452.0	508.9	299.1	864.6	729.2	482.9	1,099.6
55-64	555.4	328.4	938.0	741.2	476.3	1,151.7	1,296.6	909.9	1,844.6
65-	809.1	382.5	1,703.4	1,516.4	917.2	2,497.2	2,325.5	1,489.4	3,613.8
Stratum									
Urban	133.8	61.3	292.0	458.8	259.1	811.1	592.6	356.7	983.2
Rural	310.4	236.0	408.3	572.0	456.8	716.0	882.4	737.6	1,055.3
Others	248.7	4.4	12,273.1	925.8	2.3	79,413.2	1,174.5	24.1	36,963.5

3.11 Health-seeking behaviors

3.11.1 Health seeking behaviors of the symptomatic subjects eligible for sputum

Health seeking behaviors among those with cough 2 weeks or longer or haemoptysis is shown in Fig 3.8 and Tab 3.30. Of 1,916 subjects with above mentioned symptoms, 1,689 (88.2%) consulted somewhere for medical care; 10.3% did not care for their symptoms and 1.5% self-medicated. The proportions of those who sought care are shown in Fig 3.9 by age. The differences in the proportions among the age groups were small, although the proportions of those aged 25-54 were slightly lower than those of 55 years or over.

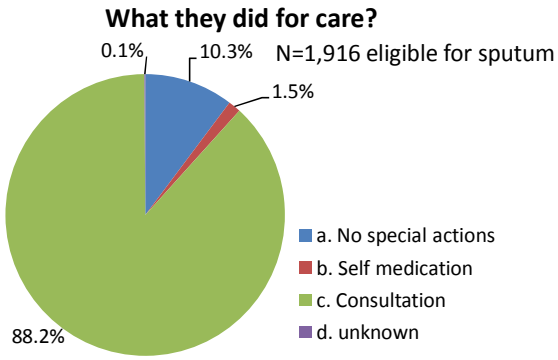
As to where they consulted for medical care, 56.3% visited public facilities (49.6% to health centers and 6.7% to government hospitals). Pharmacy accounted for 24.4% and 18.9% visited private facilities (15.0% to private clinics and 3.9% to private hospitals) (Tab 3.31), although the order of their visits was not asked if they visited multiple facilities. In any age group except for those aged 65 years old or over, more males selected "pharmacy" than females (28% vs. 22%), while more females selected "health center" than males (53% vs. 45%).

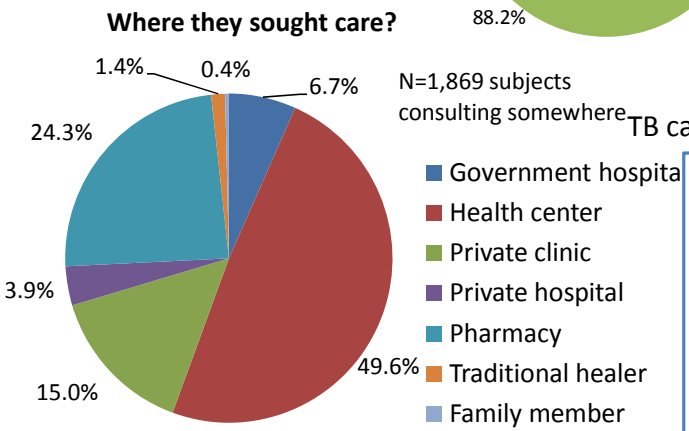
Nevertheless, 26 smear-positive TB cases including 4 cases on treatment and 30 smear-negative, culture-positive TB cases were identified from 951 subjects who had previously visited public facilities as it will be discussed later.

In response to the question "Why did you visit the private sector?" to those who did not select public health facilities (health center or government hospital), nearly 30% of them replied, "time-consuming", "long distance" or "symptoms not severe". There were no special findings about the reasons for their selection of the private health sector, other than a slightly higher proportion of those aged 65 years and over who felt that public facilities were at a "long distance"(Tab 3.32).

Fig 3.8

Majority of TB suspects visited public facility, But some have not been diagnosed as TB.

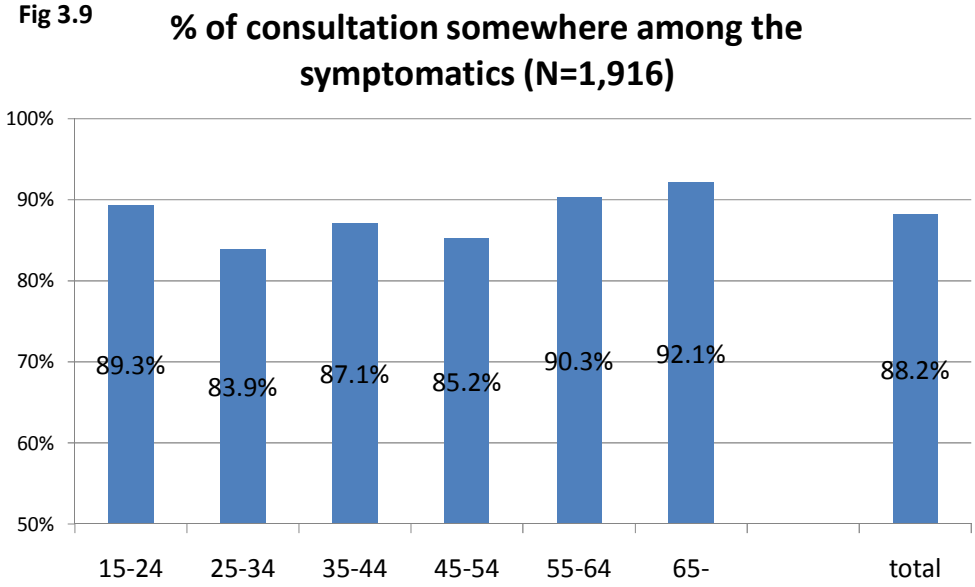




TB cases detected in the survey

114→4 S+ (1Tx), 3S-C+
837→22S+(3Tx), 27S-C+
253→3S+, 4S-C+
66→2S+, 2S-C+
413→9S+,10S-C+ (1HC)
24→1S+ (1HC)
6→no case
225 no action→5S+,3S-C+
2 NA → no case

Fig 3.9



The elderly coughing 2 weeks or longer visited somewhere for care as well.

Tab 3.30 What they did for care

Age group (total)	15-24		25-34		35-44		45-54		55-64		65-		sub-total	
Health Seeking Behavior	N	%	N	%	N	%	N	%	N	%	N	%	N	%
a. No special actions	12	9.2%	31	13.1%	34	11.0%	58	13.0%	29	8.3%	33	7.4%	197	10.3%
b. Self medication	2	1.5%	6	2.5%	6	1.9%	7	1.6%	5	1.4%	2	0.5%	28	1.5%
c. Consultation	117	89.3%	198	83.9%	269	87.1%	381	85.2%	316	90.3%	408	92.1%	1,689	88.2%
d. unknown	0	0.0%	1	0.4%	0	0.0%	1	0.2%	0	0.0%	0	0.0%	2	0.1%
Total	131	100.0%	236	100.0%	309	100.0%	447	100.0%	350	100.0%	443	100.0%	1,916	100.0%

Age group (male)	15-24		25-34		35-44		45-54		55-64		65-		sub-total	
Health Seeking Behavior	N	%	N	%	N	%	N	%	N	%	N	%	N	%
a. No special actions	8	11.4%	23	21.7%	26	17.2%	41	18.7%	19	12.5%	18	9.0%	135	15.1%
b. Self medication	1	1.4%	1	0.9%	3	2.0%	1	0.5%	2	1.3%	1	0.5%	9	1.0%
c. Consultation	61	87.1%	82	77.4%	122	80.8%	176	80.4%	131	86.2%	180	90.5%	752	83.8%
d. unknown	0	0.0%	0	0.0%	0	0.0%	1	0.5%	0	0.0%	0	0.0%	1	0.1%
sub-total	70	100.0%	106	100.0%	151	100.0%	219	100.0%	152	100.0%	199	100.0%	897	100.0%

Age group (female)	15-24		25-34		35-44		45-54		55-64		65-		sub-total	
Health Seeking Behavior	N	%	N	%	N	%	N	%	N	%	N	%	N	%
a. No special actions	4	6.6%	8	6.2%	8	5.1%	17	7.5%	10	5.1%	15	6.1%	62	6.1%
b. Self medication	1	1.6%	5	3.8%	3	1.9%	6	2.6%	3	1.5%	1	0.4%	19	1.9%
c. Consultation	56	91.8%	116	89.2%	147	93.0%	205	89.9%	185	93.4%	228	93.4%	937	92.0%
d. unknown	0	0.0%	1	0.8%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.1%
sub-total	61	100.0%	130	100.0%	158	100.0%	228	100.0%	198	100.0%	244	100.0%	1,019	100.0%

Tab 3.31 Where they sought care

Age group (total)	15-24		25-34		35-44		45-54		55-64		65-		Total	
Consultation	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Government hospital	2	1.7%	5	2.5%	21	7.8%	27	7.1%	24	7.6%	35	8.6%	114	6.7%
Health center	47	40.2%	88	44.4%	135	50.2%	201	52.8%	169	53.5%	197	48.3%	837	49.6%
Private clinic	21	17.9%	35	17.7%	47	17.5%	53	13.9%	45	14.2%	52	12.7%	253	15.0%
Private hospital	8	6.8%	6	3.0%	11	4.1%	13	3.4%	14	4.4%	14	3.4%	66	3.9%
Pharmacy	37	31.6%	65	32.8%	57	21.2%	87	22.8%	60	19.0%	105	25.7%	411	24.3%
Traditional healer	1	0.9%	0	0.0%	4	1.5%	6	1.6%	5	1.6%	8	2.0%	24	1.4%
Family member	1	0.9%	1	0.5%	0	0.0%	1	0.3%	1	0.3%	2	0.5%	6	0.4%
Number of subjects	117	100.0%	198	100.0%	269	100.0%	381	100.0%	316	100.0%	408	100.0%	1,689	100.0%
Age group (male)	15-24		25-34		35-44		45-54		55-64		65-		sub-total	
Consultation	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Government hospital	1	1.6%	3	3.7%	11	9.0%	14	8.0%	8	6.1%	20	11.1%	57	7.6%
Health center	20	32.8%	28	34.1%	56	45.9%	87	49.4%	61	46.6%	88	48.9%	340	45.2%
Private clinic	12	19.7%	16	19.5%	18	14.8%	22	12.5%	18	13.7%	26	14.4%	112	14.9%
Private hospital	4	6.6%	1	1.2%	3	2.5%	6	3.4%	4	3.1%	4	2.2%	22	2.9%
Pharmacy	22	36.1%	33	40.2%	34	27.9%	44	25.0%	32	24.4%	43	23.9%	208	27.7%
Traditional healer	1	1.6%	0	0.0%	1	0.8%	4	2.3%	5	3.8%	3	1.7%	14	1.9%
Family member	1	1.6%	1	1.2%	0	0.0%	1	0.6%	1	0.8%	0	0.0%	4	0.5%
Number of subjects	61	100.0%	82	100.0%	122	100.0%	176	100.0%	131	100.0%	180	100.0%	752	100.0%
Age group (female)	15-24		25-34		35-44		45-54		55-64		65-		sub-total	
Consultation	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Government hospital	1	1.8%	2	1.7%	10	6.8%	13	6.3%	16	8.6%	15	6.6%	57	6.1%
Health center	27	48.2%	60	51.7%	79	53.7%	114	55.6%	108	58.4%	109	47.8%	497	53.0%
Private clinic	9	16.1%	19	16.4%	29	19.7%	31	15.1%	27	14.6%	26	11.4%	141	15.0%
Private hospital	4	7.1%	5	4.3%	8	5.4%	7	3.4%	10	5.4%	10	4.4%	44	4.7%
Pharmacy	15	26.8%	32	27.6%	23	15.6%	43	21.0%	28	15.1%	62	27.2%	203	21.7%
Traditional healer	0	0.0%	0	0.0%	3	2.0%	2	1.0%	0	0.0%	5	2.2%	10	1.1%
Family member	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	2	0.9%	2	0.2%
Number of subjects	56	100.0%	116	100.0%	147	100.0%	205	100.0%	185	100.0%	228	100.0%	937	100.0%

Tab 3.32 Reasons why they didn't consult public facility (proportion of each reason to the total subjects)

Age group (total)	15-24		25-34		35-44		45-54		55-64		65-		Total	
Reason	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Not severe	19	27.9%	24	22.9%	28	24.8%	43	27.9%	46	36.8%	35	19.8%	195	26.3%
No money	7	10.3%	7	6.7%	5	4.4%	16	10.4%	10	8.0%	17	9.6%	62	8.4%
Long distance	18	26.5%	36	34.3%	37	32.7%	44	28.6%	28	22.4%	63	35.6%	226	30.5%
Time-consuming	20	29.4%	35	33.3%	42	37.2%	46	29.9%	36	28.8%	54	30.5%	233	31.4%
Number of subjects	68	100.0%	105	100.0%	113	100.0%	154	100.0%	125	100.0%	177	100.0%	742	100.0%

Age group (male)	15-24		25-34		35-44		45-54		55-64		65-		sub-total	
Reason	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Not severe	11	27.5%	9	17.6%	15	27.3%	27	36.0%	24	38.1%	11	15.3%	97	27.2%
No money	4	10.0%	5	9.8%	2	3.6%	3	4.0%	6	9.5%	7	9.7%	27	7.6%
Long distance	11	27.5%	21	41.2%	19	34.5%	18	24.0%	13	20.6%	29	40.3%	111	31.2%
Time-consuming	10	25.0%	13	25.5%	18	32.7%	23	30.7%	16	25.4%	19	26.4%	99	27.8%
Number of subjects	40	100.0%	51	100.0%	55	100.0%	75	100.0%	63	100.0%	72	100.0%	356	100.0%

Age group (female)	15-24		25-34		35-44		45-54		55-64		65-		sub-total	
Reason	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Not severe	8	28.6%	15	27.8%	13	22.4%	16	20.3%	22	35.5%	24	22.9%	98	25.4%
No money	3	10.7%	2	3.7%	3	5.2%	13	16.5%	4	6.5%	10	9.5%	35	9.1%
Long distance	7	25.0%	15	27.8%	18	31.0%	26	32.9%	15	24.2%	34	32.4%	115	29.8%
Time-consuming	10	35.7%	22	40.7%	24	41.4%	23	29.1%	20	32.3%	35	33.3%	134	34.7%
Number of subjects	28	100.0%	54	100.0%	58	100.0%	79	100.0%	62	100.0%	105	100.0%	386	100.0%

3.11.2 Health-seeking behaviors of TB patients detected in the survey

There were individuals who had sought some sort of medical attention before they were diagnosed as TB in the survey. Tab 3.33shows where TB patients with any duration of cough went for medical care. Of the 103 smear-positive TB cases, 4 cases were put on treatment at public facility and the remaining 99 cases, of which 86 (87%) had cough of any duration, were diagnosed as TB for the first time in the survey. Of the 86 cases with cough, 39 (55%) had consulted public facilities. It is not known how many of them were properly examined by the health staff, what was the provisional diagnosis, or whether they were smear positive or not; what is clear though, is that they were not diagnosed as TB at that time. Similarly, of the 119 smear-negative, culture positive cases with cough who had sought medical attention, 55 (46%) cases had visited some public facilities. Of the 268 cases with negative culture, but CXR suggestive of active TB with cough, 146 (54%) had visited public health facilities.

