



# Country-specific lockdown measures in response to the COVID-19 pandemic and its impact on tuberculosis control: a global study

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## ABSTRACT

The objective of this study was to describe country-specific lockdown measures and tuberculosis indicators collected during the first year of the COVID-19 pandemic. Data on lockdown/social restrictions (compulsory face masks and hand hygiene; international and local travel restrictions; restrictions to family visits, and school closures) were collected from 24 countries spanning five continents. The majority of the countries implemented multiple lockdowns with partial or full reopening. There was an overall decrease in active tuberculosis, drug-resistant tuberculosis, and latent tuberculosis cases. Although national lockdowns were effective in containing COVID-19 cases, several indicators of tuberculosis were affected during the pandemic.

**Keywords:** COVID-19; Tuberculosis; Physical distancing; Health policy; Global health; Communicable disease control.

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As the COVID-19 pandemic progressed, and due to the lack of readily available vaccines or treatments, public health measures intended to contain the spread of the disease were put in place. These included rapid diagnosis, rapid isolation of cases, physical distancing, use of face masks, school closures, smart working, travel restrictions, and closure of international borders. Countries worldwide implemented nationwide lockdowns to contain the spread of the virus and reduce the number of cases.<sup>(1)</sup> On the other hand, studies have demonstrated that the COVID-19 pandemic has substantially affected tuberculosis services in many countries.<sup>(2,3)</sup> We collected the lockdown measures adopted by various countries to manage the pandemic in order to gauge the best practices and lessons learned. We aimed to describe these country-specific lockdown measures and tuberculosis control indicators collected over the same period.

Invitations to participate in the study were sent to 24 countries (the study coordinators). Data were retrospectively collected from the beginning of lockdown measures until December 31, 2020. Data on lockdown and other social restrictions (compulsory use of face masks and hand hygiene; international and local travel restrictions; restrictions to family visits; and school closures) were collected, including dates and whether they were fully or partially implemented. Tuberculosis control indicators (total number of tuberculosis cases, drug-resistant tuberculosis cases, newly diagnosed tuberculosis cases, and latent tuberculosis cases) were also collected.

National preventive measures were collected from 24 countries spanning five continents: 10 in Europe (France, Greece, Italy, Kosovo, Lithuania, the Netherlands, Portugal, Russia, Spain, and the United Kingdom), 6 in Asia (Bhutan, Cambodia, India, Oman, the Philippines, and Singapore), 5 in America (Argentina, Brazil, Mexico, Paraguay, and the USA), 2 in Africa (Kenya and Niger), and 1 in Oceania (Australia). Tables 1 and 2 show such data, by continent and country.

Lockdown measures were implemented in all countries surveyed. The earliest lockdown was in Australia on February 1, 2020, and the latest was in Singapore on April 7, 2020. The majority of the countries implemented multiple lockdowns with partial or full reopening. Compulsory use of face masks was partial only in Mexico and Kenya. Compulsory hand hygiene was established as a full measure in all countries included in the study, except Kenya (only partially implemented). International traveling was partially restricted in Brazil, Cambodia, Lithuania, Russia, Singapore, the UK, and the USA. Local traveling was partially restricted in Brazil, Cambodia, Lithuania, and Niger. In the Netherlands, neither international nor local travels were restricted. In Mexico, no measure was taken with respect to local travels. The Philippines did not report international or local travel restrictions. Restrictions on family visits occurred in Australia, Cambodia, the Netherlands, Portugal, Russia, the

UK, and the USA. In Brazil, Kenya, Mexico, and Niger no measure was taken with regard to family visits. Full school closures occurred in all countries included in the study, except Russia (only partial closures).

Tuberculosis cases decreased from 32,898 in 2019 to 16,396 in 2020 with a sudden decline in March of 2020 in the surveyed centers, concomitantly with the commencement of lockdowns in the majority of the countries. This decrease was observed in all countries included in this study, except in tuberculosis centers in Australia, Singapore, and the state of Virginia (USA). The number of drug-resistant tuberculosis cases also decreased (from 4,717 in 2019 to 1,527 in 2020), even in countries that have a smaller number of drug-resistant tuberculosis cases, such as Argentina, Brazil, India, Mexico, and Russia. Newly diagnosed tuberculosis cases in outpatient clinics decreased from 7,364 in 2019 to 5,703 in 2020, except for centers in Australia and in the state of Virginia (USA). In addition, fewer individuals were diagnosed with latent tuberculosis.

