



Tuberculosis elimination in Oman: winning the war on the disease

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ABSTRACT In 2014, the World Health Assembly adopted the new End TB Strategy that targets ending tuberculosis (TB) by 2035. This article describes the progress made to eliminate TB in Oman.

Data from officials and other sources provided the information to assess the situation in Oman.

In the period 1981–1992, TB notifications decreased by 11% per year. Between 1992 and 2016, the rates declined more slowly at 4.6% per year, *i.e.* from 16 to 7.8 per 100 000. During 2010–2016, 2352 TB cases (80% males and 60% Omani nationals) were reported. Bacteriologically confirmed TB cases decreased from 47 to 38 per million population, with a cumulative decline of 19%. The success rate of TB treatment was >87%. Among the new cases, 1.2% were multidrug-resistant TB cases. TB mortality rate dropped by 39% between 1990 and 2016.

TB control efforts in Oman have produced remarkable effects. However, the pre-elimination threshold set at <10 notified TB cases per million population per year is not yet in reach. There is a need for an urgent national response and careful consideration of new available interventions.



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The national TB control programme of Oman has enforced concrete steps to implement key TB elimination measures. The overall TB notification rate for all new TB cases declined significantly from 91 to 7.8 per 100 000 population during 1981–2016 ($p < 0.001$). <http://ow.ly/sZyJ30mrueV>

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Introduction

Tuberculosis (TB) is a major public health concern worldwide [1]. In 2016, TB affected 10.4 million people and killed 1.7 million worldwide with over 95% from low- and middle-income countries [2].

“Ending TB” is a target that has been addressed by both the United Nations Sustainable Development Goals (SDG) 2016–2030 and the World Health Assembly resolution of 2014. In low TB burden countries, achieving incidence levels aligned with the established international targets requires additional tailored actions. The goals of the World Health Organization (WHO) End TB Strategy are to reduce the number of TB deaths by 95% and its incidence by 90% by 2035, and to ensure that no family or patient incur catastrophic expenditures because of this disease [3–9].

With the vision of adapting the new End TB Strategy for low-burden countries and the progress made, in 2014, the WHO, along with the European Respiratory Society and other partners, established a framework for TB elimination in these countries. The framework states eight priority strategic interventions, which target reducing TB incidence, along with pre-elimination and elimination measures [3].

There are few publications on TB in Oman [10–13] describing the TB elimination initiative [14, 15]. This article summarises the progress made towards TB elimination in Oman, identifies the challenges to be confronted by the national TB control programme (NTP), highlights the lessons learnt and proposes the steps to reach the international targets towards TB elimination.

Material and methods

A retrospective study was undertaken on a 36-year assessment of the detection, management and treatment outcomes of TB cases (all forms) reported between 1981 and 2016 in Oman. Data were gathered from the national electronic case-based TB Registry, the annual health reports [16], the annual progress reports of the Ministry of Health (MOH) and WHO global TB reports [1]. The information was analysed with a focus on the principal characteristics of reported TB cases (time, place, sex, age, residency and nationality), patient management (history of previous anti-TB treatment, localisation of disease, laboratory results, HIV status and treatment outcomes) and mortality rate.

The National Centre for Statistical and Information Census [17] was used to calculate rates per 100 000 population. The projections of TB incidence in Oman were taken into account from 2011 to 2016. A p-value <0.05 was selected as a cut-off level for statistical significance with application of the Chi-squared test.

NTP of Oman

Approximately 4.4 million people live in the national territory of Oman; 78% of them are living in urban areas, 22% in rural areas and 33% in the capital city of Muscat [16, 17]. Oman established its NTP in 1975, which became an integral component of the Dept of Communicable Disease Control at the MOH in 1990. In 1984, the NTP National Committee was set up consisting of concerned stakeholders and by 2014 the committee was integrated into the Communicable Disease National Committee. The NTP is the apex body responsible for formulating national policies and monitoring programme implementation. Every governorate has a TB focal point to monitor the TB programme. Well-established TB programmes are equipped with adequate and trained human resources in central, governorate and treating hospitals.

