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Sri Lanka's COVID-19 response and maintaining health services: implications for future pandemics

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ABSTRACT

This study examines how Sri Lanka, a lower-middle income country, managed its COVID-19 response and maintained health services. It draws on an extensive document review, key informant interviews and a national survey of public experience and opinion to assess what Sri Lanka did, its effectiveness and why.

Owing to a strong health system and luck, Sri Lanka stopped the first wave of COVID-19 infections, and it adopted a 'Zero-COVID' approach with the explicit goal of stopping outbreaks. This was initially effective. Outbreaks reduced healthcare use, but with minimal impact on health outcomes. But from end-2020, Sri Lanka switched its approach to tolerating transmission and mitigation. It took proactive actions to maintain healthcare access, and it pursued a COVID-19 vaccination effort that was successful in covering its adult population rapidly and with minimal disparities. Despite this, widespread transmission during 2021–2022 disrupted health services through the pressure on health facilities of patients with COVID-19 and infection of healthcare workers, and because COVID-19 anxiety discouraged patients from seeking healthcare. This led to substantial mortality and more than 30 000 excess deaths by 2022.

We find that Sri Lanka abandoned its initially successful approach, because it failed to understand that its chosen strategy required symptomatic PCR testing in primary care. Failure to invest in testing was compounded by groupthink and a medical culture averse to testing.

Sri Lanka's experience confirms that strong public health capacities, robust healthcare systems and intersectoral action are critical for pandemic response. It shows that civilian–military collaboration can be beneficial but contested, and that lack of fiscal space will undermine any response. It also demonstrates that pandemic preparedness cannot guarantee a successful pandemic response. Policy and research must pay more attention to improving decision-making processes when faced with pandemics involving novel pathogens, rapid spread, and substantial scientific uncertainty.

WHAT IS ALREADY KNOWN ON THE TOPIC

⇒ The COVID-19 pandemic severely disrupted healthcare systems and health outcomes in low and middle income countries (LMICs), as cases overwhelmed health systems and control measures prevented patients accessing healthcare.

WHAT THIS STUDY ADDS

⇒ This study adds evidence on how one LMIC, Sri Lanka, leveraged a strong health system to substantially mitigate the impact of COVID-19 on its health services and healthcare access and at least initially control transmission, while tracing the complex dynamics between epidemic control, health system impact and health outcomes.

⇒ Using a range of evidence and key informant interviews, it explains how Sri Lanka successfully implemented a Zero-COVID strategy but failed to sustain it owing to a failure to understand the critical role of symptomatic testing in that approach.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study adds evidence on how strong public health capacities, robust healthcare delivery systems and intersectoral action are critical inputs for pandemic response, but also how civilian–military interaction, even if beneficial, can be contested, and how lack of fiscal space can undermine the overall response.

⇒ Sri Lanka's experience shows clearly that pandemic preparedness and even luck cannot guarantee a successful pandemic response, and that policy and research need to pay more attention to improving decision-making processes when faced with pandemics involving novel pathogens, rapid spread, and substantial scientific uncertainty.

INTRODUCTION

Sri Lanka is a lower-middle income country (LMIC) in South Asia, with 22 million people living in a 66 000 square kilometre island, with a life expectancy at birth of 76 years in 2019

(online supplemental table 1). Sri Lanka is advanced in its demographic and epidemiological transitions. Prior to the COVID-19 pandemic, it had eliminated several infectious diseases, including polio, malaria and measles, and its disease burden was dominated by non-communicable diseases (NCDs) with a high prevalence of diabetes.[1]

Sri Lanka's health achievements, among the best for a country at its income level, are enabled by high levels of healthcare access.[2] Use of medical services, hospital capacity and immunisation coverage levels are comparable to high-income countries. Owing to low levels of government health spending (~2% of gross domestic product (GDP)), this is achieved through a mixed health system of parallel and independent public and private sectors.[2 3] All Sri Lankans have universal access to free public healthcare, which is financed from general revenue taxation, but can opt out to seek private care, with richer patients more likely to do so than poorer ones. The private sector provides half of outpatient care, and about 5% of inpatient admissions, with the government providing almost all preventive services including immunisation.

Sri Lanka detected its first COVID-19 case at the border in late-January 2020, before a gap of 6 weeks and the next wave of imported cases. Sri Lanka responded by building on its health system strengths. It experienced successes and failures. This study examines its experience, identifies key factors, and derives lessons for Sri Lanka and other countries.

We first outline the data sources and methods we used to examine the COVID-19 response and maintenance of health services. We describe the national strategy and then specific activities. These include coordination, epidemic control, vaccination, public communication and information sharing, management of health services and economic support. We then evaluate some core actions, before discussing our overall findings and conclusions.

METHODS

Data sources

Our study used diverse data sources. We reviewed online news articles, government documents and circulars and reports shared by stakeholders and key informants. We reviewed situation reports, guidelines and data from websites maintained by the Ministry of Health (MOH), MOH Epidemiology Unit and MOH Health Promotion Bureau, and social media postings by government departments.

We conducted key informant interviews (KIIs) with 22 individuals involved in the COVID-19 response during March–August 2022, to obtain additional information and perspectives. Key informants (KIs) included government officials, politicians, health professionals, business and union representatives, military leaders and other experts. We guaranteed KIs confidentiality unless they specifically waived this, and we are not disclosing the composition of KIIs by type and sector to prevent identification of individuals. The interview guidelines were customised for each KI and compiled from a question bank covering a range of study topics. We obtained a positive response from all KIs approached, including politicians, health professionals, business, unions, the military and former MOH senior officials, except for the MOH which did not give permission to interview serving senior officials.

We used several data sets. These included data sets maintained by the Institute for Health Policy (IHP) and previously described,[4] which tracked metrics of the COVID-19 pandemic and response both globally and in Sri Lanka, collating data from public data sources. To assess the impact of COVID-19 on public well-being, healthcare use and opinion, we used survey data collected by the Sri Lanka Health and Ageing Study (SLHAS) during 2018–2022. The SLHAS is an MOH-approved, national longitudinal cohort study. Its Wave 1 survey recruited, interviewed and examined a nationally-representative sample of the adult population in 2018/2019 just before the pandemic started,[1] and Wave 2, conducted by computer-assisted telephone interview during 2021/2022, reinterviewed Wave 1 participants and an additional sample of adults reached by random digit dialling.[5]

We modified a routine survey of private hospitals run by the IHP to ask additional questions on COVID-19 service provision. We also obtained data by request from government agencies and the military, and via Right to Information (RTI) requests submitted to the MOH.

Analyses

Our study pursued several lines of inquiry, informed by the research design of the overall multicountry study.[6] We used an epidemiological framework and relevant literature from countries that pursued similar strategies to assess the data on cases, deaths, testing and vaccination, and other Sri Lankan studies, to characterise the epidemiological dynamics of the pandemic in Sri Lanka. We assessed the government response by characterising its explicit and implicit strategies, and how these changed over time. We paid specific attention to the strategies used and their effectiveness: (1) to control transmission; and (2) to mitigate impacts on health services, the economy and public well-being. To assess impact on services we used SLHAS survey data to quantify unmet need, and we examined inequalities in access to COVID-19 testing and vaccination, using concentration indices, multivariate regression and survival analysis. All analyses were performed using statistical software Stata V.17.0 (StataCorp, College Station, Texas, USA).

We also considered what motivated policymakers to adopt critical strategies, how strategy was communicated to the public and public opinion as tracked by the SLHAS.

Patient and public involvement

KIIs included private business and unions but did not involve the public or patients. We used the SLHAS surveys

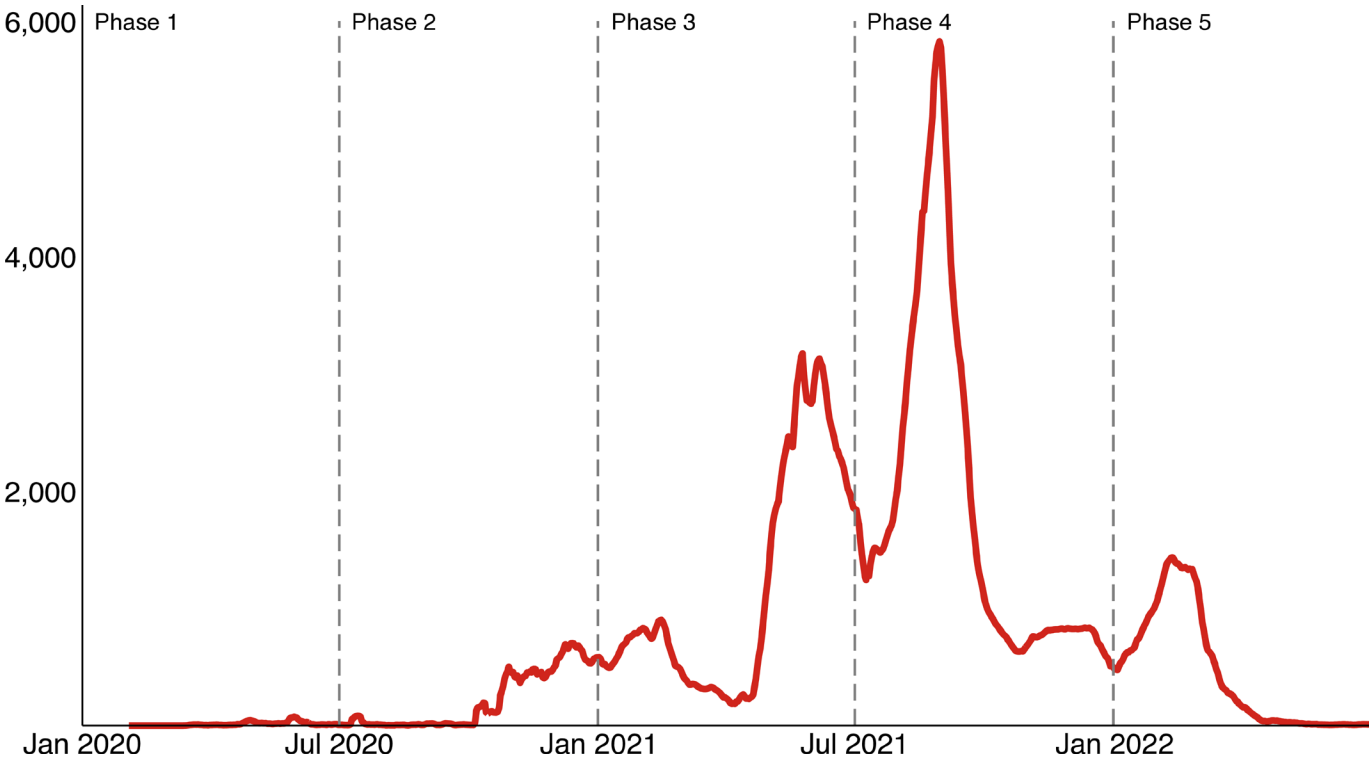

Figure 1 Daily COVID-19 cases, January 2020 to March 2022.