Tab 3.33 Behavior patterns of TB cases towards symptoms

S+ cases: 103										
On treatment	4	Not on treatment	99	100%	=	No TB history 89	100%	+	TB history 10	100%
Where?		No cough	13	13%		13	15%		0	0%
Government hospital	1	Any cough	86	87%		76	85%		10	100%
Health center	3	No attention	13	15%		12	16%		1	10%
Pharmacy	-	Self medication	2	2%		2	3%		-	-
		Consultation	71	83%		62	82%		9	90%
		Where?								
		Government hospital	8	11%		7	11%		1	11%
		Health center	31	44%		28	45%		3	33%
		Private clinic	6	8%		5	8%		1	11%
		Private hospital	2	3%		1	2%		1	11%
		Pharmacy	24	34%		21	34%		3	33%
		Traditional healer	-	-		-	-		-	-
		Family care	-	-		-	-		-	-

S-C+ cases: 211										
On treatment	2	Not on treatment	209	100%	=	No TB	100%	+	TB history	100%
Where?		No cough	58	28%		53	27%		5	31%
Government hospital	-	Any cough	151	72%		140	73%		11	69%
Health center	2	No attention	27	18%		26	19%		1	9%
Pharmacy	-	Self medication	5	3%		5	4%		-	-
		Consultation	119	79%		109	78%		10	91%
		Where?								
		Government hospital	9	8%		7	6%		2	20%
		Health center	55	46%		48	44%		7	70%
		Private clinic	14	12%		14	13%		-	-
		Private hospital	5	4%		4	4%		1	10%
		Pharmacy	32	27%		32	29%		3	30%
		Traditional healer	3	3%		3	3%		-	-
		Family care	1	1%		1	1%		-	-

Bac- CXR active cases: 459										
On treatment	21	Not on treatment	438	100%	=	No TB	100%	+	TB history	100%
Where?		No cough	118	27%		106	29%		12	15%
Government hospital	4	Any cough	320	73%		254	71%		66	85%
Health center	16	No attention	47	15%		37	15%		10	15%
Pharmacy	1	Self medication	5	2%		5	2%		-	-
		Consultation	268	84%		212	83%		56	85%
		Where?								
		Government hospital	22	8%		16	8%		6	11%
		Health center	124	46%		86	41%		38	68%
		Private clinic	41	15%		37	17%		4	7%
		Private hospital	4	1%		4	2%		-	-
		Pharmacy	73	27%		66	31%		7	13%
		Traditional healer	1	0%		1	0%		-	-
		Family care	1	0%		1	0%		-	-
		NA	2	1%		1	0%		1	2%

3.12 Drug susceptibility test

Of 306 MTB strains isolated from the survey TB cases, 278 strains stocked in a refrigerator were sent to RIT/JATA for drug susceptibility test (DST). DST results were available for only 193 strains which were recovered by culture examination, probably due to low viability of the strains.

There was no MDR-TB among them: 9 (4.7%) strains with any resistance (2 to INH and 7 to SM) including only 7 (4.1%) strains with mono-resistance (1 resistant to INH and 7 to SM) as shown in Tab 3.34.Of the 9 cases mentioned above with any resistance, 8 cases had no past history of TB and 1 case had unknown TB history. Although the DST was performed for only two-thirds of all the TB strains obtained from the community-based survey and a conclusion can hardly be drawn, it seems that there was no increase of any drug resistant TB among the communities.

Tab 3.34 Drug susceptibility patterns

	TB prevalence survey, 2002		Drug resistance survey, 2000-2001		Drug resistance survey, 2006-2007		TB prevalence survey, 2011	
	N	%	N	%	N	%	N	%
Total number of strains tested	245		734		781		193	
Sensitive to all 4 drugs	226	92.2%	651	88.7%	670	85.8%	184	95.3%
ANY RESISTANCE	19	7.8%	83	11.3%	111	14.1%	9	4.7%
Isoniazid (INH)	13	5.3%	57	7.8%	62	8.0%	2	1.0%
Rifampicin (RMP)	0	0.0%	7	1.0%	19	2.4%	0	0.0%
Ethambutol (EMB)	0	0.0%	1	0.1%	13	1.5%	0	0.0%
Streptomycin (SM)	8	3.3%	39	5.3%	64	8.1%	8	4.1%
MONORESISTANCE	17	6.9%	64	8.7%	45	5.8%	8	4.1%
Isoniazid (INH)	11	4.5%	39	5.3%	36	4.8%	1	0.5%
Rifampicin (RMP)	0	0.0%	3	0.4%	3	0.4%	0	0.0%
Ethambutol (EMB)	0	0.0%	0	0.0%	3	0.4%	0	0.0%
Streptomycin (SM)	6	2.4%	22	3.0%	3	0.4%	7	3.6%
MULTIDRUG RESISTANCE	0	0.0%	3	0.4%	16	2.0%	0	0.0%
INH + RMP	0	0.0%	1	0.1%	3	0.4%	0	0.0%
INH + RMP + EMB	0	0.0%	0	0.0%	5	0.5%	0	0.0%
INH + RMP + SM	0	0.0%	2	0.3%	1	0.1%	0	0.0%
INH + RMP + EMB + SM	0	0.0%	0	0.0%	7	0.9%	0	0.0%
OTHER PATTERNS	2	0.8%	16	2.2%	9	1.2%	0	0.0%
INH + EMB	0	0.0%	1	0.1%	0	0.0%	0	0.0%
INH + SM	2	0.8%	14	1.9%	9	1.2%	0	0.0%
INH + EMB + SM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
RMP + EMB	0	0.0%	0	0.0%	0	0.0%	0	0.0%
RMP + SM	0	0.0%	1	0.1%	0	0.0%	0	0.0%
RMP + EMB + SM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
EMB + SM	0	0.0%	0	0.0%	0	0.0%	0	0.0%

4. DISCUSSION

4.1 Eligibility criteria

All adults aged 15 year old and over, who stayed in selected households for 14 days or more, at the time of the census visit were eligible for the survey, excluding military and diplomatic compounds, hospitals and hotels. Although there might have been some cases whose eligibility was difficult to be determined because they stayed at one place only on weekends and went out for work to other places on weekdays during the harvest season, the survey census was considered to have been properly implemented in general. This is because the census results shows that the proportions of ineligible population were larger in the young than in the elderly, larger in males than in females, and larger in rural areas than in urban areas (Tab 3.1), which was mainly due to migration out of villages to cities especially among young males in rural areas.

No hospital was located in the surveyed areas. However, since the DOTS expansion in the early 2000 , most TB cases were diagnosed and treated in ambulatory base, an impact of excluding hospitalized TB patients from the survey was considered to be negligible small.

4.2 Survey participation

A high overall participation rate of 92.6% in the survey (Tab 3.2) was achieved because we made two pre-visits before starting each field operation and strongly involved the community in the field work in close collaboration with the village leaders and local authorities concerned. In addition, in several urban or suburban clusters, we shifted the operational time to late evening until 9 pm to enable workers occupied during daytime to attend. Yet, lower participation rates in 4 of the 13 urban clusters were observed (Tab 3.3). The recruitment of participants in populous urban areas was quite challenging. Houses with a stately gate or apartment compounds with guards hindered the survey staff from even addressing the dwellers. Neighbors did not know each other and no influential community leader prompted them to participate. Recruitment of participants in urbanized communities is a greater challenge for the national surveys.

4.3 Participants

4.3.1 TB-related symptoms

In the survey, the presence of 8 TB-related symptoms within a month of the interview was inquired: 57.6% with any cough, 47.6% with fever, 42.0% with sputum, 42.0% with fatigue, 30.5% with chest pain, 23.6% with weight loss, 15.9% with night sweat and 0.9% with haemoptysis (Tab3.7).Consequently, nearly 80% of them complained of at least one of the 8 symptoms, which seemed to be quite a large proportion. It might be because most smokers have cough and sputum, and sometimes complain of chest pain, or because some village people might have expected some benefits from the survey by over-expressing their symptoms. In such a sense, the eligibility for sputum examinations by symptoms (cough 2 weeks or longer, or haemoptysis), which gave a 5.1% positivity rate among the participants, seems to be appropriate because its specificity was 95% for bacteriologically positive TB (smear-positive TB and smear-negative, culture-positive TB).

4.3.2 Health-seeking behaviors

Those with cough 2 weeks or longer or haemoptysis consulted public health facilities more than expected. In fact, the first facility they visited might have been the private sector such as pharmacies, which are more accessible than public facilities. However, now that the sales of TB drugs in private pharmacies are officially banned in Cambodia, they eventually may be presenting to public facilities. Females seemed to prefer the public sector to private given the maternal and child health care offered at the public sector. The result showed that the proportion of middle-aged males who sought medical attention was smaller than any other age and sex group. Similar issues with health-seeking behaviors in this group are observed in other countries as well.

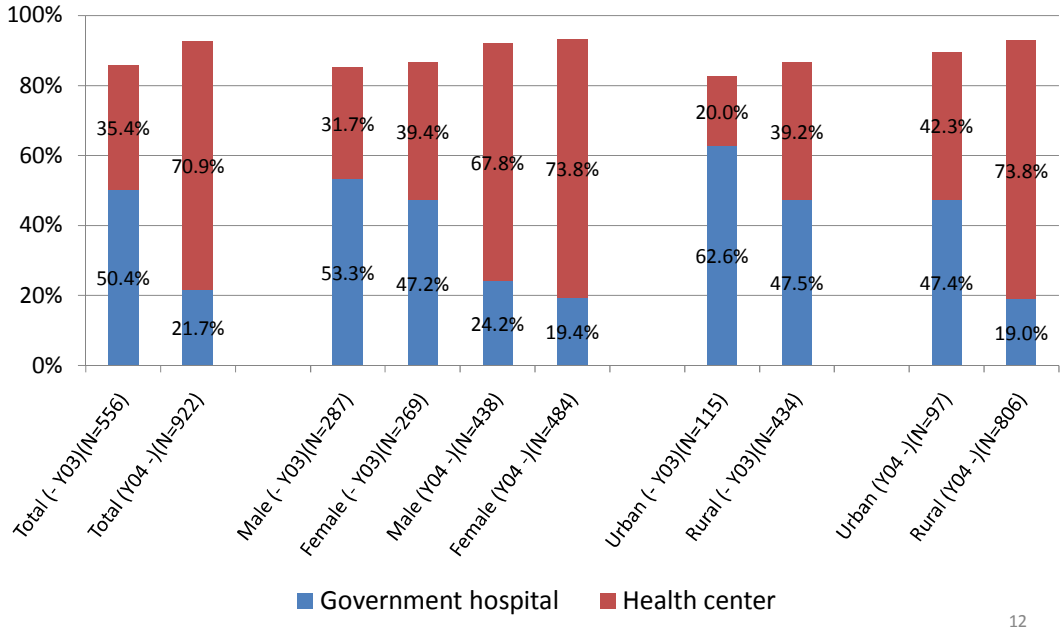
4.3.3 TB history and coverage of the public sector

Of the 80 subjects who were currently on TB treatment, 72 (90%) were treated at public facilities. The remaining 8 persons were treated at private facilities or outside the country. Therefore, the majority of TB patients were receiving TB treatment in the public sector, although their first contact may be the private sector such as pharmacies or clinics which may be more accessible.

Fig 4.1 shows the comparison of proportions of TB cases previously treated at public health facilities. The time period was divided into two: prior to 2004, and 2004 and beyond, when the DOTS expansion was nearly completed. As the bar represents the sum of the proportions of TB cases treated at the public sector (government hospitals and health centers), the remaining portion indicates the proportions treated at the

private sector. Overall (the two left bars), the proportion of TB cases treated at health centers doubled from 35.4% prior to 2004 to 70.9% in 2004 and beyond, and the total of the proportions of TB cases treated at the public sector increased from 85.8% to 92.6%, respectively. The four right bars represent the proportions of TB cases treated at the public sector by area (urban and rural). Although the majority of TB cases were treated at government hospital in urban areas, the proportions of health centers increased rapidly in rural areas after 2004, which parallels the nationwide DOTS expansion to peripheral facilities.

Fig 4.1 Proportion of TB cases previously treated at public health facilities by sex and stratum (prior to 2004, and in 2004 and beyond)



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4.4 Field screening

There were a total of 324 subjects with abnormal lung findings by the final CXR reading but without sputum specimens, because their CXR were initially interpreted as normal in the field: 17 subjects with CXR suggestive of active TB, 130 subjects with healed TB and 177 with other lung diseases on CXR in the final reading, (Tab 3.10). Of the 17 subjects with CXR suggestive of active TB, 9 subjects had one sputum sample additionally collected after the field operation as a corrective measure. Of these, 8 had negative culture and one had 2-colony positive culture without identification results due to failure of growth in sub-culture. As the proportions of culture-positive TB in subjects with non-cavitary, minimal lesions on CXR suggestive of active TB, healed TB and other lung diseases on CXR were 24.0%, 2.2% and 1.3%, respectively (Tab 3.19 and Tab 3.26), the number of bacteriologically positive TB cases that were missed among these 324 subjects excluding 8 subjects with one culture-negative result is estimated to be 7 cases in total (2.16, 2.86, and 2.30, respectively), increasing the prevalence of bacteriologically positive cases by 2.2% (7/314).

