

# Heterogeneity of the COVID-19 epidemic in Australia: What can we learn from it?

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## Review

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# Abstract

It has been more than one year since the World Health Organization declared the pandemic of COVID-19. Countries around the world are still struggling to control their epidemics. Australia has shown its resilience in the fight against the epidemic by providing a comprehensive response involving the whole-of-government and whole-of-society. Despite the overall successful national response, the epidemic in Australia has been heterogeneous across states. We conducted a mixed-methods study to analyze the epidemic and explain the variable manifestation of the epidemic across states in Australia. Most of the COVID-19 cases and deaths were in Victoria and New South Wales states due to differences in governance of the epidemic and public health responses (quarantine and contact tracing) among states. Countries could learn not only from Australia's overall successful response, through good governance, effective community participation, adequate public health and health system capacity and multisectoral actions, but also from the heterogeneity of the epidemic among states. Successful response to epidemics in countries with a decentralized administration requires multi-level governance with alignment and harmonization of the response.

## Highlights

- Australia has shown its resilience in the fight against the COVID-19 epidemic by providing a comprehensive response involving the whole-of-government and whole-of-society.
- A mixed-methods study identified that the epidemic in Australia is heterogeneous; Victoria affected the most compared to other states.
- Victoria's high epidemic level is due to limitations in the governance and public health responses, including quarantine and contact tracing.
- Countries could learn not only from Australia's overall successful response but also from the heterogeneity of the epidemic among states.
- Successful response to epidemics in countries with a decentralized administration requires multi-level governance with alignment and harmonization of the response.

## Background

The pandemic of coronavirus infectious disease (COVID-19), caused by (SARS-CoV-2), is spreading rapidly around the world. Stepping up to control the spread of the epidemic remains the focus of public health authorities around the world. Globally, as of February 22, the epidemiological situation is variable across regions: with the Americas (48,228,712 cumulative cases and 1,106,906 deaths) and Europe (36,575,529 cumulative cases and 812,410 deaths) most affected followed by South-East Asia (13,188,211 cumulative cases and 202,607 deaths), Eastern Mediterranean (5,998,998 cumulative cases and 139,468 deaths), Africa (2,723,431 cumulative cases and 68,294 deaths), and Western Pacific (1,531,366 cumulative deaths and 27,019 deaths) (1). The Western Pacific region has the least burden of the epidemic. The epidemic is also variable across countries around the world (1).

Australia is one of the successful countries in the response to COVID-19, with 28,930 confirmed cases and 909 deaths as of February 22nd, 2021. COVID-19 cases and deaths per million population are less than many developed countries in Europe and America. This has been possible due to good governance of the epidemic

response, adequate public health and health systems capacity, community engagement and trust, and multicultural actions (40). Besides, Australia's protection of its indigenous populations can be considered as one of the most successful models. Australia successfully protects its indigenous populations by implementing several interventions, including restricting travel restrictions to remote areas, setting up COVID-19 clinics, rapid testing and expansion of workforce capacity. Indigenous Australians are six times less likely to contract COVID-19 than those in Canada and Brazil. Among the 800,000 indigenous peoples across the country, there was only 148 cases and no death due to COVID-19(2).

Nevertheless, the epidemic in Australia has variable expressions across states, with high and low cases and deaths per million population compared to the national average. We think it is useful to analyze and explain the heterogeneity of the epidemic in Australia so that lessons can be learned to better control the next waves of COVID-19 and even (re)emerging epidemics in the future. Therefore, the purpose of this article is to analyze and explain the heterogeneity of the epidemic in Australia with the aim to provide recommendations towards ending the current epidemic and preparing for adequate response to epidemics in the future. We hope that the lessons from Australia will also be valuable to other countries.

## Methods

We conducted a mixed-methods study including quantitative and qualitative data. Quantitative method was used to analyze the different epidemics across states in Australia. We employed a qualitative method to explain the epidemics in the different states. Epidemiologic data was extracted from Australian government reports and data was analyzed by comparing the confirmed cases, deaths and testing rates cases and deaths, hospitalization rate, death rate, the number of people tested per million population.