Several factors may contribute to explain the relationship of COVID-19 pandemic/lockdown measures with tuberculosis indicators. In the management of the pandemic, human and financial resources were reallocated from tuberculosis services to COVID-19 units, compromising tuberculosis care. In addition, for fear of leaving their home (fear of SARS-CoV-2 infection or fear of stigma), people avoided visiting tuberculosis services and health care centers/hospitals in general. Also, access to tuberculosis services was hampered due to restrictions on movement and reduced opening hours of health services. Indeed, there was a drastic reduction in the number of consultations and hospital admissions for various medical conditions. Emergency department (ED) admissions decreased by more than 50% in 2020, as compared with 2019.<sup>(4)</sup> EDs serve as the frontline for symptomatic respiratory patients in many countries, with a high number of tuberculosis cases diagnosed in this setting.<sup>(5)</sup> In a retrospective study in Nigeria,<sup>(6)</sup> pulmonary tuberculosis was diagnosed in almost 30% of adults presenting to EDs with respiratory complaints. In this sense, the reduction in ED visits may have contributed to a reduction in the number of tuberculosis cases diagnosed during the pandemic.

Tuberculosis testing and preventive therapy have also been impacted by the COVID-19 pandemic. Tuberculosis testing decreased in some of the countries included in the study, such as in the Philippines, Kenya, and Brazil. Relative declines in preventive therapy, ranging from 30% to 70%, were described in several tuberculosis centers such as in Brazil, Kenya, the Philippines, and Russia.<sup>(2)</sup>

A decline in the number of drug-resistant tuberculosis cases reported was observed in Argentina, Brazil, India, Mexico, and Russia. Globally, around 45% fewer people were tested for multidrug-resistant tuberculosis (MDR-TB).<sup>(7)</sup> In Brazil, there was a 14% reduction in the consumption of Xpert MTB/RIF Ultra

Table 1. Lockdown measures and dates instituted by each country in Africa and Europe.<sup>a</sup>

Country	F/P	Compulsory face mask use	International travel restriction	Local travel restriction	Restriction to family visits	School closure	Compulsory hand hygiene
France	F	07/20/2020-12/31/2020	03/17/2020-06/02/2020	03/17/2020-05/10/2020	03/17/2020-05/10/2020	03/12/2020-05/10/2020	02/28/2020-12/31/2020
	P	03/17/2020-07/19/2020	10/30/2020-12/15/2020	10/29/2020-12/15/2020	10/30/2020-12/15/2020	10/30/20-12/31/20	
Greece	F	08/08/2020-06/24/2021	03/09/2020-05/18/2020	12/16/2020-12/31/2020	03/23/2020-05/04/2020	05/3/2020-18/5/2020 (high schools)	
		Since 06/24/21 (compulsory only in indoor spaces)	11/07/2020-01/11/2021			03/05/2020-06/01/2020 (elementary schools)	
						11/07/2020-01/11/2021 (elementary schools)	
						11/07/2020-02/01/2021 (high schools)	
Italy <sup>b,c</sup>	P		Since 11/26/2021				
	F	03/09/2020-05/04/2020	03/09/2020-06/21/2020	03/09/2020-05/31/2020	03/09/2020-05/18/2020	03/09/2020-05/18/2020	01/31/2020-ongoing
	P	10/13/2020-ongoing					
	P	05/19/2020-12/31/2020	11/01/2020-ongoing (regional variations)	10/24/2020-ongoing <sup>b</sup>		09/11/2020-ongoing (rotation by age groups)	
Kenya	F	04/05/2020-ongoing (mostly P)	03/25/2020-08/01/2020	03/25/2020-07/06/2020	No measures except in relation to domestic travel	03/15/2020-10/12/2020	Ongoing (P)
Kosovo	F	03/11/2020-ongoing (mostly P)	03/27/2020-06/02/2020	03/23/2020-06/01/2020	03/23/2020-06/01/2020	03/27/2020-06/27/2020 (all schools)	07/13/2020-ongoing (P)
			From that date-ongoing (P)			09/14/2020-ongoing (online e-learning only for heavily affected classrooms)	
Lithuania	F	03/14/2020-06/10/2020			12/14/2020-ongoing	03/14/2020-06/10/2020	01/31/2020-ongoing
	P	11/04/2020-ongoing	03/14/2020-06/10/2020	03/14/2020-06/10/2020		04/11/2020-ongoing	
			04/11/2020-ongoing	11/04/2020-ongoing			

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**Table 1.** Lockdown measures and dates instituted by each country in Africa and Europe.<sup>a</sup> (Continued...)