to examine and elicit public opinion and experience in the population and chronic disease patients. We held a dissemination meeting in Colombo in April 2023, where key stakeholders, including representatives of civil society participated and provided feedback. Gates Ventures has published selected study results online.[7]

RESULTS

Timeline and phasing

Figure 1 illustrates the epidemic curve for reported COVID-19 cases in Sri Lanka. The government's strategies changed over time in response to changes in transmission and morbidity, and perceptions about its ability to control transmission and consequences for the economy. The pandemic's impact on health services also evolved. To frame our analyses and to facilitate understanding of the complex dynamics of the pandemic, we divided the pandemic timeline in Sri Lanka into successive 6 month phases, considering changes in epidemic transmission and response strategies in each period (see online supplemental text 1 for detailed characterisation and explanation).

Phase 1 (January 2020 to June 2020) covers the first outbreaks, all of which were ended. Phase 2 (July 2020 to December 2020) corresponds to the start of sustained local transmission, which remained undetected for months before manifesting in the Brandix outbreak, which was a large outbreak in October 2020 that was associated with a garment manufacturing factory owned by the Brandix company. Phase 3 (January 2021 to June 2021) saw government's strategy switch from stopping all outbreaks to vaccination and opening borders, with less emphasis on preventing transmission in the face of the Alpha variant. In Phase 4 (July 2021 to December 2021), the country was hit by the Delta variant, resulting in thousands of deaths (online supplemental figure 1), significant pressure on health services and abandonment of most control measures, although the government reluctantly imposed a 2-month national lockdown. Phase 4 also saw most of the adult population being vaccinated with two COVID-19 vaccine doses. In Phase 5, which continues through 2022, successive Omicron waves hit the country, and the country's attention shifted to the consequences of a collapse in the economy. COVID-19 testing largely stopped during Phase 5, and case numbers no longer provided meaningful information about transmission levels.

Although official cases (which required a positive PCR test) were only 587 245 (3% of the population) through end-2021, it can be inferred from epidemiological analysis, seroprevalence studies, low PCR testing rates (online supplemental figures 2–3) and global experience that most Sri Lankans had been infected at least once by that point, and that actual deaths (14 979 reported) were more than 20 000.

The control strategy

Sri Lanka was better prepared for the COVID-19 pandemic than most countries. Enabling factors included having minimal exposure to the initial outflow of the virus from China (online supplemental figure 4); being an island with one international airport; having a public

health workforce with substantial experience in contact tracing and infectious disease control; a military that was able to rapidly establish border quarantine facilities; and a public with high levels of trust in the health system (online supplemental text 2).

Through Phase 2, Sri Lanka aimed to minimise the entry of the SARS-CoV-2 virus through border controls, and to detect and rapidly end outbreaks to prevent any sustained local transmission to minimise health, social and economic impacts. The government's official strategy of stopping all outbreaks[8] resembled that of a few, mostly East Asian and Pacific, countries that attempted to prevent sustained community transmission. Key interventions were similar to those of New Zealand, the country which most clearly articulated what has been dubbed the 'Zero-COVID' approach[9 10] : (1) border controls to minimise entry of the virus; and (2) PCR testing in the community, tracing of contacts of detected cases and isolation to detect and stop local transmission chains and to provide an exit from lockdowns. This was supplemented by extensive public health and social measures (PHSMs) to slow transmission.

Sri Lanka's approach, explicitly fashioned after the 'Hammer and the Dance' approach proposed in an online article by an American analyst,[11] arose from its initial advantages and success in stopping outbreaks. It was supported by many local health experts and internal research on international responses by the military, and advocated for by the doctors' trade union, the Government Medical Officers Association (GMOA). However, KIIs could not identify who initially proposed this approach.

During Phase 2, epidemiological inference and genomic analyses[12] indicate that cryptic sustained local transmission started sometime around June/July 2020, becoming visible in October 2020. As case numbers increased, most political leaders and health officials became fatalistic about the inevitability of spread, and came under increasing pressure from business interests, particularly in tourism, to tolerate transmission. Control efforts unravelled, with relaxation of border security and testing, contact tracing and isolation efforts. This implicitly abandoned the official strategy, but the government never officially announced this or explained coherently its new strategy. Though Phases 3 and 4 in the face of high levels of transmission, focus shifted to mitigating impacts on health services and the economy. From then the public health response focused on vaccination, with the USA and the UK being role models for President Rajapaksa.

Strategic actions

Coordination

In March 2020, the government established two coordination mechanisms. The Presidential Task Force for COVID-19 provided a coordination forum of government agencies, health agencies and other stakeholders to discuss strategy and policy. The National Operations Centre for Prevention of COVID-19 Outbreak (NOCPCO), headed by the Army Commander, coordinated preventive, control, quarantine, and other pandemic-related operations.

The government generally excluded non-governmental entities and independent technical experts, other than business groups and health sector stakeholders, from these mechanisms. The largest Sri Lankan community service organisation, Sarvodaya, independently coordinated and led a collective of civil society organisations (CSOs) to provide social support to the community.

Epidemic control measures

Border security

Through end-2020 (Phases 1–2), Sri Lanka implemented a strict border security regimen to prevent entry of the virus. This included suspension of visas for foreigners, mandatory 14-day quarantine for all arrivals with PCR testing, and suspension of routine commercial flights from mid-March 2020 to January 2021.[13 14] KIIs revealed that political leaders entrusted the running of quarantine facilities to the military, as health authorities lacked capacity to rapidly set these up and later to run them. Government quarantine was free, but from 2021 authorities allowed the private sector to operate paid quarantine facilities with better accommodation. During 2020–2021, the military operated 233 quarantine facilities for returning Sri Lankans, and the private sector established 119 paid facilities. This system processed 249 797 international arrivals of which 80% stayed in government facilities.

In Phase 3, from end-2020, the government allowed entry of tourists with restrictions. From April–June 2021, border controls and restrictions for all arrivals were incrementally relaxed, although tourist numbers did not recover rapidly owing to depressed global tourist travel (online supplemental figure 5).

The border security regime was effective in minimising entry of the virus until the end of Phase 2, when this remained the strategic priority. The inclusion of PCR screening served to reduce the risk of hidden infection leaks, which would have been 1% with simple 14-day quarantine.[15] Despite several hundred thousand arrivals (mostly returning Sri Lankans), there were few outbreaks (<10) due to imported infections, a performance comparable with Zero-COVID countries such as China, Vietnam, Bhutan, Australia and New Zealand. However, a culture of defensiveness and lack of openness to independent scrutiny led to unwillingness to admit to or to audit potential quarantine leaks, limiting improvements.

Testing, tracing, and isolation

From Phase 1, MOH instigated an intensive test, trace and isolate (TTI) effort, coordinated by the MOH Epidemiology Unit, and implemented by the cadre of 2800 public health inspectors (PHIs) attached to local preventive health units. The State Intelligence Services (SIS) provided support, particularly in leveraging use

of mobile device data and other big data for contact tracing. Through 2020, identified cases and contacts were placed in institutional isolation or quarantine in government hospitals. During Phases 1–2, TTI was effective, as evidenced by the identification of an average of 20+ contacts for each new case, and termination of all but one community transmission chain. Enabling factors included the prior experience of public health staff with contact tracing, interagency collaboration, reliance on PCR tests and the policy of tracing all upstream and downstream, first and second level contacts, an approach pushed by key stakeholders, such as the GMOA. The choice of PCR testing over rapid antigen tests (RATs) was crucial, as it allowed the detection of old infections, which was needed for contact tracing in the Zero-COVID-type approach.[16]

From Phase 3, with abandonment of the control strategy and shortages of PCR kits for PHIs, the TTI effort weakened. From June 2021 asymptomatic or mild cases were isolated at home, with community supervision by healthcare workers. In Phase 4, contact tracing and isolation efforts essentially stopped.

Testing capacity

Sri Lanka established domestic testing capacity for SARS-CoV-2 virus early, benefiting from technical collaboration with Hong Kong experts, and pre-existing PCR capacity at local universities and the TB control programme. Health authorities expanded capacity by organising a national network of testing laboratories, including hospital, university, private sector and military laboratories, supported by centralised procurement and distribution of supplies.

