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ORIGINAL RESEARCH ARTICLE

An Economic Evaluation of Government-Funded COVID-19 Testing in Australia

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Abstract

Objective Easy and equitable access to testing has been a cornerstone of the public health response to COVID-19. Currently in Australia, testing using polymerase chain reaction (PCR) tests for COVID-19 is free to the user, but government funding for rapid antigen tests (RATs) is limited. We conduct an economic analysis of alternative government policies regarding the funding of COVID-19 testing in Australia.

Methods A decision tree model was developed to describe COVID-19 testing pathways for the Australian population over a 1-week period. The model outputs were analysed to estimate R numbers associated with alternative funding policies, which were used to estimate COVID-19 cases over a 6-month time horizon. Healthcare costs and quality-adjusted life-year (QALY) effects were applied to new COVID-19 cases. The model was populated using responses to a de novo population survey and published data sources.

Results Compared with no government-funded COVID-19 testing, government-funded testing is estimated to generate large incremental net monetary benefits (INMBs), up to A$15 billion in the base-case analyses. Government-funded PCR testing and RATs for all is predicted to maximise INMBs in most tested scenarios, though funding RATs for all and not PCR tests has similar INMBs in many scenarios and generates higher benefits to costs ratios.

Conclusions Our interpretation of the modelled analysis is that at the time of writing (July 2022), with high vaccination uptake in Australia and few other public health measures in place, Australian governments should consider reducing funding of PCR testing, for example, limiting capacity to essential workers and individuals with known risk factors for serious symptoms, and fund RATs for all.

1 Introduction

The novel coronavirus SARS-CoV-2, now known as COVID-19, was declared by the World Health Organisation (WHO) a global pandemic in 2020 and continues to spread throughout the world with new more transmissible variants. COVID-19 had a relatively low impact on Australia until the latter half of 2021, but cases are now increasing rapidly—from under 100,000 confirmed cases in September 2021 to over 8 million by July 2022 [1]. Even prior to the escalation in cases, the pandemic was having a significant impact on the Australian economy—a cost of A$311 billion was reported in the 2021–2022 federal budget [2].

Key Points for Decision Makers

The rate of COVID-19 cases in Australia has remained relatively stable over the course of 2022, at a rate that is affecting health system capacity. Most public health measures have been rolled back, but governments continue to fund PCR testing.

The presented modelled analysis shows that government funding of PCR testing and RATs for all maximises net benefits, but if budget impact is an issue, Australian governments should consider reducing PCR testing and funding RATs for all.

The presented decision analytic model was populated using published data and findings from a de novo survey of the Australia population, but consultations with relevant experts would better inform the use of the model as a policy tool.

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As recommended by the WHO, surveillance is a key component of the public health response to COVID-19 [3]. Since the start of the pandemic, testing and contact tracing have been the primary measures used to interrupt the spread of COVID-19 [4]. One of the benefits of population-wide active testing for cases is that it allows countries to rapidly identify new cases, isolate affected individuals and their close contacts and slow further transmission of the disease.

Australia's response has included the use of primary care and large community-based testing hubs to implement free-to-the-user polymerase chain reaction (PCR) tests for COVID-19. PCR tests are conducted by healthcare workers who take a swab from the back of the nose or throat. The swab is then sent to a pathology laboratory for testing and individuals receive their results via a mobile phone text message in approximately 24 hours, although it can take days to receive the result. It is estimated that the PCR testing system has cost the Australian government A$3.7 billion to deliver up to early 2022 [5]. The presentation of the highly transmissible Omicron variant in Australia, coinciding with a relaxation of public health restrictions, led to a surge in the numbers of COVID-19 cases in Australia, swamping the PCR testing system. Rapid antigen tests (RATs) (referred to as lateral flow tests in some other countries) are an alternative test for COVID-19, which could supplement the PCR testing system.

In November 2021, the Australian Therapeutic Goods Administration (TGA) approved the use of RATs which individuals can use to self-swab at home with results available within 15–20 minutes. PCR testing remains the gold standard in terms of accuracy; however, the Cochrane review of RATs reported a mean true positive rate (sensitivity) of 72% for symptomatic COVID-19 cases and 58% for people with COVID-19 but without symptoms [6]. Recent studies suggest similar test performance for the Delta and Omicron COVID-19 variants [7]. In Australia, unlike PCR testing, RATs are generally not free and are available for purchase at supermarkets and pharmacies. The cost is also a potential cause of inequity with respect to the impact of COVID-19, particularly when multiple tests are needed. In January 2022, the Australian federal government ruled out providing free RATs, though some state governments provide free RATs for registered close contacts of people with COVID-19 [8].

