Cross-sectional studies of tuberculosis prevalence in Cambodia between 2002 and 2011

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Objective To measure trends in the pulmonary tuberculosis burden between 2002 and 2011 and to assess the impact of the DOTS (directly observed treatment, short-course) in Cambodia.

Methods Cambodia’s first population-based nationwide tuberculosis survey, based on multistage cluster sampling, was conducted in 2002. The second tuberculosis survey, encompassing 62 clusters, followed in 2011. Participants aged 15 years or older were screened for active pulmonary tuberculosis with chest radiography and/or for tuberculosis symptoms. For diagnostic confirmation, sputum smear and culture were conducted on those whose screening results were positive.

Findings Of the 40,423 eligible subjects, 37,417 (92.6%) participated in the survey; 103 smear-positive cases and 211 smear-negative, culture-positive cases were identified. The weighted prevalences of smear-positive tuberculosis and bacteriologically-positive tuberculosis were 271 (95% confidence interval, CI: 212–348) and 831 (95% CI: 707–977) per 100,000 population, respectively. Tuberculosis prevalence was higher in men than women and increased with age. A 38% decline in smear-positive tuberculosis (P = 0.0085) was observed with respect to the 2002 survey, after participants were matched by demographic and geographical characteristics. The prevalence of symptomatic, smear-positive tuberculosis decreased by 56% (P = 0.001), whereas the prevalence of asymptomatic, smear-positive tuberculosis decreased by only 7% (P = 0.7249).

Conclusion The tuberculosis burden in Cambodia has declined significantly, most probably because of the decentralization of DOTS to health centres. To further reduce the tuberculosis burden in Cambodia, tuberculosis control should be strengthened and should focus on identifying cases without symptoms and in the middle-aged and elderly population.

Introduction

Tuberculosis remains a major global health problem, with 8.6 million estimated incident cases and 1.3 million estimated deaths in 2012. Cambodia ranks second among the 22 countries with a high tuberculosis burden. Since the World Health Organization (WHO) adopted the DOTS (directly observed treatment, short-course) strategy in 1994, which is based on the passive detection of cases of smear-positive tuberculosis, this policy has been the foundation of global tuberculosis control. Cambodia’s national tuberculosis control programme introduced DOTS in hospitals in 1994 and decentralized it to primary care health centres between 1999 and 2004 with the technical support of WHO and the Japan International Cooperation Agency.

To evaluate the impact of the national tuberculosis control programme in Cambodia, Cambodia conducted its first national tuberculosis prevalence survey in 2002 (hereafter referred to as the 2002 survey). The results revealed a prevalence of smear-positive pulmonary tuberculosis of 362 cases per 100,000 people aged 10 years or older (269 per 100,000 overall). For bacteriologically-positive (i.e. smear-positive tuberculosis case and/or smear-negative, culture-positive tuberculosis case) tuberculosis among individuals aged 10 years or older, the prevalence was shown to be 1208 per 100,000.

In 2005, the year after DOTS became available at all health centres throughout the country (i.e. not just in the 141 tuberculosis units that existed already, primarily in hospitals), the rate of notification of new smear-positive tuberculosis cases peaked and subsequently stagnated for three years. In the following years treatment success rates were consistently above 90% thanks to the efforts of the national tuberculosis control programme. The question then is whether the prevalence of tuberculosis declined, and if so, by how much with respect to the first tuberculosis survey. To respond to these questions, the national tuberculosis control programme conducted a second national tuberculosis prevalence survey in 2010–2011 (hereafter referred to as the 2011 survey). The objectives of the study presented here were to measure the current prevalence of smear-positive pulmonary tuberculosis and bacteriologically-positive pulmonary tuberculosis and to evaluate the change in tuberculosis prevalence in Cambodia between the 2002 and 2011 surveys.

Methods

Survey design

A population-based, cross-sectional survey was conducted in 2010–2011. Like the 2002 survey, it was based on multistage cluster sampling and stratified by urban, rural and remote areas.

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To be able to meet the study objectives, we needed to detect a statistically significant reduction of 42% or more, with a relative precision of 25%, in the prevalence of smear-positive tuberculosis among adults (i.e. people 15 years of age or older) between surveys, we calculated that a sample of approximately 38,400 adults was needed. This was based on a 5% margin of error for an observed prevalence of 256 per 100,000, a design effect of 1.43 and an assumed participation rate of 90%. The target cluster size was set to 640. Thus, the number of clusters was calculated to be 60 for urban and rural clusters. In addition, two remote clusters in the four provinces that were excluded from the 2002 survey, because they were difficult to reach and because of security concerns, were included.