4.5 Laboratory examinations

4.5.1 Smear examinations

As shown in Tab 3.14, 97.6% of bacteriologically positive subjects based on fluorescence microscopy (FM) and culture examination were re-examined with conventional smear microscopy with Ziehl-Neelsen (ZN) stain. There were 13 subjects without complete ZN results due to missing or broken slides; 7 subjects had two negative cultures. Of the remaining 6 subjects with positive culture, 5 subjects had two negative smears by FM, of which one subject had scanty-positive smear by ZN and was categorized as a definite smear-positive TB case. One subject who had one negative smear by FM had also one negative smear by ZN. As a result, therefore, there were no smear-positive TB cases except one in this group.

4.5.2 Culture examination

Of the 114 smear-positive subjects including 4 MOTT, there were 20 smear-positive, culture-negative subjects (Tab 3.20). Of these, 7 subjects with scanty-positive smear and normal CXR were considered to be false-positive smear or false-negative culture for MOTT (Tab 3.21). Of the remaining 13 smear-positive, culture-negative subjects, 2 TB cases were put on TB treatment. Therefore, the culture recovery rate of smear positive subjects including 4 MOTT subjects was 90 % (94/105), which was a little lower than 94 % (74/79) in the first survey.

In the second survey, the ratio of smear-negative, culture-positive TB to smear-positive TB cases was 2.05(211/103), which was a little smaller than 2.34 (190/81including the cases aged 10-14 years) in the first survey. There might have been some more smear-negative, culture-positive TB cases among the 459 cases with negative culture and CXR suggestive of active TB.

The proportion of smear-positive TB to culture-positive TB cases among the definite TB cases was 30 % (90/301) in the second survey, which was close to 28% (74/264) in the first survey.

4.6 Health-seeking behavior of TB cases

The survey indicated that many of the TB cases with any duration of cough (Tab 3.33) had sought medical attention within the month prior to the survey. Although little is known about the care they received, including whether they had smear-positive TB at that time, most of them remained undiagnosed for TB until the survey. This may suggest that OPD staff at hospitals and staff at health centers should have higher level of suspicion for TB for those with any respiratory symptoms, regardless of the duration of cough, and CXR examination should be considered when TB suspects have negative smears. This also suggests limitations of current diagnostic tools, including TB suspect criteria and low sensitivity of smear microscopy.

4.7 Prevalence rates of TB

4.7.1 Prevalence rates by different analysis methods

The survey revealed the smear-positive prevalence rate to be 271 (95%CI: 212-348) and the bacteriologically positive prevalence rate to be 831 (95%CI: 707-977) per 100,000 aged 15 years or older. Although several analytical methods were conducted, the same analytical method as in the first survey was adopted for the primary estimation of prevalence rate in order to make the results between the first and the second survey comparable: design-based analysis restricted to survey participants who received CXR screening and/or symptom screening without imputation. Stratification, PSU level clustering effect and weights adjusting for sampling probability were taken into account. Other analytical methods with imputation showed only from -1.4% to 6.2% difference in smear-positive prevalence rates from the primary estimate. A detailed explanation of the analytical methods including imputations is provided in Annex 10.

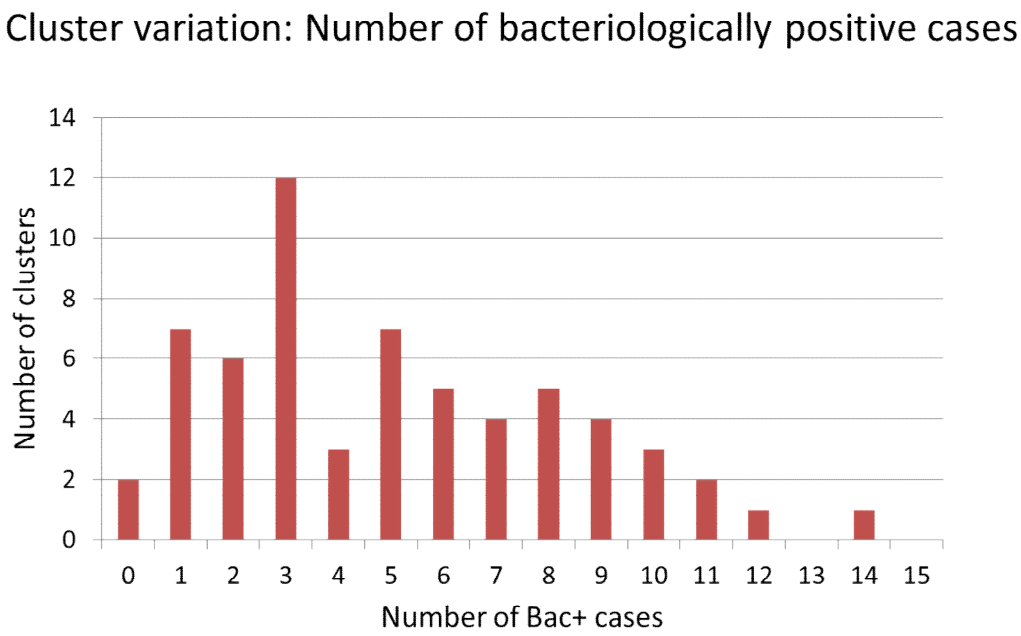
Although the second survey demonstrated a decline in TB burden in Cambodia compared with the first survey, it also revealed a picture that was similar to the TB situation in the first survey: a sharp increase in the prevalence rate with age, higher prevalence rate in males than in females, higher prevalence rate in rural areas than in urban areas, and higher prevalence rate in smear-negative, culture-positive TB than in smear-positive TB. The NTP Cambodia needs to make sustained efforts and increased measures to tackle these issues.

4.7.2 Cluster variation and geographical differences

In the first survey, the clusters in Phnom Penh and provincial towns showed statistically significant lower prevalence rates than in rural clusters. Although the definition of rural or urban clusters by the government is different between the 2002 and 2011 census, the same tendency was observed in the second survey (Tab 3.29) without any age-sex adjustment. There may be two main reasons for this: more elderly people in rural areas than in urban areas, and poorer access to medical facilities in rural areas than in urban areas.

Fig 4.2 shows cluster variations in the number of bacteriologically positive TB cases identified in the survey. The number ranged from 0 to 14 cases with the mode of 3 cases in 12 clusters. There were 20 (32%) clusters which had 7 or more TB cases, or approximately 1% or higher bacteriologically positive prevalence rate.

Fig 4.2



4.8 Comparison with the first National TB Prevalence Survey, 2002

The first nationwide TB prevalence survey in Cambodia was carried out for the subjects aged 10 years or older in 2002 at an early stage of DOTS expansion to health centers and revealed that weighed prevalence rates of the population aged 10 or more were 362 (95%CI: 284-461) for smear-positive TB. Assuming there were no children with smear-positive TB under 10 years old, the smear-positive prevalence rate was estimated as 269 per 100,000 populations (Tab 4.1).As the NTP, Cambodia introduced DOTS into the hospital level in 1994 and expanded it nationwide to the peripheral level through health center and community involvement in the early 2000, this figure can be regarded as not only the initial impact of hospital DOTS, but also a baseline for the health center DOTS.

Differences in methods between the two surveys are shown in Tab 4.2.The major difference was the age group of the survey population. While the target population in the first survey was those aged 10 years or older, in the second survey it was set as those aged 15 years or older. This was because prevalence surveys are very unlikely to detect TB cases among those under 15, making it more sensible to reduce both workload and expenses by excluding the younger population. Another difference between the two surveys was the tuberculin survey, which was carried out as part of the first prevalence survey to estimate the true prevalence of infection and the annual risk of infection. The second survey did not include this because the tuberculin distribution curves were quite difficult to interpret due to unclear cut-off point for infection.

To compare the results between the first and second survey, we abstracted data so that the demographical and geographical background would match, e.g. those aged 15 years or older and 20 provinces excluding the 4 remote provinces. Comparing the results between the first (2002) and second survey (2011) in the population aged 15 years or older of the 20 surveyed provinces, a statistically significant decline of 38% was observed in the smear-positive prevalence rate (4, 2% annual reduction) ; and 45% in bacteriologically positive prevalence rate (Tab 4.3) .

Tab 4.1 Summary of the 1st National TB Prevalence Survey in Cambodia, 2002

Estimated TB Prevalence, Cambodia, 2002	Rate (per 100,000)		
	Point Estimate	95% C.I.	No. of Cases
(For population aged 10 years or older)			
Smear-positive TB	362	284-461	33,998
Smear-negative, culture-positive TB	846	675-1,059	79,450
Bacteriologically negative, but Active-TB suggestive**	1,370	1,117-1,680	128,657
Bacteriologically Positive TB	1,208	997-1,463	113,447
Pulmonary Active TB suggestive**	2,579	2,205-3,013	242,095
(For all age*)			
S(+) TB	269	211-343	

*Assuming that there was no smear positive case in children aged less than 10 years
2002 Population Re-estimation form Cambodia Inter-Census Population Survey '03: 12,630,000
74.34% of eligible population was aged 10 or more in this prevalence survey: 9,389,000
** Including active TB suspected only by a single X-ray examination

Tab 4.2 Differences in methods between 2002 and 2011 survey

Different parts		2002 survey	2011 survey
Sampling method	primary sampling unit	district by PPS	district by PPS
	secondary sampling unit	village, randomly	commune by PPS
	third sampling unit	not applicable	village by PPS
Survey subjects		aged 10 years or older (the sampling frame consists of all age population)	aged 15 years or older (the sampling frame consists of population aged 15 years or older)
Survey areas		excluding 4 remote provinces	the whole country
Sample size		21,098	39,680
Number of clusters		42 (7 urban and 35 rural)	62 (13 urban, 47 rural and 2 remote areas)
Symptom screening		cough 3 weeks or longer, or haemoptysis	cough 2 weeks or longer, or haemoptysis
Smear examination		conventional microscopy by Ziehl-Neelsen stain	fluorescence microscopy with Auramine stain, followed by conventional method

Tab 4.3 Comparison of prevalence in the matched group between 2002 and 2011 survey

Matched group: aged 15 years or older in 20 provinces				
Prevalence	2002 survey	2011 survey	Reduction	P value
Smear-positive TB	437	272	-37.7%	0.012
(95% CI)	(348 - 558)	(211 - 351)		
Bacteriologically positive TB	1,497	820	-45.2%	< 0.01
(95% CI)	(1,238 - 1,808)	(694 - 968)		

4.8.1 Prevalence rates for those aged 15 years or older

For comparison with the results from the survey of 2011, prevalence among participants aged 15 years or over in the survey 2002 was estimated from the original data set. Cluster level weights proportional to inverse of product of size of all age eligible and participation rate of those aged 15 years or over, clustering effects and stratification (urban/rural following census definition at the time of each survey) were incorporated in analysis by using svy commands of Stata. As mentioned in Section 4.8, the remote province stratum was removed from the 2011 survey for comparison with the 2002 survey. Difference in prevalence between 2 surveys are tested by t-test using 2 sets of point estimates and standard errors incorporating clustering effects, weights and stratification from the two surveys.

Smear-positive prevalence rates were 272 /100,000 (95%CI: 211-351) in the 2011 survey and 437/100,000 (95%CI: 342-558) in the 2002 survey after the matching, with a significant reduction 38% (p=0.012), which may be attributable to nationwide DOTS expansion from 1999 to 2004 and its sustaining together with the introduction of such specific activities as community DOTS, TB/HIV and PPM-DOTS years after. The trend in notification according to the NTP indicated that new smear-positive TB peaked at 21,004 in 2005 (Fig 1.1), followed by a gradual decline, which was thought to reflect the significant reduction in smear-positive prevalence. During the nine years from 2002 to 2011, the NTP treated 169,809 new smear-positive TB cases and 58,537 smear-negative pulmonary TB cases, with high treatment success rate of over 90% (2).

In Fig 4.3, the breakdown of smear-positive prevalence rates in the two surveys by symptom is shown; a 56% reduction in prevalence rate was observed among the symptomatic (i.e. cough 2 weeks or longer, or haemoptysis), while the prevalence rate of those without TB suspect symptom (asymptomatic) declined by only 8% . This tells us both the effectiveness and the limitation of DOTS strategy, which has focused on passive detection by smear microscopy; DOTS is quite effective in diagnosing and treating symptomatic, smear-positive TB cases who voluntary seek medical care, but, on the other hand, may be less effective in detecting asymptomatic or moderately symptomatic TB cases who are less likely to take any action for care.

Bacteriologically positive prevalence rate also significantly decreased by 45% from 1,497/100,000 (95%CI: 1,238-1,808) in 2002 to 820/100,000 (95%CI: 694-968) in 2011 (t-test for difference in observed prevalence between the two surveys: ($p < 0.01$). The reduction rates by symptom for smear-negative, culture-positive TB cases are shown in Fig 4.4.Similarly in this case, a 48% overall reduction was observed in these 9 years with a 43% reduction in prevalence rate for asymptomatic cases and a 60% reduction in symptomatic cases. It may be difficult to explain clearly why the prevalence rate for smear-negative, culture-positive cases was nearly halved, when only around 60,000 smear-negative pulmonary TB cases, far below 170,000 smear-positive TB cases, were treated in 9 years through the NTP. One possible explanation is that smear-negative, culture-positive TB may either have considerably high rates of progression to smear-positive TB, or may become culture-negative due to natural healing, which may be a big driving force in the reduction of the prevalence of smear-negative, culture-positive TB as well as detecting and treating smear-negative TB cases. As the NTP statistics shows that the number of smear-negative TB notified increased from 2,852 in 2002 to 8,301 in 2010, it is no doubt that the NTP has strengthened the diagnostic capacity of smear-negative TB at hospitals equipped with CXR since 2002, based on the lesson learned from the first survey.

Declines of HIV prevalence among general population and HIV positive TB may in part contribute to a reduction of TB prevalence, because HIV has been a limited factor of TB epidemic in Cambodia (5, 6, 7) (Tab 4.4). The first nationwide HIV sero-prevalence survey among TB patients was carried out in January 2003, just one month after the completion of the first TB prevalence survey. All notified TB cases during the survey period were tested for HIV and 8.2% of new smear-positive pulmonary cases were HIV positive. Although periodic surveys of HIV sero-prevalence among TB in Cambodia showed steady declining trend, the declines of HIV prevalence in Cambodia did not have a great influence on the reduction in TB prevalence indicated by the two TB prevalence surveys.