By 1995, TB treatment was available at all hospitals with appropriate laboratory capacities. Monitoring, follow-up, case finding, contact tracing, screening and evaluation systems were invariably adopted across the country. In addition, the NTP activities have been integrated into the primary, secondary and tertiary healthcare services, and well-financed NTP. TB reporting has been made mandatory for both public and private sectors along with development of TB registry and surveillance integrated into the National Communicable Disease Surveillance System.

The previous DOTS (directly observed treatment, short course) strategy of WHO, with all its components, was implemented in Oman in 1996. The surveillance activities to monitor and assess TB drug resistance and the treatment of latent tuberculosis infection (LTBI) in high-risk groups were set up in 1998. Furthermore, contacts exposed to bacteriologically confirmed TB cases were screened and assessed, and isoniazid preventive therapy (IPT) in household contacts aged <5 years and in people living with HIV (PLHIV) was implemented; the programmatic management of drug-resistant TB (PMDT) was initiated on a large scale in 2006. The provision of TB care, control and prevention services were ensured for foreign-born individuals.

The NTP activities have been integrated into the primary, secondary and tertiary healthcare services provided by the MOH and in the private sector. At primary healthcare level, TB cases are identified and notified. Presumed TB cases are referred to the closest hospital for the confirmation of TB diagnosis and treatment.

The national policy on TB prevention, care and control detailed in the national guidelines has been used within the NTP network since 1996.

In 1991, TB reporting was integrated into the National Communicable Disease Surveillance System [18, 19]. TB case is classified based on WHO case definitions [18, 20] and have to be reported to the NTP within 24 h of the diagnosis with pulmonary TB (PTB) and within a week for those with extrapulmonary TB (EPTB).

All new TB patients are treated with the standard regimens recommended by WHO and PMDT [21–23] that are implemented through the clinical services offered within the NTP network.

Progress towards TB elimination

On January 4, 1997, the Gulf Health Council (GHC) endorsed the goal of TB Elimination, aiming at reducing the incidence of new smear-positive cases among nationals to fewer than one per 100 000 population by 2010. This has been the first TB elimination initiative ever defined at a subregional level in the Eastern Mediterranean Region (EMR) and taken up by the six GHC health ministers [24].

Results

The overall TB notification rate for all new TB cases declined significantly from 91 to 7.8 per 100 000 population during 1981–2016 ($p < 0.001$) (Figure 1). TB notification declined sharply from 91 to 37 cases per 100 000 population during 1981–1990 with an average decline rate of 9% per year. A further decrease from 21 to 14 cases per 100 000 population was observed between 1991 and 2000 with a decline rate of 4.5% per year. During 2001–2010, the decline was from 12 to 10 cases per 100 000 population at the average rate of 1.7% per year. During 2011–2016, the decline was from 11 to 7.8 cases per 100 000 population with a 5.7% decline rate per year. Overall, the TB notification rate has remained below 100 cases per million population since 1991 (Figure 2). The overall downward trend of new TB cases was 92% during 1981–2016. However, the highest reduction in TB cases was 73% during 1981–1992.

The annual notification rate of PTB declined by 9%, 4.5%, 1.7% and 5.7% per year during 1981–1990, 1990–1999, 2000–2009 and 2010–2016, respectively.

During 2010–2016, 2352 patients met the case definition of TB. Of these, 1409 (60%) cases were Omani nationals and 943 (40%) were foreign-born people. The trend of the notification rate of bacteriological confirmed PTB cases declined among nationals until 2015. The rate increased by 34% (from 23 to 68 per million population) in 2016, while the decline of the notification rate continued in foreign-born individuals (figure 2).

Among the 943 foreign-born persons, 721 (76%) were from India, 103 (11%) from Bangladesh, 66 (7%) from Indonesia, 25 (3%) from Pakistan and 28 other nationalities. Moreover, 305 (32%) of these foreign-born individuals were housemaid workers.

