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COVID-19 in Cuba: Assessing the National Response

Enrique Galbán-García MD PhD, Pedro Más-Bermejo MD PhD DSc

ABSTRACT

The COVID-19 pandemic exhibits different characteristics in each country, related to the extent of SARS-CoV-2 local transmission, as well as the speed and effectiveness of epidemic response implemented by authorities. This study presents a descriptive epidemiological analysis of the daily and cumulative incidence of confirmed cases and deaths in Cuba from COVID-19 in the first 110 days after first-case confirmation on March 11, 2020. During this period, 2340 cases (20.7 x 100,000 population) were confirmed, of which 86 patients died (case fatality 3.67%; 52 men and 34 women). Mean age of the deceased was 73.6 years (with a minimum of 35 years and a maximum of 101), with the average age of men lower than that of women. More than 70% of all deceased had associated noncommunicable diseases. The incidence curve ascended for five weeks and then descended steadily. The average number of confirmed cases and deaths for the last week included (June 23–28, 2020) were 25 and 1 respectively; the curve always moved within the most favorable forecast zone of available mathematical models and the effective reproductive number fell below 1 after the fifth week following the onset of the epidemic.

We present the prevention and control measures implemented during this period—some unique to Cuba—and assess their effectiveness using two analytical tools: comparison of observed deaths and confirmed cases with those predicted by mathematical models; and estimation of the effective reproductive rate of SARS-CoV-2. Some distinctive features of this strategy include nationwide door-to-door active screening for individuals with fever and/or symptoms of respiratory distress, isolation of cases and quarantine of contacts of confirmed cases and of persons suspected of having the virus. During this period, Cuba's response to the epidemic was successful in flattening the curve and limiting transmission, resulting in fewer cases and a lower number of subsequent deaths.

KEYWORDS COVID-19, SARS-CoV-2, epidemiology, pandemic, emerging infectious disease, contact tracing, patient isolation, Cuba

INTRODUCTION

COVID-19, aided in its spread by the rapid and extensive international movement of people and goods, was designated a global pandemic by WHO in March 2020, after its initial onset in China in late 2019. Epidemics of other coronaviruses producing severe respiratory symptoms, such as SARS-CoV-1 in 2002[1] and MERS-CoV in 2012,[2] never earned this designation.

The susceptibility of an epidemiologically-naive world population to COVID-19's etiological agent, SARS-CoV-2, and its basic reproduction number (R_0) (initially estimated to be between 2 and 3), favored wide penetration of human communities and resulted in far-reaching chains of transmission from almost all infected individuals.[3] Compared to other diseases caused by coronaviruses, COVID-19 has resulted in a large number of severe cases and deaths, leading to a high global case fatality rate (>5% during the period analyzed),[3] at a time when preventive or curative treatments specific to the virus (antiviral drugs or vaccines) were not yet available.

The magnitude of this disease and its clinical implications have been such that within just the first 6 months after its identification, more than 10 million cases and 50,000 deaths were recorded.[4] Given these figures, it is unsurprising that health services in many population centers worldwide were strained and, in some cases, even overwhelmed.

IMPORTANCE

This paper describes and analyzes the characteristics of Cuba's response to the COVID-19 epidemic during the first 110 days after the first case was diagnosed. It highlights the particularities and the participation of the country's healthcare system, scientific community and government in confronting the disease.