Providing free RATs for asymptomatic cases has been criticised because of their low sensitivity and cost [9, 10]. To inform government decisions around the funding of RATs, in this paper we present a decision analysis of the healthcare costs and quality-adjusted life-years (QALYs) associated with alternative COVID-19 testing strategies. The modelled analyses evaluate COVID-19 testing strategies in the context of the observed spread of the Omicron variant of COVID-19 in Australia in early 2022. However, the developed model is a general policy model that can be updated to evaluate testing strategies as the spread of the Omicron variant of COVID-19 changes, or as new variants emerge.

2 Methods

Figure 1 presents a decision tree model that describes COVID-19 testing pathways for the Australian population over a 1-week period, excluding individuals who have had COVID-19 within the last 12 weeks, who are not considered at risk of infection during this period [8]. The model differentiates between individuals who are and are not known close contacts of individuals with COVID-19. For both groups, the tree describes separate pathways for individuals who are and are not infected with COVID-19.

For known close contacts who develop COVID-19, individuals may take a RAT, obtain a PCR or not get tested on finding out they are a close contact. The following are assumed to isolate early:

- positive RAT, a positive PCR and a proportion of those who do not test
- false-negative initial RAT, taking multiple RATs or obtaining a PCR to confirm the negative RAT

Of the remaining individuals with COVID-19, those not developing COVID-19-like symptoms are assumed not to isolate. Those that do develop COVID-19-like symptoms may take a single RAT, multiple RATs, obtain a PCR or not get tested with associated probabilities of isolating late.

Non-known close contacts may use RATs on a regular basis or use RATs before visiting a high-risk location, for example, an aged care facility. For those who develop COVID-19, individuals taking RATs on a regular basis and a proportion of those using RATs before visiting a high-risk location are assumed to isolate early. Others may isolate late if they develop symptoms.

Known close contacts who *do not* develop COVID-19 may take a single RAT, multiple RATs, obtain a PCR or not get tested. The model does not represent false positive due to the very high specificity of both RATs and PCR testing [6].

Using the outputs from the decision tree, R numbers (numbers of people one infected person will infect) for early, late and no isolation COVID-19 cases were estimated for each government COVID-19 testing policy. In line with the relatively stable numbers of observed COVID-19 cases in Australia in 2022 [1], R numbers for early, late and no isolated COVID-19 cases were calibrated to generate a weighted aggregate R number of 1 for the current testing scenario (government-funded PCR testing with a <2-hour waiting time). The calibrated R numbers for early, late and no isolated COVID-19 cases were then applied to the estimated numbers of early, late and no isolated COVID-19

