CSP CADERNOS DE SAÚDE PÚBLICA
REPORTS IN PUBLIC HEALTH

REVISÃO
REVIEW

The response by South Korea to the COVID-19 pandemic: lessons learned and recommendations for policymakers

A resposta da Coreia do Sul à pandemia de COVID-19: lições aprendidas e recomendações a gestores

La respuesta de Corea del Sur a la pandemia de COVID-19: lecciones aprendidas y recomendaciones a gestores

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doi: 10.1590/0102-311X00118621

Abstract

The studies published on the South Korean response to COVID-19 point to different reasons for the country's success. No reviews were identified on South Korea from January 2020 to April 2021 or that analyzed the pandemic's recrudescence. Aimed at better systematization of South Korea's success in controlling the epidemic, we conducted an integrative review to analyze that country's experience with the COVID-19 pandemic, seeking to identify the relationship between the measures adopted, the health system's characteristics, and evolution of the selected indicators. Various databases were used, beside epidemiological bulletins and press conferences of the Korea Centers for Disease Control and Prevention (KCDC). We also analyzed reports by the World Health Organization (WHO) and the European Observatory on Health Systems and Policies. The study's results allow identifying a set of lessons based on the South Korean experience with control and management of the disease. The response by South Korea was successful, due to action in the control of risks and harms, action on social determinants to mitigate the socioeconomic effects of the health crisis, prior experience with other respiratory disease epidemics, and effective national coordination.

Pandemics; COVID-19; Health Systems; Surveillance; Health Policy

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Introduction

The COVID-19 pandemic is one of the most serious global health problems of the 21st century [1,2,3]. Comparisons of responses to COVID-19 by different countries show similarities and differences in the measures adopted and the results. Understanding the aspects that influenced greater or lesser success in control of the disease is essential to back decision-makers and contribute to planning to respond to future pandemics.

Various studies have reported South Korea as a successful case in the control of COVID-19 [4,5,6,7,8]. In the first two months of the health crisis, the incidence was reduced, maintaining a low case-fatality rate [5] and quickly flattening the epidemic curve without closing borders or commercial establishments [6], even given the geographic proximity to China [8].

However, the reasons cited for this successful response vary. One study [8] attributed the country's success to its preexisting capacity, especially due to the revision of the legal and organizational frameworks after MERS in 2015, allowing a rapid and effective response during the first wave of COVID-19, plus available financial support, the governance system, and a workforce experienced in outbreak management [8]. Another set of studies claims that the country's success is due to mass testing of the population, leading to early case identification, isolation, contact tracing and quarantine [9,10,11,12].

Another study highlights the high reliability of records of confirmed and suspected cases (around 95%), which facilitated timely management of information and interventions [13]. Other studies cited the effective use of mobile technologies for tracking, timely supply of personal protective equipment to workers, adequate treatment of patients, and population awareness-raising [11,14]. According to Nageshwaran et al. [14], the use of these digital technologies in COVID-19 contributed to South Korea's response to the epidemic. These authors pointed out that digital surveillance proved effective in mapping patients' movements and strengthening traditional public health measures [14].

Park [12] attributed the reduction of SARS-CoV-2 transmission to both testing and a combination of public health and socioeconomic policies, the existing public health infrastructure, and timely and transparent information from public health authorities comprising the control tower. Meanwhile Choi [15] highlighted the strong national coordination in the production of collaborative governance in which public and private stakeholders worked for the public good.

Various authors have analyzed the health systems [10,11], surveillance measures, and respective strategies [9,14]. Others have focused on governance, surveillance measures, and the health system [5,16] with analyses in various periods, mostly in the first semester of 2020. However, no reviews were identified on South Korea from January 2020 to April 2021 or that analyzed the pandemic's recrudescence.

This justifies the importance of systematizing the explanations cited for South Korea's success. The current study aimed to answer the following question: "How did the linkage work between the health system and surveillance measures in response to the COVID-19 pandemic in South Korea?".

To better understand South Korea's success in controlling the epidemic, the study aimed to analyze that country's experience in tackling COVID-19, seeking to identify the relationship between the measures, the health system's characteristics, and the evolution of selected indicators.

Methodology

An integrative review was conducted, adapted from the proposal by Whittemore & Knafl [17], with South Korea's response to the COVID-19 pandemic as the object. Three searches were performed: the first from May to July 2020, the second in November 2020, and the third in April 2021, to identify articles on South Korea's response to the increase in new confirmed COVID-19 cases in the country and with the epidemic's recrudescence from August 2020 to April 2021.

The strategy used in the first search included all parts of the articles (title, abstract, and full text) in PubMed (https://pubmed.ncbi.nlm.nih.gov/) and Science Direct (https://www.sciencedirect.com/). Through the Brazilian Graduate Studies Coordinating Board (CAPES) Periodicals Portal (https://www.periodicos.capes.gov.br/), we accessed PubMed Central and Science Direct, MEDLINE, One File (Gale), Directory of Open Access Journals (DOAJ), Web of Science, Wiley Online Library, Taylor

& Francis Online, BMJ Journals, Oxford Journals, and SAGE Journals. We used combined descriptors associated with the terms "COVID-19" and "South Korea" (Box 1). The same databases and search strategies were used in the second and third searches, with restriction only by title, abstract, and keywords. In the CAPES Periodicals Portal, we used restriction by title and subject.

We also included articles (via manual search) that were found in the references of the selected articles to complement information on the country's response to the pandemic or to allow a better understanding of the South Korean health system's organization.

The searches yielded 528 articles with the respective descriptors, imported to EndNote (http://www.endnote.com/) and removing duplicates (Figure 1). After excluding duplicate articles, 44 were selected for reading the full text. We also excluded studies that did not focus on this response or that conducted comparative studies of countries, but without demarcating the response as the object of study.

Data were extracted in Microsoft Excel (https://products.office.com/) and analyzed for identification of measures adopted by the country, the relationship to the epidemic's evolution, and the health system's characteristics. Article selection was performed by two independent researchers who reached consensus on the selected studies. The data extraction procedures were recorded in matrices containing the year, title of the article, authors, periodicals, and principal findings in relation to the adopted measures.

We also used the available data from the World Health Organization (WHO) COVID-19 dashboard from January to April 2021 for South Korea (https://COVID19.who.int/table), the Korea Centers for Disease Control and Prevention (KCDC; http://ncov.mohw.go.kr/en/), the databases from the European Centre for Disease Prevention and Control (ECDC; https://www.ecdc.europa.eu/en/COVID-19-pandemic), and Our World in Data (https://ourworldindata.org/). We analyzed reports by WHO, the European Observatory on Health Systems and Policies, and KCDC, available in English, on the South Korean health system and the country's response to the pandemic.