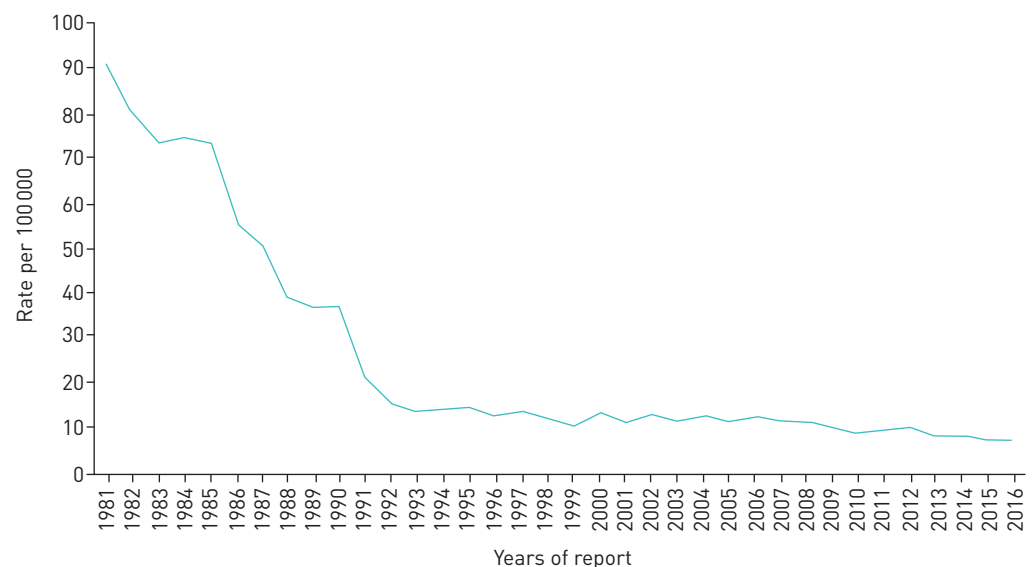


FIGURE 1 Tuberculosis (all) notification rates, Oman, 1981–2016.

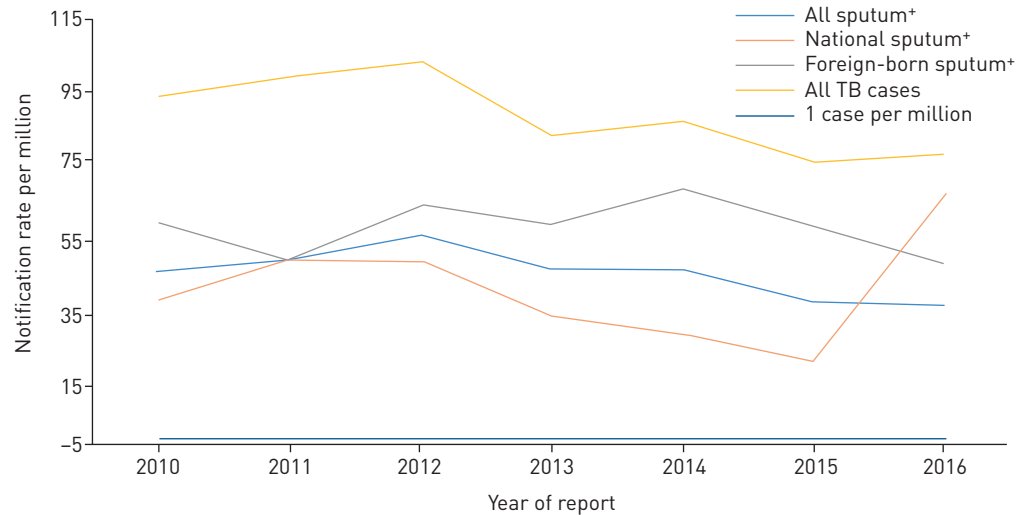


FIGURE 2 Trends in tuberculosis (TB) notification rate, Oman, 2010–2016.

In the 2352 notified TB cases (all types), the average age specific rates per 100000 were 15, 42, 103, 49 and 99 for the age groups 15–19, 20–24, 25–34, 35–44 and >45 years, respectively, and 1895 (80%) were males. The distribution of TB forms showed that: 1) 1244 (53%) were PTB patients, of whom 1003 (87%) were bacteriologically confirmed PTB cases and 283 (12%) clinically diagnosed PTB cases; and 2) 825 (35%) were EPTB patients. In 2016, 34% of 345 TB cases were diagnosed using Xpert MTB/RIF (Cepheid, Sunnyvale, CA, USA).

198 (8%) notified TB cases, were <14 years of age; among them, 87% (172 out of 198) were Omani nationals. In this age group, the notified rate ranged between 0.2 and 0.7 per 100000. 11 (5%) children had bacteriologically confirmed PTB, 60 (30%) had clinically diagnosed TB and 129 (65%) had EPTB.