We conducted a scoping review to identify the factors that may explain the heterogeneity of the epidemics in Australia. We used the following response measures in our review and synthesis: governance, public health capacity, community engagement, health system, multiple sectoral actions, and vulnerability, which have helped Australia and the world in the corresponding response planning. We searched the literature for the period from January 2020 to February 2021 by using a mixed-methods study design. The main databases used for this report review are PubMed, Scholar, Embase and Medline. Grey literature is also included in our search, especially government reports. In the selected documents, we also conducted a manual search for their citations. We exclude duplicates in the search data by using EndNote X 9.0 software.

The search string is based on the keywords "[weaknesses and strengths of coronavirus OR COVID-19 OR SARS-CoV-2 strategy] [All Fields] AND [Victoria OR New South Wales OR Queensland OR Australian Capital Territory OR Northern Territory OR South Australia OR Western Australia OR Tasmania]' [Title/Abstract].

### Eligibility Criteria

Inclusion criteria are as follows: (1) weakness and strengths of the response to COVID-19 in Victoria; (2) weakness and strengths of the response to COVID-19 in New South Wales; (3) weakness and strengths of the response to COVID-19 in Queensland; (4) weakness and strengths of the response to COVID-19 in Australian Capital Territory; (5) weakness and strengths of the response to COVID-19 in Northern Territory; (6) weakness and strengths of the response to COVID-19 in South Australia; (7) weakness and strengths of the response to

COVID-19 in Western Australia; (8) weakness and strengths of the response to COVID-19 in Tasmania. The review includes all papers based on qualitative, quantitative, and mixed studies. The review is limited to papers published in English.

### Article Selection And Data Extraction

The relevance of the identified studies was evaluated by a two-stage screening process. The first stage is based on its title and abstract. 10 articles were excluded according to irrelevant titles and abstracts. For the second filter, we review the full text such as the publication date, the nationality of the author, the title, the main content of the study, and the main findings. Studies in languages other than English or applied fields unrelated to the COVID-19 are excluded. A total of 28 records were included. The summary of papers 'name, state, study type, findings were recorded. A description of the included studies is shown in Table 1.

## Results

The COVID-19 epidemiologic data for Australia and its states is displayed in Table 1 below. As of February 22, there were 28,930 confirmed cases and 909 deaths. There were 118 cases in ACT, 5,150 cases in NSW, 104 cases in NT, 1,323 cases in QLD, 610 cases in SA, 234 cases in TAS, 20479 cases in VIC, 912 cases in WA. There were 3 deaths in ACT, 54 deaths in NSW, 0 deaths in NT, 6 deaths in QLD, 4 deaths in SA, 13 deaths in TAS, 820 deaths in VIC, 9 deaths in WA (3). Victoria is the most affected state: the number of cases and deaths per million population in Victoria are almost three times the national. NSW is the second most affected state with half of the cases per million population and a quarter of the deaths per million population of the national average. Northern Territory is the least affected in the country.

Table 1  
COVID-19 cases in Australia as of February 22nd, 2021(3)

	Total cases	Total cases per 100,000	Total deaths	Total deaths per 100,000	Hospitalization rate	Case fatality rate	Total tests	Total tests per 100,000
ACT	118	26.7	3	0.7	0.00%	2.54%	168,443	39,347
NSW	5,150	55.3	54	0.7	0.04%	1.05%	4,926,267	60,683
NT	104	18.8	0	0.0	5.41%	0.00%	118,981	48,445
QLD	1,323	23.1	6	0.1	0.88%	0.45%	1,912,189	37,380
SA	610	30.9	4	0.2	0.34%	0.66%	1,069,938	60,913
TAS	234	42.8	13	2.4	0.00%	5.56%	170,421	23,004
VIC	20,479	305.9	820	12.4	0.00%	4.00%	4,870,358	73,461
WA	912	29.9	9	0.3	0.00%	0.99%	853,710	19,720
<b>Australia</b>	<b>28,930</b>	<b>111.8</b>	<b>909</b>	<b>3.6</b>	<b>0.07%</b>	<b>3.14%</b>	<b>14,090,307</b>	<b>55,334</b>

According to the search strategy, 65 articles were initially retrieved from the online database after duplicate records were removed. A total of 10 articles were considered irrelevant after the abstract and title were filtered. In the second step of the review, a total of 17 full text irrelevant articles were excluded. 22 articles were left. Finally, the name and type of study, state, and findings were recorded. One study assessed the deficiencies in Victoria's handling of the COVID-19 epidemic. Six papers include all the strategies in response to covid-19 in each state. Eight papers describe New South Wales response and South Australia and the Northern Territory and the Australian Capital Territory each have an article analyzing their response measures.