Information on mobility in different locations and types of establishments was obtained from the Google Mobility database (available at https://www.google.com.br/COVID19/mobility/). The data were imported in csv format and the graphs were produced in Microsoft Excel.

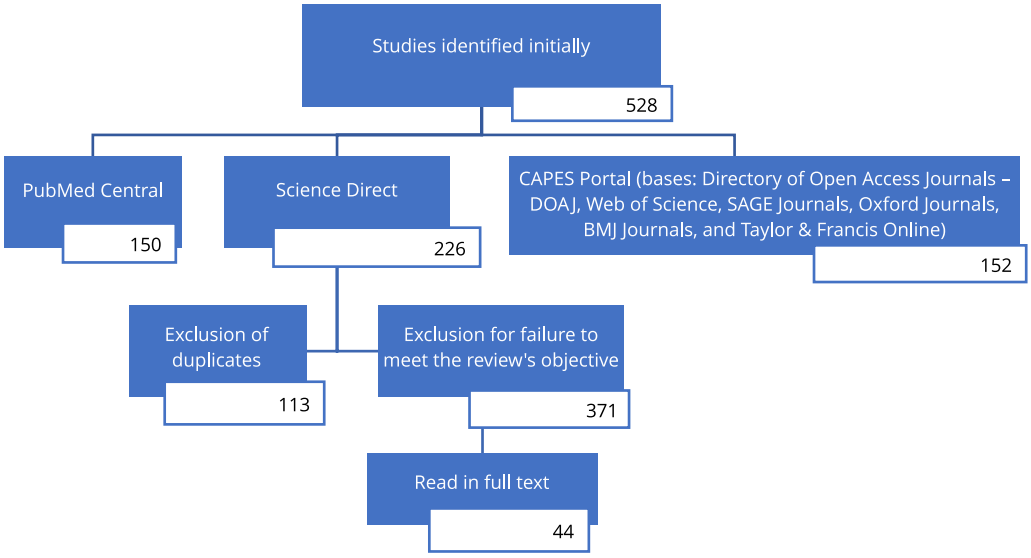
Box 1

Databases according to search strategies used.

DATABASE/LIBRARY	SEARCH SSTRATEGIES	TOTAL ARTICLES
PubMed Central (direct search in database)	"Republic of Korea"[MeSH] AND ("COVID-19"[Supplementary Concept] OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept] OR "COVID-19 diagnostic testing"[Supplementary Concept]) AND "response"	11
	COVID-19 AND "South Korea" AND "health system"	19
	COVID-19 AND "South Korea" AND "national response"	68
	COVID-19 AND "South Korea" AND "surveillance"	52
Science Direct (direct search in database)	COVID-19 AND "South Korea" AND "health system"	103
	COVID-19 AND "South Korea" AND "national response"	11
	COVID-19 AND "South Korea" AND "surveillance"	112
Searches in the following databases, starting from the CAPES Periodicals Portal: Directory of Open Access Journals – DOAJ, Web of Science, SAGE Journals, Oxford Journals, BMJ Journals, Taylor & Francis Online	COVID-19 AND "South Korea" AND "national response"	33
	COVID-19 AND "South Korea" AND "health system"	13
	COVID-19 AND "South Korea" AND "surveillance"	106
Total before exclusion of duplicates		528 articles

Figure 1

Number of articles on the South Korean response to COVID-19, based on search in selected databases.



Note: search period: June 2020 to April 2021.

The data were analyzed according to three dimensions: (i) characteristics of the country, government, and health system; (ii) evolution of the epidemic; and (iii) measures adopted in response to the COVID-19 pandemic. The health system's characteristics included infrastructure, population's healthcare coverage, physicians per inhabitant, form of services provision, healthcare financing and expenditures, organization of services, and the health system's history. The evolution of the pandemic included date of the first case, evolution up to the hundredth case and later, and case-fatality in relation to the surveillance and control measures adopted by the country.

Results

Characteristics of South Korea and its health system

South Korea is the world's 13th largest economy according to its GDP [18]. The population is more than 52 million and the country's territory measures 100,210 km^2. The political system is a representative Presidential democracy. Besides the federal level, there are regional and local governments headed by elected representatives [18].

The health system consists of two subsystems: (a) one based on health insurance with public administration, financed by private resources, under the responsibility of a single insurance company, the National Health Insurance Corporation, with coverage of 96% of the population; and (b) a public health program called Medical Aid, with public financing through taxes, targeted to the poor and covering 4% of the population [18,19,20]. The health insurance adopts purchase of services from private providers, including a users' copayment component [18,19,20]. The infrastructure features high availability of ICU beds (6.8/1,000 inhabitants, above the global average), concentrated in the private sector [18].

According to reports, these healthcare establishments are distributed across different levels of care and operate in a fragmented and unlinked mode, without a network having case-resolution

capacity through coordination by primary healthcare. There are multiple portals of entry into the health system through services with different technological densities [18,20,21].

For the control of diseases, the country had a structure linked to the Ministry of Health and Welfare (MoHW), namely the KCDC, which dealt with epidemiological information and investigation of outbreaks. Public health is managed in centralized format by the agency that coordinates the country's surveillance activities [18,20], using a decentralized structure located in the 16 provinces and 253 local public health centers, but with limited autonomy [18].

In 2015, the South Korean National System for Prevention and Control of Infectious Diseases was restructured, based on an unsatisfactory rating of the country's response to the MERS-CoV epidemic. The reform was designed according to a proposal debated in numerous seminars by epidemiologists and other experts, in addition to public hearings.

This reorganization resulted in building an early response system to contain outbreaks of infectious diseases in timely fashion, with the creation in the KCDC of an Emergency Operations System to monitor information on infectious diseases in real time and to respond immediately to detected outbreaks. The reform also established a specialized system for diagnosis and treatment within the existing quarantine installations for the detection and prevention of emerging infectious disease outbreaks, besides the creation of a screening system in the emergency units. The infrastructure for infection control in hospitals was also expanded, along with a revision of the management/governance models for emerging infectious diseases.

In September 2020, the KCDC was transformed into an independent government agency called the Korea Disease Control and Prevention Agency (KDCA), with the incorporation of the National Institute of Health (NIH), National Institute of Infectious Diseases (NIID), Regional Centers for Disease Control and Prevention (RCDCs), National Tuberculosis Hospitals, and National Quarantine Stations. The expansion of its autonomy and team gave this agency more authority and responsibility in the coordination of the national response to infectious diseases [22].