Expansion in capacity slowed after the first wave of cases were controlled. By end-2020 testing capacity and rates fell far below those of other middle-income countries, and closer to that of poorer low-income countries (figure 2). This was a policy choice and not the consequence of resource constraints. Senior health officials, whom the President, other political leaders and the military deferred to on this issue, did not think it necessary to increase capacity, despite vocal criticism by the GMOA, Public Health Inspectors Union (PHIU) and other local experts. Officials were also often reassured that testing was adequate by WHO staff and other experts. KIIs advised that political leaders would have found funds if asked, and the World Bank provided funds in May 2020 which were available to purchase urgent testing equipment and supplies (online supplemental text 3) but were not fully spent through 2022. Local Rotary clubs raised funds to purchase large, automated testing machines, and private sector informants disclosed they were willing to fund these if the MOH had wanted.

When case numbers increased rapidly at the end of Phase 2, the testing system was overwhelmed leading to pressure to relax the criteria for testing. Its capacity was limited by too few test machines, failure to adopt innovations such as saliva testing and large-scale test pooling, and failure to automate processes leading to huge pressures on staff.

Through Phase 2, case detection relied on PCR tests. Testing was publicly financed and free. In Phase 3, as financing became inadequate, the MOH let private laboratories undertake PCR testing for private patients. This led to concerns about private hospitals price gouging or saving costs by test pooling, which led to a ban on private sector test pooling, and in August 2021 a price cap of US$33 per test.[17] RATs were introduced in December 2020 to supplement PCR testing. As cases surged through 2021, MOH shifted to relying more on RATs and less on PCR tests.[18] However, the retail sale of RATs to consumers was not permitted.

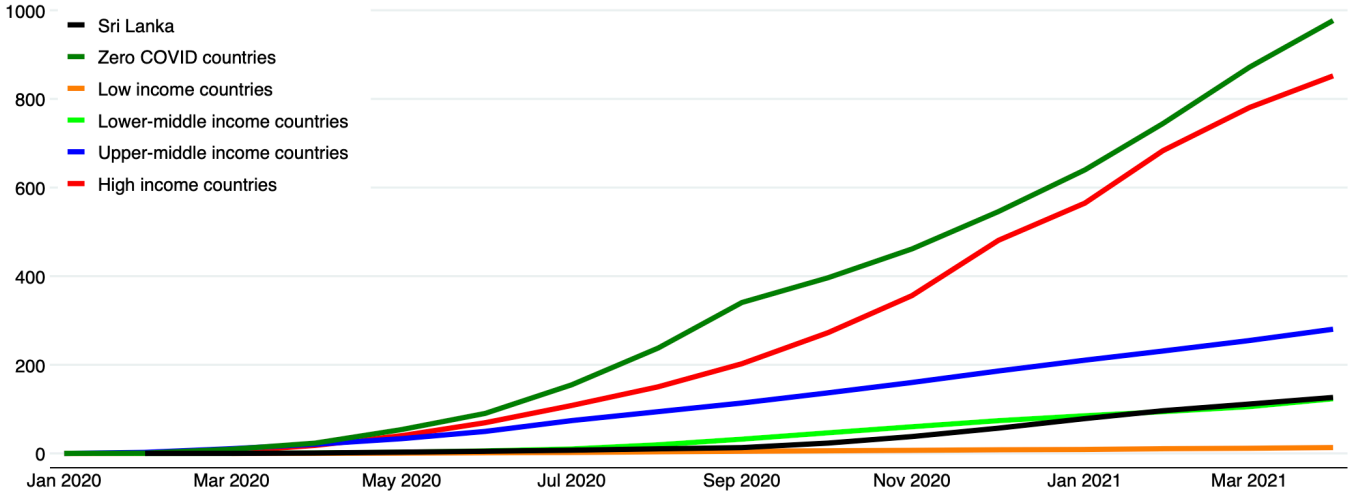

Figure 2 PCR testing in Sri Lanka in global comparison, January 2020 to April 2021 (monthly tests per 1000 people). Notes: Authors' analysis of Institute for Health Policy Global COVID-19 Testing database. Zero-COVID countries include Australia, New Zealand, Hong Kong SAR (China) and Singapore. High-income countries exclude the four Zero-COVID territories.

Social distancing, lockdowns, mobility restrictions and masks

The government employed social distancing measures to reduce transmission. These included lockdowns, closures of schools and universities, limitations on gatherings and public messaging on maintaining interpersonal distances in public spaces. In Phase 1, there was a national lockdown for 1 month, but subsequent lockdowns were generally more localised. Google and Facebook mobility data indicate generally high public compliance in response to these (online supplemental figure 6), comparable to other countries. In Phase 4, when the Delta variant caused the biggest wave, the government resisted intense public clamour to impose a lockdown, and when it did, it provided exemptions to numerous sectors. Nevertheless, the public strongly supported the national lockdown, preferring it to have been imposed earlier and more stringently, and supporting stronger measures (online supplemental figures 7–8).

Educational institutions remained shut between lockdowns. Schools were closed for 17 months, one of the longest periods in the world (online supplemental figure 9). Masks were mandated in public from October 2020, by which time supplies were established.[19] The mask mandate was lifted in June 2022,[20] and Facebook survey data indicate good compliance (online supplemental figure 10).

Vaccination

Sri Lanka implemented an aggressive vaccination effort in 2021 to vaccinate all adults. This was facilitated by a robust national immunisation programme that routinely achieved near universal coverage of childhood vaccines, political support for procuring adequate vaccine supplies, minimal vaccine hesitancy, logistics support by the military and high levels of trust in the health services and military (online supplemental text 4).

Through early-2021, the State Ministry of Primary Health Care Epidemics and COVID Disease Control pushed for ambitious coverage targets covering all adults, and self-purchasing vaccines instead of relying on COVAX. There was public criticism of delays in placing orders, but public sector procurement rules did not permit advance purchasing of vaccines not approved by the WHO and the local National Medicines Regulatory Authority (NMRA). The Cabinet approved purchasing vaccines using Treasury funds in February 2021, and the government later secured World Bank and Asian Development Bank (ADB) loans for additional vaccines. While awaiting delivery of purchased and COVAX vaccines, the government also obtained donations of vaccines from China, which eventually dominated supply (online supplemental text 5). After a delay in approvals by the NMRA, which required WHO approvals, large supplies of Sinopharm vaccines were administered from July 2021, with newly imported stocks typically given out within days, leading to rapid increases in coverage (online supplemental text 5). Adult one dose coverage reached 50% by late-July 2021, and two dose coverage reached 95% by mid-March 2022 (online supplemental figure 11).

Although health officials raised concerns about vaccine hesitancy in the youth and a negative impact of social media, SLHAS survey data indicate minimal hesitancy (online supplemental text 5). Vaccine hesitancy was even less in the youth in practice, with delays driven only by brand preference for Pfizer, which led people to wait for availability. However, uptake of the third booster dose was lower, which may have contributed to much higher mortality in 2022 (figure 4).

Given the need for rapid deployment and competing demands on preventive health staff to handle TTI, the military played a critical role in assisting MOH clinics and they set up vaccination centres (some open 24 hours) and mobile units to reach people with restricted mobility. Military-operated vaccination centres, staffed by 5200 personnel, delivered 2.4 million vaccinations. The military also designed and managed an electronic COVID-19 vaccine register, as the MOH lacked capacity to establish and maintain one.

Public communication and information sharing

The crisis forced authorities to engage in unprecedented levels of public communication, involving multiple channels and multiple actors in government. Much of this developed reactively during the crisis, and significant gaps and weaknesses were apparent.

The authorities used daily media briefings to provide the public with updates, which were widely covered by television, radio, print and social media. Though initially led by the Director-General of Health Services (DGHS), the Army Commander and head of NOCPCO became the lead spokesperson in Phase 2, after the incumbent DGHS was transferred without immediate replacement. Unlike in many countries, elected politicians rarely led media briefings.

As the government implicitly abandoned its elimination strategy, health officials increasingly understated the risk of COVID-19. Official health spokespeople overestimated the ability of the authorities to control the virus and the benefits of vaccination, while understating uncertainties in knowledge. We could not determine if this was due to political pressure to underestimate risks, or a desire to comply with perceived political wishes, or a desire to minimise public anxiety, or whether this represented their own beliefs; the MOH did not approve a request to interview relevant officials as KIs. However, KIs disclosed that when some officials or ministers took a more pessimistic public position or called for more aggressive control, they were often sidelined or scolded privately.

Data collection and reporting in relation to the pandemic was handled chiefly by the MOH, principally its Epidemiology Unit, and NOCPCO (online supplemental text 6). Although Sri Lanka has RTI legislation to make government data accessible to the public, the culture of data sharing and transparency is underdeveloped, and

most government data were not shared. Often regular data releases were made only to media representatives, and not directly to the public limiting wider access. Public authorities never published detailed test statistics as some other countries did, although these data were available. This also hindered decision-makers, with some KIIs within the government complaining of data hoarding by key MOH units.

There were controversies about the transparency and accessibility of the data that were released to the public.[21] In one instance when the daily COVID-19 death toll passed 100, the President intervened to change how the MOH reported COVID-19 death statistics. Although there were some legitimate arguments to justify changes, the impression was that political leaders wanted to downplay the number of deaths (online supplemental text 6). Health authorities were also slow to counter misleading or stigmatising information from other stakeholders, including ministers and civil society. For example, many ministers extolled the untested treatment pushed by a charlatan, and some unions and politicians singled out Muslims as sources of infection.

This affected vaccination. Through 2021, authorities conveyed the message that two COVID-19 vaccine doses would protect people and achieve herd immunity, without conveying their limitations that were already known by the scientific community. This likely hindered later uptake of COVID-19 boosters.

Maintaining health services and health system resilience

During Phases 1–2 after the first national lockdown, COVID-19 had minimal impacts on health services when local transmission was minimal,[22] but significant disruption with negative impacts on health outcomes occurred in Phases 3–4 when the country was hit by the Alpha and Delta waves.