The pandemic has manifested differently in each country, both in terms of the level to which various communities have been affected, and authorities' response to the disease, including transmission prevention and containment measures. As of June 28, 2020, global data reveal the United States and Brazil as the countries with the most confirmed cases and the most deaths from COVID-19, with cases in the millions and deaths in the hundreds of thousands in each. Countries such as Russia, India, the United Kingdom, Peru, Chile, Spain, Iran, Mexico, Pakistan, Turkey, Germany, France and South Africa also report very high case numbers and deaths.[4]

In other countries—including Iceland, Paraguay, Uruguay, Lebanon, Slovakia, Lithuania, Latvia, Costa Rica and Jamaica—the epidemic has evolved more favorably, despite recent outbreaks in some. A group of countries on the African continent are reporting low or moderate numbers of confirmed cases and deaths, but the pandemic started later in that region and could still be considered in its initial period.[4]

When comparing the numbers of confirmed cases and deaths between different countries, factors both intrinsic and extrinsic to SARS-CoV-2 must be considered. For example, the number of cases at any given point depends on the time the epidemic has been developing in each nation, the intensity of case detection (measured in the number of confirmatory tests carried out per million inhabitants), as well as on the virus's pathogenicity, virulence and transmissibility. These last three factors have been common to all regions, regardless of the genomic variants identified to date.[5]

Statistics on the number of cases, case fatality rates and other indices specific to each country depend on the mitigation strategies adopted and how the data are compiled.[6] In Cuba, positive cases, their contacts and suspected cases (the latter identified through active, door-to-door screening) are isolated either in health institutions or in centers adapted for this purpose.[7] In other

countries, responsibilities for isolation and reporting are often left to individual households, which can increase the likelihood of under-reporting in the absence of contact tracing, given that many of these cases may be asymptomatic. Recording cause of death of a patient with a severe comorbidity such as cancer or chronic kidney disease who is also positive for SARS-CoV-2 adds to reporting differences depending on the practices of each country, and misreporting increases when a high proportion of deaths occur in the home. The number of tests carried out can also modify the statistics, as the greater the number of individuals tested, the greater the number of less-severe infections detected, which will then show a drop in the overall case fatality rate.

Finally, the case fatality rate also depends on factors such as the average age of the population (older populations tend to increase case fatality), prevalence of underlying chronic non-communicable diseases (comorbidities), and the strain placed on health services (either exhaustion or infection of healthcare personnel attending COVID-19 cases, or when health services have been overwhelmed and are thus unable to care for the patient load).

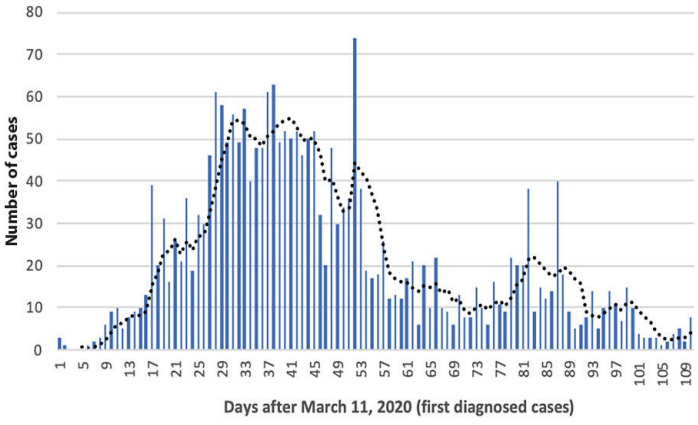
This paper analyzes the particular characteristics of Cuba's response to the COVID-19 epidemic, as well as participation of the country's health system, scientific community and government in confronting it.

THE COVID-19 EPIDEMIC IN CUBA

The first three cases (all Italian tourists) were identified on March 11, 2020. This date represents the start of the epidemic in Cuba. In the following 110 days (through June 28, 2020), 2340 cases of COVID-19 were confirmed, and 86 of those individuals died from the disease. Of the total infected, 162 (7.0%) acquired the disease abroad, returning to Cuba within the virus's incubation period.

Figure 1 shows the number of cases diagnosed daily during this period. The extreme values are between 0 and 74 with an average of 21 cases/day, while case detection, always confirmed by real-time polymerase chain reaction (RT-PCR) increased throughout the period, resulting in >168,000 tests with an average of 1500–2000 daily, totaling almost 15,000 per million population by the end of the 110-day period.

