

## Buying Time with COVID-19 Outbreak Response, Israel

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Israel's response during the containment phase of the COVID-19 outbreak in early 2020 led to a delay in sustained community transmission and effective mitigation. During February–April 2020, a total of 15,981 confirmed cases resulted in 223 deaths. A total of 179,003 persons reported electronically to self-quarantine and were entitled to paid sick leave.

Countries' responses to the coronavirus disease (COVID-19) emergency have been determined by their geopolitical, societal, and healthcare system characteristics. A successful response results from early identification of effective interventions tailored for these specific characteristics. At the outset of the COVID-19 outbreak response, Israel's healthcare system faced a chronic shortage of healthcare resources; however, as Israel shifted from containment to mitigation, structural characteristics were leveraged to enhance the response. We describe Israel's healthcare system attributes as related to geopolitical and societal status and how these factors affected the outbreak response.

Israel's national healthcare system serves a population of 9.1 million (1). With 1.8 acute care hospital beds per 1,000 inhabitants and a national total of 758 licensed intensive care unit (ICU) beds, the healthcare system in Israel constantly lacks resources (2,3). In 2016, the average annual occupancy of internal medicine beds was 99% (monthly range 93%–107%) (4); during peak influenza season, overflow patients must receive mechanical ventilation in internal medicine wards. A shortage of surge ICU capacity during the early stages of the COVID-19 outbreak forced Israel to focus on early aggressive containment strategy.

Israel's life expectancy at birth of 82 years ranks eighth among Organization for Economic Cooperation and Development countries (1,5). Israel's National Health Insurance Law (NHIL) guarantees that every legal resident receives all ambulatory and urgent medical care with very low copayment. Robust

community-based healthcare services reduce the need for emergency visits to acute care medical centers. When medically indicated, all urgent care referrals and hospitalizations are free of charge. The result of these policies was that patients with suspected COVID-19 were assessed, isolated, and treated without individual hesitancy or fear of medical expenses.

During a state of national emergency, the Ministry of Health (MoH) assumes control of hospital referrals and admissions, specifically ICU hospitalizations. Stockpiles of pandemic preparedness emergency equipment, including mechanical ventilators, personal protection equipment, and critical medication, are inventoried and managed at the national level. Throughout peak COVID-19 transmission, the MoH coordinated and diverted admissions of mechanically ventilated patients to avoid overwhelming ICU capacity.

Israel's land borders are infrequently traversed by international travels, and the country is functionally a geopolitical island. In 2019, of 4.6 million tourist entries into Israel, 88% were via international flights (6). Despite its culturally and politically diverse population, Israel's society shows social cohesion, resilience, and trust in public health and government institutions.

When the COVID-19 epidemic was first reported, Israel's MoH implemented a containment strategy that consisted of early travel restrictions to countries reporting COVID-19 transmission, as well as extensive testing and self-reported quarantine of returned travelers (Appendix Figures 1–3, <https://wwwnc.cdc.gov/EID/article/26/9/20-1476-App1.pdf>) (7). Patient contacts were identified through contact tracing and mobile phone surveillance. The MoH posted the whereabouts of confirmed cases on its website and through a mobile phone application. Persons could ascertain and report patient exposure electronically to the MoH and enter self-quarantine at home. Quarantined persons reporting electronically were issued a general statement of illness and became entitled to paid sick leave for the duration of quarantine time, enforced on employers by emergency MoH regulations and upheld by the Israel supreme court (8). Overall, by April 30, 2020, a total of 179,003 persons had self-reported to quarantine; 89,775 (50%) were returned travelers, and 89,228 (50%) were identified contacts of confirmed cases (9; Appendix Figure 4). To address increased transmission in ultra-Orthodox neighborhoods and in several Arab districts, focal lockdown measures were implemented in late April 2020. Cultural