During the same period, most of the TB cases (all forms) were notified in the Muscat governorate (average rate 105 per 100000), North Batinah (average rate 63 per 100000) and Dhofar governorate (average rate 54 per 100000) as shown in figure 3. 12–23% of TB notifications (18% on average) were reported by the private health sector. From 2011 to 2016, the diagnosis of PTB within 30 days since the onslaught of symptoms increased from 34% to 41% and from 22% to 49% among nationals and foreign-born individuals, respectively.

During the period 2010–2016, the TB treatment success [20] was above 87% (75–100%) [25, 26]. Fewer than 4% of patients were lost to follow-up and 3% not evaluated.

From 2010 to 2016, among 1244 new bacteriologically confirmed PTB cases, 33 (2.7%) had multidrug-resistant (MDR)-TB and only 19 (1.5%) were tested for HIV. During this period, the annual average rate of notified co-infected TB/HIV cases was 2.4% (range 1–4%). During 2014–2016, HIV co-infection showed an increasing trend from 1% to 3% among all TB cases.

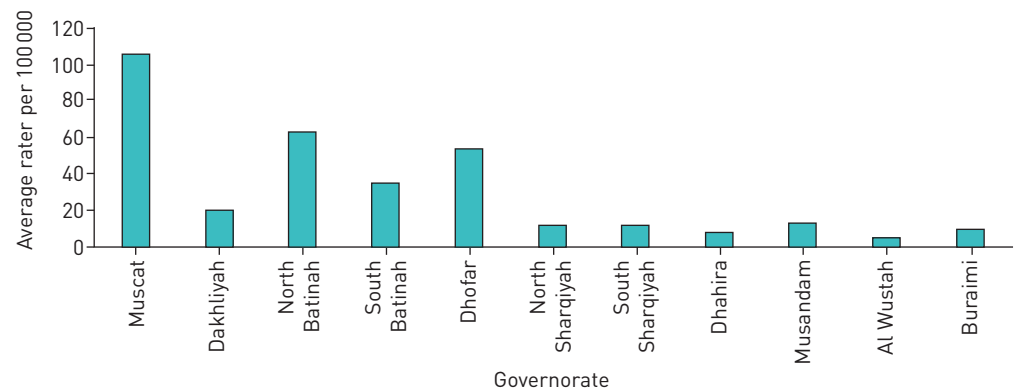


FIGURE 3 Tuberculosis rates by governorate (province), Oman, 2010–2016.

In 2011, 1327 contacts were identified and 852 (64%) screened; 124 (15%) had a positive result either with the tuberculin skin test (TST) or an interferon- γ release assay (IGRA). In 2016, of 1473 identified contacts, 1028 (70%) were screened and 142 (14%) had LTBI. In addition, 455 were identified as foreign-born contacts, 410 (90%) were screened and 80 (20%) had LTBI. TB risk factors among nationals and foreign-born people were diabetes (9% to 13%), which exhibited an increasing drift, unlike other risk factors, such as smoking (20% to 9%), family history of TB (15% to 9%) and alcohol abuse (5% to 3%), which showed declining trends.

During 1990–2016, the TB mortality rate dropped by 39%, from 1.8 to 0.71 deaths per 100 000 population. TB was the leading cause of death in <10% cases, with 90% deaths recorded among the elderly with other comorbidities. During 2010–2016, the annual death rate of TB/HIV co-infected cases increased from 0.3 to 0.7 per 100 000 population [25–27].

Discussion

Oman is a low-incidence country [3] where TB notification (all forms) rates have steadily decreased at <100 cases per million since 1991. Furthermore, the TB mortality rate dropped by 39% from 1990 to 2016. Yet, with the current decline in mortality of 2.4% per year, Oman will not reach the WHO elimination target of the decline in TB mortality <90% by 2035 in view of the data obtained in 2015. The average annual rate of mortality decline required to achieve elimination by 2035 is 11.5% [3].