Figure 1: Moving average trend of COVID-19–confirmed cases in Cuba, for 110 days after first-case diagnosis



Source: Daily report of confirmed COVID-19 cases. Ministry of Public Health, Cuba. Available at: https://salud.msp.gob.cu/

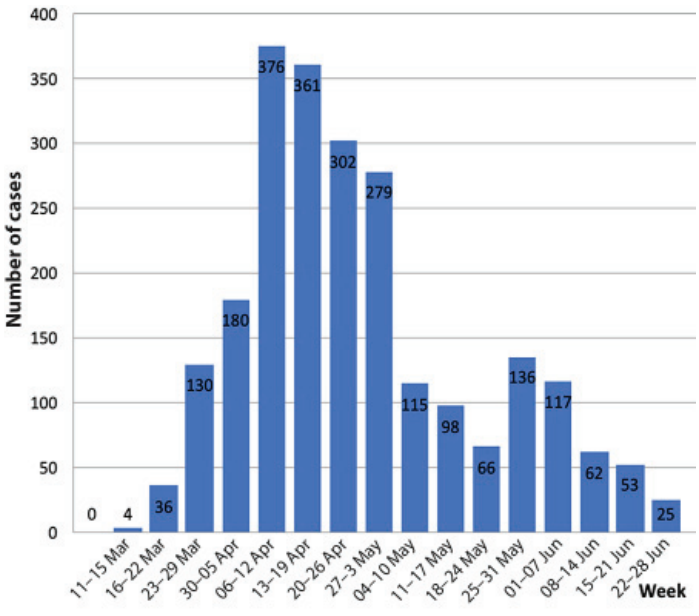
The highest number of confirmed cases for one day coincided with outbreaks of local transmission in two institutions where vulnerable people lived (a nursing home and a social security institution where 47 and 58 cases were identified, respectively). In this period, small- and moderate-sized outbreaks were relatively frequent, mainly within family groups and involving some sort of violation of established preventive measures, as revealed in epidemiological followup.[8]

The trend line calculated by five-day moving averages (Figure 1) smooths out the short-term fluctuations derived from the time elapsed between identification of suspected cases or contacts of primary cases and the sampling, transportation, RT-PCR testing and the cutoff timing for including results in the national registry and reporting system. The confirmed curve shows a rise of just over a month in duration, followed by a plateau lasting for approximately 15 days. The descent begins near day 45 and is interrupted only briefly by spikes in cases associated with the outbreaks already mentioned. The weekly case record corroborates our earlier assertion that the curve has a 5-week ascending arm and then begins to descend for the next 11 weeks (Figure 2).

During the 110-day period studied, the 2340 people infected with the SARS-CoV-2 virus constituted a national incidence rate of 20.7 per 100,000 population. Of this total, 1174 were men (50.2%) and 1166 women (49.8%); 162 (7.0%) acquired the infection abroad, mainly in the USA and Spain, countries with significant travel to and from Cuba. The largest number of cases sorted according to geographic area occurred in western Cuba, specifically in Havana, the capital and most cosmopolitan city. Havana alone accounted for 54.7% of the country's total cases.

As a result of contact tracing, 88.4% of confirmed cases were traced to previously confirmed cases, and 54% were identified when asymptomatic or presymptomatic, suggesting that most were found in the early stages of infection. This has probably

Figure 2: COVID-19 cases in Cuba by week



Source: Daily report of confirmed COVID-19 cases. Ministry of Public Health, Cuba. Available at: https://salud.msp.gob.cu/

contributed to reducing SARS-CoV-2 transmission in Cuba, as contacts that are traced from previously confirmed cases are referred for quarantine in isolation centers for the maximum incubation period counted from the most recent exposure that contact had with their index case.[7]

Total confirmed cases included persons from 1 year to 101 years of age. For the purposes of this analysis, they were divided into the following age groups: <20 (12.4%); 20–39 (29.9%); 40–59 (35.6%); and ≥60 (22.1%) years.