We have structured our findings according to the framework (based on the required measures in the COVID-19 response) we utilized to conduct the review and synthesis.

## **Governance**

Australian federal system has three levels of government: the federal government, as well as state and local governments for six states and two territories - the Australian Capital Territory and the Northern Territory.

With regards to the responsibilities for the epidemic, the federal government manages quarantine and international border movement, and intervenes through fiscal power for conditional appropriations, while states and territories take primary responsibilities for public health, hospitals, schools, and law and order. This epidemic requires the active participation of the federal and state governments region to respond. Therefore, close cooperation among governments is needed, as the pandemic impacts are beyond the scope of federal and state/territory responsibilities (1, 2).

However, the management of aged-care facilities has emerged as a major weakness of cooperation between the two governments (3). Aged-care institutions in Australia are privately owned and managed with the federal government only active on the issues related to funds and regulation. State governments are responsible for public health, public order and hospital management. When a 'disaster event' such as COVID-19 occurs, whether residents should be transferred or treated in nursing homes and who should take the responsibility are questioned (5). In the second wave of the epidemic, more than 1,300 cases of COVID-19 occurred in Victoria's aged-care facilities and 655 elderly died accounting for 72% of total deaths (4).

There was another governance issue in cooperation and taking of responsibility for passengers of the "Ruby Princess" cruise ship disembarking without adequate coronavirus testing or quarantine measures in Sydney, New South Wales. There were 663 COVID-19 cases from passengers linked to "Ruby Princess" and 28 died (7), triggering a dispute between the federal government and the state governments (5).

Similarly, the Queensland Government has been accused of insufficient governance in border restrictions (8). In July 2020, police allowed two women who tested positive to enter Queensland without verifying their false border declaration forms (9, 10), which was criticized by the public (11).

Compared with the three states mentioned above, WA, SA TAS ACT, NT have performed well in COVID-19 epidemic by taking context-specific actions instead of "one size fits all" approach (12) and have succeeded in controlling the epidemic by enacting health legislation and safeguarding the rights of people with disabilities, thus prevented the second wave of the epidemic from getting out of control (13).

## **Public Health Response**

Public health response is based on four elements: domestic and international border control, surveillance work and testing capabilities, contact tracing as well as quarantine. The overall testing rate in each state was high, with Victoria having higher rate than other states with 51,363 per 1,000 persons (14). However, the severe outbreaks in Victoria were linked with the shortcomings in hotel quarantine, which eventually required more stringent lockdown measures to be taken by the state government (15), and the second wave of the epidemic was traced back to the staff of the two quarantine hotels (16). Besides, the genome sequencing briefing confirmed that many cases in northern Melbourne were related to confirmed cases in quarantine hotels (17, 18). The resulting outbreak, which was responsible for 768 deaths and 18,418 cases (19), reflecting inadequate contact tracing of 3763 cases of local transmission (14). A parliamentary investigation found that the Victorian government was stubbornly reluctant to accept the new digital contact tracing system with a manual data entry process at the beginning, which is unsuitable for tracking contacts. A digital system was later introduced in the subsequent reform of the surveillance system, and a decentralized contact tracing center was established with more contact tracing personnel (14).

The second wave of deadly outbreaks in Victoria spread to New South Wales with the first case of community transmission occurred in a hotel in Sydney, and the state Department of Health actively carried out tracing work (22). The virus spread at a low level in New South Wales and surveillance work has been progressing well. Control measures and large-scale testing have been very successful in reducing the current infected cases with a testing rate of 40,540 per 100,000 people (14).