Response to the COVID-19 epidemic

The South Korean government encouraged the MoHW to adopt a national response based on data and science [23]. At the beginning of the pandemic, in March 2020, Ha [24] defended the position that the response should be risk oriented. The Chief Presidential Secretary, responsible for governance of all sectors, was a health systems researcher, which favored coordination between the Office of the Prime Minister, the Ministry of Social Assistance, and the KCDC, allowing a rapid response based on epidemiological information and resource reallocation. The MoHW worked in coordination with the provincial and metropolitan governments.

The response protocol activated by the government aimed to ensure coordinated and inter-sector action [25], with participation by society and under strong national leadership [5]. Importantly, since 2016 the KCDC had established a risk assessment system [26,27].

The country's response to the pandemic was triggered through the National Plan for Management of Infectious Diseases, based on which the local governments produced their implementation plans in coordination with the national level [16].

The first-level alert was issued on January 3, 2020, after notification of the first COVID-19 cases in China. The second-level alert was issued on January 20, 2020, following identification of the first case in South Korea [28,29]. This first case was a woman coming from Wuhan, China [30], identified at the airport. On January 27, 2020, the third-level alert was issued due to the increase in cases. Cases analyzed from January 20 to February 10, 2020, show that infection occurred mainly in Wuhan, but also in Guangdong (China), Singapore, Japan, and Thailand [30]. On February 20, South Korea reached the hundredth positive case of the disease and reported the first COVID-19 death [31] (Box 2). There was a sharp rise in incidence until late February [32] (Table 1; Figure 2; Box 2).

The country's alert reached the highest level (level 4), mainly due to the massive outbreak in Daegu, on February 23, 2020 (Figures 2 and 3). The government mobilized national response protocols aimed at coordination between society and various levels of government to contain the pandemic [5] and installed the National Disaster Prevention and Countermeasures Headquarters, headed by the Prime Minister. On March 21, 56.8% of the cases, that is, 5,051 of the 8,897 confirmed cases in the

entire country, were linked to the 31st patient associated with the Sincheonji Church of Jesus [5]. This was the largest cluster associated with spread of the disease, with the epicenter in the city of Daegu [32], followed by the Daenam Hospital in the same city [33]. The mass contamination in the church, responsible for wide dissemination of the virus, was called "black swan" [34]. The increase in Rt in the month of April was related to the growth in local transmission in Greater Metropolitan Seoul (Seoul, city of Incheon, and province of Gyeonggi) [35]. The proportion of recovered cases was higher in women [36].

South Korea developed an approach along two lines, namely the clinical case management response and the public health response, to prevent and detect new infections [5]. As for case management, actions in the health system were divided into two subsystems, "COVID-19" and "non-COVID-19", aimed at guaranteeing continuity of care for the population's other health needs.

Box 2

Principal measures adopted by South Korea to contain the COVID-19 epidemic, by date (January 2020 to April 2021).

PERIOD	MEASURES ADOPTED
January/2020	January 3 – First level of alert. Ban on entry from city of Wuhan and province of Hubei (China) and strengthening of quarantine for individuals arriving in South Korea.
	January 20 – Second level of alert activated.
	January 27 – Third level of alert activated.
February/2020	February 23 – Fourth level of alert activated.
March/2020	March 2 – Postponement of start of classes in schools and kindergartens from March 2 to April 8.
	March 19 – Special quarantine measures for individuals entering the country, including temperature checks, completion of health questionnaire at airports, and recommendation for use of cellphone app to inform changes in health status.
	March 22 – Start of four-week communication campaign (e.g., stay at home and avoid crowds), encouragement to avoid religious and sports events in closed places and entertainment venues; everyone coming for a long stay required to take COVID-19 test and self-quarantine (14 days) at home or in facilities designated by government.
April/2020	April 1 – Expansion of mandatory isolation policy for everyone arriving in the country, including short stays.
	April 5 – Reinforcement of penalty for violation of isolation measures with one year imprisonment or USD 8,000 in fines.
	April 9 – Gradual start of schoolyear with online classes, first with older students (middle and high school) and later elementary school.
	April 13 – Recommendation for all Korean and foreign travelers coming from the United States to be tested in the first three days, regardless of symptoms.
	April 20 – Start of flexibilization phase for physical distancing measures, while campaign extended to May 5.
	April 20 – Permission for religious meetings and some social activities as long as hygiene protocols maintained.
	April 22 – Publication of protocols for individuals and communities to balance daily activities and quarantine.
May/2020	Early May – Start of professional basketball season without fans.
	May 6 – Release of distancing measures and change to "daily life quarantine" and completion of six weeks strong social distancing campaign, with change to so-called daily life quarantine system, "5 Basic Rules": (1) stay at home for 3-4 days if sick; (2) keep two arms' length distance from others; (3) wash hands 30 seconds. Cough or sneeze into sleeve; (4) Ventilate personal space at least twice a day and disinfect regularly; and (5) maintain contact with family and friends, but with physical distancing. Orientation for the elderly to keep medicines for chronic diseases and contact with public health centers in case of symptoms. At the community level, encouragement for participation by everyone.
	On May 6, schools opened gradually but the universities that had started online classes on March 9 extended this modality to the end of the spring semester.
July/2020	July 26 – Gradual permission for fans to attend baseball and football games.
August/2020	August 23 – Social distancing level 2 applied nationwide.
	August 30 – "Enhanced" level 2 social distancing applied to Seoul and greater metropolitan area.

(continues)

Box 2 (continued)