Tab 4.4 Trend in HIV sero-prevalence rate among TB patients in Cambodia

Year	2003	2005	2007	2009
Among all forms of TB	11.8%	9.9%	7.8%	6.3%
Among new smear-positive TB	8.2%	5.4%	3.9%	3.7%

Fig 4.3

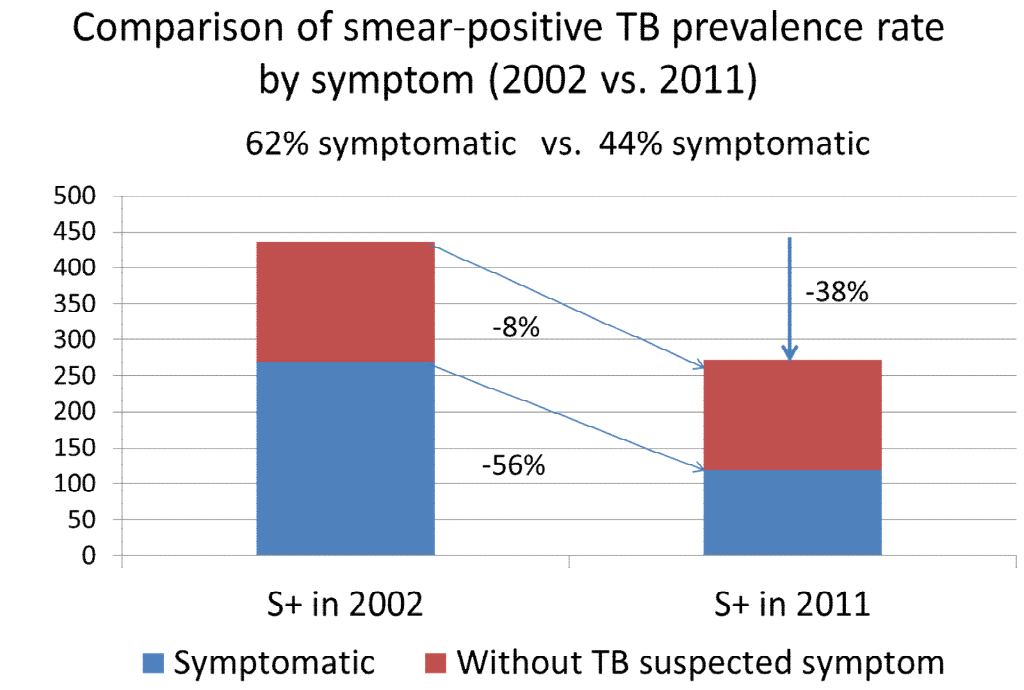
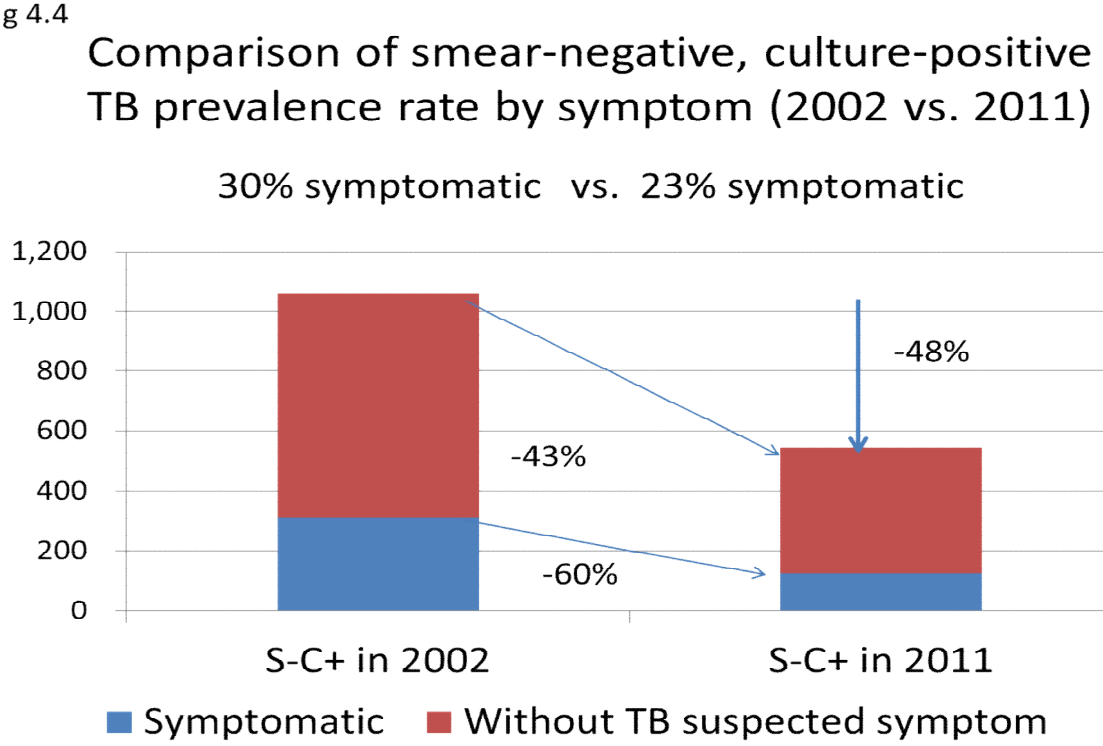


Fig 4.4



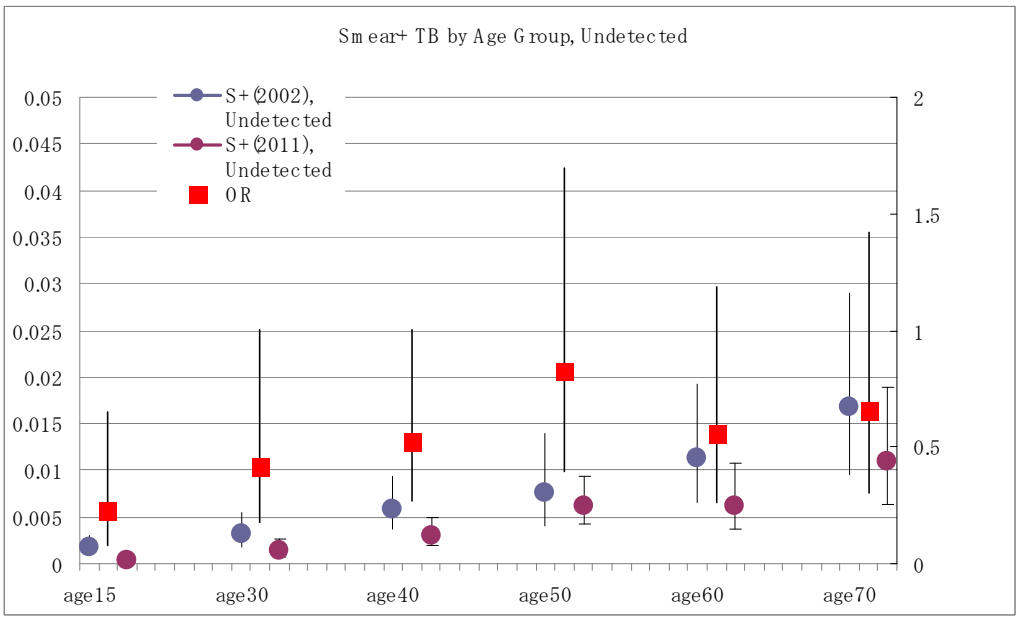
4.8.2 Prevalence rates of undetected TB cases by age

Prevalence rates of undetected TB cases by age were compared between the two surveys as shown in Fig 4.5 and Fig 4.6, where those aged 15-29 years old are grouped because of its small number of smear-positive TB. TB cases who were on treatment were excluded in order to exclude the effect of improved access to treatment by DOTS expansion. The left axis in the figures represents the prevalence rate of undetected TB and the right axis represents the odds ratio (OR) of the prevalence rate in 2011 compared to that in 2002.

For smear-positive prevalence rates (Fig 4.5), those aged 15-29 years old had a significantly lower OR of 0.22 (95% IC: 0.077-0.65). In all other age groups, the ORs were less than 1.0, though not statistically significant: 0.42 in 30-39 year-olds, 0.52 in 40-49 year-olds, 0.82 in 50-59 year-olds, 0.56 in 60-69 year-olds, and 0.65 in those who were 70 years or over. It appears that the smear-positive prevalence rate begin to decline from younger generations by successfully cutting the chain of transmission from the older generations to the young. In addition, the detection rate might be higher in younger age groups than older age groups because the 2002 tuberculin survey (3) suggested lower ARI of around 1% among young children compared with the prevalence and notification of disease in community.

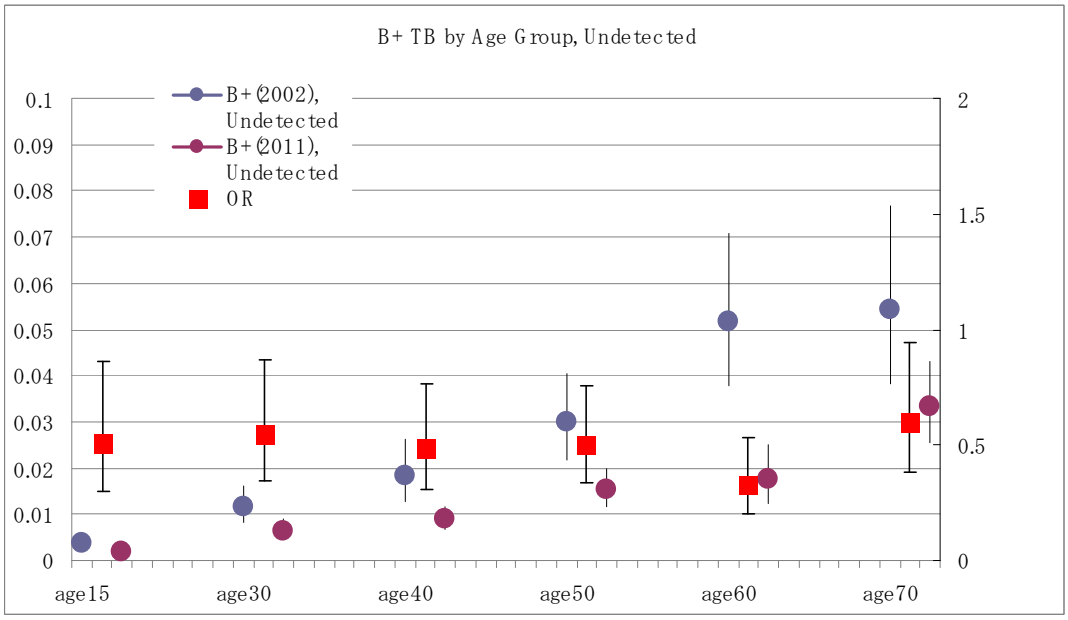
Fig 4.6 shows the prevalence rated of bacteriologically positive TB by age in the first and the second surveys and their ORs. The NTP in Cambodia has made a great impact on TB epidemiology through tremendous efforts in TB control including DOTS expansion to health centers and communities, implementation of TB/HIV care at referral hospitals, improving the diagnostic capacity of smear-negative TB by CXR, introduction of Private Public Mix (PPM) DOTS and so forth, which is proven by the significant reduction in prevalence rates in all age groups

Fig 4.5 Comparison of smear-positive prevalence rate by age (2002 vs. 2011)



Significant reduction in prevalence rate is observed among the young aged 15 -29.

Fig 4.6 Comparison of bacteriologically positive prevalence rate by age (2002 vs. 2011)



Significant reduction in prevalence rate is observed in any age group.

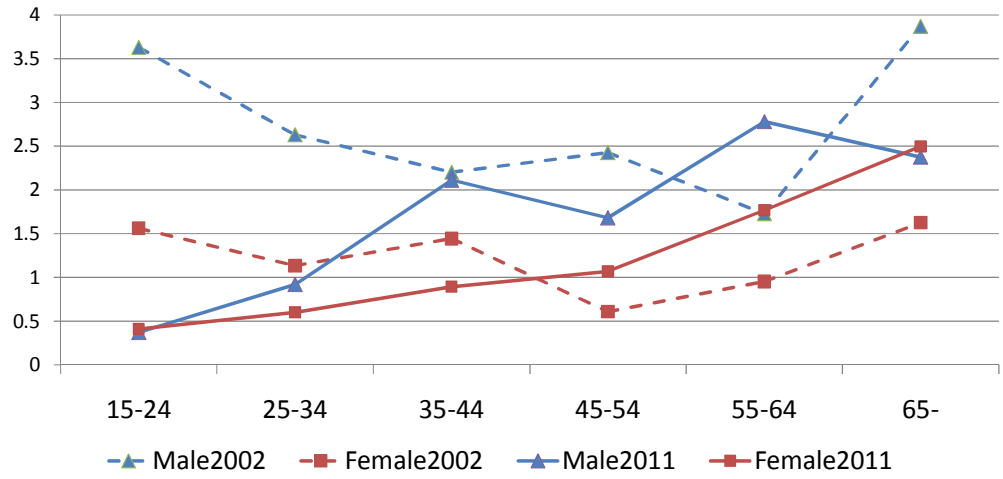
4.9 Comparison with surveillance data

We compared ratios of prevalence rate (P) to notification rate (N) by age and sex, which indicates how many years are needed to detect all prevalent cases in theory. If a P/N ratio is less than 1.0, it means that NTP detects more TB cases in a year than prevalent cases.

Fig 4.7 shows the P/N ratios by age and sex in 2002 (dotted lines) and in 2011 (solid lines). In 2002, the graph for males had a U shape between 1.5 and 4.0 P/N ratios, while that for females were nearly horizontal between 0.5 and 1.5 P/N ratios, but consistently below those for males. In 2011, however, the P/N ratiosfor both males and females were low at around 0.5 for 15-24 year-olds and then increased with age. In other words, TB control in younger generation showed improvement in both males and females, but not as much in the middle-aged and the elderly, and even became worse in females aged 45 years or over comparing the P/N ratios to that in 2002.