In the 110-day period studied COVID-19 was the cause of 86 deaths, resulting in case fatality rate of 3.7%. This rate in Cuba was lower than that reported worldwide (4.96%) and lower than that of Latin America (4.8%) in the same time frame. The monthly case fatality rate decreased to 1.2% in June. Of the 86 deceased, 52 (60.5%) were men and 34 (39.5%) women, with case fatality considerably higher for men (4.4% vs. 2.9%), despite the fact that the average age of men was lower (70 years vs. 79.1 years). The deceased included two non-Cubans (one Russian and one Italian), and a Cuban national residing in Spain, all of whom were infected abroad.

Of the deceased, 85% had a history of one or more serious chronic non-communicable disease (NCD) comorbidities. Table 1 summarizes the most common NCDs associated with SARS-CoV-2 infection in the 86 people who died. High blood pressure and diabetes mellitus were the most frequent, which concurs with reports in the international literature.[9] Given the wide range of comorbidities that sometimes accompany positive cases it is not possible to assume that COVID-19 was the primary cause of death in all cases, although older adults and people of any age with serious underlying conditions are known to be at increased risk of becoming seriously ill and dying if infected with SARS-CoV-2.[10]

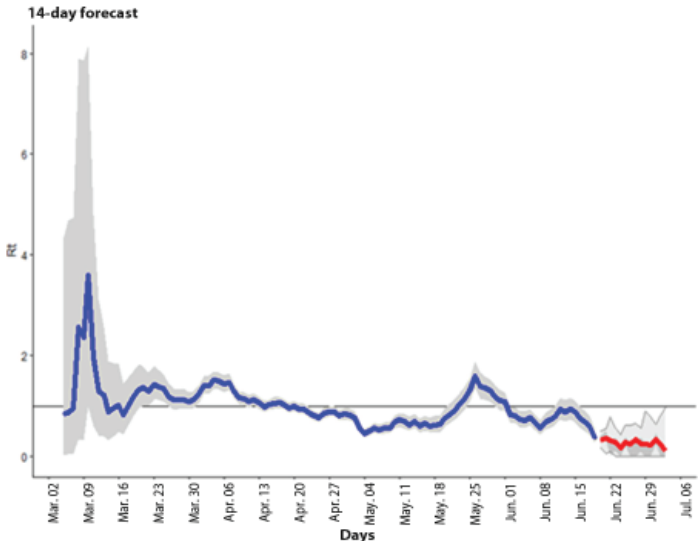
Figure 3 shows the results of estimating the effective reproductive number R_t using daily data from new cases reported between March 11 and June 28, 2020 across Cuba. The dark line corresponds to the mean of each value and the shaded lines correspond to 95% confidence intervals. R_t expresses the epidemic's reproduction ratio; a key goal for stemming any epidemic is to achieve R_t <1, indicating that infected individuals are not causing new cases. Both R_t and R_0 by themselves are insufficient measures to characterize the dynamics of any disease in a population, but they have value as a complement to other indicators, as illustrated in the Cuban experience.

Table 1: Most frequent comorbidities associated with COVID-19 deaths in Cuba, by sex, March 11–June 28, 2020

Comorbidity	Women N = 34		Men N = 52		Total * N = 86	
	No.	%	No.	%	No.	%
Arterial hypertension	13	38.2	30	57.7	43	50.0
Diabetes mellitus	15	44.1	18	34.6	33	38.4
Ischemic heart disease	6	17.6	13	25.0	19	22.1
Chronic obstructive pulmonary disease	3	8.8	9	17.3	12	14.0
Chronic kidney disease	5	14.7	8	15.4	13	15.1
Cancer	1	2.9	8	15.4	9	10.5
Dementia	4	11.8	3	5.8	7	8.1
Heart failure	3	8.8	1	1.9	4	4.7