PERIOD	MEASURES ADOPTED
September/2020	September 14 – Social distancing level 2, KCDC implements reinforcement of measures, i.e., hiring and training more epidemiological intelligence officers, research and development related to infectious diseases, including clinical trials and support for vaccine development, through recently created National Institute of Infectious Diseases (NIID); support for local response efforts in closer coordination through 5 Regional Centers for Disease Control and Prevention, reinforcement of monitoring and analysis for rapid response; reinforcement of vaccine supply and management.
	September 25 – Recommendations for Autumn Harvest holiday: stay at home with close family; keep 2-meter distance, wear mask at home and outdoors if it is not possible to keep 2-meter distance, prefer open and ventilated places without crowds. Physical activities in neighborhood parks, nearby trails, and recreational parks. Cultural activities with prior reservations and use of TV programming. For elderly population, parents, and grandparents, prefer video call greetings.
October/2020	October 19 – Announcement of information on flu surveillance and influenza vaccination calendar.
	October 27 – Orientation on social distancing for safety during Halloween. Avoid events, especially in case of fever or respiratory symptoms; encouragement for non-face-to-face meetings and without contact; avoid clubs, bars, pubs, restaurants, cafes, and nighttime entertainment venues if possible. For unavoidable commitments, recommendation for use of safety measures (avoid hours with more movement, sharing costumes, with symptoms wear masks, 2-meter distancing, hand hygiene. Avoid physical contact, no sharing of glasses and utensils, temperature check, disinfection of physical spaces). In case of participation in group meetings and a positive test result, inform other participants so that they can test.
November/2020	November 11 – Announcement of distancing measures levels 1 to 3.
	November 19 – Elevation of social distancing levels to 1.5 in Seoul, Gyeonggi Province, and city of Icheon.
	November 24 – Elevation of social distancing to level 20 in Seoul, Incheon, and Gyeonggi and level 1.5 in Honam region (Gwangju, Jeonbuk, and Jeonnam): home office for 1/3 of workforce, rotating work and lunch hours, mask-wearing in all indoor spaces, suspension of all nonessential business trips, cancellation of all nonessential in-person meetings.
December/2020	December 1 – Social distancing level 1.5, except in Greater Metropolitan Seoul, which remains at 2.0.
	December 7 – Revision of criteria for closing isolation for COVID-19 cases.
	December 8 – Social distancing level 2.5 for Greater Metropolitan Seoul: reinforcement of distance learning, ban on in-person private classes, restriction on travel to other regions. Restriction on functioning of bars, restaurants, and other installations until 9:00 PM; limitation of events to 50 participants or less, accommodations not allowed for parties; restriction of meetings and physical activity in closed environments; takeout food only in cafés; closing of saunas; ban on religious events. In other areas of the country, more restrictive measures, social distancing level 2. Restaurant delivery until 9:00 PM, closing of nightclubs and pubs, song rooms, and gyms at 9:00 PM, mandatory mask-wearing, events limited to 100 participants, of in-person classes in schools, limitation of in-person participants in regular religious services.
	December 12 – Social distancing level 1 – Request for population to participate in surveillance. In metropolitan area, emergence of local gatherings, maintenance of some level 2 measures such as: mandatory mask-wearing in places with mandatory infection control and preventive measures for high-risk facilities, places with risk of exposure to large numbers of people such as public transportation and demonstrations, as well as installations with vulnerable population groups such as in hospitals and home care services, regardless of prevailing level of distancing. Enforcement of fines in case of inadequate mask-wearing.
	December 21 – Special measures for prevention of infections during winter holidays, such as: testing in convalescent hospitals, psychiatric hospitals, and outpatient clinics; mandatory diagnostic testing every 1-2 weeks or rapid antigen 1-2 times a week); restriction of entry of unauthorized personnel; staff not allowed to participate in private social gatherings. In religious institutions, maintenance of level 2.5 measures applied throughout the country, with regular non-in-person services. Private meetings limited to 5 persons except for permanent members and not allowed in restaurants. Ban on rental of party rooms, temperature checks in establishments with large circulation. 50% maximum occupancy in resorts and ban on ski and snowboard resorts, ice skating, and other winter sports facilities. Closing of popular New Year´s destinations including sunset and sunrise lookouts and national parks.
January/2021 to April/2021	February 22 – Start of COVID-19 vaccination. April 20 – After 87 days, daily cases exceeded 600, fueling concerns over a fourth wave. KDCA warned that the fourth wave had to be avoided during the vaccination phase for elderly. Preventive measures reinforced, with agreements at various government levels.

KCDC: Korea Centers for Disease Control and Prevention; KDCA: Korea Disease Control and Prevention Agency.
Source: KCDC/KCDA (http://www.kdca.go.kr/, accessed on 30/Apr/2021).

Table 1

New cases, total accumulated cases, new deaths, total deaths, case-fatality, deaths/million, tests per case, and total COVID-19 tests according to date of recording, South Korea (January 2020 to April 2021).

Date	New cases	Total accumulated cases [a]	New deaths	Total deaths [b]	Case-fatality (%) [b/a]	Deaths *	Tests per case [c/b]	Total accumulated tests [c]
19/Jan/2020	5	5	0	0	0.00	0.00	0.00	0
30/Jan/2020	2	10	0	0	0.00	0.00	24.40	244
15/Feb/2020	0	32	0	0	0.00	0.00	241.69	7,734
29/Feb/2020	813	3,154	4	17	0.50	0.31	29.82	94,055
15/Mar/2020	76	8,166	3	75	0.90	1.46	32.84	268,212
31/Mar/2020	125	9,786	4	162	1.70	3.16	41.95	410,564
15/Apr/2020	27	10,591	3	225	2.10	4.33	50.47	534,552
30/Apr/2020	4	10,765	1	247	2.30	4.84	57.58	619,881
15/May/2020	27	11,018	0	260	2.40	5.11	65.96	726,747
31/May/2020	27	11,468	1	270	2.40	5.29	79.42	910,822
15/Jun/2020	36	12,121	0	277	2.30	5.42	91.22	1,105,719
30/Jun/2020	43	12,800	0	282	2.20	5.50	99.51	1,273,766
15/Jul/2020	39	13,551	0	289	2.10	5.68	105.62	1,431,316
31/Jul/2020	36	14,305	1	301	2.10	5.87	109.32	1,563,796
15/Aug/2020	166	15,039	0	305	2.03	5.95	111.40	1,675,296
30/Aug/2020	299	19,699	2	323	1.64	6.32	97.68	1,924,170
15/Sep/2020	106	22,391	4	367	1.64	7.16	96.67	2,164,578
30/Sep/2020	113	23,812	6	413	1.73	8.09	97.56	2,322,999
15/Oct/2020	110	24,998	1	436	1.74	8.60	98.04	2,450,739
30/Oct/2020	113	26,384	1	463	1.75	9.05	99.01	2,612,231
15/Nov/2020	208	28,546	1	493	1.73	9.63	97.63	2,786,878
30/Nov/2020	439	34,201	3	526	1.53	10.26	89.50	3,061,172
15/Dec/2020	880	44,364	13	600	1.35	11.94	77.56	3,441,220
30/Dec/2020	1,050	59,773	20	879	1.47	17.55	69.58	4,159,522
15/Jan/2021	513	71,241	22	1,217	1.70	24.11	69.88	4,978,075
30/Jan/2021	458	77,850	15	1,414	1.81	27.70	72.15	5,616,530
15/Feb/2021	344	83,869	5	1,527	1.82	29.92	73.48	6,162,860
28/Feb/2021	356	89,676	8	1,603	1.79	31.30	74.14	6,649,006
15/Mar/2021	382	96,017	6	1,675	1.74	32.73	73.79	7,084,940
30/Mar/2021	447	102,582	3	1,729	1.69	33.76	74.71	7,663,999
15/Apr/2021	698	112,117	6	1,788	1.59	34.91	73.95	8,291,126

Source: World health Organization [31]; Our World in Data [65]; Korea Disease Control and Prevention Agency (http://www.kdca.go.kr/, accessed on 30/Apr/2021).