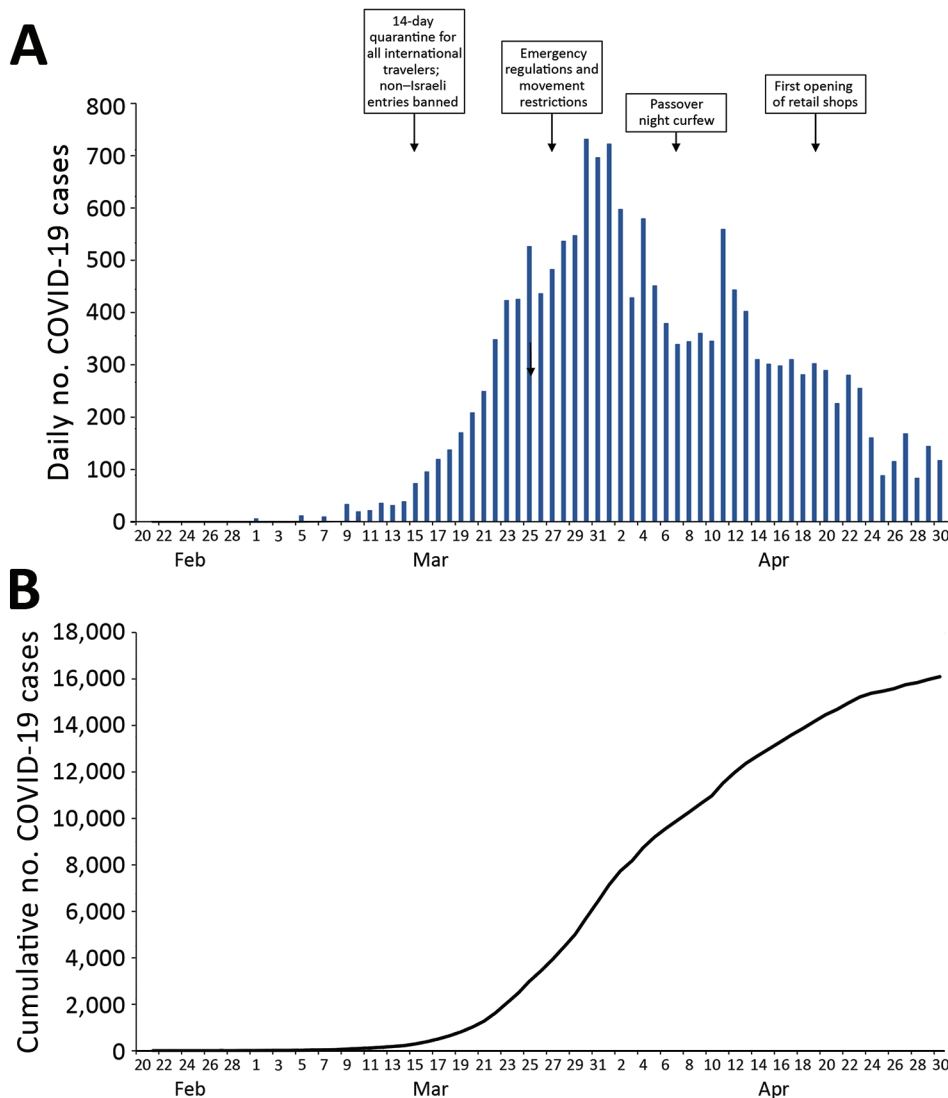
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characteristics and communal responsibility led to public adherence to these sometimes onerous requirements and contributed to civil obedience.

Altogether, Israel's containment measures proved successful in creating weeks of delay in peak transmission, more than those for some countries in Europe and cities in the United States (Figure). This delay afforded Israel's healthcare system and the MoH time to implement preparedness measures including medical staff training, emergency department preparation for suspected patient isolation, building isolated COVID-19 units, and shifting resources to compensate for the low number of ICU beds. For example, by April 9, Sheba Medical Center in Tel Hashomer had built 327 isolated COVID-19 ICU hospitalization beds with mechanical ventilation capacity, completely separated from its 71 general (non-COVID-19) ICU beds (10).

Moving from containment to mitigation, wide-scale social distancing measures were implemented (Appendix Table). These measures included school closure, movement and travel restrictions, discontinuation of nonessential work and commerce, and complete national curfew during the holidays of Passover and Independence Day. Local curfews were instituted in neighborhoods and cities with high COVID-19 incidence and in Muslim populations during Ramadan.