Country	F/P	Compulsory face mask use	International travel restriction	Local travel restriction	Restriction to family visits	School closure	Compulsory hand hygiene
Netherlands	F	12/01/2020-ongoing	None	None	03/23/2020-05/31/2020	03/23/2020-ongoing	03/23/2020-ongoing
	P	09/30/2020-11/30/2020 (recommendation only)	None	None	03/23/2020-05/31/2020	12/17/2020-ongoing	
Niger	F	01/22/2021-ongoing	03/19/2020-09/15/20	None	12/17/2020-ongoing	03/18/2020-05/31/2020	03/18/2020-ongoing
	P	03/18/2020-01/21/2021	09/15/2020-ongoing	03/27/2020-04/11/2020	None	10/01/2020-10/15/2020	
Portugal <sup>b,c</sup>	F	10/27/2020-ongoing	03/15/2020-05/22/2020	04/02/2020-05/18/2020	03/12/2020-09/14/2020 <sup>b</sup>	03/12/2020-ongoing	03/18/2020-ongoing
	P	03/18/2020-10/26/2020	03/09/2020-ongoing	03/18/2020-05/22/2020	03/15/2020-05/04/2020	03/09/2020-05/18/2020	
Russia <sup>b</sup>	F	05/12/2020-07/12/20 (regional variations)	03/09/2020-ongoing	03/30/2020-06/08/2020	03/15/2020-05/04/2020	03/09/2020-05/18/2020	03/05/2020-ongoing
	P	03/27/2020-ongoing (regional variations)	03/05/2020-ongoing (regional variations)	06/09/2020-ongoing (individuals > 65 years of age and/or with chronic diseases)	03/27/2020-05/19/2020	03/21/2020-01/18/2021	
Spain <sup>b,c</sup>	F	05/21/2020-ongoing	03/14/2020-06/21/2020	03/19/2020-06/21/2020	03/14/2020-05/22/2020	03/14/2020-06/21/2020	03/14/2020-ongoing
	P	10/25/2020-ongoing	10/25/2020-ongoing	10/25/2020-ongoing	03/14/2020-05/22/2020	03/14/2020-06/21/2020	03/14/2020-ongoing
United Kingdom	F	06/15/2020-ongoing (transportation)	03/23/2020-05/10/2020	03/23/2020-05/10/2020	03/23/2020-06/01/2020	03/20/2020-06/01/2020	03/04/2020-ongoing
	P	07/24/2020-ongoing (shops)	06/08/2020-ongoing	12/19/2020-ongoing	03/23/2020-06/05/2020	12/18/2020-02/22/2021	
	P	07/24/2020-12/31/2020	06/08/2020-ongoing	12/19/2020-ongoing	03/23/2020-06/05/2020	12/18/2020-02/22/2021	

F: full; and P: partial. <sup>a</sup>Ongoing as of December 31, 2020. <sup>b</sup>Local, provincial, or regional variations adopted. <sup>c</sup>Periods with full or partial restriction rotations.