Compared with Victoria and New South Wales, the testing rate in Queensland was lower with 25,306 tests per 100,000(14). However, fewer cases were reported, and most can still be traced back to another confirmed case or high-risk activities, such as international travels. Electronic records were used to contact and track the potentially infected people through QR codes, electronic forms and online reservation systems. The government's strategy of active contact tracing and strict containment measures seemed to be working. The Queensland Department of Health has increased its testing capabilities by increasing manpower and working hours to manage the demand for respiratory clinics across the state, especially in the South East of the state. Meanwhile, the COVID-19 wastewater surveillance programme was launched to monitor infection trend in communities that supplied wastewater to the sewer system and overall public health actions (23).

The number of confirmed cases in other states was much lower than in Victoria, New South Wales, and Queensland, with most of the cases infected overseas (14) and very few cases of community transmission. All states still have adopted strict contact tracing and quarantine measures (24) to control the epidemic. Digital apps such as Check In App are also used to track attendees and provide information (25).

## **Community Engagement**

According to the COVID-19 prevention guidelines for the general population, people need to maintain a social distance of 1.5m in public and wash hands regularly with hand sanitizer or soap (26). Meanwhile, the mandatory order of wearing masks in public places reduced the risk of transmission from asymptomatic or mildly symptomatic people (27). A survey shows that the compliance rate for wearing masks in Victoria is high with almost 99% of people wearing masks in public (30) and 75 % of residents wearing masks in public (30).

However, other social restrictions are not well observed in Victoria. From March 23 to August 26, the Victorian Police issued almost 20,000 fines for Covid-19 breaches (28), among which 1,669 fines were for not keeping social distancing, 2,145 were for violations of the Melbourne curfew, 5761 were for "non-compliance with instructions" and 20 were for failure to self-isolate, which far exceeded the 1,440 fines that were issued in New South Wales (29).

## **Vulnerability**

The first confirmed case in Australia was reported in Victoria on January 25, 2020, from a man who travelled internationally from Wuhan to Australia. The first cases of the second wave of outbreak were also an international passenger in the quarantine hotel. Melbourne, Victoria has a large and busy airport for both domestic and overseas passengers. Compared with other states, Victoria has easier access to cases acquired overseas as the risk of contracting infectious diseases increases while traveling. As of 20 January, there were a total of 1,044 cases acquired overseas (4).

Moreover, Victoria is a multicultural state with large immigrant communities(28.4% of total population. Many of Melbourne's hot spots are from immigrant communities including Darebin, Moreland, Brimbank, Hume, Cardinia and Casey where the proportion of people speaking other languages other than English are 40%, 41.2%, 62%, 46%, 13%, and 38.2% respectively. During the second wave, the delivery of public health orders was not sufficient for Culturally and Linguistically Diverse communities (32), with over 6,000 cases in these communities.

Studies have proved that the possibility of COVID-19 spreading among people increases with an increase in population density (5, 6). The population density of Victoria and New South Wales is higher than other states (26.11 persons per km<sup>2</sup> and 9.52 persons per km<sup>2</sup> respectively) (33). It is, therefore, possible that population density might have facilitated community transmission of the virus in Victoria and New South Wales more than other states.

The highest case fatality rate is reported from Victoria and Tasmania, with 4.00% and 5.56% respectively, in addition to the highest number of deaths per million population in Victoria. The higher percentage of elderly population in these states might be a factor behind this. The percentage of residents above 65 years is 13.2% and 14% in Victoria and Tasmania respectively while the proportion is around 12% in other states (7).

## **Health System**

The capacity of the intensive care units (ICU) is relatively balanced, about 2.8 ICUs beds per 100,000 people, ranging from 2 to 5 hospital beds per 100,000 population in each Australian state, with all states have increased medical and health workforce to manage the peak of the epidemic (34). Victoria has expanded the capacity of its health system, including increasing the number of beds in ICUs to more than 7,000 and installing more than 1,000 ventilators (35). However, the health system in Victoria was under extreme pressure at the peak of the second wave, with more than 700 confirmed cases a day (36) and in New South Wales and Queensland, the capacity of ICUs has doubled, and more ventilators have been added (37).

In other states, hospitals, aged-care facilities, and specialized COVID-19 clinics have recruited more doctors, nursing and other health professionals to respond to the growing demands on the health system (38, 39).