Based on recent projections, after 2010, there is a noticeable decline in TB incidence from 94 to 79 per million population (cumulative reduction of 20%) and an annual average reduction of 5.7%, which is one of the highest ever observed. However, the rate of decrease per year during the same period is insufficient to achieve the pre-elimination threshold by 2035 (<10 cases per million population) [3]. Rather, with this rate, the pre-elimination target in Oman could only be reached in 2050, requiring an average yearly decline rate of around 12% [3]. This decline was mainly attributed to well-established TB programme with adequate and trained human resources at centres and hospitals with appropriate laboratory capacities, monitoring, follow-up, case finding, contact tracing, screening and evaluation systems, which were invariably adopted. In addition to a well-financed TB national programme, the NTP activities have been integrated into the primary, secondary and tertiary healthcare services. TB reporting and registration were mandatorily reported and integrated into the National Communicable Disease Surveillance System, and TB diagnosis and treatment were practically available across the country. The provision of TB care, control and prevention services were insured free of charge for all national and foreign-born members of the population. Furthermore, fewer TB cases were reported. Less drug-resistant TB and all cases were managed and treated mainly in one hospital. The TB notification rate increased by 34% in 2016, attributed to increased involvement of the private sector in reporting TB cases and enhancing active search for TB cases, particularly among contacts.

Oman has implemented some of the substantive components of the eight priority actions of the WHO's framework for TB elimination [3–5] and figure 4 summarises the maximum implementation of eight TB priority action areas in Oman by the end of 2016.

Firstly, political commitment has been demonstrated through a strong governance and stewardship of the NTP within the MOH. To this end, a single administrative structure has been established to lead the TB elimination strategy with the NTP central unit and the governorate units. Integration of TB national strategic plans into the 5-year national health plan has been enabled and access to high-quality TB services has been maintained with provision of free TB care services. In addition, a national network of laboratory services has been made available. Quality assurance scheme has been implemented in all laboratories for TB diagnosis. The Central Public Health Laboratory (CPHL) is linked to the supranational TB reference laboratory of Prince Léopold Institute of Tropical Medicine (Antwerp, Belgium) and Institute Superiore DiSanita (Rome, Italy). IGRAs, molecular techniques such as a line probe assay, Xpert MTB/RIF testing and second-line spoligotyping using mycobacterial interspersed repetitive units–variable number tandem repeat analysis are available in the CPHL. Xpert MTB/RIF testing is presently performed in five public tertiary and secondary care facilities and in the private sector.

A national policy of 2006 restricted the use of TB medicines and tests for public sector and health service settings authorised by the MOH. In addition, TB national policy and guidelines for infection prevention and control have been evolved based on the national and GCC guidelines [28, 29]. These policies have been applied across the country to reduce transmission of infections in healthcare settings.

Secondly, for the most vulnerable populations, systematic TB screening has been implemented among PLHIV and contacts exposed to TB index cases. Those in whom active TB is ruled out, receive IPT. Furthermore, preventive antiretroviral therapy is offered to all PLHIV with TB regardless of their CD4 count [30].