**Table 2.** Lockdown measures and dates instituted by each country in the Americas, Asia, and Oceania.<sup>a</sup>

Country	F/P	Compulsory face mask use	International travel restriction	Local travel restriction	Restriction to family visits	School closure	Compulsory hand hygiene
Argentina	F	03/20/2020-ongoing	03/20/2020-11/06/2020	03/20/2020-11/06/2020	03/20/2020-11/06/2020	03/20/2020-02/17/2021	03/20/2020-ongoing
	P		11/06/2020-ongoing	11/06/2020-12/01/2020			
Australia <sup>b,c</sup>	F	06/30/2020-ongoing	03/27/2020-ongoing (2-week quarantine for all arrivals)	03/31/2020-11/07/2020		06/30/2020-11/22/2020	01/21/2020-ongoing <sup>d</sup>
	P		01/23/2021-ongoing (self-isolation for all overseas arrivals)	03/16/2020-ongoing	05/30/2020-ongoing (limited travels and number of visitors)	03/23/2020-05/25/2020 (children encouraged to stay at home)	
Bhutan	F	March to June 2020 (Govt. recommended use of face masks)	03/23/2020-08/30/2021 (restriction on tourist entry; mandatory 21-day facility quarantine)	09/11/2020-ongoing (mandatory 7-day facility quarantine for individuals wishing to travel from high-risk areas (southern districts) to other districts)	02/07/2020-ongoing (no direct family visit restrictions; recommendations: avoiding mass gatherings; limiting travel visitors; businesses allowed to operate until 10 p.m.; public transportation, including taxis and buses, allowed to carry only 50% of capacity)	03/18/2020-12/31/2020 (preschool to grade 6) (03/18/2020-07/01/2020 (grades 7-11))	March 2020-ongoing (hand washing facilities made available in schools, hospitals, and public places)
		07/04/2020-ongoing (Govt. made use of face masks mandatory)	08/30/2021-ongoing (mandatory 2-week quarantine for individuals with proof of full vaccination and 21-day quarantine for unvaccinated individuals)				
Brazil <sup>b</sup>	F	04/18/2020-ongoing			None	03/21/2020-10/01/2020 (public and private schools)	03/13/2020-ongoing
	P	05/04/2020-ongoing	03/18/2020-ongoing	03/17/2020-ongoing		10/01/2020-ongoing (public and private schools)	
Cambodia	F	04/01/2020-ongoing				03/15/2020-08/31/2020	03/15/2020-ongoing
	P		04/16/2020-11/15/2021 (2-week quarantine for all international arrivals)	03/15/2020-04/01/2020 04/10/2021-10/31/2021 (by province)	04/15/2021-05/10/2021 (limited to 15 days or less)	02/20/2021-10/01/2021 11/01/2020-02/20/2021 10/01/2021-12/31/2021	

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**Table 2.** Lockdown measures and dates instituted by each country in the Americas, Asia, and Oceania.<sup>a</sup> (Continued...)

Country	F/P	Compulsory face mask use	International travel restriction	Local travel restriction	Restriction to family visits	School closure	Compulsory hand hygiene
India	F	03/25/2020-ongoing	03/25/2020-ongoing	03/31/2020-07/01/2020	03/25/2020-07/01/2020	03/25/2020-ongoing	03/21/2020-ongoing
	P			07/01/2020-ongoing			
Mexico <sup>b</sup>	F		03/15/2020-09/30/2020	None	None	03/14/2020-ongoing	02/28/2020-ongoing
	P	09/30/2020-ongoing					
Oman	F	05/18/2020-ongoing	03/29/2020-09/30/2020	04/01/2020-04/29/2020	03/15/2020-06/30/2020	03/15/2020-11/01/2020	01/01/2020-ongoing
	P			07/25/2020-08/08/2020	01/27/2021-ongoing		
Paraguay	F	11/27/2020-ongoing	03/17/2020-10/15/2020	03/17/2020-05/18/2020	07/20/2020-ongoing	03/10/2020-02/09/2021	03/10/2020-ongoing
	P		03/17/2020-ongoing			02/10/2020-ongoing	
Philippines		03/01/2020-ongoing	Not reported	Not reported	03/16/2020-10/30/2020	03/16/2020-ongoing	03/16/2020-ongoing
Singapore <sup>b</sup>	F	04/14/2020-ongoing		None	04/07/2020-06/01/2020	04/08/2020-05/18/2020	01/31/2020-ongoing
	P	04/03/2020-04/14/2020 (encouraged)	01/29/2020-ongoing (regional variations)		06/02/2020-06/17/2020 (2 visitors only)	05/19/2020-06/01/2020 (graduating cohort only)	
USA <sup>b</sup> (State of Virginia)	F	05/26/2020-ongoing (indoors)		03/30/2020-06/10/2020		03/13/2020-06/30/2020	02/07/2020-ongoing
	P		02/28/2020-ongoing (CDC and US State Department only)	04/12/2020-12/21/2020	03/30/2020-ongoing (limited number of visitors)	9/15/2020-ongoing	

F: full; P: partial; Govt.: government; and CDC: Centers for Disease Control and Prevention. <sup>a</sup>Ongoing as of December 31, 2020. <sup>b</sup>Local, provincial, or regional variations adopted. <sup>c</sup>Periods with full or partial restriction rotations. <sup>d</sup>For travellers returning from Wuhan, China.

assay cartridges.<sup>(9)</sup> However, a declining consultation rate and a reduction in recognition and detection of diseases due to the pandemic could consequently cause delayed diagnosis and treatment,<sup>(9)</sup> contributing to the increase in the number of MDR-TB cases in the future.