Management of patients with COVID

During Phases 1–2, MOH designated specific public hospitals for COVID-19 positive cases. As cases surged in Phase 3, health authorities established intermediate COVID care centres (ICCs) for asymptomatic and stable patients with COVID-19,[23] with the military contributing personnel. During Phases 3 and 4, the MOH authorised private hospitals to manage patients with COVID-19 and to run their own ICCs, but this was accessible mainly to affluent patients.

Generally, the public sector had sufficient intensive care unit (ICU) beds (expanded from an initial 560) but had to expand capacity substantially during Phase 4. The military contributed with rapid construction of additional facilities. The MOH leveraged an existing monitoring system to optimise ICU bed allocation for both COVID-19 and other patients. The national ambulance service also played a critical role in transporting patients.

Hospital and clinic service delivery

During Phases 1–2 and except for the first national lockdown, health authorities maintained normal operations in public clinics, facilitating access for healthcare workers and patients with curfew passes and staff transport.[24] Later, hospitals used RATs to screen new admissions to minimise in-hospital transmission.

After initial disruptions caused by mobility restrictions and closures due to fear of COVID-19, the MOH proactively restarted and maintained maternal and child health and immunisation services at Medical Officers of Health clinics.[25] The MOH instructed clinics to remain open and provided guidelines to mitigate infection risks, with provision to substitute infected public-health midwives.[26] During 2021–2022, it largely cleared immunisation backlogs from 2020 (online supplemental table 1).[27 28] The public sector exclusively managed suspected/confirmed pregnant/postpartum mothers and newborns, with COVID-19 positive cases sent to a designated national centre for management.[29]

Routine services were only substantially affected during the Alpha and Delta waves, when substantial local transmission occurred. During the Delta wave, pressure on beds and staff shortages due to COVID-19 infection were overwhelming, leading to suspension of non-emergency care. Despite this, Sri Lanka's historical prioritisation of hospitals in public spending limited the impact,[2] as it had hospital bed capacity (4.2 beds per 1000 capita) several times more than the average in middle-income (2.3) and South Asian (0.6) countries and more comparable to that of high-income countries (5.2).[30]

Preventive service delivery

Preventive health activities were disrupted as public health staff were mobilised to contain COVID-19 transmission and later to administer vaccinations, despite MOH instructions to maintain routine services and military assistance.[31] Fortunately, closed borders, reduced mobility, social distancing and masks reduced other infectious disease transmission. Dengue fell to one quarter of predicted levels during March 2020 to April 2021,[32] despite reduced control activities. It helped that dengue vector breeding sites are often located in workplaces like construction sites and schools.[33]

Medicines

During Phase 1, senior MOH managers acted proactively to maintain supply of medicines, particularly for patients with chronic conditions. They reached out to the private sector to understand the challenges private distributors faced and to identify supportive measures, an unprecedented move by a public sector that rarely worked with the private sector.

The MOH revised regulations to allow 2 months' medication supply for MOH outpatients instead of 1 month. It introduced temporary postal delivery for registered patients.[34] Private sector patients with NCDs were allowed to obtain medicines at government hospitals if unable to

reach their usual private hospital.[35] Private pharmacies were permitted to stay open during lockdowns, to deliver medicines directly to homes and to accept prescriptions sent by electronic means.

Public awareness of the new distribution mechanisms was high. SLHAS Wave 2 data indicate that 30% of adults needed a regular medication refill, of which 85% were aware of the MOH postal delivery mechanism, and 33% of them had benefited from it, with 90% reporting satisfaction. Additionally, 40% of adults needing refills knew that private pharmacies offered home delivery, although only 5% of them had used this option (online supplemental figure 12). However, foreign exchange shortages and fiscal constraints began to impact overall medicines supply from 2021.

Telehealth

There were several initiatives to develop telehealth services to improve access, which expanded use of remote consultation from almost zero. Many MOH clinics provided consultations by telephone, including using algorithms to remotely screen possible COVID-19 cases.[36] The University of Kelaniya developed a system to facilitate primary care teleconsultations by phone and WhatsApp, which other public sector facilities adopted.[36] Private channelling companies, which act as booking agents for private specialists, and private providers allowed patients to remote consult specialists via video or audio. Internet bandwidth was increased at many public facilities, and telecom providers provided equipment, software and additional bandwidth to MOH facilities, often free.

Remote consultations surged during national lockdowns when mobility restrictions made access to private providers difficult. Private channelling industry sources reported that teleconsultations grew from zero to peak at 35% of consultations in March 2020, before averaging 5–10% of consultations during October 2020 to October 2021. SLHAS Wave 2 data indicate that remote consultations remained at 5–12% of outpatient encounters through 2022, suggesting a permanent increase in telehealth service usage.

Impacts on healthcare access and use

We assessed impacts on healthcare usage using provider data (online supplemental text 7). In 2020 inpatient admissions declined by a fifth (public sector −18% and private sector −26%), while outpatient visits dropped by a third (public sector −32% and private hospitals −23%) compared with 2019. Usage partially recovered in 2021, with available data indicating a 17% reduction in private hospital admissions and an 18% drop in private hospital outpatient visits compared with 2019.

We assessed the impact on unmet healthcare needs with SLHAS data following the same approach that the European Union (EU) uses with its EU Statistics on Income and Living Conditions survey (online supplemental text 7). Unmet needs for medical care, dental care and medicines in the previous 12 months increased substantially from 2019, rising from 4%, 4% and 5% of adults to 17%, 14% and 20%, respectively, in 2021/2022. The end of the August to October 2021 lockdown and waning of the Delta wave led to improvements (figure 3). During August 2021 to January 2022, COVID-19 was a bigger barrier than cost factors. Primary reasons were (1) fears of catching COVID-19 or being diagnosed with COVID-19 (40%), and (2) mobility restrictions and transport barriers during lockdowns (26%), versus (3) cost barriers (37%). Poorer Sri Lankans were less likely to cite fear of COVID-19 as a barrier, reducing overall inequality in unmet need in 2021/2022 compared with 2019. Patients with chronic NCDs reported more unmet need for medicines, indicating that mitigations efforts were not completely successful.

Economic support and policies

Government financed its response mostly from its own resources, with foreign assistance most important for health interventions. Key international funders were the World Bank, ADB, China, India and Japan (online supplemental text 3).[37 38]

During Phases 1–2, household and business hardships mainly resulted from PHSMs, especially mobility restrictions, and reduced export earnings. These most affected informal and daily workers, and industries such as tourism. The government implemented initiatives to assist households (online supplemental text 8)[8 39]: cash grants or food rations for low-income, elderly, COVID-19 or lockdown affected households; and extended deadlines for utility and credit card payments. CSOs also organised assistance but this was less likely than government assistance to reach the poorest households (online supplemental text 8). Business support focused on tax concessions, with some assistance in accessing loan facilities. However, overall public economic support to businesses and households was small, less than 1% of GDP,[40] compared with 3–10% of GDP in most developing Asian countries.[41] Beneficiary households typically received just US$25–100, with no direct business support beyond tax concessions, unlike other countries (online supplemental text 8).

The weak economic support measures were the inevitable consequence of the government's constrained fiscal capacity.[42 43] Decades of low taxes and tax cutting policies had led to twin fiscal and current account deficits, financed in the 2010s through increased foreign commercial debt. This left the economy ill-prepared for the COVID-19 shock: no fiscal reserves, low foreign exchange reserves and dwindling access to foreign financing. Sri Lanka started the pandemic with government revenue at just 12% of GDP, a fiscal deficit of 9% of GDP, public debt at 89% of GDP and foreign debt at 39% of GDP (online supplemental table 2). The new government in 2019 compounded this. It implemented substantial tax cuts and maintained an overvalued exchange rate. This reduced revenues to 9% of GDP and foreign reserves to just 3 months of imports and raised the fiscal

Figure 3 Unmet need for medical care due to financial costs, travel barriers, waiting times, unavailability or COVID-19 (% of adults, past 4 weeks), September 2021 to May 2022. Notes: Percentage of adults (14 days moving average) reporting unmet need due to financial costs, travel barriers, waiting times, lack of service availability and fear of COVID-19. Authors' analysis of Sri Lanka Health and Ageing Study Wave 2 data, weighting to match national population. Wave 2 interviews (N=4606) conducted September 2021 to May 2022.

deficit to 11% of GDP and public debt to 104% of GDP in 2020. Failure to reverse fiscal and monetary policies when COVID-19 hit left the government in a fiscal straitjacket with no room for significant spending.

COVID-19 worsened Sri Lanka's problems. It reduced foreign exchange earnings from tourism, exports and migrant remittances, and reduced tax revenues (online supplemental table 2). While the initial COVID-19 strategy in Phases 1–2 mitigated any damage, lack of fiscal space led policymakers to prioritise perceived immediate economic needs over control of the virus, which contributed to the unravelling of the COVID-19 strategy from 2021.

Underlying economic issues may have undermined the public health response in other ways. Low taxes had limited the government health budget to under 2% of GDP for decades.[2 3 42 44] This shaped a medical culture that was averse to spending on laboratory tests and less receptive to appreciating the importance of testing for controlling viral transmission.

Evaluation of key actions

COVID-19 control strategy

Sri Lanka's control strategy requires evaluation at two levels: (1) strategic, and (2) implementation.

Sri Lanka's initial official COVID-19 control strategy aimed to prevent sustained local transmission.[8] This largely worked in 2020, but from 2021 Sri Lanka changed tack and experienced sustained local transmission. Given the unreliability of testing data, Sri Lanka's success in controlling COVID-19 and protecting population health must be evaluated by examining its impact on overall mortality (figure 4). The crude death rate fell from 6.7 deaths per 1000 persons (2019) to 6.0 in 2020, before increasing to substantially above the pre-COVID-19 baseline in 2021 (7.4) and 2022 (8.1).[45] The initial fall was in line with experience in successful Zero-COVID countries. But the subsequent increases, equivalent to over 30 000 excess deaths over the whole time period, resembles more the experience of the UK and USA (online supplemental table 3).