Multistage sampling with stratification was conducted as follows. First the country was stratified into urban, rural and remote areas. Within each stratum, first districts, then communes and finally villages were selected, with sampling probability proportional to size, based on the 2008 population census. Accordingly, 13 clusters from urban areas, 47 clusters from rural areas and two clusters from remote areas were selected.

The population eligible for the survey included all residents aged 15 years or older in the selected clusters who were present during the survey. A resident was defined as a person who had lived in the selected household for at least two weeks.

Survey procedures

Two teams performed the fieldwork from December 2010 to September 2011. In each cluster, data were collected during a seven-day period. First, the survey team conducted a house-to-house census based on the household list provided by the village authorities. The purpose was to collect information on family members, check for eligibility and inform survey participants of the purpose of the survey and the procedures involved. For families that were not available during the visit of the team, authorities or neighbours informed the team if these families were eligible for the survey. Eligible participants who were capable of walking were invited to the field operation site. Invited participants who did not show up at the site were classified as absent. Eligible disabled people were visited by the interviewers in their homes, where they were questioned and asked to submit two samples for sputum examination irrespective of their respiratory symptoms. No chest X-rays were performed at home.

At the field operation site, participants were interviewed by a trained interviewer, mainly nurses and pharmacists, using a structured questionnaire that included a section on tuberculosis symptoms, health seeking behaviour and treatment history. Chest X-rays were performed by radiological technicians at the site with a portable machine. The participants were then screened for eligibility for sputum collection, which depended on the results of chest X-rays and on the presence or absence of symptoms of tuberculosis (cough for two weeks or longer and/or blood in the sputum, as recommended by WHO).3,4 Anyone with abnormal findings in the lungs or mediastinum – except for a single small calcified nodule or unilateral pleural adhesions – was considered eligible for sputum collection. Over interpretation of chest X-rays was encouraged. Eligible participants were asked to submit two sputum specimens: one was obtained after the interview and the other was collected by the survey participant early the following morning in a cup provided by the laboratory staff. Survey participants who did not turn up to the field operation site the next morning with the second sputum sample were visited at home by the team. Participants who gave two samples received a small gift. The sputum quality was later determined in the laboratory.

Diagnostic procedure

Sputum specimens collected in the field were stored on ice, transferred to one of two designated culture centres and examined by smear and culture within five days of collection. All sputum smears were screened using fluorescence microscopy. Two solid culture media (3% Ogawa and Kudoh)5 were used for each specimen. The Capilia tuberculosis assay was used to identify Mycobacterium tuberculosis.6,7 To compare the prevalence of smear-positive tuberculosis in the two surveys, we re-examined all the microscopy slides from the subjects with smear-positive and/or culture-positive results as well as with a chest X-ray suggestive of active tuberculosis by conventional microscopic examination with Ziehl-Neelsen staining.

Two respiratory physicians and/or radiologists interpreted the chest X-rays. A third expert resolved discrepancies in their interpretation. A central medical panel including international experts on respiratory diseases determined the final diagnosis, with reference to the survey tuberculosis case definitions in Box 1, on the basis of both the bacteriological examinations and of the findings on chest X-ray.

Data analysis

All data were entered into EpilInfo 3.5 (Centers for Disease Control and Prevention, Atlanta, United States of America). Some key data were double-entered for quality control; discrepancies were resolved by checking against the raw data. Prevalences, odds ratios (ORs) and their 95% confidence intervals (CIs) were calculated by using logistic