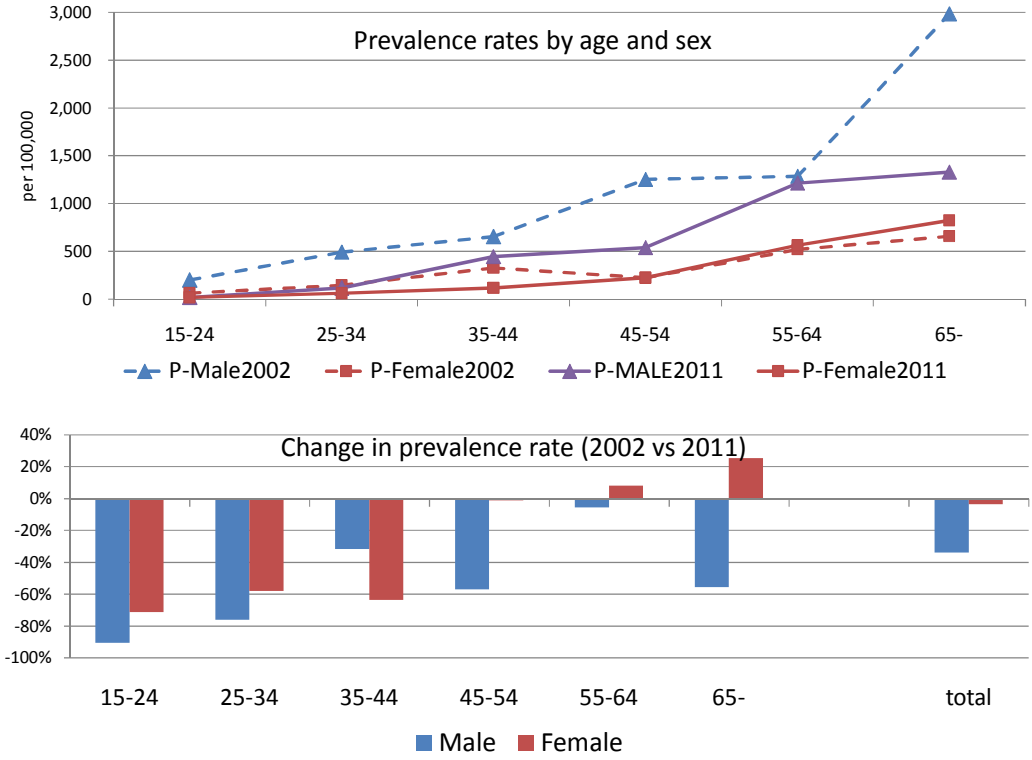
For further analysis, prevalence rates and notification rates by age and sex in 2002 (dotted lines) and 2011 (solid lines) are shown in Fig 4.8 and Fig 4.9, respectively. Prevalence rates in males substantially declined expect for those aged 55-64 years, while those in females were hardly reduced in those aged 45 years or older and increased for those over 65 years of age. On the other hand, notification rates in both males and females declined in all age groups except for those of 15-24 year-olds. As a result, the P/N ratios from the current survey showed a trend for increase with age as shown in Fig4.7.

Fig 4.7 Prevalence rate / Notification rate (2002 vs. 2011)



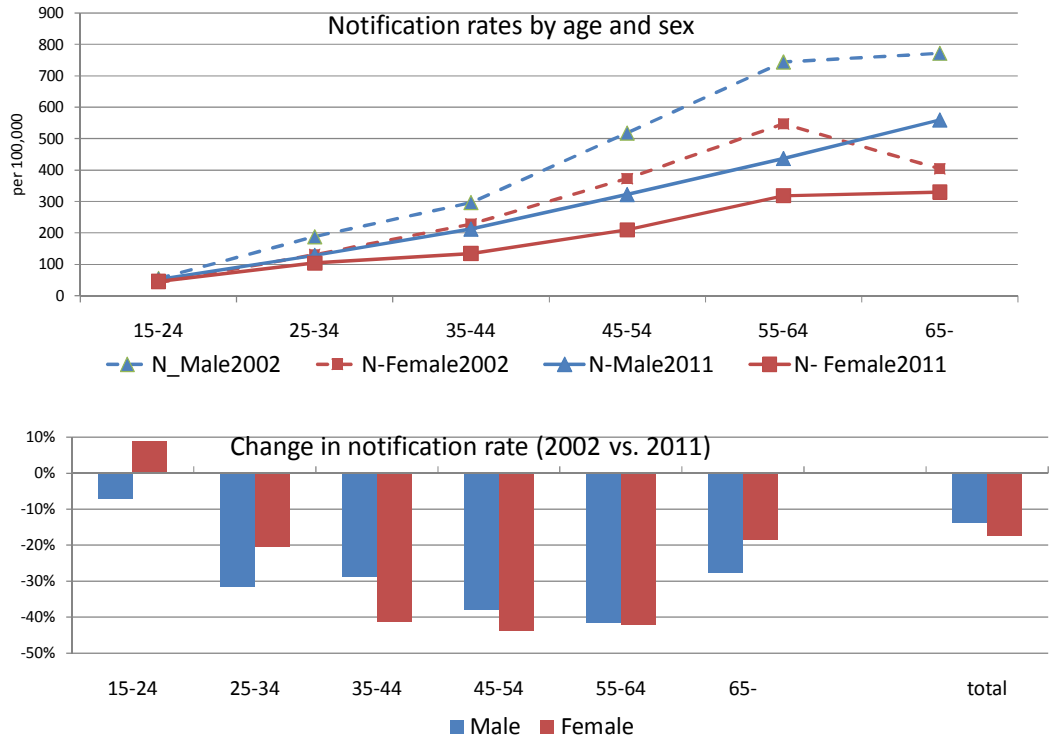
- P/N ratios by age have been drastically changed, especially in younger age groups.
- P/N ratios in the elderly of male remains still high.
- P/N ratios in the elderly of female becomes a little worse.

Fig 4.8



Greater reduction in prevalence rate in young age groups

Fig 4.9

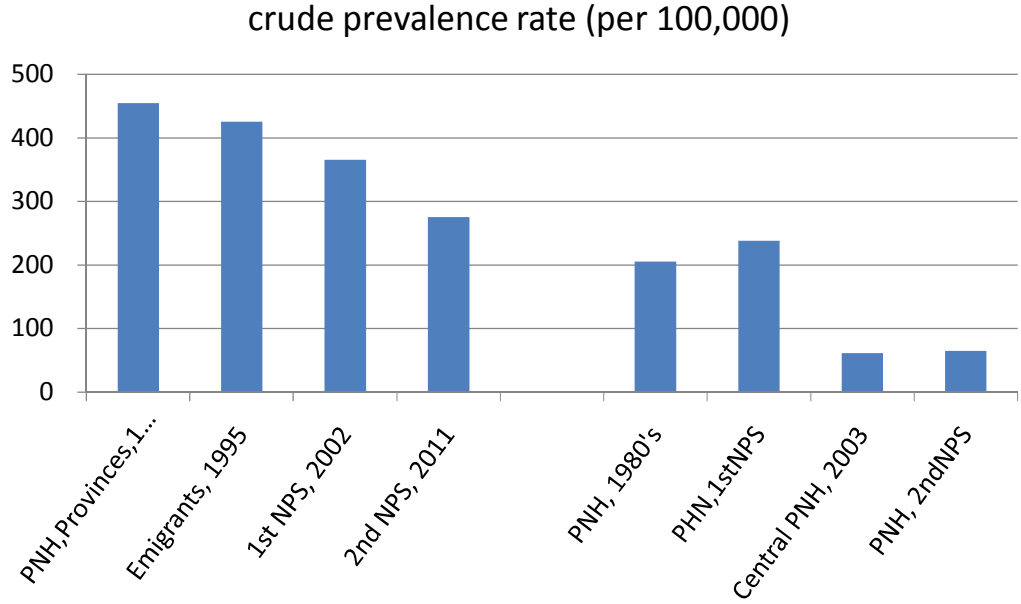


Greater reduction in notification rate in middle age groups

4.10 Comparison with previous surveys in Cambodia

We summarized crude prevalence rates obtained from five previous surveys in Cambodia (3,8,9), which include active case finding in 1980's in some provinces, TB screening for emigrants in 1995, the first national prevalence survey in 2002, a prevalence survey in central Phnom Penh in 2003, and the second national prevalence survey in 2011. Therefore bars on the left in Fig 4.10 represent national or provincial crude prevalence rates and the four bars on the right represent crude prevalence rates in Phnom Penh. Steady decline in the prevalence rates over time were observed both in provinces or emigrants and in Phnom Penh, and Phnom Penh has consistently shown lower prevalence rates than in provinces or other areas.

Fig 4.10 Prevalence rates from surveys and active case detection in Cambodia



Prevalence rates of S+TB have steadily declined in Cambodia.
Phnom Penh, the capital, shows lower prevalence rate than rural areas.

4.11 Comparison with other recent nationwide surveys

The prevalence rates from the survey were compared with those from other national surveys (10,11,12), as shown in Tab 4.3. The second survey revealed a 38% reduction in smear-positive prevalence rate among those aged 15 years or older, compared with the first survey in 2002. Nevertheless, Tab 4.5 shows that Cambodia still remains the top in prevalence rates in Asia and among the 22 TB high burden countries (1).The NTP, Cambodia will have to sustain continuous efforts in tackling TB, confronting the new challenges revealed by the second survey.

Tab 4.5 Prevalence rates from other recent nationwide surveys

		Smear-positive prevalence rate (per 100,000)	Bacteriologically positive prevalence rate (per 100,000)
Cambodia 2002	10y-	362 (284-461)	1208 (997-1483)
Philippines 2007	10y-	260 (170-360)	660 (510-880)
Viet Nam 2007	15y-	197 (149 -254)	307 (248 -367)* *1 culture
Myanmar 2009	15y-	242 (186 - 315)	613 (502-748)
China 2010	15y-	66 (53-79)	119 (103-135)
Ethiopia 2011	15y-	108 (73–143)	277 (208 -347)* * 1 culture
Cambodia 2011	15y-	272 (209-354)	820 (691 – 971)

4.12 Strengths and limitations of the survey and analysis

The survey protocol was reviewed by the WHO Global Task Force on TB Impact Measurement and international experts and was approved by the National Ethics Committee for Health Research, Ministry of Health, Kingdom of Cambodia. Based on the protocol, a standard operating procedure (SOP) was formulated, which was effectively used for the training, the field operation and the central level activities.

To ensure the quality of data acquisition, various interventions were made before and during the field operation. After a field test for interview and CXR screening, two pilot tests, which simulated census taking, field screening and laboratory examinations in the same way as the survey, were carried out at a rural village in Takeo province and in an urban area in Phnom Penh, respectively. At the time of implementing field work at the first 5 clusters, the first review meeting for field work took place among the team members. The mid-term review was made by inviting international experts from development partners to discuss the field operation including census taking and symptom and CXR screening, laboratory performance, and data management which had been practiced. In addition, WHO training courses for consultants and survey coordinators on national TB prevalence survey were conducted in Cambodia and the participants including WHO experts, who played an important role as external reviewers for the Cambodian survey through their supervisory visits to the survey field.

The following limitations were recognized in the survey.

4.12.1 Survey design

1) Prevalence of TB in children and extra-pulmonary TB were not assessed.
2) Effect of the HIV epidemic on TB prevalence was not assessed because HIV examination was not included.

4.12.2 Operational aspect

1) Although the overall participation rate was very high, some urban clusters in Phnom Penh had relatively lower participation rates.
2) In some clusters soon after starting the field operation, the participants without CXR were not asked to submit their sputum specimens.
3) Some CXR films with poor quality were not re-taken in the field.
4) Some subjects with CXR abnormality were not classified into those eligible for sputum examinations by the field screening.
5) There was a delay in sending laboratory results to data management room due to heavy workload during the survey in addition to the routine jobs
6) Too harsh decontamination process during culture examination may have led to some smear-positive, culture negative TB cases.
7) Miss-coding of 7-digit survey ID was sometimes found on CXR films or CXR registry book; might have been avoided by allotting serial numbers.

4.12.3 Analysis

1) Additional smear examinations with Ziehl-Neelsen stain were required to compare the results with those from the first survey.
2) Differences in CXR interpretation results between Cambodian radiologists and Japanese experts were sometimes found and a third film reader was required to make the final reading.

5. PROGRAM IMPLICATIONS

5.1 Impact of DOTS expansion on TB epidemiology

The second survey 2011 revealed that the prevalence rate of smear-positive TB in people 15 years old and older in Cambodia was reduced by 38 % during a period of nine years. This was achieved by tremendous efforts by the NTP, the WHO, JICA, USAID and other partners. In particular, the introduction of DOTS into hospitals with support by the WHO in 1994 and the subsequent nationwide DOTS expansion to health centers in 1999-2004 with the technical and financial support of WHO and the JICA Project together with continued and other specific activities with support from other partners , which were the key to success in TB control, as they made great contributions to the detection and treatment of most infectious cases with smear-positive TB with more than 90% treatment success rate. The NTP in Cambodia should maintain the facility DOTS at hospitals and health centers as a core of TB control, combining other types of DOTS like community DOTS and public-private mix DOTS. There are other factors that are possibly associated with the reduction in TB prevalence in the country: the decline of HIV sero-prevalence rates among TB patients(5,6,7)) and doubling of GDP per capita in the last nine years, which should last long in the future for continuous reduction of TB prevalence.

5.2 Limitation of DOTS strategy focusing on symptoms

The 56% reduction in smear-positive prevalence rate of TB was observed among the symptomatic (i.e.cough 2 weeks or longer, or haemoptysis), while the prevalence rate of the asymptomatic (those without TB suspect symptom) declined by only 8%. This tells us both the effectiveness and the limitations of DOTS strategy, which has focused on passive detection of symptomatic TB cases who have sought medical care by themselves.

At the time of the first survey in 2002, there were more symptomatic smear-positive TB cases with cough 2 weeks or longer or haemoptysis than asymptomatic cases (cases without TB suspect symptom). At present, on the contrary, symptomatic cases represent only 44%. Among smear-negative, culture-positive TB cases, only 23% meet the TB suspect definition under the current NTP.

The NTP should consider two things for further reduction in TB: 1) strengthening the diagnostic capacity for OPD patients with respiratory symptoms; and 2) expansion of active case detection to highly prevalent groups such as the elderly, household contacts with smear-positive TB and those co-infected with HIV.