## Multisectoral Actions

The multisectoral actions in each state are similar with a series of far-reaching economic initiatives in partnership with private sectors, which further revitalizes states' economies as moving beyond the threats of COVID-19. Each state has a plan for the next phase to ensure domestic employment while continuing to protect health (74). For example, rent remission and land tax exemption have been adopted to reduce the burden on commercial tenants and landlords. Grants ranging from \$3,000 to \$10,000 were distributed to individuals and small businesses. In addition, the states have implemented the Jobkeeper and Jobseeker programs to guarantee the basic living expenses of businesses and people.

School closure is an important measure taken in many countries and Australia closed its campuses and implemented online school and university teaching at the peak of the epidemic. From March 27, 2020 to April 22, 2020, more than 90% of schools worldwide suspended classes or adopted online teaching including schools in Australia (8).

## Discussion

The COVID-19 epidemic is variable across different states in Australia, with the highest burden in Victoria. Effective and timely measures that contribute to the control of the epidemic (governance, public health response, health system, community engagement, vulnerability, governance and public health actions) were less adequate in New South Wales and Victoria compared with other states, while health system capacity, community engagement and population vulnerability were similar across states.

Inadequate governance was demonstrated in aged-care facilities. The COVID-19 outbreak in aged-care facilities has highlighted that the federal government and state governments in the work of coping with cases in nursing homes lack of appropriately actions which has resulted in 655 deaths of elderly people (4). In contrast, no deaths were reported in nursing homes in Hong Kong, Singapore and South Korea with well-trained infection control doctors and adequate personal protective equipment (44). Therefore, in addition to improved governance of age-care facilities, regular and targeted training is needed for the nursing staff to incorporate infection prevention principles into daily practice in Australia. At the same time, the combination of strengthening infection control procedures and maintaining an adequate supply of personal protective equipment is still essential to prevent the epidemic.

New Zealand has a similar parliamentary system to Australia though without the tension of a federal and state policies at odds over some COVID-19 responses such as internal border closures and declaration of outbreak 'hot spots. (41). New Zealand's unitary governance system (unlike Australia's multi-level governance), concentrates authority in the central government, reducing conflicts among levels of governments, facilitating greater coordination and cooperation (2). China has provided a successful example in responding to the epidemic, demonstrating a strong cooperation between provincial governments and the central government (42) in implementing the measures such as strict blockades through community supervision (43).

Quarantine and contact tracing are effective ways to cope with COVID-19 (45, 46), by which Japan, South Korea and Singapore have effectively controlled the epidemic in districts (48) where many tests, strict isolation measures and digital contact tracking technology have been applied (49). Taiwan and Hong Kong's response to

the epidemic has been considered as among the most successful models worldwide. They have achieved positive results in controlling the epidemic, mainly due to early recognition and timely response, isolation of suspicious cases and adequate personal protective equipment (9).

Tailored health communication is vital for an effective epidemic prevention and control (50). Detailed and timely information, about the expected behaviours, testing and contact tracing, should be provided in a suitable format. (51).

### **Limitations Of The Study:**

(1) All published reports and papers may not be included in the search scope of the database; (2) The data and literature are only collected until February 2021, but the epidemic changes rapidly; (3) The quality assessment of this study has not been conducted.

## **Conclusion**

Australia is able to control its epidemic with comprehensive strategies built on good governance, adequate public health and health systems capacity, community engagement and trust, and multicultural actions. Despite the successful management of the epidemic in the country, Victoria and New South Wales fared less than other states because of differences in governance, quarantine, contact tracing, and health communication. Countries could learn from Australia to control their epidemics. The success of an epidemic response depends on governance at both federal and state levels. It is thus equally important to understand local epidemic in terms of population at risk so that appropriate and proactive measures can be undertaken.