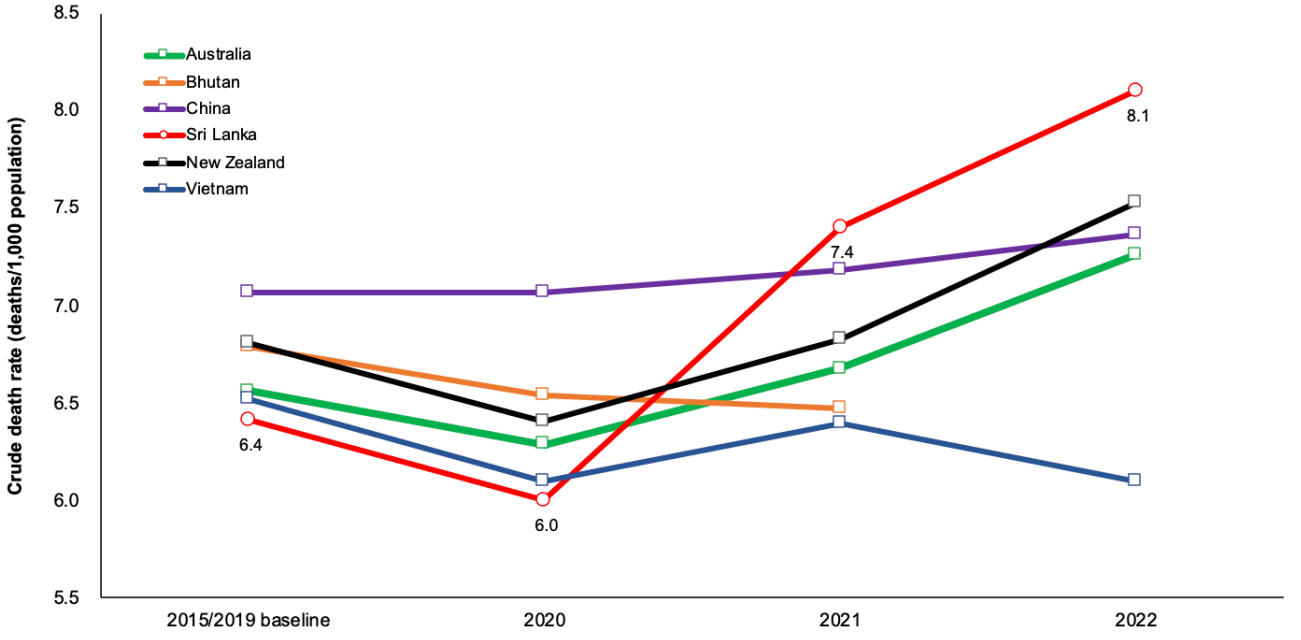

Figure 4 Changes in crude death rates for Sri Lanka and selected countries that pursued Zero-COVID approach, 2015–2022. Source: Compiled by authors using data from Department of Census and Statistics, Sri Lanka; Australian Bureau of Statistics, Australia; National Bureau of Statistics, China; General Statistics Office, Vietnam; Statistics New Zealand, New Zealand; and World Bank World Development Indicators. Full details given in online supplemental table 3.

Why did policymakers abandon the initially effective strategy, which played to Sri Lanka's strengths? The immediate reason, confirmed by KIIs, is that the outbreak that became visible in late-2020 was too large to control with the interventions attempted. As political leaders lost faith in the health authorities' ability to control the virus, they aligned with competing voices that argued that the economic costs of preventing transmission were excessive and that such efforts were doomed to failure. This raises the question of why the control strategy failed to stop the late-2020 outbreak before it reached such levels?

It is necessary to reference the insights of Australian and New Zealand epidemiologists that underpinned their more successful Zero-COVID strategies.[16 46] Ironically, these were informed by a preprint published in April 2020 by a Sri Lankan Australian researcher and colleagues.[47] They anticipated that even the best border security regime would fail frequently, and prevention of sustained local transmission depended on early detection of cryptic chains of transmission within the community. Modelling indicated that the most feasible option for achieving this involved intensive PCR testing at the primary care level of people with coughs, colds and respiratory symptoms, followed by downstream and upstream contact tracing. Both countries estimated independently that this required testing rates of approximately one test per 1000 capita daily to detect hidden outbreaks while they still numbered fewer than 20 infected persons, that is, small enough to be controlled. Sri Lanka's strategy never met these requirements. While its border security and contact tracing performance matched these countries, Bhutan and Vietnam, testing rates never exceeded 0.2 tests per capita or 3500 tests per day before detection of the Brandix outbreak (online supplemental figure 2). This was substantially lower than Bhutan and Vietnam, both poorer LMICs, and testing was less effective focusing on random testing and hospital patients. The Australian and New Zealand modelling imply that with such an inefficient and inadequate testing policy hidden transmission chains seeded by a single imported infection would persist for months and infect several hundred people before detection, which matches the Brandix outbreak. Genomic sequencing and back forecasting of the epidemic curve support this inference, both indicating a quarantine leak in mid-2020.

If epidemiology can explain the failure of the control strategy, it does not explain why Sri Lanka maintained such a low testing rate, given that it had access to both government and donor financing, and given frequent and often strident public calls by many local health experts and stakeholders to increase testing. KIIs with a range of health, military and other sources revealed that policymakers and the experts advising them were unaware of the Australian and New Zealand analyses and that the testing strategy was unlikely to achieve the desired goal. We found no evidence of any efforts to quantify an adequate testing rate, despite stakeholder concerns. KIIs and media reporting indicate that a general sense of complacency prevailed, reinforced by reassurances by staff of international agencies and trusted foreign and local experts that testing was adequate through 2020.

While the overall strategy was based on a technical paradigm, although flawed, with significant influence from technical experts, detailed implementation of strategy was often disrupted by a wide range of stakeholders and political interests. This was facilitated by longstanding governance weaknesses which permitted formally technocratic processes to be subject to undue political and social influences. Two specific examples illustrate this.

One was the vaccination rollout, initially detailed by technical committees working to international guidelines. However, during implementation, stakeholders and even officials often subverted the agreed-upon phasing to favour specific groups. Although this interference did not have a major impact on the overall phasing of coverage, they generated public criticism and eroded trust in the vaccination process. A second example was the prolonged dispute over the forced cremation of COVID-19 deaths, which caused considerable anguish to the Muslim community and damaged Sri Lanka's relations with several foreign countries.[48] This was not justified by the scientific evidence, but the MOH's efforts to change the guidelines through review by expert committees encountered political pressures and inadequate objectivity by experts involved.[49 50]

Coordination and the role of the military

The two government mechanisms to coordinate government agencies and stakeholders generally ensured cohesive implementation. MOH collaboration with the private medical sector functioned well most of the time and was unprecedented given a history of limited public–private collaboration. However, there were several weaknesses.

Civil society criticised the coordination mechanisms and the COVID-19 response for being excessively military dominated, or specifically dominated by the Army Commander. KI interviews and our assessment of the evidence revealed a complex situation. We found a significant degree of both policymaker and senior military deference to the technical advice of health staff. We found no evidence that the military made any substantive public health technical decisions, including critical errors in the design of the control strategy–in each case MOH personnel proposed the actions. However, some KIs reported that particularly during Phase 3 mid-level MOH personnel sometimes bypassed inappropriately the top-level MOH officials to brief and lobby military decision-makers, subverting decisions previously agreed by MOH at taskforce meetings. In these cases, both health and military personnel shared culpability for poor governance, and we speculate that weak MOH leadership failed to reassert lines of authority.

Nevertheless, the Army Commander had a prominent role, being the lead public face of the government and having the most influence within the taskforce, at the expense of MOH officials (from late 2020) and elected ministers. Several factors may have contributed to this: constitutional centralisation of executive authority in the President; a culture of deference of ministers to the President; and the inclination of President Gotabaya Rajapaksa, who had a military background, to delegate to military officers. While KIs noted negative consequences, such as unwillingness of many doctors in the taskforce to voice dissenting views, it is difficult to disentangle how much of this was ultimately driven by the role of the Army Commander and how much by the hierarchical, centralised decision-making that is the norm in Sri Lanka. At the same time, the removal of the seniormost MOH official by the President in mid-2020, left a lacuna which the Army Commander filled in the absence of a strong MOH leadership.

In several areas we assessed, for example, border quarantine, design and operation of the COVID-19 vaccination database, emergency construction of public facilities, military involvement was evidently necessary. This was because relevant public agencies or private contractors either lacked capacity to take on the function or could not be swiftly procured through government procurement procedures. Use of the military and intelligence services to handle mobile device data for contact tracing could not have been entrusted to other agencies owing to data protection and confidentiality concerns. In other areas, like vaccination support and military assistance to the police in enforcing mobility restrictions, the military provided reserve capacity which allowed civilian agencies to concentrate on other essential tasks. In the case of vaccination, even this support might have been inadequate, as the vaccination drive led to reductions in testing activities because public health staff were redirected to vaccination duties.

Another weakness in the coordination mechanism was groupthink. At critical points, there was inadequate questioning of assumptions, consideration of alternative perspectives and appreciation of the inherent uncertainties in the COVID-19 evidence base. Observation during KIIs suggests that the self-confidence of senior military officers, which may have been beneficial for implementation, was associated with inadequate sensitivity to risks and uncertainties (a known characteristic of the military mindset[51]), which in turn may have influenced the taskforce deliberations. This was most apparent in the failure to increase testing in 2020, which was associated with failure to consider alternative views or to assess fully the risks.