* Per million inhabitants.

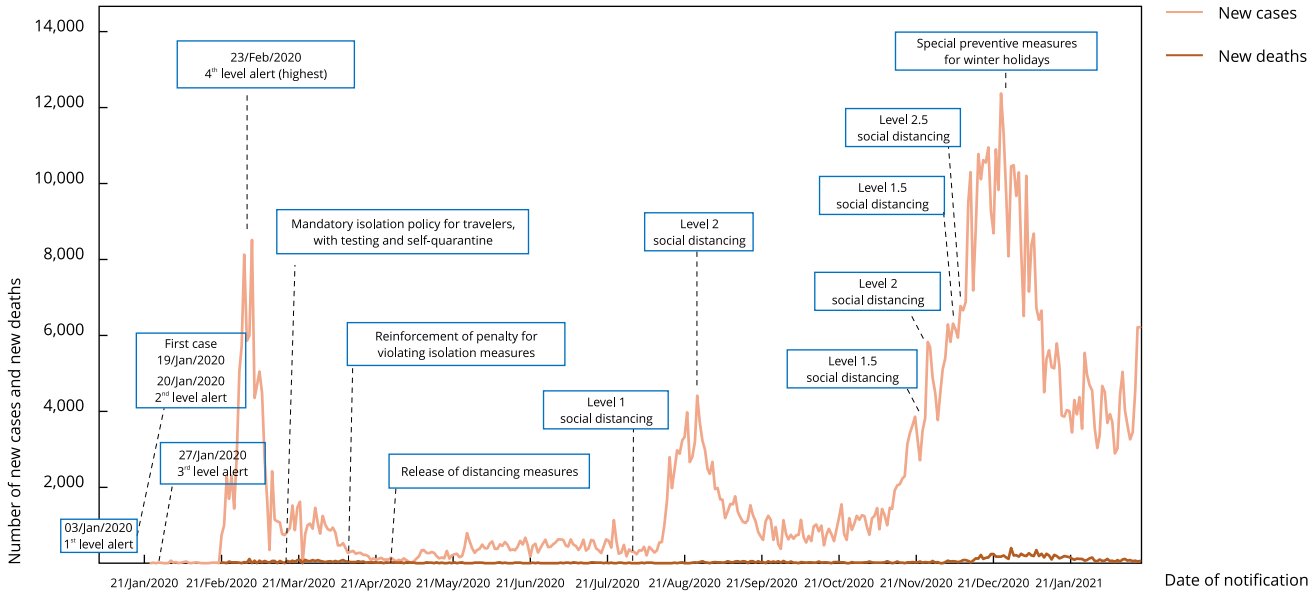
Governance and national coordination were relevant for the flow and delivery of supplies and organization of the referral system, with referral of patients between levels of care and on the city limits and provincial borders, even in the absence of a clear legal structure.

In care for COVID-19 cases, South Korea's low case-fatality rate has been attributed to the capacity to reduce the infection rate in high-risk populations through detection and early isolation of cases [37], which prevented an overload on hospitals, leaving them available to care for the more severe cases [5].

The country's infrastructure for tacking COVID-19 was also expanded with: (i) implementation of Screening Centers at the district level to asses individuals with fever or respiratory symptoms; (ii) organization of negative-pressure intensive care units in university hospitals and those accredited

Figure 2

COVID-19 cases and deaths reported in the previous 24 hours according to date of recording and measures adopted. South Korea, January 21, 2020 to January 21, 2021.



Source: Korea Disease Control and Prevention Agency (http://www.kdca.go.kr/, accessed on 30/Apr/2021).

through them; (iii) definition of hospitals and allocation of respiratory disease specialists for treatment of noncritical patients; (iv) implementation of clinical beds in "nonhospital" spaces (field hospitals) for treating mild cases, alongside health workforce training; (v) definition of governance and national coordination; and (vi) deployment of actions and inputs for health workforce protection.

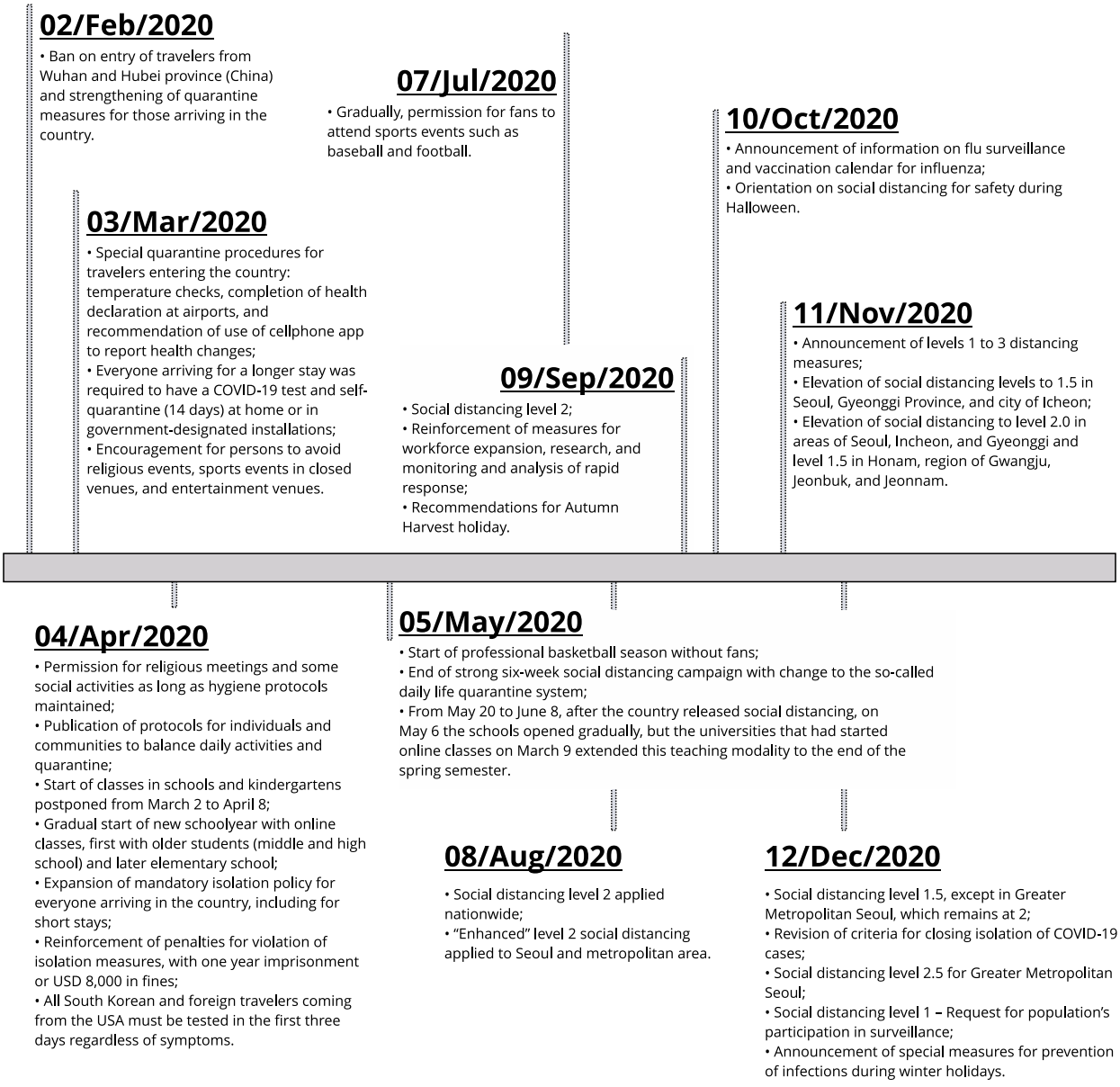
Social communication technologies were used to encourage the population to maintain distancing and home work [38], and the country adopted various such measures, varying according to the epidemiological situation [19] and including cancellation of public events, travel bans/restrictions, and closing of schools and universities, all implemented progressively (Figures 2 and 3).