<table>
<thead>
<tr>
<th>Box 1. Case definitions for the 2011 national tuberculosis prevalence survey, Cambodia</th>
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<tbody>
<tr>
<td>Smear-positive tuberculosis case:</td>
</tr>
<tr>
<td>• two positive sputum smears and a sputum culture-negative for mycobacteria other than <em>Mycobacterium tuberculosis</em>, or</td>
</tr>
<tr>
<td>• one positive sputum smear plus a sputum culture-positive for <em>M. tuberculosis</em>, or</td>
</tr>
<tr>
<td>• one positive sputum smear and a chest X-ray consistent with tuberculosis.</td>
</tr>
<tr>
<td>Sputum smear-negative, culture-positive tuberculosis case:</td>
</tr>
<tr>
<td>• negative sputum smears and at least one sputum culture-positive for five or more colonies of <em>M. tuberculosis</em>, or</td>
</tr>
<tr>
<td>• negative sputum smear and one sputum culture-positive for four or fewer colonies of <em>M. tuberculosis</em>, and a chest X-ray consistent with tuberculosis.</td>
</tr>
<tr>
<td>Bacteriologically-positive tuberculosis case:</td>
</tr>
<tr>
<td>• smear-positive tuberculosis case or smear-negative, culture-positive tuberculosis case.</td>
</tr>
</tbody>
</table>
regression models incorporating sampling designs (stratification, clusters and weights) in STATA version 12 (StataCorp LP, College Station, USA). ORs are commonly used for cross-sectional studies data such as prevalence surveys. For comparison of prevalences between the surveys, we used OR as approximation of prevalence ratio because odds [prevalence/(1−prevalence)] is an approximation of prevalence, since tuberculosis is a rare disease. Weights defined as the inverse of the number of participants at each cluster were applied to the 2011 survey data. For comparison in prevalence between 2002 and 2011 surveys, four different strata (urban and rural for both 2002 and 2011) were incorporated in the models. Adjusted weights incorporating the proportion of the eligible subjects aged 15 years or older at each cluster were applied to the 2002 survey data in the models, because the sampling of the 2002 survey was based on all age population.

Ethics approval

The survey protocol was approved by the National Ethics Committee for Health Research, Ministry of Health, Cambodia. Written informed consent was obtained from each survey participant or his or her guardian.

Comparison of survey results

To compare the results between the 2002 and 2011 surveys, we used data only from people aged 15 years or older who were residents of 20 of Cambodia’s 24 provinces (the four remote provinces were excluded). Because tuberculosis cases in the youngest age group were so few, the youngest group spanned from 15 to 29 years and the remaining age groups had a 10-year span: 30–39, 40–49, 50–59, 60–69 and over 70 years.

Results

Prevalence

Of the 40,423 eligible subjects, a total of 37,417 (92.6%) participants (17,007 males and 20,410 females) were screened for active pulmonary tuberculosis. Of these, 12.8% (4780/37,417) were considered eligible for sputum examination. At least one sputum specimen was provided by 96.5% (4612/4780) of those eligible. A total of 114 subjects were smear-positive; 222 were smear-negative but culture-positive. Although in nine cases the culture was positive for mycobacteria other than Mycobacterium tuberculosis, these subjects were assessed to see if they met the survey case definitions. In the end, the central medical panel determined that 103 smear-positive tuberculosis cases and 211 smear-negative, culture-positive tuberculosis cases met the survey case definitions (Fig. 1).

The number of smear-negative, culture-positive tuberculosis cases identified was double the number of smear-positive tuberculosis cases. The ratio of males to females among smear-positive tuberculosis cases was 15:1:10, and participants 55 years or older
(16.8% of all participants) accounted for 55.3% (57/103) of such cases. Among cases with smear-negative, culture-positive tuberculosis, the ratio of males to females was 14.8:10, and the prevalence of smear-negative, culture-positive tuberculosis was 1.9% (6/314) of the total (Fig. 2). Only 14.8% (45/103) of the smear-negative, culture-positive tuberculosis cases and 22.7% (48/211) of the smear-negative, culture-positive tuberculosis cases presented symptoms of pulmonary tuberculosis. Of all the bacteriologically-positive tuberculosis cases, 8.3% (26/314) had a history of tuberculosis, 1.9% (6/314) were receiving treatment and 22.6% (71/314) did not report any cough.

The prevalence of smear-positive tuberculosis among individuals 15 years or older was 271 per 100,000. Prevalence was higher in men than in women: 361 (95% CI: 265–493) and 1097 (95% CI: 653–1550) cases per 100,000, respectively, in those aged 65 years or older. Among people aged 35 to 44 years, the prevalence of bacteriologically-positive tuberculosis reached almost 1% (Fig. 3).

### 2002 survey versus 2011 survey

When comparing the same age groups and provinces, the prevalence of smear-positive tuberculosis was reduced by 38%: from 437 cases per 100,000 in 2002 to 272 in 2011 ($P = 0.0085$). Similarly, the prevalence of bacteriologically-positive tuberculosis was reduced by 45%, from 1497 to 820 cases per 100,000 ($P < 0.0001$) (Table 2).