In order to contain the spread of the new coronavirus, the public was instructed to stay at home. However, this policy may not be feasible in some settings. In developing countries, informal jobs make up the majority of employment: 54% in Latin America, 67% in Southeast Asia, and 86% in Africa.<sup>(10)</sup> These workers may not have the option to stay at home, and not all governments can provide emergency financial

assistance to support them to stay at home. In some countries in Africa (Egypt, Kenya, Nigeria, and South Africa) and in Latin America (Peru, Brazil, Argentina, Mexico, and Colombia), the time to commute to work is significantly affected by the poverty level. A higher poverty level translates to a smaller reduction in commuting time.<sup>(11)</sup> In these lower-income areas, the number of COVID-19 cases could be higher, and, consequently, there might be fewer resources for and awareness of other diseases such as tuberculosis.

The adoption of stay-at-home measures and the use of face masks due to COVID-19, there could have reduced the transmission of other communicable



diseases such as tuberculosis. On the other hand, strict containment policies can facilitate the household spread of tuberculosis, since contact at the household level is one of the most important factors in the tuberculosis transmission chain.<sup>(12)</sup> However, the impact of increased household transmission will be noticed only in future years, because tuberculosis has a long incubation period.

In tuberculosis centers in Australia, Singapore, and the state of Virginia (USA), no reduction in the number of reported tuberculosis cases was observed. This finding may be attributable to increased surveillance of both tuberculosis and COVID-19 in these settings. In fact, the adoption of organizational changes was important to the maintenance of consultations for non-COVID-19-related problems.<sup>(9)</sup> For example, Bhutan set up walk-in flu clinics across the country to triage individuals with cough and fever to reduce the risk of COVID-19 transmission. Taking advantage of the infrastructure and investment, Bhutan also started tuberculosis screening at the flu clinics. This initiative supported the tuberculosis control efforts in intensifying the identification of tuberculosis cases and ensured the continuity of tuberculosis health care services without disruption during the COVID-19 pandemic. In addition, the use of telehealth/telemedicine may have prevented a reduction of diagnosing tuberculosis.<sup>(9)</sup> During the lockdown, many places implemented telehealth services; however, this is not widely available in all tuberculosis centers unfortunately.

The future consequences of the COVID-19 pandemic and lockdown measures are yet to be known. Cilloni et al.<sup>(13)</sup> estimated that a three-month interruption of tuberculosis services would cause an additional 1.19 million tuberculosis cases and 361,000 tuberculosis deaths in India, as well as 24,700 new tuberculosis cases and 12,500 tuberculosis deaths in Kenya. The WHO modeling suggests that the negative impacts on tuberculosis mortality and incidence in 2020 will become much worse in the coming years. Moreover, the COVID-19 pandemic is expected to have a negative impact on tuberculosis determinants, average income,

and malnutrition rates. Considering that 30-50% of the incidence of tuberculosis is attributable to malnutrition, an increase in the prevalence of malnutrition may have an effect on tuberculosis incidence and mortality.<sup>(7)</sup> In addition, the Stop TB Partnership,<sup>(14)</sup> together with other institutions, conducted a modeling analysis to evaluate the potential impact of COVID-19 response on tuberculosis in high-burden countries; they suggested that there will be an additional 6.3 million cases of tuberculosis between 2020 and 2025, and an additional 1.4 million tuberculosis deaths in the same period.

In summary, although national lockdowns were effective in reducing COVID-19 cases, several indicators of tuberculosis were dramatically affected during the pandemic. Improvement of surveillance will be necessary, as an increase in the number of tuberculosis cases, drug-resistant tuberculosis cases, and tuberculosis deaths may be expected in future years.

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## AUTHOR CONTRIBUTIONS

DRS and GBM: drafting of the manuscript. All authors reviewed and approved the final version of the manuscript.

## ETHICAL APPROVAL

The coordinating center and the participating centers had ethics clearance in abundance with their institutional regulations.

## CONFLICT OF INTEREST

None declared.

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