The country drew on standard procedures for risk communication in public health emergencies that had been implemented in 2017 [16]. When COVID-19 struck, the KCDC published daily information on its website on the evolution of the pandemic, updates to the strategies, and revision of regulations and measures in keeping with the epidemic's evolution in the country [39]. Preventive practices were published continuously by the government [29] such as physical distancing and other preventive measures [40]. Studies have reported extensively on policies for the use of face masks [41]. Medical associations came out publicly in support of the KCDC [42]. Alerts were sent to citizens' cellphones by local authorities, with the new confirmed cases and their recent trajectories whenever available. The system had already been adopted by the Ministry of the Interior and Safety to inform on disasters [39].

The isolation protocols that were adopted followed the recommendations of the International Health Regulations, not involving the closing of national borders [19]. A program was implemented for self-quarantine and contact tracing for all travellers [43], with mandatory use of a cellphone app [23]. Individuals identified as contacts of confirmed or suspected cases were placed under home quarantine, or when this was not possible in public support centers at no charge [5]. In specific situations, there were also partnerships with the private sector, aimed at expansion of the healthcare infrastructure.

Figure 3

Timeline with principal measures in South Korean response to COVID-19 pandemic (January 21, 2020 to January 21, 2021).



Source: Korea Disease Control and Prevention Agency (http://www.kdca.go.kr/, accessed on 30/Apr/2021).

In Daegu, a network was operated that consisted of the Emergency Response Advisory Group, the Daegu Medical Association, and three support groups that acted in coordination in the control of the COVID-19 epidemic [16]. In the case of Hanam, the medical association, the Public Health Center, and the central and provincial governments joined forces to screen, test, and monitor the population by sharing public and private infrastructure as well as the workforce [44].

As for case surveillance, widespread testing was adopted as a fundamental strategy for identifying cases and tracing contacts [39,45,46,47]. South Korea established its testing capacity with three interventions: public-private partnerships for the development of testing technologies that included RT-PCR, the gold standard for COVID-19; approval of testing for suspected cases; and rapid development of these tests by the country through partnership with local governments [5,44,46].

In a pioneering approach, the country implemented drive-thru screening centers to expand diagnosis with the reduction of health workers' exposure [39,45,48]. Tests took an average of 10 minutes to perform, and the results were sent directly to patients through text messages within three days. In regions with difficulties for vehicle circulation, mobile compact booths were developed to perform walk-thru tests [39,48]. Public health doctors, or health professionals that worked during their period of military service, were deployed in the process [15]. They were sent quickly to the COVID-19 epicenters and performed tests in Screening Centers, airports, and hospitals.

A 24-hour telephone hotline was set up for screening by primary care physicians to orient and manage cases [44]. Free tests were offered in case of symptoms [48]. This policy of care for cases that aimed at early detection, decreasing the pace of new infections, allowed more effective containment of the disease than in other countries [5,39]. Extensive epidemiological investigations were conducted in the field, using information and communication technologies (ICTs), with intergovernmental cooperation [15], using not only patient interviews and medical records but also credit card transactions, GPS, and television circuits to identify cases and contacts movements [5,28,49]. After the MERS outbreak in 2015, a national regulation facilitated sharing of these investigations with the general public [5,39,50,51].

Large-scale epidemiological investigation was possible due to the presence of 30 rapid response teams from the KCDC and expansion of the number of workers in local services [49]. In approximately 250 districts, a temporary taskforce of officers from the epidemiological intelligence service was established with elementary and middle-level employees from government health centers. Although these workers were not regular qualified civil servants, they were trained in standard protocols for contact tracing. Importantly, since 1999, through the Field Epidemiology Training Program, the country had already adopted epidemiological intelligence service officers at the central and provincial levels in conducting epidemiological investigations [52].

The combination of surveillance measures, contact tracing, and workforce expansion and qualification aimed to inform the population and produce information to support decisions by the country's authorities. Data and artificial intelligence (AI) streamlined the response and expanded the effectiveness in the activities' coordination [16]. The fact that South Korea has the world's fastest Internet favored the process [19]. Cellphone apps and online maps developed by private initiative and government agencies played an essential role in monitoring the epidemic's evolution, to alert the public to the risk of exposure, and in the rapid adaptation of testing centers according to needs [48].

With the increase in cases and the difficulty tracing contacts manually, the Ministry of Land, Infrastructure, and Transport deployed an integrated surveillance system to perform this activity automatically in collaboration with the KCDC and the Ministry of Science and Technology [39,53]. A preexisting data platform for intelligent cities was adapted, combining data from the National Police Agency, three telecom companies [5], and 22 credit card companies, culminating in the COVID-19 Intelligent Management System [39], a support system for epidemiological investigation, which reduced the tracing time to less than 10 minutes.

The MoHW also developed a cellphone app to monitor potential patients, with threats of legal penalties (fines and imprisonment) to reinforce the limitations on movement. The Ministry of the Interior and Safety provided an app to monitor self-quarantine and assess contacts' health conditions. With the expanded use of digital technologies, the question of right to privacy and use of data in the response to public health problems was problematized [54]. Critics pointed to the excessive use of the State apparatus to control individuals through digital techniques [55], with violation of infected patients' civil liberties and allowing stigma by society [56,57]. Despite psychological and mental health interventions, the need was identified for a better public approach to avoid collapse of the social support systems and stigmatization of patients [58].