The prevalence of smear-positive tuberculosis cases with symptoms of presumptive tuberculosis decreased by 56%, from 272 to 120 cases per 100,000 ($P = 0.001$), whereas the prevalence of smear-positive tuberculosis without symptoms decreased by only 7%, from 165 to 153 cases per 100,000 ($P = 0.7249$) (Fig. 4). Among smear-negative, culture-positive tuberculosis cases, significant reductions were observed in cases with and without symptoms of pulmonary tuberculosis. Prevalence dropped by 60% (from 314 to 126 cases per 100,000, $P = 0.0002$) and by 44% (from 746 to 421 cases per 100,000, $P = 0.0011$), respectively (Fig. 4).

The prevalence of tuberculosis cases in the 2011 survey and ORs of the age-specific prevalence in 2011 to that in 2002 are shown in Fig. 5. Among people aged 15–29 years, a significant reduction in the prevalence of smear-positive tuberculosis was noted (OR: 0.23; 95% CI: 0.08–0.66), while no significant reductions were observed among people aged 30 years or older, although the ORs were less than 1.0. The prevalence of bacteriologically-positive tuberculosis declined significantly in all age groups.

### Table 1. Tuberculosis prevalence in the second national tuberculosis cross-sectional survey, Cambodia, 2011

<table>
<thead>
<tr>
<th>Diagnostic confirmation by age</th>
<th>Prevalence per 100,000 people* (95% CI)</th>
<th>No. of estimated casesa</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 15 years of age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smear-positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>271 (212–348)</td>
<td>26,204</td>
</tr>
<tr>
<td>Male</td>
<td>361 (265–493)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>197 (127–303)</td>
<td></td>
</tr>
<tr>
<td>Smear-negative, culture-positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>560 (458–685)</td>
<td>54,031</td>
</tr>
<tr>
<td>Male</td>
<td>736 (587–922)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>413 (319–533)</td>
<td></td>
</tr>
<tr>
<td>Bacteriologically-positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>831 (707–977)</td>
<td>80,234</td>
</tr>
<tr>
<td>Male</td>
<td>1097 (895–1344)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>609 (486–763)</td>
<td></td>
</tr>
<tr>
<td>All agesa</td>
<td></td>
<td>183 (142–234)</td>
</tr>
</tbody>
</table>

CI: confidence interval.
* Prevalence was calculated for the participants and then extrapolated to per 100,000 people.
† The population aged 15 years or older was 965,482.††
‡ Estimated on the assumption that there was no smear-positive tuberculosis 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.
Discussion

The present study shows that the prevalence of tuberculosis has declined significantly over the past nine years in Cambodia. This decline took place between the initial and final stages of decentralization of the DOTS programme. The 2002 and 2011 tuberculosis surveys in Cambodia are repeat national surveys, which offer the opportunity to assess the epidemiological impact of decentralization of the DOTS strategy by a consistent, proper screening method. Only two studies based on repeat surveys after the DOTS strategy was deployed have been published. One of them, conducted in the Philippines, focused on DOTS expansion with the involvement of the private sector in tuberculosis control; the other one was a study conducted in a rural area in southern India. Several studies have evaluated the impact of DOTS by using mathematical models or surveillance data. The expected decline of 5–10% per year in incidence has not been achieved in 22 countries with a high tuberculosis burden that have implemented DOTS, but tuberculosis prevalence in 15 of these countries has decreased.

Although our study design does not allow conclusions to be drawn about the cause of the reduction in tuberculosis prevalence, this may be attributable, at least partly, to the decentralization of DOTS to health centres between 1999 and 2004 and to a consistently high (>90%) treatment success rate. The following facts suggest that this may be the case. First, during DOTS decentralization the national tuberculosis control programme aimed to detect new smear-positive tuberculosis cases. In the beginning notification of such cases increased dramatically, from 14,570 in 1998 to 21,001 at the peak, in 2005. However, the increase in the notification of new smear-positive cases was followed by stagnation and a decline to 15,812 in 2011. This occurred despite continuing efforts to increase case detection through community-based DOTS, public–private mixed DOTS, cross-referrals for tuberculosis cases co-infected with human immunodeficiency virus (HIV) and strengthened case-finding to detect smear-negative tuberculosis cases by means of chest X-rays. The decline in notifications might reflect the reduction in tuberculosis prevalence that the 2011 survey showed. Second, the public sector has played a major role in tuberculosis detection and treatment in Cambodia. The 2011 survey showed that 92.5% (74/80) of tuberculosis cases undergoing treatment at the time of the survey and 92.6% (1369/1478) of previous tuberculosis cases had been treated at public hospitals or health centres.