Although the taskforce brought together many stakeholders, there was no representation by independent technical experts, nor adequate involvement of experts with expertise in subjects such as public communication, public opinion, and social behaviour.

Control interventions

Sri Lankans generally accepted imposition of lockdowns, mobility restrictions and mask mandates without significant social protest. Compliance was generally good, although this frayed with long lockdowns and as the pandemic persisted. The effectiveness of these PHSMs remains uncertain, and later lockdowns were less

stringent. International research, including some done in Sri Lanka, has mostly found weak or no evidence for the effectiveness of lockdowns,[4] but it is unclear how familiar local experts were with this research. In Sri Lanka, lockdowns in densely populated, poor, urban areas often did not stop transmission, because of the difficulties for residents to isolate for long periods.

The public generally thought that testing access was adequate (online supplemental text 4), but the decision to allow the private sector to offer testing was preceded by frequent calls by members of the public and by private sector providers to allow the private sector to offer testing. In analysis of SLHAS data (online supplemental text 9), we found that use of all and private testing was pro-rich (all testing: concentration index, CI=0.04, p<0.0001; private testing: CI=0.03, p<0.0001), and that of public testing was not significantly unequal though there was a modest pro-rich gradient (CI=0.01, p=0.24). Concentration index analysis also found that testing was pro-rich when it was of close contacts (p<0.02) or symptomatic (p<0.09), and only pro-poor for random testing (p<0.001). We also found that women and Muslims were significantly less likely to be tested.

As COVID-19 vaccine coverage was high across the population, we used SLHAS data to analyse disparities in time to be fully vaccinated (online supplemental text 9). We found that time to full coverage was largely equal with no disparities by sex, education, socioeconomic status quintile, sector of residence, being a healthcare worker or Facebook or WhatsApp use, once differences in when population groups became eligible was accounted for. However, we found that Muslims took longer to be fully vaccinated (p=0.01).

Public communication and public confidence

In routine public communication, elected politicians typically played a secondary role to health officials, with the Army Commander taking a lead role in his capacity as head of the taskforce. The consequences of this for actual pandemic control are complicated and difficult to evaluate. It is important to acknowledge that the role of the Army Commander raises normative issues outside our empirical analysis.

The military, health officials and health stakeholders enjoyed more credibility and public trust than political leaders, as evidenced in their higher favourability ratings (online supplemental text 4). This may have facilitated public communication and reduced public anxiety. It was reflected in the public having more confidence than in other countries in the ability of the government's pandemic team to manage the pandemic, and in the overall response (online supplemental text 4).

Simultaneously, public distrust in government reports about the spread of COVID-19 was higher than most countries (online supplemental text 4). This likely reflected the greater political influence on public messaging, as opposed to underlying strategy, and efforts to downplay negative news and uncertainties. Although political leaders and officials may have believed that avoiding bad news was sound strategy, it was detrimental. Public figures who vocally called for more aggressive action to control virus transmission, such as the state minister for COVID-19, the GMOA and the PHI union, generally enjoyed higher favourability ratings than the President, health minister and other political leaders who did not (online supplemental text 4).

Overly optimistic messaging about the benefits of vaccination negatively impacted uptake of booster vaccination. Stigmatising and racist communication by politicians and stakeholders may have contributed to lower uptake of testing and vaccination by the Muslim community, although the effects were not large (online supplemental text 9). In contrast, in SLHAS Wave 2 interviews conducted October 2021 to December 2022 (N=1430), the percentage of individuals reporting unmet need for medical treatment in previous 12 months was no higher among Muslim (9.6%, 95% CI 4.9 to 18.1) than in Sinhala respondents (9.7%, 95% CI 8.0 to 11.6).

DISCUSSION

The key challenge for countries at the start of the COVID-19 pandemic was how to minimise impacts on health, health systems and wider society, until such time that vaccination might provide an exit route. Sri Lanka's performance was mixed. It did well during 2020 but performed badly in the following 2 years. Although healthcare use fell in 2020, it had minimal adverse health impacts and overall mortality fell. But in 2021–2022, disruptions to healthcare use and service provision led to increases in mortality, with a substantial reversal of prepandemic health gains (figure 4). And although COVID-19 was not a fundamental reason, these failures in 2021–2022 contributed to the profound political and economic crisis that hit Sri Lanka in 2022, which led to the collapse of the government and economic bankruptcy, with continuing deleterious consequences for health and its health system.

This reversal was due to Sri Lanka's initially successful strategy unravelling when it confronted the late-2020 outbreak that was too large for it to control. Most countries were unable to stop outbreaks from the initial pandemic wave, but Sri Lanka was one of a few countries that could and did. For most countries prevention of transmission was moot from early in the pandemic, but Sri Lanka retained this option through 2020. Its response must be evaluated from that perspective.

Several factors facilitated Sri Lanka's positive performances, many of which it shared with successful Zero-COVID countries. This was not captured by assessments such as the Global Health Security Index,[52] confirming previously reported findings about its lack of correlation with COVID-19 pandemic performance.[4] Some factors were linked to core health system strengths. These included: strong public health capacities (infectious disease control, vaccination); a robust health system

with large hospital bed capacity and universal coverage; genuine desire of health officials to protect access; and strong public trust in the health authorities, healthcare workers and vaccination. Fortuitous factors were being an island, reduced exposure to the initial Wuhan wave and reserve military capacity that could be mobilised to support public efforts.

These factors and an early border closure allowed Sri Lanka to end its first outbreaks, and for it to adopt a Zero-COVID approach in terms of goals. But its implementation failed within months. The Zero-COVID approach was a three-legged stool consisting of: (1) secure borders, (2) contact tracing and isolation and (3) intensive symptomatic PCR testing in the community. Sri Lanka implemented the first two, but not the third. This arose for several reasons. First, the experts responsible for the strategy were not aware of (and did not investigate) the epidemiological thinking behind the Australian and New Zealand approaches and did not attempt to assess technically what an adequate testing regime might be. Second, the decision-making process and linked technical experts suffered from groupthink, a culture of defensiveness and lack of openness to alternative ideas, which made them unreceptive to concerns, often public, expressed by other local experts. Third, longstanding resource constraints had bred a medical culture that was averse to spending on 'unnecessary' laboratory testing, and a health policy establishment that was accustomed to working within budgets and unaccustomed to making the case for additional money to political decision-makers. Fourth, in a situation where uncertain knowledge encouraged the use of heuristic shortcuts, the Anglophile medical and political culture in Sri Lanka led decision-makers to pay more attention to American and British thinking on the COVID-19 response, while ignoring the contrary thinking in Australia and New Zealand and elsewhere in East Asia, particularly China, which other regional countries benefited from.[53] This groupthink and lack of interest in East Asia parallels similar problems that the UK COVID-19 Inquiry has revealed,[54] and the cost-averse medical culture has similarities to that in Malaysia and Japan.

We can only speculate on why Sri Lanka did not overcome these problems. We suggest two reasons. One is that Sri Lanka's historical health achievements were driven by continuous, incremental managerial improvements based on technocratic assessment of global evidence and trial and error within a stable framework.[55] This decision-making works well with long-term challenges, such as maternal mortality or hospital efficiency, but the OODA (observe, orient, decide, act) loop is too slow for an acute emergency such as COVID-19, where scientific knowledge is subject to large uncertainties and change. Sri Lanka's chronically under-funded health system lacked spare capacity to process the incoming information and to think out-of-the-box. The second is that the political (and military) leadership relied too much on official health authorities and the WHO for advice and was too incurious to investigate alternative perspectives. One solution might have been provision for a 'red team' facility that generated independent critiques of strategy.

When considering COVID-19's effects on health services, these were complex. We distinguished several pathways of impact. Two direct pathways were: (1) infection of healthcare staff, and (2) pressure on healthcare resources from sick COVID-19 cases. These only had substantial impacts in Sri Lanka during peaks in infection, such as the 2021 Delta wave, and these were partially mitigated by Sri Lanka's substantial hospital capacity. Two indirect pathways involved 'COVID anxiety', which led patients to stay at home, and healthcare providers to adopt excessively precautionary behaviours. Both impacted access in Phase 1 in Sri Lanka (in addition to the effects of mobility restrictions), but although healthcare providers adapted, public 'COVID anxiety' continued to suppress healthcare use, only dissipating in 2022. In future pandemics, policymakers may need to do more to reassure the public, and to institute better protocols to prevent cross-infection in healthcare settings.

It is clear from the data on unmet need and healthcare use that all these effects significantly impacted service delivery and access throughout 2020–2022. However, increased mortality was only seen in 2021–2022. This suggests that the direct impacts are the most critical, consistent with control of transmission being beneficial in protecting health and health systems. Sri Lanka's experience as a failed Zero-COVID country is instructive, since it enjoyed big mortality benefits from controlling transmission near zero but suffered large and continuing mortality losses when it gave up on stopping transmission.

Despite the strategic errors, Sri Lanka did well in implementation and mitigating impacts on health coverage. These include border security, contact tracing and isolation, medicines access, clearing childhood immunisation back-logs, managing ICU and hospital bed supply during waves, implementing COVID-19 safe protocols in healthcare, COVID-19 vaccination and intersectoral coordination and public–private collaboration. These positives were facilitated by pre-existing strengths of the health system, a cohesive national taskforce, trusting implementation to competent health sector and military managers and political willingness to draw on the military as the state's human resource reserve.