Taken together, these containment and mitigation steps may have contributed to the relatively low peak incidence, low mortality rate, and preservation of healthcare system function in Israel (Figure; Appendix Table). On the basis of these experiences to date, we recommend that countries fully leverage their particular geopolitical, social, and healthcare system characteristics as soon as possible in response to crises of such magnitude.



**Figure.** Numbers of COVID-19 cases and key public health interventions by date of implementation, Israel, February–April, 2020: A) daily numbers; B) cumulative totals.

## About the Author

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## References

1. Israel Central Bureau of Statistics. Population of Israel on the eve of 2020. 2019 [cited 2020 Mar 25]. <https://www.cbs.gov.il/en/mediarelease/Pages/2019/Population-of-Israel-on-the-Eve-of-2020.aspx>
2. Organization for Economic Cooperation and Development. OECD data: hospital beds. 2020 [cited 2020 Mar 22]. <https://data.oecd.org/healthqt/hospital-beds.htm>
3. State of Israel Ministry of Health. Hospitalization beds in Israel, January 2020 [in Hebrew]. 2020 [cited 2020 Apr 12]. [https://www.health.gov.il/UnitsOffice/HD/MTI/info/Pages/licensed\\_inpatient\\_hospital\\_beds.aspx](https://www.health.gov.il/UnitsOffice/HD/MTI/info/Pages/licensed_inpatient_hospital_beds.aspx)
4. State of Israel Ministry of Health Information Division. Hospital occupancy by admission ward and month, 2016–2017 [in Hebrew]. 2017 [cited 2020 Mar 25]. [https://www.health.gov.il/UnitsOffice/HD/MTI/info/Pages/hospital\\_Beds.aspx](https://www.health.gov.il/UnitsOffice/HD/MTI/info/Pages/hospital_Beds.aspx)
5. Chernichovsky D. Not “socialized medicine” – an Israeli view of health care reform. *N Engl J Med*. 2009;361:e46. <https://doi.org/10.1056/NEJMp0908269>
6. Israel Central Bureau of Statistics. Israel visitor arrivals in January–November 2019 [in Hebrew]. 2020 [cited 2020 Mar 25]. [https://www.cbs.gov.il/he/mediarelease/DocLib/2019/367/28\\_19\\_367b.pdf](https://www.cbs.gov.il/he/mediarelease/DocLib/2019/367/28_19_367b.pdf)
7. State of Israel Ministry of Health. HaMagen: the Ministry of Health app for fighting the COVID-19 outbreak. 2020 [cited 2020 May 12]. <https://govextra.gov.il/ministry-of-health/hamagen-app/download-en>
8. State of Israel Ministry of Health. A general statement of illness for isolated workers. 2020 [cited 2020 May 12]. <https://govextra.gov.il/ministry-of-health/corona/corona-virus-en>
9. State of Israel Ministry of Health. COVID-19 resources [in Hebrew]. 2020 [cited 2020 May 12]. <https://data.gov.il/dataset/covid-19/<eref>>
10. Leshem E, Klein Y, Haviv Y, Berkenstadt H, Pessach IM. Enhancing intensive care capacity: COVID-19 experience from a tertiary center in Israel. *Intensive Care Med*. 2020 May 25 [Epub ahead of print]. PubMed <https://doi.org/10.1007/s00134-020-06097-0>

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# Effectiveness of N95 Respirator Decontamination and Reuse against SARS-CoV-2 Virus

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The coronavirus pandemic has created worldwide shortages of N95 respirators. We analyzed 4 decontamination methods for effectiveness in deactivating severe acute respiratory syndrome coronavirus 2 virus and effect on respirator function. Our results indicate that N95 respirators can be decontaminated and reused, but the integrity of respirator fit and seal must be maintained.

The unprecedented pandemic of coronavirus disease has created worldwide shortages of personal protective equipment, in particular respiratory protection such as N95 respirators (1). Transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) occurs frequently in hospital settings; numerous reported cases of nosocomial transmission highlight the vulnerability of healthcare workers (2). The environmental stability of SARS-CoV-2 virus underscores the need for rapid and effective decontamination methods.