Table 2. Tuberculosis prevalence in people aged 15 years or older in national cross-sectional surveys in Cambodia, 2002 and 2011

<table>
<thead>
<tr>
<th>Diagnostic confirmation</th>
<th>Prevalence per 100 000 people (95% CI)</th>
<th>Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002a</td>
<td>2011a</td>
</tr>
<tr>
<td>Smear-positive</td>
<td>437 (342–558)</td>
<td>272 (211–351)</td>
</tr>
<tr>
<td>Bacteriologically-positive</td>
<td>1497 (1238–1808)</td>
<td>820 (694–968)</td>
</tr>
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CI: confidence interval.

* Matched group aged 15 years or older in 20 provinces.

Fig. 4. Tuberculosis prevalence in national tuberculosis surveys, Cambodia, 2002 and 2011

Table 2. Tuberculosis prevalence in people aged 15 years or older in national cross-sectional surveys in Cambodia, 2002 and 2011

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* Matched group aged 15 years or older in 20 provinces.
the long civil war in the 1970s and the 1980s and before the large-scale development of the private sector. Finally, the prevalence of symptomatic tuberculosis decreased much more than that of asymptomatic tuberculosis. It is plausible that the DOTS strategy, which relies mainly on passive case detection, is more effective at reducing symptomatic cases than cases without symptoms of tuberculosis.

Factors other than DOTS decentralization may have contributed to the reduction in tuberculosis prevalence. HIV sero-prevalence among patients with either smear-positive, smear-negative, or extra-pulmonary tuberculosis declined from 11.8% in 2003 to 6.3% in 2009. Also, socioeconomic factors, such as per capita gross domestic product, increased from 286 United States dollars (US$) in 1999 to US$ 830 in 2010. Also, the development of multidrug-resistant tuberculosis was minimized thanks to the consistently high treatment success rate.

This study confirms that Cambodia still has one of the highest tuberculosis prevalences in the world. The majority of the cases detected in the 2011 survey did not meet the criteria for symptomatic pulmonary tuberculosis. The prevalence of tuberculosis cases with symptoms of pulmonary tuberculosis declined by more than half between surveys, whereas that of cases without symptoms declined by only a small fraction. Furthermore, only one third of the bacteriologically confirmed tuberculosis cases identified had positive results on sputum smear microscopy, a fact that underscores the limitations of the DOTS strategy, which focuses on symptomatic patients who independently seek care and relies primarily on smear microscopy for diagnosis. The reduction in tuberculosis prevalence suggests that the current set of tuberculosis control strategies is, in general, valid and should continue until new feasible diagnostic tools become readily available. However, the findings also suggest the need for different approaches to accelerate the decline in tuberculosis prevalence and incidence in certain groups. Active case detection among individuals not likely to seek care early after symptom onset or not likely to be correctly diagnosed by smear microscopy, or those without typical chronic tuberculosis symptoms should be considered. Chest X-ray screening, combined with sensitive diagnostic tools such as GeneXpert MTB/RIF, might prove cost-effective for such individuals. Strategies such as these should produce an accelerated decline in prevalence. However, further studies are needed to assess the impact of active case detection on health outcomes and tuberculosis transmission because not enough direct evidence exists so far.

The prevalence of smear-positive tuberculosis decreased more in people aged 15 to 29 years than in people of other ages. This suggests that under the current programme for tuberculosis control, tuberculosis cases among younger adults are more easily detected than among older people. Epidemiological indicators in the younger population might reflect the effectiveness of tuberculosis control in adults, because most active tuberculosis in younger people is caused by a recent infection rather than reactivation of a remote, latent infection.