Even without closing borders or imposing a national lockdown [50], there was a decrease in mobility in public transportation centers. The number of passengers in all stations decreased by 40.6% from January to March. A change was seen in the number of passengers in the Seoul subway at different

moments in the COVID-19 epidemic [59]. The authors pointed to a larger reduction in the flow of users in stations serving workplaces compared to stations devoted mainly to leisure-time activities [59]. A study on use of the public bicycle-sharing system showed greater use of this type of personal transportation and voluntary waiving of conventional public transportation [60].

Starting in July 2020, new cases began to increase again, and different levels of physical distancing measures were announced and activated. Many confirmed cases had a history of travel to various countries, with the Unites States and Europe accounting for 65.2% [53]. On July 31 [61], among other measures, a maximum of 10% occupation was enforced in football and baseball stadiums, with online ticket purchases, mandatory mask-wearing to and from and during sports events (Box 2).

According to one study, a large antigovernment demonstration and loosening of social distancing policies led to an increase in the incidence in August 2020 [23]. Level 2 alert was issued on August 15, 2020 [62,63], due to local clusters and community transmission in Greater Metropolitan Seoul and other provinces. On September 30, 2020, the number of new cases dropped again and there was a decrease in social distancing to level 1 in October 2020, with an increase from 1.5 to 2.5 in November and subsequent months due to the rise in local transmission [64] (Table 1; Box 2; Figure 2). February 2021 witnessed a drop in cases, with mortality of 29.78 deaths/million inhabitants (February 15, 2021). Much higher rates were occurring in the United Kingdom (1,732.64 COVID-19 deaths/million), Italy (1,551.97 COVID-19 deaths/million), Portugal (1,511.37 COVID-19 deaths/million), United States (1,439.01 COVID-19 deaths/million), and Brazil (1,128.03 COVID-19 deaths/million) [65].

In February 2021, the KDCA announced the start of COVID-19 immunization in the country [66]. The first doses of the Pfizer-BioNTech vaccine, acquired through the COVAX Facility, were reserved for employees of COVID-19 referral hospitals. The country diversified the purchase of vaccines for immunization of persons working in health centers and recovery hospitals. An online registry was deployed to identify eligible individuals according to the established criteria. No publications were identified that analyzed the reason why the country only began vaccination in early 2021.

South Korea adopted a set of compensatory and social protection measures aimed at decreasing the economic impact of COVID-19 and guaranteeing maintenance of citizens' livelihood [65]. The government announced the budget for measures to mitigate the pandemic and its economic effects, with the approval of a set of fiscal measures that included credit guarantees and emergency support for families and tourism, export industry, and strategic companies.

There were emergency subsidies in the form of coupons and cash to stimulate private consumption. There was also a budget outlay focused on job creation; emergency loans to companies in financial difficulties; the Korean New Deal Project, in which the country planned to create 1.9 million new jobs and invest USD 133 billion by 2025, with a focus on digital and "ecofriendly" projects. The country adopted measures to reduce workplace exposure to COVID-19 with the publication of a protocol and stimulus for flexible arrangements (home office and flexible hours, among other measures). Income support was established for sick workers and their families, for persons that had lost their jobs or income from self-employed work, stimulus for companies to adjust the work schedules and protect jobs and financial support for those suffering a reduction in consumer demand, as well as suspension of tariff payments, including electricity bills.

Discussion

The study found evidence that allows relating South Korea's success in the control of the COVID-19 pandemic to a combination of strategies that include surveillance, timely case investigation, and use of digital technologies and AI, besides other inter-sector measures. National coordination by a collegiate body, technically qualified and centralized in an agency affiliated with the MoHW, was identified as one of the positive factors in the response to COVID-19 [7,19].

Thus, the response backed by epidemiological data oriented the adoption of measures and the quick mobilization of the protocol for the response to infectious diseases. The implementation of adequate surveillance allowed more flexible social distancing according to the local epidemiological situation.

Another outstanding feature was the assessment of suspected cases at Local Screening Centers with referral to healthcare units based on the degree of severity. These findings are reinforced by studies [5,8] reporting that the main lessons learned in the South Korean experience were early threat detection, rapid activation of the national emergency protocol by the national leadership, as well as triggering of the process for prompt establishment of the country's diagnostic capacity.

According to the literature, the negative response to MERS in 2015 motivated the South Korean government to elaborate a protocol, including the establishment of public-private partnerships under State regulation for the development of high-sensitivity tests [16,44,47,51,67]. The previous negative experience reportedly induced the production of such technologies as the implementation of drive-thru clinics and a culture of the use of surgical masks in the country [19].

Meanwhile, the SARS epidemic in 2004 led the KCDC to reformulate the system of preparedness and response to imported infectious diseases through the implementation of an Emergency Operations Center, strengthening risk communication and the risk assessment strategy with the creation of new divisions and expansion of the number of professionals for epidemiological investigation [68].

Other studies point to a concern over substantial economic losses and the population's fear of a possible new epidemic experience as factors favoring adherence to government's instructions [5,34].

The containment measures after the first cases, with a rigorous testing policy for early identification of cases, contact tracing, and recommendation of timely quarantine or isolation were essential. These findings have been ratified by comparative studies [9,10,11].

ICTs were listed as an important element in the response to the pandemic, as well as the availability of test results and up-to-date information on COVID-19 on the government and local websites; the governments' integrated communication strategies, including municipalities; and the walk-thru testing stations. Intragovernmental interaction and the inter-sector response also appear to have been relevant elements. One study found that countries that were better equipped and prepared with testing, hospital infrastructure, and contact tracing, among other measures, responded better to the epidemic [39]. These results are corroborated by other authors [14] who point to real-time epidemiological digital dashboards, interactive maps for locating cases, use of mobile apps, and georeferencing to monitor compliance with quarantine as factors that contributed to dealing with the pandemic.

Although the results of this review characterize primary care in South Korea as far from having a network structure with case resolution and coordinating care (approaching selective primary care [69]), the organization of the response to the pandemic used both the physical and human infrastructure and the establishment of local partnerships between various services as facilitating element in receiving users with respiratory symptoms for referral and case management.

The importance of primary care in responding to the pandemic has been well documented [70,71,72], showing that it is particularly effective in mild and moderate cases, in the coordination of users in the network, and in clinical management and monitoring of isolation, besides post-COVID-19 patient follow-up [70,73,74]. The expansion of existing structures and their linkage to primary care allowed control of the disease and avoided its spread.