Source: epidemiological case histories
*A deceased individual may have had more than one comorbidity

Figure 3: Effective reproductive number (R_t) for COVID-19 cases in Cuba, March 2–July 6, 2020



Calculated using symptom onset date for each patient. Serial interval distribution, using the Anne Cori method.[11] Author: Dr Waldemar Baldoquin. Pedro Kourí Tropical Medicine Institute, Cuba

The effective reproduction number R_t differs from the basic reproduction number R_0 in that it changes over time and depends on the true susceptibility of the population.[11] R_t has been estimated periodically during the first 110 days after the first confirmed case. In the first few days, high values (close to 5) can be observed in Figure 3, which is consistent with the exponential dynamics of the COVID-19 epidemics in many countries.[12] For the next 15 days, R_t began a sustained decline, reaching values slightly above 1, until later in the seventh week when it fell below this limit (R_t <1). This indicator temporarily spiked above 1 during a local transmission outbreak, but once it was controlled, R_t continued to fall. At the end of the 110-day period, the red portion of the figure demonstrates that even the upper value of the 95% interval is <1, suggesting that the transmission rate has slowed, consistent with the introduction of prevention and containment measures.

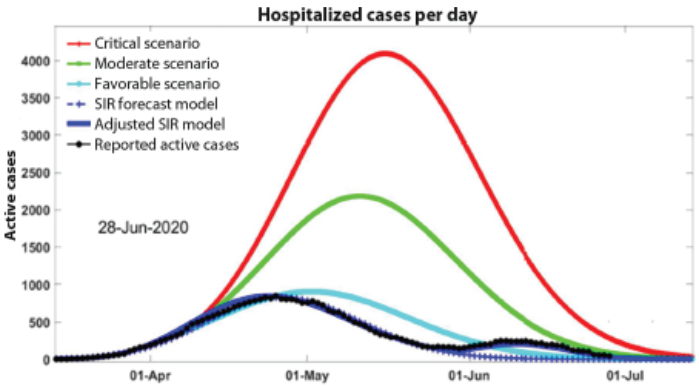
CONFRONTING COVID-19: CUBAN STRATEGIES AND RESULTS

Among the decisions taken by Cuban authorities was to gather specialists in biomedical, hard and social sciences into a Technical Advisory Team within the Ministry of Public Health. The team was tasked with periodically analyzing the epidemic situation, identifying problems and recommending solutions for different scenarios. Among other things, this facilitated incorporation of new treatments and innovations for improved patient care, as well as timely predictions useful in guiding strategies for controlling the epidemic. The contribution of Cuban institutions and scientists has been recognized in the media by government and health authorities.[13]

Researchers from the University of Havana's Mathematics Department applied several prognostic models for the course of

the epidemic in Cuba (Figure 4). The SIR model (Susceptible-Infected-Recovered), based on a system of ordinary differential equations, has been used elsewhere and was chosen due to its simplicity and ease of interpretation.[14,15] Figure 4 shows the expected case curves in three theoretically possible scenarios (favorable, moderate and critical). The active confirmed cases reported each day are registered in black (total cases minus those recovered or deceased).

Figure 4: SIR forecast model of hospitalized COVID-19 cases diagnosed up to 106 days after epidemic's start and projected epidemiological scenarios for the epidemic in Cuba. March–July 2020



Source: Dr Raúl Guinovart. Mathematics Faculty, University of Havana

The Cuban strategy included active screening for persons with asymptomatic infections. This was supported by the use of an epidemiological surveillance system (which tracks the location and contacts of potential vectors of communicable diseases) in place throughout the country for many years before the appearance of COVID-19.[7,16] This explains why 54% of confirmed cases were either in asymptomatic or presymptomatic stages at the time of their confirmation, and the share of asymptomatic cases continued to increase as the epidemic evolved, reaching close to 70% in the final weeks of the 110-day period.