We recognise that the military's role is controversial in Sri Lanka.[56 57] However, KIIs and other evidence we reviewed indicate the need for a nuanced view. First, we note that considered discussion of the military's role in Sri Lanka is challenging. Four decades of internal conflict that ended in 2009, during which survival of the state and civilian-led democracy often depended on the military, left a complex legacy of a large military establishment with significant organising capacities, a civil society with polarised views about the military and frequent suspicions about military motivations and a public with high levels of trust in the military. Many of the military involvements in the COVID-19 response, for example, in

border security, vaccination, contact tracing, emergency construction, were contested by segments of civil society as excessive and undesirable militarisation, but paralleled the use of the military in established Western democracies.[58–60] Globally, military involvement was a double-edged sword which could strengthen the COVID-19 response but threaten citizenship rights and community trust so crucial for effective epidemic response.[61] In Sri Lanka's case, we found that the military role was often necessary and overall a net plus in strengthening COVID-19 control. We could not assess its net impact on rights since this requires disentangling this from the inevitable restriction of liberties associated with many PHSMs, but the evidence revealed no negative net impact on community trust, with the public retaining high levels of confidence in the military (online supplemental text 4). This leaves normative questions as to the appropriate role of the military in society,[61] but our empirical study cannot answer these, beyond simply noting that the Sri Lankan public's positive view of the military should not be irrelevant in a democracy.

Sri Lanka did badly in other areas. Uptake of COVID-19 vaccine boosters was low, and 8 million expired Pfizer doses were eventually destroyed.[62] There was over-optimism in official messaging and reluctance to discuss uncertainties, both by health officials and political leaders. There was lack of transparency and sharing of data, and opaque decision-making processes with frequent failure to explain the basis of policies, despite Sri Lanka's constitution enshrining the public's normative right to information. This eroded public trust in COVID-19 communications, impaired accountability, contributed to poor decision-making and undermined local analysis which might have informed a better response. There are no easy remedies, as this reflects deep-seated problems of bureaucratic and political culture, and a society where demonisation of political opponents is often the norm making social discourse about common problems difficult. Practical actions might be providing systematic training to senior health officials on public communication when faced with pandemic uncertainty and how to better handle stakeholders including political leaders, and having facilities to bring in expert advice on communications. The bigger problems of lack of transparency, unwillingness to share information and narrow space to discuss common problems will require sustained pressure by political leaders and civil society to use RTI legislation to normalise transparency and efforts to strengthen dialogue.

Sri Lanka's fiscal and foreign exchange constraints emerge as a consistent negative backdrop in our analysis. The government lacked money to provide significant economic support to mitigate the impact of PHSMs and contraction in global demand. This and dwindling foreign reserves contributed at the political level to the strategy shift from preventing transmission to living with the virus. Inflexible procurement processes motivated by chronic fiscal deficits delayed vaccine procurement. A health sector that had operated for decades under stringent fiscal constraints[3] lacked spare technical capacity to understand the epidemiology of COVID-19 control, was disinclined to invest in testing as a control intervention and was less motivated to push booster vaccination which would have reduced excess mortality through 2022. Although Sri Lanka entered an International Monetary Fund (IMF) adjustment programme in 2022 to tackle its fiscal problems, this might not improve Sri Lanka's capacity for pandemic response. The IMF targets, which include raising taxes to a still low 15% of GDP, are the minimum to achieve sustainable debt repayment.[63] More ambitious revenue goals are required to increase health spending. These will not be adopted without wider social consensus and demands from health stakeholders, who have been silent or even opposed to raising taxes.[64]

CONCLUSIONS

Sri Lanka's response to COVID-19 was marked by successes and failures, which provide lessons for itself and other countries.

A well-functioning health system can give countries a significant advantage in facing pandemics like COVID-19. This includes strong public health capacities in infectious disease control including surveillance, contact tracing and epidemiological analysis; robust immunisation capacity with high levels of public trust; competent system managers to manage and balance service delivery in response to urgent demands; and substantial hospital capacity more than most LMICs. To this must be added fiscal capacity, which means adequate taxes, fiscal reserves and space to borrow in an emergency, to finance health interventions and economic support, something which Sri Lanka clearly lacked. And if fiscal capacity exists, countries must pre-emptively legislate procurement processes fit for pandemic situations.

Sri Lanka was fortunate to be one of a small number of countries that was able to stop the first pandemic outbreaks. Its initial pursuit and later abandonment of its Zero-COVID strategy carries several lessons. The first is that when this is feasible, preventing transmission of a COVID-19-like pathogen is in the long run better for public health, health services and society than tolerating sustained transmission, until such time that an exit route is available. The second is that the Zero-COVID approach could only work with all three components: secure borders, contact tracing and isolation and adequate symptomatic PCR testing in the community. Sri Lanka is an object lesson in what happens when the third element was missing. It suggests that for countries to have implemented this approach in 2020, they had to have sufficient technical capacity to independently work out the epidemiological underpinnings, since international advice was often wrong.[53]

Sri Lanka's experience adds to growing evidence on how groupthink by public health experts and policymakers often failed in the face of a pandemic

characterised by pathogenic novelty and scientific uncertainty. Responding to such challenges requires avoiding heuristic shortcuts, such as treating COVID-19 like influenza, or simply relying on the usual role models. Finding mechanisms to minimise this risk should be a priority, and Sri Lanka would need to invest more in its own technical capacities, both within and outside government, and in efforts to increase transparency in both political and technical spheres.

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REFERENCES

1 Rannan-Eliya RP, Wijemunige N, Perera P, *et al*. Prevalence of diabetes and pre-diabetes in Sri Lanka: a new global hotspot-estimates from the Sri Lanka Health and Ageing Survey 2018/2019. *BMJ Open Diabetes Res Care* 2023;11:e003160.
2 Rannan-Eliya RP, Sikurajapathy L. Sri Lanka: "Good Practice" in Expanding Health Care Coverage. In: *Good Practices in Health Financing Lessons from Reforms in Low- and Middle-Income Countries*. Washington, DC, USA: World Bank, 2008: 311–54.
3 Amarasinghe SN, Dalpatadu KCS, Rannan-Eliya RP. *Sri Lanka Health Accounts: National Health Expenditure 1990–2019*. Colombo, Sri Lanka: Institute for Health Policy, 2021. Available: http://www.ihp.lk/publications/docs/HES2106.pdf
4 Rannan-Eliya RP, Wijemunige N, Gunawardana JRNA, *et al*. Increased intensity of PCR testing reduced COVID-19 transmission within countries during the first pandemic wave. *Health Aff (Millwood)* 2021;40:70–81.
5 Rannan-Eliya R, Dissanayake V, Perera P, *et al*. n.d. Cohort profile: The Sri Lanka Health and Ageing Study (SLHAS) [Submitted]. Int J Epidemiol
6 Guha M, Tanugi-Carresse AC, Mullen L, *et al*. n.d. Maintaining essential health services during COVID-19: cross-country lessons of health system resilience from Asia, sub-Saharan Africa and Latin America [Submitted]. *BMJ Glob Health*
7 Rannan-Eliya RP, Wijemunige N, Perera S, *et al*. COVID-19 Response and Maintenance of Essential Health Services in Sri Lanka, . 2023Available: https://www.exemplars.health/emerging-topics/ecr/sri-lanka [Accessed 1 Sep 2023].
8 Government of Sri Lanka. Combatting COVID-19 – Sri Lankan approach. Colombo, Sri Lanka,
9 Baker M, Kvalsvig A, Verrall AJ, *et al*. New Zealand's elimination strategy for the COVID-19 pandemic and what is required to make it work. *N Z Med J* 2020;133:10–4.
10 Normile D. Zero COVID' countries seek exit strategies. *Science* 2021;373:1294–5.
11 Pueyo T. Coronavirus: the hammer and the dance. *Medium* March 20, 2020. Available: https://tomaspueyo.medium.com/coronavirus-the-hammer-and-the-dance-be9337092b56 [Accessed 15 Jun 2023].
12 Jeewandara C, Jayathilaka D, Ranasinghe D, *et al*. Genomic and Epidemiological analysis of SARS-Cov-2 viruses in Sri Lanka. *Front Microbiol* 2021;12:722838.
13 Ministry of Health. *Release of persons who have quarantined from the quarantine centers*. Colombo, Sri Lanka: Ministry of Health, 2020.
14 Ministry of Health. *Preventive measures for airline crew members*. Colombo, Sri Lanka: Ministry of Health, 2021.
15 Tu H, Hu K, Zhang M, *et al*. Effectiveness of 14 day quarantine strategy: Chinese experience of prevention and control. *BMJ* 2021;375:e066121.
16 Lokuge K, Banks E, Davis S, *et al*. Exit strategies: Optimising feasible surveillance for detection, elimination, and ongoing prevention of COVID-19 community transmission. *BMC Med* 2021;19:50.
17 Nilar A. Maximum price for PCR & Antigen tests declared. *News 1st* August 11, 2021. Available: https://www.newsfirst.lk/2021/08/11/maximum-price-for-pcr-antigen-tests-declared/ [Accessed 15 Jun 2023].
18 Ministry of Health. *Revised Guidelines on Laboratory Testing Strategy for COVID-19*. Colombo, Sri Lanka: Ministry of Health, 2021.