5.3 Strengthening existing diagnostic capacity

Of the 103 smear-positive TB cases identified in the survey, 71 (69%) who had cough of any duration had sought some form of care and 39 (38%) cases had consulted public facilities. Similarly, of the 119 smear-negative, culture positive cases with cough who consulted care of some sort, 55 (46%) cases had visited public facilities. The current diagnostic procedures which entirely depend on smear microscopy should be thoroughly reviewed: active use of CXR for any respiratory symptom cases; referral system for smear-negative suspects to facility equipped with CXR; or introduction of more sensitive diagnostics including WHO-approved diagnostics such as Xpert MTP/RIF than smear microscopy.

5.4 TB in the middle-aged and the elderly

The prevalence rates sharply increases with age and those aged 55 years or older are the majority of prevalent TB cases, especially in smear-positive TB. In addition, the P/N ratios show that the situation in the middle-aged and the elderly for both males and females has not changed much compared with those from the first survey. A question arises as to why they had higher P/N ratios than the younger. Are they unaware of their respiratory symptoms or are they less likely to take actions for medical care? Unfortunately, the second survey was unable to find clear answers to these questions because the response from the survey participants indicated that the older were aware of their symptoms and sought medical attention for their symptoms as well as, or even more than the younger. One possible explanation may be that the middle-aged and the elderly have a higher risk of developing TB by reactivation from previous infection rather than from a new infection. Incidence among the younger can be reduced by eliminating new transmissions from infectious sources, but the reactivation among the middle aged and the elderly is difficult to control. A follow up study (13) after the first survey revealed that those with CXR suggestive of active TB but negative culture have a high incidence rate of bacteriologically positive TB of 8.5% a year and two-thirds of incident cases with smear-positive TB were produced from those with any abnormal shadow on CXR. Interventions such as INH preventive therapy

or full TB treatment might need to be considered for those with CXR suggestive of active TB but negative bacteriological-test results. Another option is performing active case finding for the middle-aged and the elderly.

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ANNEX

Annex 1: Executive Committee

1	Chairman	H.E.	Dr. Mao Tan Eang	Director, CENAT
2	Vice chairman	Dr.	Team BakKhim	Vice Director, CENAT
3	Member	Dr.	Huot Chanyuda	Vice Director, CENAT
4	Member	Dr.	Suong Sarun	Vice Director, CENAT
5	Member	Dr.	Uong Mardy	Vice Director, CENAT
6	Member	Dr.	Keo Sokonth	Chief of Technical Bureau, CENAT
7	Member	Dr.	Tieng Sivanna	Vice Chief of Technical Bureau, CENAT
8	Member	Dr.	Khun Kim Eam	Vice Chief of Technical Bureau, CENAT
9	Member	Dr.	Khloeung Phally	Vice Chief of Technical Bureau, CENAT
10	Member	Dr.	Tan Kun Dara	Vice Chief of Administrative Bureau, CENAT
11	Member	Dr.	In Sokhanya	Chief of Planning and statistics unit, CENAT
12	Member	Dr.	Pheng Sok Heng	Chief of Laboratory unit, CENAT
13	Survey coordinator	Dr.	Peou Satha	Chief of Radiology unit, CENAT
14	Technical advisor	Dr.	Kosuke Okada	Project Leader, CENAT/JICA National TB Control Project
15	Technical advisor	Dr.	Rajendra PH Yadav	Medical Officer / WHO, Cambodia
16	Technical advisor	Dr.	Jamhoih Tonsing	Project Director, FHI/TB CARE
17	Technical advisor	Dr.	Pratap Jayavanth	International M&E Advisor,CENAT/Global Fund

Annex2: External contribution from the WHO Global Task Force on TB Impact Measurement

1	Dr. Katherine Floyd	Coordinator, TB Monitoring and Evaluation Unit Stop TB Department, WHO, Geneva	Organizer, WHO training courses and workshop in Cambodia
2	Dr. Ikushi Onozaki	TB Monitoring and Evaluation Unit, Team leader of the prevalence survey group Stop TB Department, WHO, Geneva	from basic design to analysis
3	Dr. Norio Yamada	Research Institute of Tuberculosis, Japan Anti-tuberculosis Association	from basic design to analysis
4	Dr. Sara J. Whitehead	US CDC, Southeast Regional Office	protocol review, and mid-term and final reviews
5	Dr. Philippe Glaziou	Stop TB Department, WHO, Geneva	final review and estimation of the burden
6	Dr. Charalampos Sismanidis	Stop TB Department, WHO, Geneva	protocol review, data analysis and final review
7	Dr. Sian Floyd	London School of Hygiene and Tropical Medicine	protocol review and field review
8	Dr. Emily Bloss	Center for Disease Control and Prevention, USA	protocol review and field review

Annex 3: Letter from the Cambodian National Ethics Committee

ក្រសួងសុខាភិបាល
MINISTRY OF HEALTH
គណៈកម្មាធិការជាតិក្រមសីលធម៌
សំរាប់ការស្រាវជ្រាវសុខភាពដែលពាក់ព័ន្ធនឹងមនុស្ស
National Ethics Committee for Health Research

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ព្រះរាជាណាចក្រកម្ពុជា
KINGDOM OF CAMBODIA
ជាតិ សាសនា ព្រះមហាក្សត្រ
NATION RELIGION KING

រាជធានីភ្នំពេញ, ថ្ងៃទី....16..ខែ..08....ឆ្នាំ201.0...

Dr. Mao Tan Eang

Project: The National TB Prevalence Survey 2010-2011

Reference: August 13th, 2010 NECHR meeting minute

Dear Dr. Mao Tan Eang,

I am pleased to notify you that your protocol entitled "The National TB Prevalence Survey 2010-2011" has been approved by National Ethic Committee for Health Research (NECHR) in the meeting on August 13th, 2010. This approval is valid for twelve months after the approval date.

The Principal Investigator of the project shall submit following document to the committee's secretariat at the National Institute of Public Health at #2 Kim Il Sung Blvd, Khan Tuol Kok, Phnom Penh. (Tel: 855-23-880345, Fax: 855-23-881949):

- Annual progress report
- Final scientific report
- Patient/participant feedback (if any)
- Analyzing serious adverse events report (if applicable)

The Principal Investigator should be aware that there might be site monitoring visits at any time from NECHR team during the project implementation and should provide full cooperation to the team.

Regards,

Chairman

H.E. Prof ENG HUOT

លេខ ២ មហាវិថី គីម អ៊ិលសុង . ខ័ណ្ឌទួលគោក . រាជធានីភ្នំពេញ . ទូរស័ព្ទ (៨៥៥-២៣) ៨៨០ ៣៤៥ . ទូរស័ព្ទដៃ (៨៥៥-១២) ២៨០ ៧៩០ . (៨៥៥-១២) ៨៤២ ៤៤២
2 Blvd KIM YL SUNG, Khan Toul Kork, Phnom Penh , Tel : (855-23) 880 345 , Mobile phone : (855-12) 280 790, (855-12) 842 442

Annex 4: Technical Committee

Team Leaders

1	Survey coordinator	Dr.	Peou Satha	Chief of Radiology unit, CENAT
2	Team leader	Dr.	Kouet Pichenda	Vice Director, CENAT
3	Team leader	Dr.	Keo Sokonth	Chief of Technical Bureau, CENAT
4	Team leader	Dr.	Saint Saly	Chief of Research unit, CENAT
5	Team leader	Dr.	Chea Manith	Planning, Statistics & IEC unit, CENAT

Sub-Committee of Census

1	Chief	Dr.	Koy Bonamy	Hospital MDR unit, CENAT
2	Vice chief	Ph.	Phoeung Bunva	Chief of Pharmacy unit, CENAT
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4	Member	Ms.	Doung Lay	Administrative Bureau, CENAT
5	Member	Ms.	In Sokhoeun	Hospital MDR unit, CENAT
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7	Member	MA.	Hang Kunthy	Financial Bureau, CENAT
8	Member	Ms.	Soy Sopeak	Pharmacy unit, CENAT
9	Member	Ms.	Mam Chan Sophal	Administrative Bureau, CENAT
10	Member	Ms.	Pich Rumnead	Pharmacy unit, CENAT
11	Member	Mr.	Long Pheavy	Dispensary unit, CENAT
12	Member	Mr.	Keo Moeuk	Hospital unit, CENAT
13	Member	Ms.	Loeuk Dary	Hospital unit, CENAT
14	Member	MA.	Mao Kolsopheap	Dispensary unit, CENAT

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1	Chief	Dr.	Peou Satha	Chief of Radiology unit, CENAT
2	Vice chief	Mr.	Chet Sambo	Radiology unit, CENAT
3	Member	Dr.	Ten Sothara	Hospital unit, CENAT
4	Member	Dr.	Noem Sithat	Hospital unit, CENAT
5	Member	Mr.	Lao Bo	Administrative Bureau, CENAT
6	Member	Mr.	Hem Phalit	Radiology unit, CENAT
7	Member	Mr.	My Borin	Radiology unit, West OD, Phnom Penh
8	Member	Mr.	Eang Neou	Radiology unit, CENAT
9	Member	Mr.	Chhoun Sokhum	Hospital unit, CENAT
10	Member	Mr.	Lim Radeth	Radiology unit, Phnom Penh School
11	Member	Ms.	Chhom Sophorn	Hospital unit, CENAT
12	Member	Ms.	Yav Yurin	Hospital unit, CENAT
13	Member	Mr.	Ang Sombo	Radiology unit, HC SerySophorn, B. Meanchey Province

14	Member	Mr.	Prom Tomy	Radiology unit, Kampot RH, Kampot Province

Sub-Committee of Bacteriology

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2	Vice chief	Mr.	Yang Samol	Laboratory unit, CENAT
3	Member	Ms.	Preak Sokuntea	Laboratory unit, CENAT
4	Member	Mr.	Seam Sok Aun	Laboratory unit, CENAT
5	Member	Ms.	Phang Mom	Laboratory unit, CENAT
6	Member	Ms.	Phan Aun	Laboratory unit, CENAT
7	Member	Ms.	An Sokheng	Laboratory unit, CENAT
8	Member	Mr.	Phorn Phorm	Laboratory unit, CENAT
9	Member	Ms.	Saint Sophal	Laboratory unit, CENAT
10	Member	Ms.	San Socheat	Laboratory unit, CENAT
11	Member	Ms.	Soun Maryneth	Laboratory unit, CENAT
12	Member	Ms.	Kim Pidor	Laboratory unit, CENAT
13	Member	Ms.	Boy Sambo	Laboratory Officer, WHO Cambodia

Sub-Committee of Statistics

1	Chief	Dr.	Tieng Sivanna	Vice Chief of Technical Bureau, CENAT
2	Vice chief	Dr.	Khun Kim Eam	Vice Chief of Technical Bureau, CENAT
3	Member	Dr.	Long Ngeth	Planning, Statistics & IEC unit, CENAT
4	Member	Dr.	Seng Saorith	Planning, Statistics & IEC unit, CENAT

Sub-Committeeof Administration

1	Chief	Mr.	Tek Sophoeun	Chief of Financial Bureau, CENAT
2	Vice chief	Mr.	Ny Keophara	Vice Chief of Financial Bureau, CENAT
3	Member	Mr.	Nhem Sychan	Financial Bureau, CENAT
4	Member	Mr.	Sok Seng Run	Financial Bureau, CENAT

Battambang Laboratory

1	Member	Mr.	Mr. Yeng Sambath	Culture unit, Battambang
2	Member	Mr.	Khan Thang	Chief of Laboratory unit, Battambang
3	Member	Ms.	Keo Chanthary	Assistant Laboratory unit, Battambang

Annex 5: Experts of the JICA Project

1	Dr. Kosuke Okada	Supervisor (project leader)
2	Dr. Norio Yamada	Epidemiology / Statistics
3	Dr. Masaki Ota	Epidemiology / Data management
4	Dr. Takashi Yoshiyama	Chest X-ray examination (diagnosis)
5	Dr. Kunihiko Ito	Chest X-ray examination (diagnosis)
6	Dr. Hiroyuki Nishiyama	Chest X-ray examination (diagnosis)
7	Mr. Yutaka Hoshino	Chest X-ray examination (film shooting)
8	Ms. Hiroko Matsumoto	Bacteriological examination (quality assurance)
9	Mr. Tetsuhito Sugamoto	Bacteriological examination (culture, identification and DST)
10	Ms. Kiyomi Yamamoto	Coordinator / Data management

Annex 6: Contributors to survey report writing

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2	Dr. Kosuke Okada	JICA/CENAT National TB Control Project, RIT/JATA
3	Dr. Ikushi Onozaki	Stop TB Department, WHO, Geneva
4	Dr. Norio Yamada	Research Institute of Tuberculosis, JATA
5	Dr. Kouet Pichenda	Vice director of CENAT
6	Dr. Saint Saly	Chief of Research unit, CENAT
7	Dr. Khum Kim Eam	Vice Chief of Technical Bureau, CENAT
8.	Dr. Rajendra PH Yadav	Medical Officer / WHO, Cambodia
9	Dr. Pratap Jayavanth	International M&E Advisor, CENAT/Global Fund
10	Dr. Miwako Kobayashi	WHO, Cambodia Office
11	Ms. Kiyomi Yamamoto	JICA/CENAT National TB Control Project, RIT/JATA
12	Mr. Boy Sambo	CENAT/WHO Cambodia

Annex 7: List of Forms

(The underlined forms are attached here. Other forms should be referred in the SOPs)

Name	**Form Nº**	**Remarks**
Household registry	Form01	Triplicate carbon-copy
Household number	Form02	
Invitation card	Form03	Backside with survey information
Informed consent form	Form04	
Individual survey sheet	Form05	Interviewing sheet
ID Card	Form06	Mini Carbon-copy interviewing sheet
X-ray registry	Form07	
TB suspects list	Form08	Triplicate (specimen transportation, Lab-unit, Team leader)
Lab-examination Form	Form09	Triplicate
Summary report of each surveyed cluster	Form10	After finishing each cluster operation
Lab-rechecking registry	Form11	Duplicate
Smear registry	Form12	
Culture registry	Form13	
List of cluster TB patient registered for TB treatment at OD	Form14	
Central Data Management Unit Logbook	Form15	
Information Sheet	Form 16	
Smear positive	Form 17	
Smear negative culture positive	Form 18	
Smear negative culture negative CXR positive	Form 19	
Dispatch sheet of positive culture	Form 20	

(Form01)

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KINGDOM OF CAMBODIA

MINISTRY OF HEALTH Nation Religion King

National Tuberculosis Control Program

Prevalence Survey

HOUSEHOLD REGISTRY
(FORM 1)

Name of sample area :……Commune……District……Province……

Cluster No:[ ] [ ] Number of household: [ ] [ ] [ ]

Filled by:……..