## **Declarations**

### **Competing interests:**

Non-financial competing interests

### **Funding:**

Not applicable

### **Ethics approval and consent to participate:**

Not applicable

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## Appendix 1

	<b>State</b>	<b>Name</b>	<b>Study type</b>	<b>Findings</b>
1(10)	NSW	Reflections on COVID-19 in Sydney, Australia	Journal paper	Each State has social restrictions.
2(11)	NSW	COVID-19 in a Sydney nursing home: a case study and lessons learnt	Journal paper	Lessons learned from the Covid-19 epidemic in nursing homes.
3(12)	NSW	Modelling the impact of COVID-19 on intensive care services in New South Wales	Journal paper	Modelling estimates of peak demand for critical care services in New South Wales identified Covid-19 as a significant burden on the health system.
4(13)	NSW	Suppressing the epidemic in new South Wales	Journal paper	New South Wales has increased testing capacity and expanded testing opportunities for people with mild symptoms. New South Wales has a high testing rate.
5(14)	VIC/NSW/QLD/WA/SA/TAS/ACT/NT	Early analysis of the Australian COVID-19 epidemic	Literature review	The collective action taken by Australia's states in response to Covid-19 was early enough to avert a public health crisis. States have targeted interventions, extensive testing and social distancing strategies,
6(15)	VIC/NSW/QLD/WA/SA/TAS/ACT/NT	COVID-19: An Australian Perspective	Journal paper	A financial aid package developed by the Australian government to help refugees and asylum seekers survive the COVID-19 crisis.

	State	Name	Study type	Findings
7(16)	NSW	Global spread of COVID-19 and pandemic potential	Journal paper	In Australia, 16 per cent of the population is over 65. NSW, SA and QLD have a large proportion of elderly people
8(17)	NSW	COVID-19 lockdowns throughout the world		
9(18)	NSW	Learning Systems in Times of Crisis: the Covid-19 Critical Intelligence Unit in New South Wales, Australia	Literature review	New South Wales did a good job of identifying and monitoring Covid-19
17(19)	QLD	COVID-19 Pandemic– considerations and challenges for the management of medical imaging departments in Queensland	Journal paper	
18(20)	NT	The first 2 months of COVID-19 contact tracing in the Northern Territory of Australia, March-April 2020	Report	NT does a good job of quarantine and contact tracing
19(21)	ACT	Canberra’s Recovery Plan: Easing of Restrictions	Government report	The ACT’s COVID-19 roadmap provides guidance for Canberrans. This plan provides when and how the government plans to relax the coronavirus restrictions.
20(22)	NSW	COVID-19 Recovery Plan	Government report	New South Wales focuses on repairing its economy. The aim is to ensure that the economy is resilient and self-sufficient when rebuilt.

	State	Name	Study type	Findings
21(23)	VIC	Victoria road mapping for reopening - How we live in Victoria	Government report	Detailed information on social restrictions for Victoria
22(24)	VIC/NSW/QLD/WA/SA/TAS/ACT/NT	3-step framework for a COVIDSafe Australia	Government report	<p>Step 1: An important first step - connect with friends and family</p> <p>Step two: allow for rallies and support for economic recovery. Strict restrictions on high-risk activities.</p> <p>Step 3: Reopen businesses and communities with minimal restrictions.</p>
23(25)	TAS	Tasmania's Safe Border Strategy	Government report	Strict border restrictions have worked well to keep the Tasmanian community safe and establish Tasmanian procedures for detection, tracking and outbreak management.
24(26)	VIC/NSW/QLD/WA/SA/TAS/ACT/NT	Australian health sector emergency response plan for novel coronavirus covid-19	Government report	The Australian government works with the states and territories to reduce the spread of disease through strict border measures and social protection measures.
23(27)	SA	summary of the South Australian government economic responses to covid-19	Government report	The South Australian government has announced a series of measures to help small and medium businesses recover economy. These include cuts in payroll taxes, land taxes and financial aid packages

	State	Name	Study type	Findings
24(28)	VIC/NSW/QLD/WA/SA/TAS/ACT/NT	Whatever it takes COVID-19 policy responses in Australia	Government report	The report demonstrates economic measures to support individuals, families and businesses.
25(29)	QLD	Queensland Health COVID-19 response plan	Government report	<p>Queensland has increased its intensive care capacity.</p> <p>Increased medical manpower.</p> <p>Expand community screening, contact tracing and 13 health services.</p> <p>Strengthen support for regional health services.</p>
26(30)	VIC/NSW/QLD/WA/SA/TAS/ACT/NT	<p>SUMMARY OF AUSTRALIAN STATE AND TERRITORY</p> <p>GOVERNMENT ECONOMIC RESPONSES TO COVID-19</p>	Government report	Australia's state and territory governments have announced a series of economic and social measures. These include relief for commercial tenants and landlords, payroll tax breaks, and grants
27(31)	NSW □ VIC □ SA	<p>Multi-Level Government and COVID-19:</p> <p>Australia as a case study</p>	Case study	<p>Lack of cooperation between central and local governments on nursing homes and Ruby Princess Cruise.</p> <p>The central policy is one size fits all, but most states put people first.</p>