19 Government of Sri Lanka. *The Gazette of the Democratic Socialist Republic of Sri Lanka*. 2020.
20 Face mask rule in Sri Lanka lifted. *Ada Derana* June 9, 2022. Available: https://www.adaderana.lk/news.php?nid=82958 [Accessed 15 Jun 2023].
21 Jayasinghe C. "Doubtful" data has led to diminished public concern over COVID-19 in Sri Lanka: GMOA. *EconomyNext* July 16 2021. Available: https://economynext.com/doubtful-data-has-led-to-diminished-public-concern-over-covid-19-in-sri-lanka-gmoa-84081/ [accessed 10 May 2023].
22 Arambepola C, Wickramasinghe ND, Jayakody S, *et al*. Sri Lanka's early success in the containment of COVID-19 through its rapid response: Clinical & epidemiological evidence from the initial case series. *PLoS One* 2021;16:e0255394.
23 Ministry of Health. *Guidance for intermediate care centers on management of COVID-19 positive individuals*. Colombo, Sri Lanka: Ministry of Health, 2020.
24 Ministry of Health. *Guidelines to get essential workers to work during curfew*. Colombo, Sri Lanka: Ministry of Health, 2020.
25 Ministry of Health. *Interim guideline on school dental services in the new-normal phase of COVID-19 pandemic*. Colombo, Sri Lanka: Ministry of Health, 2020.
26 Ministry of Health. *Interim guidelines on maternal and child health services during curfew period during outbreak of COVID-19 infection*. Colombo, Sri Lanka: Ministry of Health, 2020.
27 UNICEF. Sri Lanka: WHO and UNICEF estimates of immunization coverage: 2022 revision. 2023. Available: https://data.unicef.org/wp-content/uploads/cp/immunisation/lka.pdf [Accessed 21 Aug 2023].
28 Overview of immunization coverage during COVID-19 period, Sri Lanka; 2023. Available: https://www.linkedimmunisation.org/wp-content/uploads/2022/12/BBB_CountryPPT_SriLanka-1.pdf [Accessed 21 Aug 2023].
29 Ministry of Health. *Interim guidelines for maternal and newborn care services in hospitals during the outbreak of COVID-19 infection*. Colombo, Sri Lanka: Ministry of Health, 2020.
30 World Bank. *World Development Indicators*. World Bank, 2023.
31 Ministry of Health. *Sustaining leptospirosis control activities amidst COVID-19 outbreak*. Colombo, Sri Lanka: Ministry of Health, 2020.
32 Surendran SN, Nagulan R, Sivabalakrishnan K, *et al*. Reduced Dengue incidence during the COVID-19 movement restrictions in Sri Lanka from. *BMC Public Health* 2022;22.
33 Liyanage P, Rocklöv J, Tissera HA. The impact of COVID–19 Lockdown on Dengue transmission in Sri Lanka; A natural experiment for understanding the influence of human mobility. *PLoS Negl Trop Dis* 2021;15:e0009420.
34 Ministry of Health. *Purchase and get medicine delivered at your door step*. Colombo, Sri Lanka: Ministry of Health, 2020.
35 Ministry of Health. *Provision of medicines for patients with non-communicable diseases (NCDs) taking treatment from the private sector*. Colombo, Sri Lanka: Ministry of Health, 2020.
36 Primary Health Care Performance Initiative. *Ensuring access to routine and essential services during COVID-19 through utlising telehealth in Sri Lanka. COVID-19 promising practices*. Colombo, Sri Lanka: Primary Health Care Performance Initiative, 2020.
37 World Bank. Sri Lanka COVID-19 Emergency Response and Health Systems Preparedness Project, . 2020Available: https://projects.worldbank.org/en/projects-operations/project-detail/P173867 [Accessed 29 Jul 2022].
38 World Bank. *Stakeholder Engagement Plan (SEP) Sri Lanka COVID-19 Emergency Response and Health Systems Preparedness Project (P173867)*. Washington, DC, USA: World Bank Group, 2021.
39 Ministry of Finance. *Annual Report 2020- Ministry of Finance Sri Lanka*. Colombo, Sri Lanka: Ministry of Finance, 2020.
40 ADB COVID-19 Policy Database. Asian Development Bank; 2022. Available: https://covid19policy.adb.org/ [Accessed 30 Dec 2022].
41 Asian Development Bank. *Asian Development Outlook 2022: Mobilizing Taxes for Development*. Manila, Philippines: Asian Development Bank,
42 International Monetary Fund. Sri Lanka: Sixth Review Under the Extended Arrangement Under the Extended Fund Facility and Requests for Waiver of Nonobservance and Modification of Performance Criterion-Press Release; Staff Report; and Statement by the Executive Director for Sri Lanka. Washington, DC, USA International Monetary Fund; 2019Nov4. Available: https://www.imf.org/en/Publications/CR/Issues/2019/11/04/Sri-Lanka-Sixth-Review-Under-the-Extended-Arrangement-Under-the-Extended-Fund-Facility-and-48787 [Accessed 15 Jun 2023].
43 International Monetary Fund. Sri Lanka: 2021 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for Sri Lanka. Washington, DC, USA International Monetary Fund; 2022Mar25. Available: https://www.imf.org/en/Publications/CR/Issues/2022/03/25/Sri-Lanka-2021-Article-IV-Consultation-Press-Release-Staff-Report-and-Statement-by-the-515737 [Accessed 15 Jun 2023].
44 Hsiao WC. *Institute of Policy Studies Health Policy Programme. A Preliminary Assessment of Sri Lanka's Health Sector and Steps Forward*. Cambridge, MA, USA: Harvard University, 2001.
45 Department of Census and Statistics. Crude birth rates & crude death rates by province district & sex 2019-2022; 2023.
46 Wilson N, Schwehm M, Verrall AJ, *et al*. Detecting the re-emergent COVID-19 pandemic after elimination: Modelling study of combined primary care and hospital surveillance. *N Z Med J* 2020;133:28–39.
47 Lokuge K, Banks E, Davis S, *et al*. Exit strategies: Optimising feasible surveillance for detection, elimination and ongoing prevention of COVID-19 community transmission. *BMC Med* 2021;19:2020.
48 Marsoof A. The disposal of COVID-19 dead bodies: impact of Sri Lanka's response on fundamental rights. *J Hum Rights Pract* 2021;13:669–89.
49 Sri Lanka Medical Association. Response of the SLMA to the issue of COVID 19 death management in Sri Lanka. Colombo, Sri Lanka Sri Lanka Medical Association; 2021Jan1.
50 College of Community Physicians Sri Lanka. In: *CCPSL Position Paper on the debate about compulsory cremation of victims of COVID-19*. 2020.
51 Knighton RJ. The psychology of risk and its role in military Decision-Making. *Defence Studies* 2004;4:309–34.
52 Nuclear Threat Initiative. GHS Index: Findings and Recommendations, . 2019Available: https://www.ghsindex.org/wp-content/uploads/2020/04/2019-Global-Health-Security-Index.pdf [Accessed 10 Jun 2020].
53 The Independent Panel for Pandemic Preparedness and Response. COVID-19: Make it the Last Pandemic; 2021 . Available: https://theindependentpanel.org/wp-content/uploads/2021/05/COVID-19-Make-it-the-Last-Pandemic_final.pdf [Accessed 15 Jun 2023].
54 UK COVID-19 Inquiry. Transcript of Module 1 Public Hearing, dated 22 June 2023; Available: https://covid19.public-inquiry.uk/wp-content/uploads/2023/06/22185025/C-19-Inquiry-22-June-23-Module-1-Day-8.pdf [Accessed 10 Nov 2023].
55 Dalpatadu S, Perera P, Wickramasinghe R, *et al*. *The Sri Lankan Model of Public Hospital Governance: A Case Study*. Institute for Health Policy on behalf of Asia Pacific Network in Health Systems Strengthening (ANHSS), 2016. Available: https://l4uhc.world/wp-content/uploads/2019/11/ANHSS-Public-Hospitals-Sri-Lanka.pdf [accessed 29 Nov 2023].
56 Kuruwita R. Military Involvement in Pandemic Control in Sri Lanka. *The Diplomat* 13 April 2023. Available: https://thediplomat.com/2023/04/military-involvement-in-pandemic-control-in-sri-lanka/ [accessed 15 Jun 2023].
57 Nandakumar T. A Military Mindset: Sri Lanka's response to the coronavirus pandemic, . 2020Available: https://www.thepolisproject.com/read/a-military-mindset-sri-lankas-response-to-the-coronavirus-pandemic/ [Accessed 20 Mar 2020].
58 Latiçi T. The role of armed forces in the fight against coronavirus. European Parliamentary Research Service; 2020Apr. Available: https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/649401/EPRS_BRI(2020)649401_EN.pdf [Accessed 15 Jun 2023].
59 Fischer H. Military Response to Omicron and COVID-19: Federal Armed Forces and National Guard. Congressional Research Service; 2022Mar28. Available: https://crsreports.congress.gov/product/pdf/IN/IN11867 [Accessed 15 Jun 2023].
60 Gad M, Kazibwe J, Quirk E, *et al*. Civil-military cooperation in the early response to the COVID-19 pandemic in six European countries. *BMJ Mil Health* 2021;167:234–43.
61 Gibson-Fall F. Military responses to COVID-19, emerging trends in global civil-military engagements. *Rev Int Stud* 2021;47:155–70.
62 7.5Mn Pfizer vaccines expired! *Sri Lanka Mirror* Available: https://srilankamirror.com/news/7-5mn-pfizer-vaccines-expired/ [Accessed 1 Sep 2023].
63 International Monetary Fund. Sri Lanka: Request for an Extended Arrangement Under the Extended Fund Facility-Press Release; Staff Report; and Statement by the Executive Director for Sri Lanka. Washington, DC, USA International Monetary Fund; 2023Mar20. Available: https://www.imf.org/en/Publications/CR/Issues/2023/03/20/Sri-Lanka-Request-for-an-Extended-Arrangement-Under-the-Extended-Fund-Facility-Press-531191 [Accessed 15 Nov 2023].
64 Sri Lanka income tax hike: GMOA to launch 'black protest week' on Jan 23. *EconomyNext* January 3, 2023. Available: https://economynext.com/sri-lanka-income-tax-hike-gmoa-to-launch-black-protest-week-on-jan-23-108087/ [Accessed 30 Aug 2023].