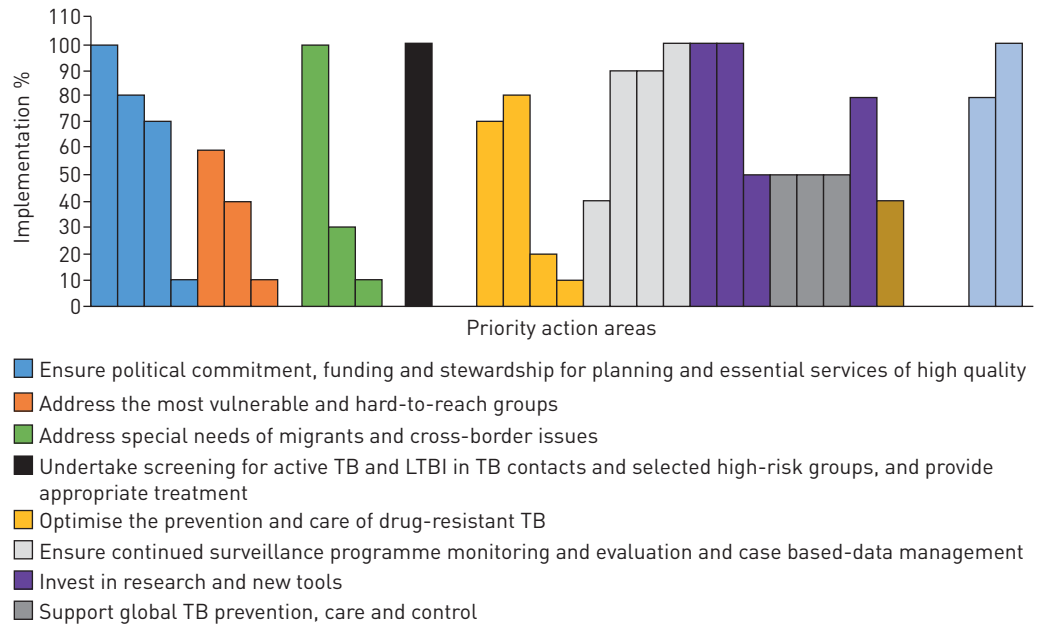


FIGURE 4 Summary of implementation of eight priority action areas in low-incidence countries, Oman. TB: tuberculosis; LTBI: latent TB infection.

Thirdly, systematic screening of active TB among foreign-born individuals is undertaken at both pre- and post-entry into Oman. The Oman MOH has designated healthcare services for foreign-born individuals, upon arrival and within a week after arrival. TB screening should be executed as part of overall universal health screening and wellbeing. Systematic screening for TB includes consideration of TB history, physical examination and chest radiography; however, testing (IGRA or TST) has not been adopted. If suspected of having TB, the patient is taken to the nearest hospital for testing with either IGRA or TST, with further management and assessment based on WHO guidelines [31]. TB contact investigation involves a systematic evaluation of the contacts of known TB patients to identify active disease or LTBI. Accordingly, TB preventive treatment has to be implemented. TB diagnosis and treatment, including drug-resistant TB management and patient support, are nominally free of charge regardless of their administrative position to live in Oman. Appropriate social protection strategies for foreign-born TB patients are likewise sought. Foremost of all, the proportion of the foreign-born population originating from high-incidence countries in the early years until 2000 was approximately 30–50% of foreign-born workers. The notified TB cases received the TB care and control free of charge until they were either converted to negative or felt sound. However, some do leave the country as their personal choice. The possible reasons for foreign-born patients leaving the country shortly after diagnosis of TB were very short-term contracts (6–8 months), discretionary employment practises of the employers and the preference of patients to go home to complete their TB treatment. Pre- and post-TB screening was launched in 1990.

No financial burden is imposed on foreign-born persons regardless of their administrative status to live in Oman.

Fourth, to comply with recommendations on LTBI management, systemic screening is implemented using TST or IGRA among case contacts of people with bacteriologically confirmed TB, including household contacts and adults, adolescents and children (HIV-negative children aged <5 years), the immunocompromised, PLHIV and suspected TB cases among foreign-born individuals upon arrival. Healthcare workers (HCWs) are not part of the cover. Those with active or positive results are given IPT daily for 6 months with a 1-year follow-up. The management of LTBI in contacts <5 years used IGRA/TST for screening. In 2007, LTBI management was expanded to all close contacts of PTB cases and to known immunocompromised patients with a negative TST who converted to positive within 2 years. In 2017, the new regimen combining rifampicin and isoniazid was adopted.

Fifth, systematic HIV testing has been implemented since 1996. MDR-TB surveillance was initiated in 2007 and data on drug susceptibility testing for isoniazid and rifampicin have been collected systematically. During 2007–2016, the prevalence of MDR-TB was 1.2% among newly diagnosed cases and 2.7% in TB/HIV co-infected patients. The prevalence of MDR-TB among new cases is low, pointing out that TB medicines are appropriately used in line with the NTP policy and not prescribed in an anarchic

manner. To avoid misuse, TB drugs are strictly regulated and are available in MOH institutions only, prescribed by specialised physicians.

Sixth, TB surveillance has used a sound electronic case-based TB register to monitor TB frequency and evaluate its prevention, care and control. The NTP central unit prepares an annual report that compiles monthly summaries from hospitals and clinics belonging to public and private health sectors. Community-driven TB awareness campaigns have taken place. The approach adopted is tailored to the culture and linguistic characteristics of both native and foreign-born communities.