Serial No	Registration No *	Name	Sex (M/F)	Date of birth	Age	Occupation	Participated	Remark
1	0100101							
2	0100102							
3	0100103							
4	0100104							
5	0100105							
6								
7								
8								

All forms must be filled with a pen.

* : Every subject eligible for the survey must be given his/her own number which has 7 digits:0000000

The first two digits indicates the number of the survey area(sampleunit) which is 1 to 64

The middle three digits indicate the serial number of households in a survey area.

The last two digits indicate the serial number of family member in a household.

**: No survey ID number means no eligibility and the reason should be explained in the remarks. If adult, delete the name by line. Children under 15 is ‘no code and no deletion’

***: Participated: when the eligible person attends the survey, please tick. R: refuse and A: absence.

****: Categorize?: occupation and remarks (the reason for R or A)

(Form04)

Informed consent form (Form04)

(Information part)

This informed consent form is for the household members who are invited to participate in TB prevalence survey in the selected clusters of Cambodia.

The aim of this survey is to assess the disease burden of active pulmonary TB. The community from the selected clusters will be screened for TB by interviewing about the TB symptoms and Chest X-ray examination. If a participant is suspected of having TB, sputum is taken for TB examinations and the results will be given back later. The information that we collect from this survey will be kept confidential. The respondents are entitled to the medical benefits and treatment for TB if necessary.

The findings of the survey will provide valuable information on the programme impact and contribute to developing appropriate plans and strategies for the National TB Programme.

(Declaration part 1)

I have read the above explanation and the information leaflet, or they has been explained to me by health staff. I have had the opportunity to ask question about it and all the questions that I have asked were answered to my satisfaction. I have been informed that the risks by the survey are minimal. I know that I will be able to receive treatment at health centre or referral hospital if I have TB. I have agreed to participate in this survey with understanding that I have right to reject any interview/screening and withdraw from the participation without affecting my further medical care.

thumb print of participant

Name of participant . . . . . .
Signature or thumb print . . . . . .
Date . . . . /. . . . ./. . . . . .

(Declaration part 2)If a participant is unable to read:

I have witnessed that the participant was fully explained about the accurate consent form and that the individual had the opportunity to ask any questions. I hereby confirm that the individual has been given informed consent to participate in the survey.

The witness must sign (if possible, this person should be selected by the participantout of the research team). The participant should leavehis/her thumb print as well.

Name of witness . . . . . .
Signature of witness . . . . . .
Date . . . ./ . . . . . ./ . . . . .

(Form05)

Kingdom of Cambodia
Nation Religion King

Individual survey sheet (Form05)

Village Commune
District Province

(1) Survey ID Nº	(2) Name	(3) Sex	(4) Age	(5) Occupation
_ _ _ _ _ _ _				

Sign by receptionist……

(6) Symptoms (last one month) and Duration			(7) Health seeking behavior			
	Yes	No	7.1 No attention	☐		
6.1 Cough	_____ days	☐	7.2 Self-medication	☐		
6.2 Sputum	_____ days	☐	7.3 Consultation		If not either **7.1**, **7.2**, **7.3a**	
6.3 Haemoptysis	_____ days	☐	a. Government hospital	☐	or **7.3b**	
6.4 Chest pain	☐	☐	b. Health centre	☐	i. Not severe	☐
6.5 Loss of B.W	☐	☐	c. Private clinic	☐	j. No money	☐
6.6 Fatigue	☐	☐	d. Private hospital	☐	k. Far distance	☐
6.7 Fever	☐	☐	e. Pharmacy	☐	L. Times waiting	☐
6.8 Night sweats	☐	☐	f. Traditional healer	☐	m. Others (specify)	☐
6.9 Others ……			g. Family member	☐	……..	
6.10 Interviewer comments for sputum collection Yes ☐ No ☐ Signature: ……			h. Other facility (specify)……			

(8) TB treatment history			(9) Radiology	
8.1- Yes ☐ No ☐			9.1 Chest X-ray taking	9.2 Result
If yes (duration)	8.2 Past☐ Year…… forget ☐	8.3 Present☐ Month…… forget ☐	a. X-ray taken	a. Normal
			b. Refuse	b. Abnormal
a. Government hospital	☐	☐	c. Unable for x-ray	9.3. Necessity to collect sputum
b. Health centre	☐	☐	d. Others	Yes ☐ No ☐
c. Private clinic	☐	☐		Reader signature……
d. Private hospital	☐	☐	**(10) Sputum collection: ……**	
e. Pharmacy	☐	☐	10.1 Comments by Team leader for sputum collection: Yes ☐ No ☐	
f. Traditional healer	☐	☐		
g. Others…… ……..			Specimen-1 ☐ ……/……/…… Specimen-2 ☐ ……/……/…… Signature of Lab-technician:……	

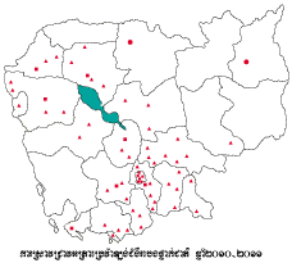
(Form07)

Chest X-ray (CXR) Register (Form07)

Nº	Survey Code	Name	Sex		Address	Field reading-specimen collection			Central reading					Remarks
			M	F		Normal	Abnormal	Request sputum	Normal	Active	Healed	Other respiratory	Cardiology	

Note: Use ✓ in the box for every reading by field or central level

(Form08)



Kingdom of Cambodia
Nation Religion King

TB Suspects List (Form08)

Operating site number.....Cluster name.....

Commune.....District.....Province.....

Nº	Survey Code	Patient's name	Age		Date of specimen collection	Others
			M	F		
1					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
2					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
3					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
4					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
5					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
6					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
7					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
8					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
9					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
10					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
12					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
13					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
14					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
15					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
16					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
17					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
18					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
19					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	
20					Specimen-1 ...../...../..... Specimen-2 ...../...../.....	

Date……/……/…….

Laboratory unit（Signature-name）
Survey team leader（Signature-name）

(Form09)

To data management unit

Slip Number

LAB 01

Laboratory Examination Forms (Form 09)

at the site

1. Survey ID No. | | | | | | | |

2. Name (in full):_____

3. Sex: ☐ Male ☐Female 4. Age:_____Year

5. Sputum collection data & aspect

D1 Specimen: dd/mm/yy_____/_____/_____ Saliva☐ Mucopurulent ☐ Bloody ☐

D2 Specimen: dd/mm/yy_____/_____/_____ Saliva☐ Mucopurulent ☐ Bloody ☐

Date:_____ Sign by lab technician at site:_____

---

at the laboratory (CENAT or BattambangRH)

6. Specimens reception date at Lab:dd/mm/yy _____/_____/_____

7. Lab culture number:_____

8. Result:

	FLUO MICROSCOPY		CULTURE				ID TEST (Capilia)
	Result	Rechecking (if SNCR)	Kudoh tube				
D1	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	Kh1	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )			a. [ ]Neg b. [ ]Pos c. [ ]NA ( )
			Kh2	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )			
D2	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	Kh1	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )			
			Kh2	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )			

Date:_____ Sign by lab-technician :_____

Form09 (Page 2)

To data management unit

Slip Number

LAB 02

Laboratory Examination Forms (Form 09)

at the site

1. Survey ID No. | | | | | | | |

2. Name (in full):_____

3. Sex: ☐ Male ☐Female 4. Age:_____Year

5. Sputum collection data & aspect

D1 Specimen: dd/mm/yy_____/_____/_____ Saliva☐ Mucopurulent ☐ Bloody ☐

D2 Specimen: dd/mm/yy_____/_____/_____ Saliva☐ Mucopurulent ☐ Bloody ☐

Date:_____ Sign by lab technician at site:_____

at the laboratory (CENAT or BattambangRH)

6. Specimens reception date at Lab:dd/mm/yy _____/_____/_____

7. Lab culture number:_____

8. Result:

	FLUO MICROSCOPY		CULTURE		ID TEST Capilia
	Result	Rechecking (if SNCP)	Kudoh tube		
D1	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	Kh1	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )	
			Kh2	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )	a.[ ]Neg b.[ ]Pos c.[ ]NA ( )
D2	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	Kh1	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )	
			Kh2	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )	

Date:_____ Sign by lab-technician :_____

Copy for culture test section

Slip Number

LAB 03

Laboratory Examination Forms (Form 09)

at the site

1. Survey ID No. | | | | | | | |

2. Name (in full):_____

3. Sex: ☐ Male ☐Female 4. Age:_____Year

5. Sputum collection data & aspect

D1 Specimen: dd/mm/yy_____/_____/_____ Saliva☐ Mucopurulent ☐ Bloody ☐

D2 Specimen: dd/mm/yy_____/_____/_____ Saliva☐ Mucopurulent ☐ Bloody ☐

Date:_____ Sign by lab technician at site:_____

at the laboratory (CENAT or BattambangRH)

6. Specimens reception date at Lab:dd/mm/yy _____/_____/_____

7. Lab culture number:_____

8. Result:

	FLUO MICROSCOPY		CULTURE		ID TEST Capilia
	Result	Rechecking (if SNCP)		Kudoh tube	
D1	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	Kh1	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )	
			Kh2	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )	a.[ ]Neg b.[ ]Pos c.[ ]NA ( )
D2	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]NA ( )	Kh1	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )	
			Kh2	a. [ ]Neg b. [ ]Scanty ( ) c. [ ]1+ d. [ ]2+ e. [ ]3+ f. [ ]4+ g. [ ]Contami h. [ ]NA ( )	

Date:_____ Sign by lab-technician :_____

(Form 10)

Summary report of each survey cluster

Cluster ID [ ] [ ]

1. Census taking

- Eligible person : persons
- Person age less than 15 years old : persons
- Total population of the cluster : persons
- Number of eligible household: households

2. Registration

- Consented person : persons
- Refused person : persons
- Absentee : persons

3. Interview

- On-site interviewed person : persons
- Outreach interviewed person : persons
- Sputum request by interview : persons

4. Chest X-ray

- X-ray taken person : persons
- Non x-ray taken person : persons (Refused: persons)
- Result of x-ray reading
  - Normal : cases
  - Abnormal : cases
    - Sputum collection : cases
    - Not required sputum : cases

5. Sputum collection

- Request for sputum collection : cases
- Collected sputum specimen : cases
  - 1st Specimen : cases
  - 2nd Specimen : cases

6. Shipment of sputum specimen

- 1st time, Date……/……./…….. : cases : containers
- 2nd time, Date……/……./……..: cases : containers

7. Nº of TB patients per cluster which registered for TB treatment at OD

- 2009 : persons
- 2010 : persons

Date……/……/……..

Survey team leader (signature and name)

(Form15)

Central Data Management Unit (CDMU) data reception logbook

Serial number	Date (dd-mm-yy)	Cluster name	# of household registers (Form01)	# of individual survey sheets (Form05)	# of TB suspect list sheets (Form08)	# of result of **smear microscopy** forms (Form09)	# of result of **culture** forms (Form09)	# of CXR registers (Form07)	Signature of receiver at CDMU	Remarks
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

(Form 17)

Smear positive Form

Form 17

Smear Positive : Team Leader: Dr. _____ Cluster No: _____ Date of field operation: _____

Province: _____ District: _____ Commune: _____

Village: _____

No	Survey ID (Lab No)	Name (Villages: if 2 or more)	Age		D1	D2	Central reading (CXR No)	Sputum by symptom (Y/N)	History (Past or Current)	Remarks
			M	F						
1	( )	( )			Smear ( )	Smear ( )	( )			
2	( )	( )			Smear ( )	Smear ( )	( )			
3	( )	( )			Smear ( )	Smear ( )	( )			
4	( )	( )			Smear ( )	Smear ( )	( )			
5	( )	( )			Smear ( )	Smear ( )	( )			
6	( )	( )			Smear ( )	Smear ( )	( )			
7	( )	( )			Smear ( )	Smear ( )	( )			
8	( )	( )			Smear ( )	Smear ( )	( )			
9	( )	( )			Smear ( )	Smear ( )	( )			
10	( )	( )			Smear ( )	Smear ( )	( )			

(Form 18)

Smear negative culture positive Form

Form 18

S(-), Culture Positive : Team Leader: Dr_____, Cluster No: _____ Date of field operation: _____

Province: _____ District: _____ Commune: _____

Village: _____

No	Survey ID (Lab No)	Name (Villages: if 2 or more)	Age		D1	D2	Central reading (CXR No)	Sputum by symptom (Y/N)	History (Past or Current)	Remarks
			M	F						
1	( )	( )			S (-) C( )	S (-) C( )	( )			
2	( )	( )			S (-) C( )	S (-) C( )	( )			
3	( )	( )			S (-) C( )	S (-) C( )	( )			
4	( )	( )			S (-) C( )	S (-) C( )	( )			
5	( )	( )			S (-) C( )	S (-) C( )	( )			
6	( )	( )			S (-) C( )	S (-) C( )	( )			
7	( )	( )			S (-) C( )	S (-) C( )	( )			
8	( )	( )			S (-) C( )	S (-) C( )	( )			
9	( )	( )			S (-) C( )	S (-) C( )	( )			
10	( )	( )			S (-) C( )	S (-) C( )	( )			

(Form 19)

Smear negative culture negative CXR active Form

Form 19

S(-)C(-), CXR Active : Team Leader: Dr. _____ Cluster No: _____ Date of field operation: _____