In general, N95 respirators are designed for one use before disposal. Extensive literature is available for decontaminating N95 respirators, of either bacterial spores, bacteria, or respiratory viruses (e.g. influenza A virus) (3–6). Effective inactivation methods for these pathogens and surrogates include UV light, ethylene oxide, vaporized hydrogen peroxide (VHP), gamma irradiation, ozone, and dry heat (A. Cramer et al., unpub data, <https://doi.org/10.1101/2020.03.28.20043471>) (3–6). The filtration efficiency and fit of N95 respirators has been less well explored, but reports

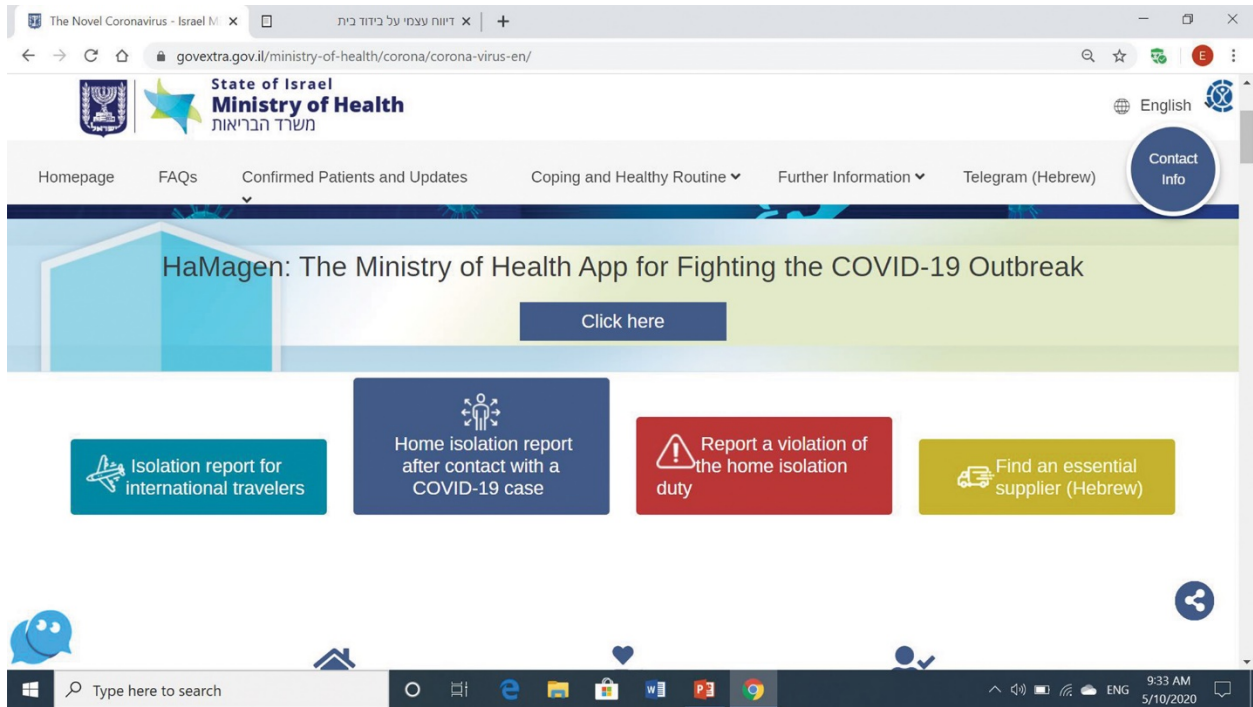
# Buying Time with COVID-19 Outbreak Response, Israel

## Appendix

**Appendix Table.** Public health response and key events during COVID-19 outbreak response, with number of confirmed COVID-19 cases and deaths, Israel, January–April 2020.\*