Seventh, Oman needs to identify hypotheses for operational research based on in-depth data analysis generated by the monitoring and evaluation system to improve programme performance.

Finally, it is worth highlighting that the Oman government has backed the international strategy and targets set by WHO, and has been actively collaborating internationally with other members of the GHC and outside, as relevant.

Challenges and the way forward

The foremost action for the NTP needs to be to review progress and challenges critically on a regular basis, with a focus on key issues that could prevent to achieve the 2035 elimination targets. Some of the key actions include: 1) an urgent need to obtain a suitable national TB elimination follow-up task force and implementation of efficient systematic monitoring; 2) appropriate LTBI management, and strengthening of TB prevention, care and control services as well as systematic testing for and treatment of LTBI to be considered for health workers and foreign-born from countries with a high TB burden supported by appropriate LTBI management, and toning up of TB prevention, maintenance and control services; 3) use of modern tools and new regimens and drugs needs to be swiftly introduced, with special attention given to private institutions; 4) a functional monitoring scheme, with specific 5-year national and governorate operational plans and milestones, need to be developed; 5) progress reports and lessons learned need to be disseminated among policy makers, HCWs and other stakeholders; 6) need for training and increase in awareness of HCWs on an active detection of TB cases, especially among high-risk groups; and 7) an efficient supervision and monitoring system needs to be established at governorate level.

Oman has a significant population of foreign-born persons (approximately 45% of the overall population) [17] and most of them are from high TB incidence countries [32]. Out of the total notified TB cases, 40% are identified among foreign-born individuals. Thus, the NTP must give priority to the provision of TB prevention, care and control of foreign-born individuals in order to eliminate TB in Oman; pre-migration screening should be linked with the countries of origin.

Oman has the highest prevalence of diabetes in the world [33–35], which triples the risk of developing TB and may result in adverse outcomes of TB treatment [36, 37]. Therefore, there is a need to establish a framework for TB care and control in diabetes patients as well as for collaborative activities between the NTP and the national diabetes programme.

TB/HIV co-infection is low (1–4%) in Oman. A recent study revealed that 3.5% of TB/HIV co-infected patients received ART in 2016 [1], far below the WHO target of universal ART coverage [38]. Increasing the coverage with ART will substantially reduce the incidence of TB as ART reduces the risk of developing TB by 60% among PLHIV [39].

Systematic screening for LTBI has shown modest progress from 64% to 70% coverage. This implies that 30% of people are not screened and therefore are at a high risk of developing active TB. Henceforth, there is a need to improve the effectiveness of screening programmes and LTBI management among high-risk groups [40].

18% of notified TB cases were reported by the private health sector where majority of the foreign-born persons seek care. Other countries in the EMR showed low reporting from the private sector [41]. NTP activities can be significantly improved through better implementation of appropriate public/private mix approach.

Approximately 40% of the bacteriologically confirmed PTB cases were diagnosed within 30 days of the onset of symptoms in both national and foreign-born patients, which is in accordance with the MOH TB policy. The possible reasons for the late diagnosis include delay in the identification of presumed TB patients by HCWs, mainly at the primary healthcare level. Timely identification of underlying factors needs to be addressed and closely followed up, especially the monthly TB screening targets assigned for primary health care settings by the governorates' TB teams.

To reach the elimination targets, a national plan was declared describing the priorities for operational research based on in-depth data analysis generated by the existing NTP information system [41]. In

addition, operational research should be pursued to address clear priorities: 1) identification of social, demographic or behavioural determinants associated with TB patients irrespective of their administrative status, and test approaches to address the role of these determinants in TB occurrence, care and control outcomes; 2) implementation of relevant modern tools like Xpert MTB/RIF and use of new drugs and regimens; and 3) development of an appropriate strategy to involve the best care providers practising in the private medical sector.

Conclusions

Although the NTP of Oman had enforced concrete steps to implement key TB elimination measures as recommended, the current TB indicators (notably, notifications and deaths) will probably maintain an unfavourable direction if critical interventions are not urgently adopted. These should be adopted in addition to all actions described in the programme that calls for an urgent development of a suitable national TB elimination follow-up task force and implementation of efficient system monitoring. The time has come to act in a more dynamic and organised way to achieve the objective of freeing the Oman population from the century-old TB threat.

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