In terms of the provision of services and coverage of care for most of the population, the South Korean health system is substantially private. However, the mobilization of available public structures at the provincial and local levels was essential for the response to COVID-19. When it proved necessary to mobilize nonpublic structures, the government was decisive in regulating the services, as in the control of the Daegu crisis, allowing legal backing for necessary interventions [31].

Considering the health surveillance diagram adopted by studies in Brasil [75], this review's results show that South Korea developed interventions to control risks and harms, besides adopting measures to prevent the pandemic's economic and social effects, with risk communication strategies capable of promoting engagement by the population, professionals, policymakers, and technicians.

Final remarks

The evidence produced by the integrative review show that South Korea succeeded in controlling transmission and mitigating the pandemic's harms, flattening the epidemic curve and without collapse of health services, suggesting that the country represents a successful case in the response to COVID-19.

There was linkage in the South Korean response between surveillance, risk and harm control, and action on certain social determinants to mitigate the pandemic's socioeconomic effects. The country presents specificities, such as having experienced the MERS epidemic, which resulted in the institutional reform of the system for handling infectious diseases, creation of a protocol with various levels of intervention in epidemics, and legislation on the use of private data in health emergencies, allowing greater adherence by the population to the various tools, besides a normative legal framework to back the government's measures in dealing with the epidemic.

The review's results allow identifying a set of lessons from the South Korean experience, aimed at control and management of the disease. These feature the importance of major national coordination, linking actions by the various government ministries and agencies with orientation for inter-sector work. The coordinated government decision was based on epidemiological information with the adoption of measures to support and allocate resources for confronting the epidemic and its effects on the country's economy. Protocols were available at each location containing appropriate level alerts for activating measures, depending on the epidemiological situation, as well as adequate risk communication using various tools and technologies, with daily updates on the situation and wide dissemination of information to society, besides daily messages on areas at increased risk. Border surveillance was performed even before confirmation of the first case.

Digital technologies (apps for mobile devices) were used as tools for case surveillance, monitoring of the self-quarantine and health situation of cases and contacts, or to follow mobility in the country. Laboratory capacity was expanded and testing centers were deployed, favoring a strategy that allowed large-scale contact tracing with early case detection and timely adoption of isolation or quarantine, leading to identification of clusters and adoption of measures to control transmission.

Temporary structures with the expansion of patient beds were created to treat less serious cases and linked to primary care for diagnosis, referrals, and local partnerships to receive individuals with respiratory symptoms. The policy highlights the importance of integration of primary care in responding to the pandemic and guaranteeing availability of personal protective equipment for health workers at various levels of care. Many workers were also recruited for epidemiological investigation and contact tracing activities in local services, which allowed expanding the epidemiological surveillance activities.

The current study displays certain limitations, as in any review, including the fact that one of the data sources was published articles with a diversity of research questions, methodological designs, and analytical techniques. We thus suggest deepening the research through comparative studies, drawing on greater methodological rigor in the data production and analysis, with a view towards allowing better comparison between countries.

The development of an effective response by South Korea has centered on epidemiological information oriented the adoption of measures for the expansion of physical infrastructure and staffing, laboratory response capacity, healthcare, and surveillance and monitoring of cases and contacts. The country's success should thus be attributed to the combination of various types of strategies, featuring actions by the national coordination linked to local levels, surveillance, and case investigation.

Contributors

T. R. A. Rossi, C. L. M. Soares, and G. A. Silva contributed to the study planning, data production and analysis, writing, and revision. J. S. Paim contributed to the data analysis, writing, and revision. L. M. Vieira-da-Silva contributed to the study planning, data analysis, writing, and revision.

Additional informations

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Acknowledgments

To the Brazilian National Research Council and Brazilian Ministry of Health (Call for Projects MCTIC/CNPQ/FNDCT/MS/SCTIE/DECIT – 07/2020).

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Resumo

Os estudos publicados sobre a resposta da Coreia do Sul à COVID-19 apontam para distintos motivos para seu êxito. Não foram identificadas revisões sobre a Coreia do Sul entre janeiro de 2020 e abril de 2021 ou que analisassem o recrudescimento da pandemia. Visando melhor sistematização sobre o seu sucesso no controle da epidemia, desenvolveu-se uma revisão integrativa para analisar a experiência daquele país no enfrentamento da pandemia de COVID-19, buscando identificar a relação entre as medidas adotadas, as características do sistema de saúde e a evolução de indicadores selecionados. Utilizaram-se distintas bases de dados, além dos boletins epidemiológicos e conferências de imprensa do Centro Sul-coreano de Prevenção e Controle de Doenças (KCDC). Adicionalmente, analisaram-se relatórios da Organização Mundial da Saaúde (OMS), do Observatório Europeu de Políticas e Sistemas de Saúde. Os resultados do presente estudo permitem identificar um conjunto de lições com base na experiência sul-coreana visando o controle e manejo da doença. A resposta da Coreia do Sul fora bem-sucedida devido às ações no controle de riscos e danos, atuação sobre determinantes sociais para mitigar os efeitos socioeconômicos da crise sanitária, a experiência prévia em outras epidemias respiratórias e a coordenação nacional expressiva.

Pandemias; COVID-19; Sistemas de Saúde; Vigilância; Política de Saúde

Resumen

Los estudios publicados sobre la respuesta de Corea del Sur a la COVID-19 apuntan distintos motivos para su éxito. No se identificaron revisiones sobre Corea del Sur entre enero de 2020 y abril de 2021 o que analizaran el recrudecimiento de la pandemia. Con el fin de una mejor sistematización sobre el éxito en el control de la epidemia, se desarrolló una revisión integradora para analizar la experiencia de aquel país en el combate de la pandemia de COVID-19, buscando identificar la relación entre las medidas adoptadas, las características del sistema de salud y la evolución de indicadores seleccionados. Se utilizaron distintas bases de datos, además de los boletines epidemiológicos y conferencias de prensa del Centro Surcoreano para el Control y la Prevención de Enfermedades (KCDC). Asimismo, se analizaron informes de la Organización Mundial de la Salud (OMS) y del Observatorio Europeo de Políticas y Sistemas Sanitarios. Los resultados del presente estudio permiten identificar un conjunto de lecciones, basadas en la experiencia surcoreana, con el fin del control y manejo de la enfermedad. La respuesta de Corea del Sur fue exitosa, debido a las acciones en el control de riesgos y daños, actuación sobre determinantes sociales para mitigar los efectos socioeconómicos de la crisis sanitaria, así como su experiencia previa en otras epidemias respiratorias y su significativa coordinación nacional.

Pandemias; COVID-19; Sistemas de Salud; Vigilancia; Política de Salud

Submitted on 18/May/2021
Final version resubmitted on 05/Aug/2021
Approved on 19/Aug/2021