## Figures

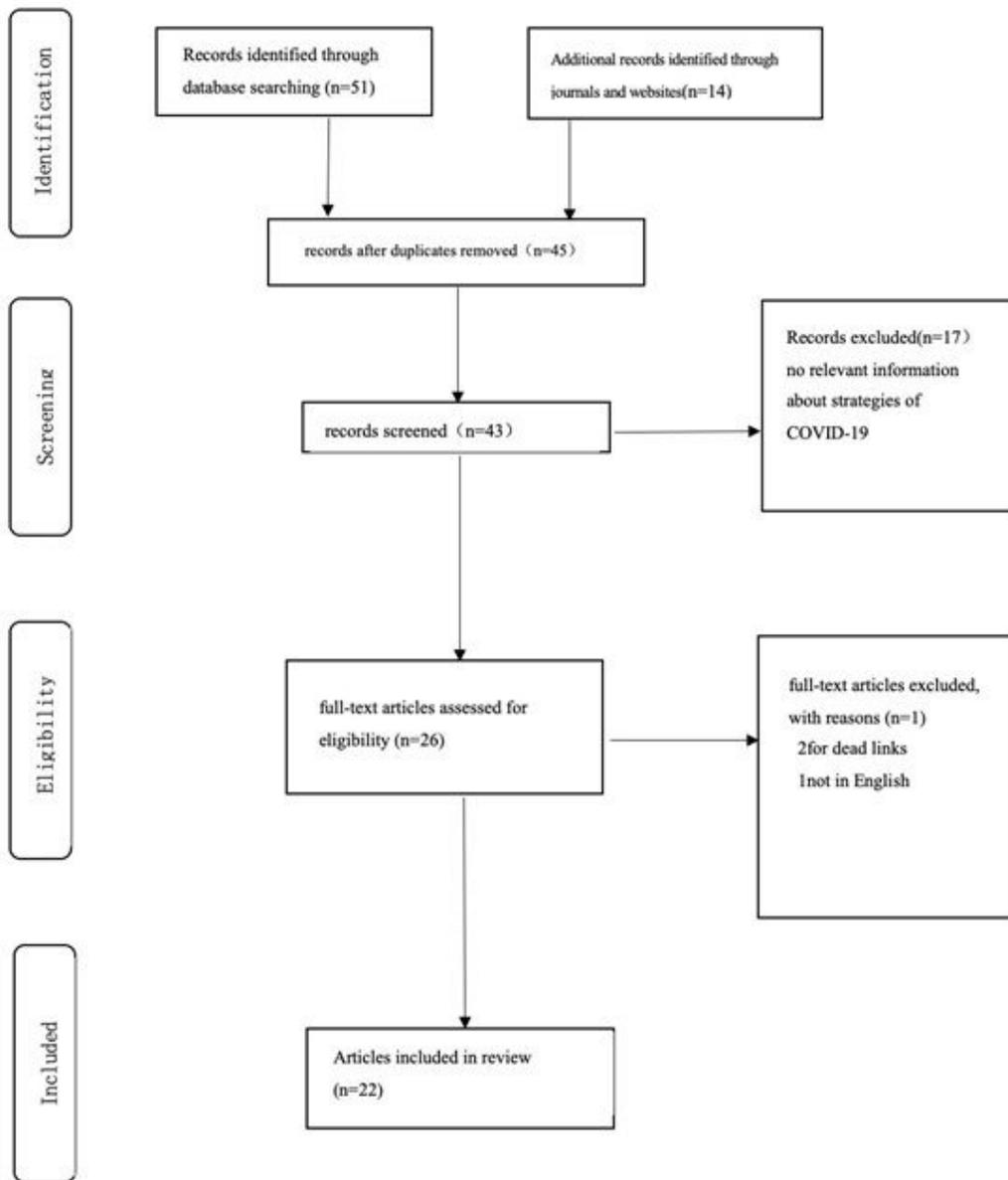


Figure 1

PRISMA flowchart