Province: _____ District: _____ Commune: _____

Village: _____

No	Survey ID (Lab No)	Name (Villages: if 2 or more)	Age		D1	D2	Central reading (CXR No)	Sputum by symptom (Y/N)	History (Past or Current)	Remarks
			M	F						
1	( )	( )			S (-) C (-)	S (-) C (-)	CXR Active ( )			
2	( )	( )			S (-) C (-)	S (-) C (-)	CXR Active ( )			
3	( )	( )			S (-) C (-)	S (-) C (-)	CXR Active ( )			
4	( )	( )			S (-) C (-)	S (-) C (-)	CXR Active ( )			
5	( )	( )			S (-) C (-)	S (-) C (-)	CXR Active ( )			
6	( )	( )			S (-) C (-)	S (-) C (-)	CXR Active ( )			
7	( )	( )			S (-) C (-)	S (-) C (-)	CXR Active ( )			
8	( )	( )			S (-) C (-)	S (-) C (-)	CXR Active ( )			
9	( )	( )			S (-) C (-)	S (-) C (-)	CXR Active ( )			
10	( )	( )			S (-) C (-)	S (-) C (-)	CXR Active ( )			

(Form 20)

2nd Prevalence Survey

Dispatch Sheet of Positive Culture

No	Survey Code	Lab Culture No	Specimen No	Date of inoculation	Smear results	Result of culture reading
1		SB	D	/ /		
2		SB	D	/ /		
3		SB	D	/ /		
4		SB	D	/ /		
5		SB	D	/ /		
6		SB	D	/ /		
7		SB	D	/ /		
8		SB	D	/ /		
9		SB	D	/ /		
10		SB	D	/ /		
11		SB	D	/ /		
12		SB	D	/ /		
13		SB	D	/ /		
14		SB	D	/ /		
15		SB	D	/ /		
16		SB	D	/ /		
17		SB	D	/ /		
18		SB	D	/ /		
19		SB	D	/ /		
20		SB	D	/ /		

Total No of sample send to CENAT: _____

Date of dispatch: / / _____

Shipper: _____

Signature: _____

Date of received: / / _____

Consignee: _____

Signature: _____

* PLEASE KEEP COPY IN YOUR LABORATORY

Annex 8: Funding sources and cost breakdown (excluding TA cost)

Funding sources

Funding Source	Contribution (USD)	Description
Ministry of Health (MOH) from Global Fund	203,650	Human resources, Operational cost
World Health Organization (WHO)		Technical assistance
Japan International Cooperation Agency (JICA)	760,300	Technical assistance, Equipment, Field operating cost, Printing, Data management, Workshop
Japan Anti-Tuberculosis Association/ Research Institute of Tuberculosis		Technical assistance
United States Agency for International Development(USAID) through TBCAP	53,600	Technical assistance Training, Workshop and Printing
TOTAL	1,017,550	

Breakdown of costs (Except Technical assistance)

Item	Cost (USD)	Percentage
Procurement (equipment and consumables)	490,100	48%
Training and Workshop	54,900	5%
Survey activities (operational cost)	412,450	41%
Printing	60,100	6%
TOTAL	1,017,550	100%

Annex 9: Equipment and Consumables provided by the JICA Project

X-ray machine, processor, etc.

No.	Item	Specifications	Qty
1	Portable X-ray unit with carrying case	Digital invert, Constant Potential KW: 3.8kVA, Input power : AC110/220V kVp Range: 40～110kV, mAs Range :0.3～90mAs, Collimator : 24V 100W Size: 340W ×261D× 200H、Weight: 13.5Kg	3
2	Film processor	Processing film size:10×10cm～35×43cm (4×4in～14×17in) Processing speed: 90/110/150 sec. Processing capacity: 90films/h (in 90sec.mode) Tank capacity: Developer 6.5L, Fixer 6.5L, Washer 5.5L AC single phase, 220V,240V, 50/60Hz Size: 657W ×768D× 510H(mm)、Weight: 58Kg	4
3	X-ray protective panel	According type with moving casters Equivalence: 0.25mmPb lead, Size 150(W) ×180(H)cm Weight: around 40Kg	4
4	X-ray film storage box	Equivalence: 1.0mmPb lead Size: 41W ×16D× 55H(cm)、Weight: 20Kg	2
5	X-ray cassette holder	For chest, Self-standing, Utilizing cassette up to 35×43(cm) Size: 45W ×52D× 180H(cm)、Weight: 14Kg	2
6	X-ray cassette with screen (With window for ID)	Green type, Speed400 Size 35×35 cm	5
7	X-ray cassette with screen	Green type, Speed4008 Size 35×35 cm	10
8	Portable dark room	Dark Curtain: shielding rate 99.99% Frame: Aluminum spare pipe with Alumite treatment Knockdown Size: 120W ×120D× 208H(cm)、Weight: 10Kg	2
9	X-ray grid	Focal range: 34-44", Ratio 8:1, 103LPI	4
10	X-ray film viewer	Size: 90W ×12D× 50H(cm) for 2films Fluorescent tubes light source	8
11	X-ray film	Green film, Size 35×35 cm , 100sheets/box	490
12	X-ray developer	Liquid Developer, 10GL	150
13	X-ray fixer	Liquid Fixer, 10GL	150
14	X-ray film marker	Transplant plastic tables, Number 0-9, Letters: A to Z, Symbols:＋－♂♀ (3pcs each with a holder)	6
15	Generator	220V, 50Hz, Rated output: 5.5KVA Fuel Type: Gasoline , Tank size: 24L Size: 58W ×68D× 58H(cm)	8
16	Lead apron	one side shield, 0.5mmpb	6
17	Protective skirt	one side shield, 0.3mmpb	4

Laboratory Equipment

No.	Item	Specifications	Qty
18	Incubator	temperature range: +5℃ to 60℃ capacity :720L, adjustable stainless shelves(4) inner door: reinforced glass with stainless steel frame Size: 100W ×60D× 120H(cm)、 Weight: 255Kg, vertical type	3
19	Fluorescence Microscope	Optical system: color-corrected infinity optics Magnifications: 100X to 1000X for visual observation Transmitted light illuminator: Fixed-koehler type with white light LED Fluorescence illuminator ：Reflected light type with blue light LED	3
20	Ultra-low freezer	temperature range: -50℃ to -86℃ capacity :333L, stainless steel shelves(3) Size: 67W ×87D× 186H(cm)、 Weight: 255Kg	1

Annex 10: Imputation of prevalence estimation

Estimation of TB prevalencefromthe Cambodia TB prevalence survey 2011
(Summary)

[Status of missing TB status data]

1. Participation Rate: 92.56%(37,417) out of the eligible population (40,423) participated in the survey.
2. Missing data of TB status among the participants: There were 5,114 eligible for sputum examination (the definition of eligibility is mentioned below). Out of them, 518had smear-positive TB status data missing and 563 had bacteriologically-positive TB status data missing because they didn't have conclusive bacteriological results (the definition of non-conclusive bacteriological results were mentioned below).

[Methods]

The following four models were carried out.

1) Model-1: Survey Analysis based on participants without imputation
   Unknown status of TB was categorized as negative. Analysis was limited to participants who received CXR screening and/or symptom screening. Stratification and PSU level clustering effect were taken into account. Weights proportional to inverse of the number of participants in each cluster was given to the participants in each cluster.
2) Model-2: Survey Analysis based on eligible population with IPW adjusting for non-participants
   Weights proportional to inverse of (1/the total number of eligible in each cluster) x (1/participation rate for age/sex subgroup of eligible population in each cluster)was given. Other specification was the same as the Model-1
3) Model-3: Survey Analysis based on participants with imputation
   Imputation model for the missed TB status among the eligible for sputum examination: MI (20sets) was carried out for imputing missing data of TB status among participants eligible for sputum examination which had non-conclusive results of bacteriological examination. MI was carried out separately for smear-positive TB and bacteriologically positive TB. The definition of eligibility for sputum examination was i) TB symptom and/or ii) any CXR shadow or no CXR results. The definition of non-conclusive bacteriological results was i) one result was negative and the other was missing or ii) both of two were missing. For participants who were not eligible for sputum examination (all of field reading, central reading and symptom didn't suggest eligibility for sputum examination), no imputation was made for this sub-group.Sex, age group, strata (urban, rural, remote), field CXR results(shadow eligible for sputum exam, no shadow eligible for sputum exam), final central CXR reading results (no abnormal shadow in lung, abnormal shadow in lung other than TB, Suggesting active TB), symptom (none, any other than TB symptom, TB symptom (cough>=2weeks AND/OR haemoptysis), current TB treatment, past history of TB treatment, and occupation were included in the MI model.
   Estimation model: Analysis for MI data sets incorporating the same specification for survey analysis as mentioned in the Model-1was applied.

4) Model-4: Survey Analysis based on eligible population with imputation (MI and IPW)
   Imputation model for the missed TB status among the eligible for sputum examination: the same method as the above 3) was applied.
   IPW for adjusting for non-participation: IPW was incorporated in the estimation model as mentioned in the Model-2.
   Estimation model: Analysis for MI data sets incorporating the same specification for survey analysis as mentioned in the Model-2 was applied.

[Statistical package used for the analysis] “mi impute chained”, “mi svyset” and “mi estimate: svy: logit” commands of Stata 12 were used for the analysis.

[Results]

The results of estimation are shown in the table 1 and 2. For both smear-positive TB and bacteriologically-positive TB, the estimates from the above models were close to each other. The difference from Model-1 was less than 10%. In the models adjusting for non-participation, estimates tended to be lower than in non-adjusting models because participation rates were lower among young age groups, which had lower prevalence.

[Conclusion]

Because participation rate was high and estimates with imputation were close to the model 1) and the 1st survey adopted the model-1, it was sensible to adopt the model-1 as the primary estimate of prevalence in this survey.

Table 1 Prevalence of Smear-Positive TB

Model	Population for estimation	Strata	PSU	Weight (*)	Imputation (**)	Point Estimates	[95% Conf.	Interval]
Model-1	Participants	Urban/Rural/Remote	District	inverse of cluster size	None	271.4	211.7	347.9
Model-2	Eligible	Urban/Rural/Remote	District	inverse of (cluster size of eligible population x age group/sex wise participation rate in each cluster)	Yes IPW adjusting for non-participation	267.7	209.4	342.1
						-1.4%	difference from model-1	
Model-3	Participation	Urban/Rural/Remote	District	inverse of cluster size	Yes (MI for missing TB status among the eligible for sputum exam)	288.1	222.4	373.3
						6.2%	difference from model-1	
Model-4	Eligible	Urban/Rural/Remote	District	inverse of (cluster size of eligible population x age group/sex wise	Yes (MI+IPW*)	284.3	367.4	368.9
						4.7%	difference from model-1	

*, **: explained in the text

Table 2 Prevalence of Bacteriologically-Positive TB

Model	Population for estimation	Strata	PSU	Weight (*)	Imputation (**)	Point Estimates	[95% Conf.	Interval]
Model-1	Participants	Urban/Rural/Remote	District	inverse of cluster size	None	831.1	706.9	976.8
Model-2	Eligible	Urban/Rural/Remote	District	inverse of (cluster size of eligible population x age group/sex wise participation rate in each cluster)	Yes IPW adjusting for non-participation	822.0	699.0	966.3
						-1.1%	difference from model-1	
Model-3	Participation	Urban/Rural/Remote	District	inverse of cluster size	Yes (MI for missing TB status among the eligible for sputum exam)	882.5	751.4	1036.3
						6.2%	difference from model-1	
Model-4	Eligible	Urban/Rural/Remote	District	inverse of (cluster size of eligible population x age group/sex wise	Yes (MI+IPW*)	873.0	743.2	1025.2
						5.0%	difference from model-1	

*, **: explained in the text

Annex11: Photographs of Prevalence Survey

Preparation for the prevalence survey

Meeting with community people

Training for the survey teams

Role-play for interview

Pilot test in Takeo Province

Data management Workshop by development partners

Preparation for field operation

Meeting with community volunteers

Meeting among team members

Setting up a survey venue

Carrying the survey equipment by cars

Checking the mobile X-ray unit

Portable dark room for film development

Field operation 1

Census taking in a rural area

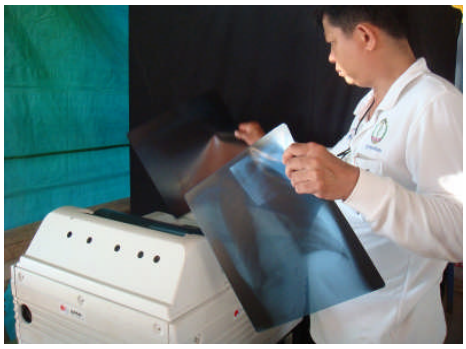
Survey site in village

Census team by motor bike

Informed consent

Interview with participants

Field operation 2



Taking chest x-ray and developing the film on site

Field supervision by NTP Manager

Screening for TB on site together with JICA Expert

Checking all documents by team leader

Explaining results to a participant

Field operation 3

Checking the ID, name etc

Keeping sputum in the ice box

Receiving the morning sputum

Carrying sputum by boat

Protect the box with adiabatic sheet

Volunteer helps to take sputum

Sending sputum by car

Field operation in Phnom Penh

Census taking in Phnom Penh

Mobile X-ray vehicle

Conducting the evening session for factory worker

Conducting operation in the congested area

Laboratory examination in CENAT

bacteriological examinations in safety cabinet

Checking culture tube for incubation

Slide reading with LED-based fluorescence

Staining the smear by

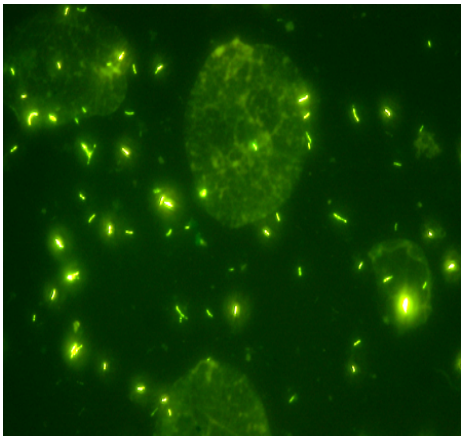
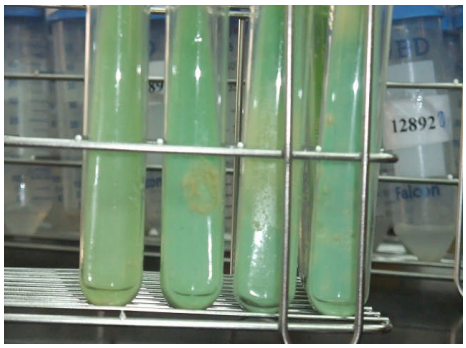


Image of AFB by fluorescent



Colonies of

Expert Meeting & Consensus Meeting

Dissemination Workshop

H.E. Dr. Mam Bun Heng, Minster of MOH and other

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