Surveillance of international travelers was established before the first cases were confirmed in Cuba, and two weeks after these confirmations (on March 24, 2020), the decision was made to close airports to international flights.[17] Before closing the airports on March 24, contacts of COVID-19–positive cases (declared 'suspected cases') were advised to remain quarantined for 14 days in hospital centers outfitted for this purpose, or were monitored at home for the same period by primary healthcare personnel, restricting movement outside and maintaining physical distancing. This made it possible to trace all contacts of the first detected case. All these contacts underwent RT-PCR tests between the third and fourth days of their quarantine, and those with symptoms were referred to hospital centers with a higher level of clinical capacity.[7] At no time during the 110 days did COVID-19 patient care cause either primary care facilities or hospital emergency services to collapse, and intensive-care unit (ICU) capacities were always available. At the end of this period, a total of 39 infected persons were still in hospital with COVID-19, one of them in the ICU.

It is known that SARS-CoV-2 infection can spread rapidly in hospital settings.[18,19] This was also the case in Cuba, where 291 hospital workers were infected (12.1% of cases), including 212 doctors and nursing staff, with no deaths among them.

To achieve physical and social distancing at the population level, government authorities eliminated large public gatherings, closed schools and non-essential workplaces, and limited public transportation, among other measures, recommending in a massive public information campaign that people wash or disinfect hands regularly, use face masks outside and leave home only when necessary. Public messaging emphasized the importance of these habits for all individuals, especially for high-risk groups. Measures were more restrictive in communities with local transmission outbreaks or a large number of cases.[17] Various researchers have concluded that such strategies are effective for cutting the chain of person-to-person transmission of SARS-CoV-2. All of these interventions are included in WHO guidelines for confronting the pandemic[12] and in the *Oxford COVID-19 Government Response Tracker (OXCGRT)*.[20] OXCGRT was developed by Oxford University (UK) as a tool to assess government response to the pandemic which achieved and maintained a rating of 100 since May 11, 2020 (ratings are assigned from 1 to 100, based on an aggregate of 17 indicators measuring government response to the pandemic).[20]

The Cuban strategy has also incorporated nationwide door-to-door screening for persons presenting with fever and/or respiratory symptoms, carried out by primary care professionals supported by medical sciences students.[7] Additionally, an application ('app') for mobile devices (a 'virtual screener') was developed for people to self-evaluate and indicate if they present symptoms, which then advises local health authorities so that a primary healthcare service provider can visit them at home.[21] Both components of the strategy have provided valuable complementary epidemiological information on presence of possible clinical cases of COVID-19 and have opened up new possibilities for surveillance and control of other diseases in the future.

Research is continuing to identify asymptomatic cases in various population groups in response to WHO's call for population-based serological studies at the local or national level.[22] A national infection prevalence survey based on infection research (RT-PCR and antibody testing) is also being conducted in a probabilistic sample representative of the entire Cuban population that includes 4000 people of all ages and 1300 households.

DISCUSSION

The COVID-19 epidemic in Cuba began after those in Asia, Europe, North America and in various other Latin American countries, which means that it is several days or weeks younger than epidemics in other countries of the hemisphere (the USA, Canada, Mexico, Dominican Republic, Brazil, Ecuador, Chile or Peru, among others).[23] The day of the highest recorded number of cases in Cuba (74) was due to an outbreak in an institution, home to a highly vulnerable population, which contributed 88 cases to the cumulative total. This means the peak of the Cuban epidemic during this 110-day period was not associated with identification of active cases scattered among residents of different communities. A sustained decline of confirmed cases was recorded, beginning after a second peak of 63 cases on April 17, 2020. On that day the total number of accumulated cases was fewer than 1000 (986). The day when the maximum number of

cases was recorded (day 74) was accompanied by one reported death and 32 accumulated deaths.