Date	Event	Cumulative no. confirmed COVID-19 cases (deaths, % mortality)
2020 Jan 23	Quarantine and COVID-19 testing for symptomatic travelers from Wuhan and suspected contacts	0 (0, 0%)
2020 Jan 30	Discontinue all flights from China	0 (0, 0%)
2020 Jan 31	Land and sea borders closed to entry of non-Israeli residents	0 (0, 0%)
2020 Feb 17	All Israeli residents returning from China, Singapore, Macao, South Korea, and Thailand are required to report online and self-quarantine for 14 days	0 (0, 0%)
2020 Feb 21	All Israeli passengers from the <i>Diamond Princess</i> ship who tested negative are repatriated and quarantined at Sheba Medical Center's dedicated COVID-19 unit. First COVID-19 case diagnosed in a woman quarantined after exposure on the <i>Diamond Princess</i> ship.	1 (0, 0%)
2020 Feb 26	Italy added to list of countries from which returning travelers must electronically report and self-quarantine for 14 days. First COVID-19 case diagnosed in a returned traveler from Italy.	2 (0, 0%)
2020 Mar 4	France, Austria, Germany, Switzerland, and Spain added to list of countries from which self-quarantine is mandated. Government and MoH workers not allowed to leave Israel. Recommendation for persons >60 years of age not to leave their homes.	15 (0, 0%)
2020 Mar 8	First case of suspected community transmission with no known COVID-19 patient contacts.	41 (0, 0%)
2020 Mar 9	All persons returned from international travel required to self-quarantine for 14 days	45 (0, 0%)
2020 Mar 11	Mass events with >100 persons forbidden	97 (0, 0%)
2020 Mar 12	Borders close to all non-citizen entries. Schools and universities are closed.	118 (0, 0%)
2020 Mar 14	All restaurants, shopping malls, cinemas, and sports facilities closed. Travel of >2 persons per vehicle banned.	184 (0, 0%)
2020 Mar 19	All citizen movement restricted to essential food shopping, medical needs, and work places defined as indispensable; all parks, gardens, and beaches are closed.	646 (0, 0%)
2020 Mar 20	First COVID-19 death in Israel	816 (1, 0.1%)
2020 Mar 25	Emergency regulations restrict all nonessential citizen movement >100 meters from home address; reduction of all public transportation to 25% volume; mandatory temperature measurement at workplaces; closure of synagogues	2,469 (5, 0.2%)
2020 Apr 8	Passover night; complete 4-day enhanced lockdown (effectively a curfew). Specific ban on meeting non-household persons for Passover.	9,918 (78, 0.8%)
2020 Apr 12	Mandatory facemask use at all public places	11,526 (108, 0.9%)
2020 Apr 19	First reduction in closure measures: reopening of regulated low-risk retail shops and increase to 30% of workforce	13,871 (172, 1.2%)
2020 Apr 22	Ramadan month movement restrictions implemented for 10-day period	14,688 (190, 1.3%)
2020 Apr 24	Beit Shemesh and Netivot, ultra-Orthodox cities with increased transmission, put in lockdown	15,223 (197, 1.3%)
2020 Apr 26	All street shops opened, including hairdressers and pickup from restaurants	15,471 (202, 1.3%)
2020 Apr 30	Restrictions on movement relieved. Three ultra-Orthodox neighborhoods in Jerusalem and 2 Arab neighborhoods in Khura, southern Israel, put in lockdown	15,981 (223, 1.4%)


\*MoH, Ministry of Health



**Appendix Figure 1.** Webpage screenshot for self-quarantine and reporting of travel or contact with confirmed COVID-19 patient (<https://govextra.gov.il/ministry-of-health/corona/corona-virus-en>).





 State Of Israel  
 Ministry of Health  
 Health


  
 gov  
 www.gov.il

Submit ✓ Check form Attachments duplicate

## Home / Motel Isolation Self-Report

[Help and Information](#) ?  
 References: 642487

### Home / Motel Isolation Self-Report

Fields marked with an asterisk are required

#### Personal Information

\*Type of Certificate of Identity ?  
 ID  Passport

\*ID Number

\*Name

\*Surname

#### The address of isolation

\*City  Street

House number  Apartment  Zip code ?

\*How many people live at home, including the person filling out this form?

\*How many rooms are there in your home?