The prevalence of tuberculosis increased with age and the decline in smear-positive tuberculosis was smaller in older age groups than in younger ones. More than half of the prevalence of smear-positive tuberculosis corresponded to the group of individuals aged 55 years or older, perhaps because older patients experience higher tuberculosis recurrence from endogenous reactivation or more vague or complex symptoms than younger people. Perhaps they also have a higher tolerance for symptoms. A study in Cambodia showed that a substantial proportion of cases occurred in individuals with abnormal findings on chest X-ray. The study revealed a high annual incidence rate (8.5%) of bacteriologically-positive tuberculosis among individuals with chest X-rays suggestive of active tuberculosis and of 2.9% among individuals with chest X-rays indicative of inactive tuberculosis. Other strategies than DOTS may be needed for countries where the populations infected with tuberculosis are ageing.

This study has limitations. First, the study spans over several years and other factors than DOTS decentralization were not controlled for, which could have been partly responsible for the changes in the tuberculosis prevalence we observed. Second, as recommended by WHO, the study included no individuals younger than 15 years or people with extra-pulmonary tuberculosis.
Therefore, we were unable to measure the prevalence of all forms of tuberculosis. Third, we did not investigate the presence of HIV co-infection among survey participants. However, since HIV seroprevalence surveys in Cambodia have shown a downward trend,\textsuperscript{19,20} we believe that the effect of HIV co-infection on tuberculosis prevalence rates is small. In addition, successful HIV control in Cambodia has contributed to tuberculosis control by reducing HIV infection and rates of co-infection and by expanding use of antiretroviral therapy.\textsuperscript{21}

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Competing interests: None declared.
**Résultats** Sur les 40 423 sujets éligibles, 37 417 (92,6%) ont participé à l'étude; 103 cas à frottis positif et 211 cas à culture positive et à frottis négatif ont été identifiés. Les prévalences pondérées de la tuberculose à frottis positif et de la tuberculose bactériologiquement positive étaient de 271 (intervalle de confiance de 95%, IC: 212–348) et de 831 (IC de 95%: 707–977) pour 100 000 habitants, respectivement. La prévalence de la tuberculose était plus élevée chez les hommes que chez les femmes et augmentait avec l'âge. Une baisse de 38% de la tuberculose à frottis positif (P = 0,0085) a été observée par rapport à l'étude de 2002, après que les participants ont été associés à des caractéristiques démographiques et géographiques. La prévalence de la tuberculose symptomatique à frottis positif a diminué de 56% (P = 0,001), alors que la prévalence de la tuberculose asymptomatique à frottis positif a diminué de seulement 7% (P = 0,7249).

**Conclusion** Au Cambodge, la prévalence de la tuberculose a fortement diminué, probablement à cause de la décentralisation du DOTS vers les centres de santé. Pour continuer à réduire la prévalence de la tuberculose au Cambodge, la lutte antituberculose doit être renforcée et se concentrer sur l'identification des cas sans symptômes et dans la population d'âge moyen et âgée.

**Objective** To determine the trends in the burden of pulmonary tuberculosis in Cambodia between 2002 and 2011, and evaluate the impact of the strategy DOTS (treatment directly observed, short course) in Cambodia.

**Methods** A cross-sectional survey of the incidence of tuberculosis in Cambodia in 2002 and 2011 was conducted using a two-stage cluster sampling design. All individuals aged 15 years and older, as well as all adults admitted to hospitals with a positive smear result, were included in the survey. The results were compared with the same survey conducted in 2002.

**Results** A total of 40 423 eligible individuals participated in the study, of whom 37 417 (92.6%) were included. A total of 103 cases with positive smear and 211 cases with positive culture and no bacilloscopy were included. The weighted prevalence of pulmonary tuberculosis at smear positive and at bacteriologically positive was 271 (95% CI: 212–348) and 831 (95% CI: 707–977) per 100 000 inhabitants, respectively. The prevalence of tuberculosis was higher in men than in women and increased with age. A decrease of 38% in the smear positive tuberculosis (P = 0.0085) was observed compared to the study of 2002, after the participants were associated with demographic characteristics. The prevalence of smear positive tuberculosis was lower by 56% (P = 0.001), whereas the prevalence of smear negative tuberculosis was only reduced by 7% (P = 0.7249).

**Conclusions** The incidence of tuberculosis in Cambodia has significantly decreased, possibly due to the decentralization of DOTS towards health centers. To continue reducing the prevalence of tuberculosis in Cambodia, the anti-tuberculosis fight must be reinforced and focus on identifying cases without symptoms and in the middle-aged and elderly age group.
References