The main epidemiological indicators associated with morbidity (number of confirmed cases, incidence rate, doubling time of cases, contacts traced, rate of tests per million population) have been consistent with the drop in infections made possible by efforts to detect both asymptomatic and symptomatic individuals and follow-up with their contacts. Thus, more than 85% of confirmed cases were contacts of previous cases. The level of virus penetration and the population's immune level to SARS-CoV-2 is still unknown but may be elucidated by the serological study currently being conducted in a representative sample of the population.

The >14,000 RT-PCR tests carried out per million population (pmp) is considered a good indicator of case finding, especially since it has been guided by active case detection carried out at the primary care level for both asymptomatic contacts as well as persons with respiratory symptoms. However, the country continues to work to obtain resources to increase this indicator (pmp) to the extent that the complex economic situation allows.

Active nationwide door-to-door screening for symptomatic cases through use of the primary healthcare system and medical schools, admission of all positive cases to hospitals and testing of all their known contacts are typical characteristics of the Cuban response to the COVID-19 epidemic. All these ensured that necessary care arrived in a timely manner, before complications. These measures may also have contributed to the relatively low case fatality rate that was observed in the country, as most fatalities occurred in persons with an average age of 74 years, almost all of whom (85%) had concurrent underlying NCDs. This indicator (case fatality rate) was lower than the global average and the average for countries of the western hemisphere calculated within the same date range.[24] Additionally, the percentage of deaths among seriously ill patients and among critically ill patients (those requiring respiration assistance), at less than 20%, is much lower than that reported elsewhere in the literature, which ranges between 50% and 70%.[7,10]

Available epidemiological indicators suggest that timely introduction of social distancing (begun on March 24, 2020 in Cuba) is recognized as an effective means of reducing transmission. This may help explain Cuba's favorable results during this period in flattening the curve of infection.

The timing of measures adopted and the intensity with which they were applied decreased opportunities for transmission between contacts, which in turn contributed to reaching the peak of the epidemic faster and with a relatively lower number of cumulative deaths during this period.

In the database available from Johns Hopkins University, USA, comparing rates of infection near epidemic day 60 in 10 Latin American countries revealed that the only country exhibiting an already flattened curve was Cuba. Costa Rica and Uruguay had begun to stabilize their curves at this point, while Peru and Brazil had the highest rates of multiplying cases.[25]

By the end of June 2020, 14 of the 15 provinces of Cuba and the special municipality of the Isle of Youth had reported no new cases for >15 days (in some provinces, for >30 days). This was one of several main criteria that allowed these territories to transition to the first of three recovery phases contemplated in the national strategy for the country's gradual reopening. Havana was the last province to achieve that certification, beginning Phase 1 on July 3, 2020, the same day that the rest of the provinces (except Matanzas) entered Phase 2.[7]

Cuba's response to the epidemic has been multisectoral.[25] The Ministry of Public Health, in charge of organizing Cuba's free and universal health services at all levels of care, has assumed technical leadership. However, the role of Civil Defense, already a key player during other disasters and epidemics in Cuba, merits recognition. Another key component of the Cuban strategy has been the contribution by scientists and their institutions as advisors to government for the design and application of various strategies, ranging from the epidemiological to patient care and development of vaccine candidates.[13] Last but not least, an essential pillar of the Cuban strategy has been collaboration by the Cuban public in adopting the measures designed and implemented by the healthcare system and government authorities.

CONCLUSIONS

During the period studied, Cuba's response to the epidemic has been among the most successful, in terms of flattening the curve and limiting viral transmission in a relatively short time, resulting in relatively low case numbers and deaths. Strategies particular to Cuba's epidemic response included building on the universal character of the health system and its strong primary care network by carrying out nationwide door-to-door screening for persons with febrile and respiratory symptoms, isolating confirmed cases and placing their traced contacts and suspected cases under quarantine, as well as early inclusion of researchers and scientific institutions in the design and structure of the strategies adopted.

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