\*Main telephone  Secondary telephone

\*Email

\*The area from which you are arriving  choose

\*The date you left this place ?  10/05/2020

\*Date of entry to Israel ?  dd/mm/yyyy

\*Were you on a connecting flight?  yes  no




Connecting flight location  choose

Did you leave the airport? ?  yes  no

Health Maintenance Organization  choose

\*Fever (38C/100.4F or higher)  yes  no

ReporterType  An individual

**Appendix Figure 2.** Electronic questionnaire webpage screenshot for self-quarantine and reporting of returned traveler in quarantine (<https://govextra.gov.il/ministry-of-health/corona/corona-virus-en>).

## Questionnaire: Contact with a COVID-19 case

[Help and Information](#)

References: 627221

### Home Quarantine Briefing

Fields marked with an asterisk are required

#### Personal Information

\*Type of Certificate of Identity

ID  Passport

\*ID Number

\*Name

\*Surname

#### Home Quarantine Address

\*City

Street

House number

Apartment

Zip code

\*How many people live at home,  
including the person filling out this form?

\*How many rooms are there in your  
home?

\*Main Telephone

Second Telephone

\*Email

#### Exposure Information

\*Cause for quarantine

\*Date of exposure

\*Exposure venue

Place of exposure

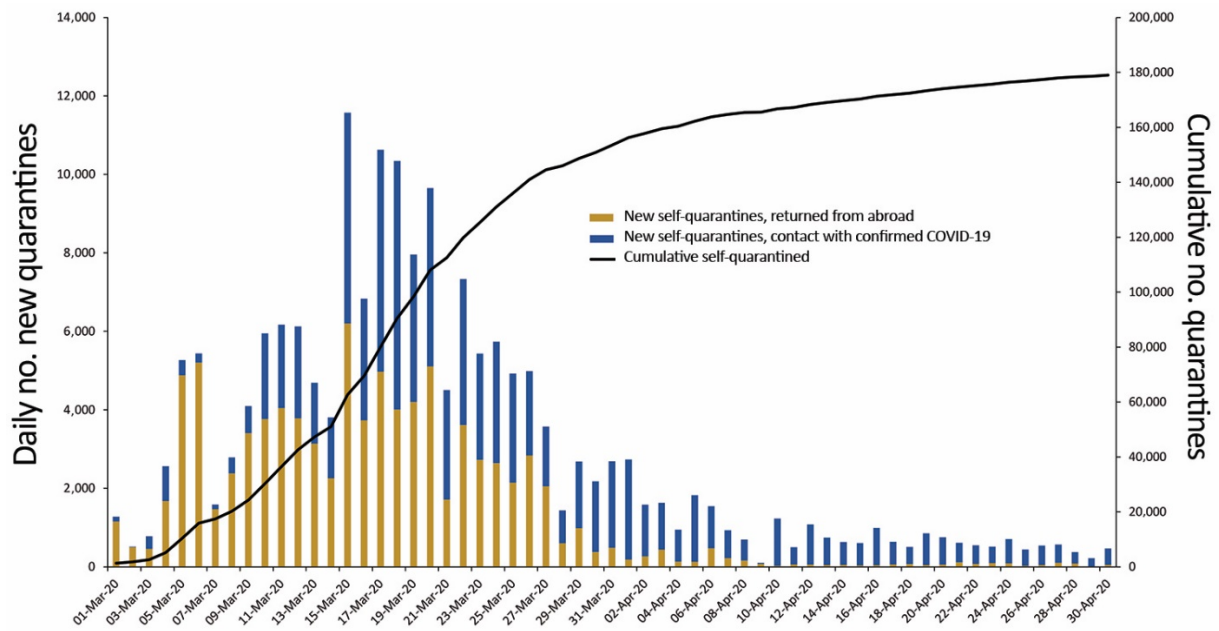
More information about why you were placed under quarantine

Health Maintenance Organization

\*Fever (38C/100.4F or higher)

ReporterType

**Appendix Figure 3.** Electronic questionnaire webpage screenshot for self-quarantine and reporting of COVID-19 patient contact in quarantine (<https://govextra.gov.il/ministry-of-health/corona/corona-virus-en>).



**Appendix Figure 4.** Daily and cumulative number of self-quarantined persons by date first self-reported and reason for quarantine (travel or case contact), Israel, March–April, 2020.