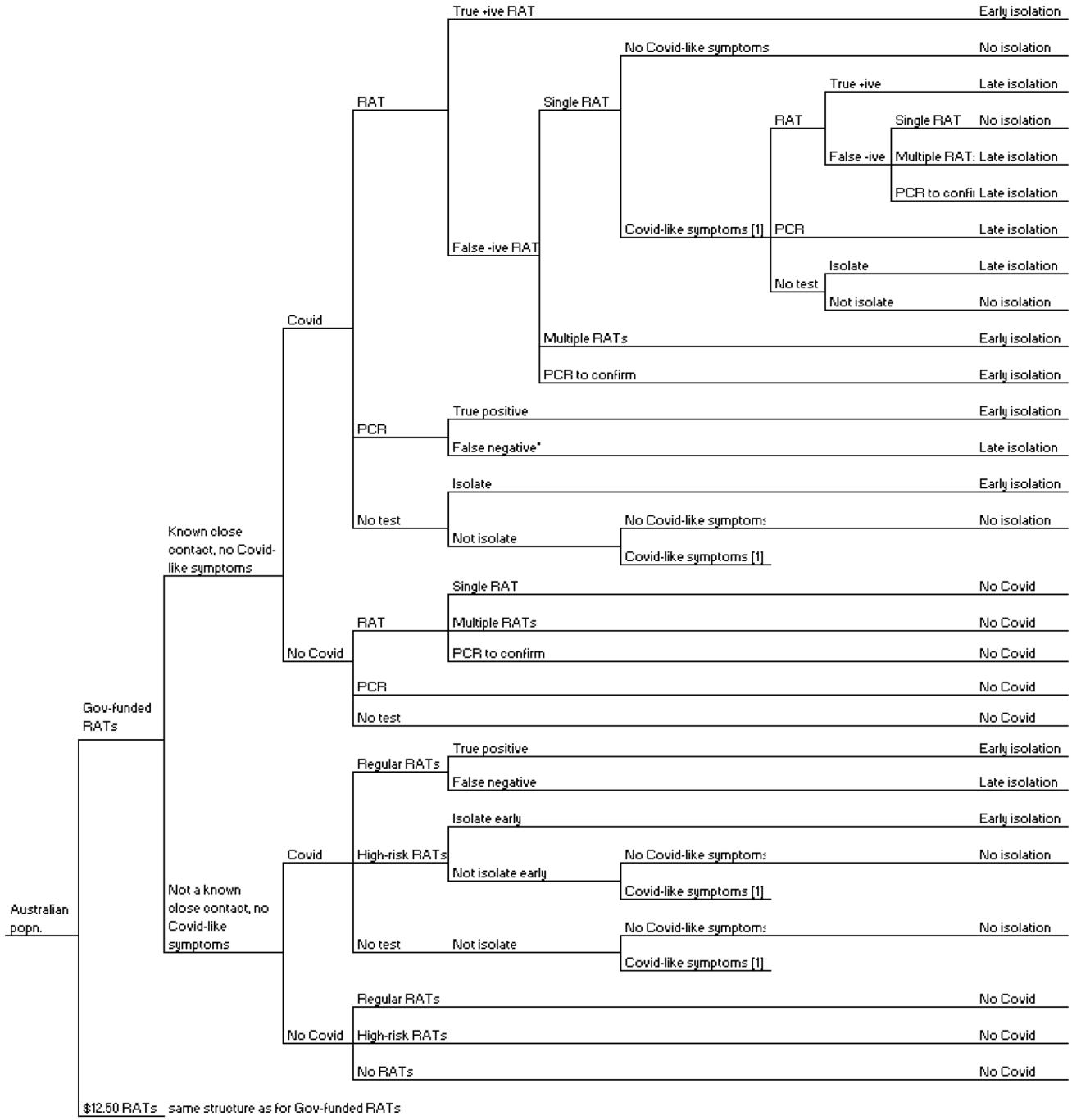

Fig. 1 Decision tree structure. *RATs* rapid antigen tests, *PCR* polymerase chain reaction test. *Late isolation assumed after false-negative PCR test result to maintain model parsimony due to high sensitivity of PCR testing

cases for each evaluated government policy to inform the estimation of weighted aggregate R numbers for each policy.

The weighted aggregate R numbers were then used to estimate the expected numbers of weekly COVID-19 cases for each government policy over a 6-month time horizon. Published estimates of the healthcare costs and QALY losses associated with COVID-19 were applied to the estimated numbers of new COVID-19 cases [11, 12]. Government funded COVID-19 testing costs were adjusted with respect to the weekly number of COVID-19 cases. Healthcare costs and costs of RATs and PCR tests were represented from an Australian government perspective.

2.1 Model Inputs

Table 1 presents the full set of input parameter values for the model. A key source of data was an online survey of the adult Australian population that was undertaken in April 2022 to estimate most of the model input parameters listed in the first column of Table 1. The survey asked respondents about their intended use of testing (i) if they were a known close contact of a COVID-19 case, (ii) if they had COVID-19-like symptoms and (iii) if they were neither a close contact nor had symptoms. For the close contact and symptoms scenarios, respondents were asked about responses to a negative RAT, that is, would they take multiple RATs or obtain a PCR to confirm the negative test result or assume they did not have COVID-19; and whether respondents would isolate if they did not get tested. In the absence of being a close contact or having symptoms, respondents were asked if they would take a RAT on a regular basis (and if so, how often) or if they would take a RAT when visiting a high-risk location, such as an aged care facility. The questions were asked under scenarios in which RATs were funded by government and in which each RAT cost the consumer A$12.50 (based on prices advertised by Australian pharmacies at the time of the survey), and under two PCR testing scenarios, stating that the wait times for PCR testing were under 2 hours and over 4 hours, respectively. Table 2 present the characteristics of the 1586 respondents who completed the survey, alongside the characteristics of the Australian population, which shows potentially important differences, especially with respect to age and gender.

Other model parameters include test characteristics of RATs and PCR testing in symptomatic and non-symptomatic COVID-19 cases [6, 7], RAT costs (A$5, assuming government purchase at a wholesale price), PCR test costs [13] and probabilities of contracting COVID-19, given an individual is and is not a known close contact of a COVID-19 case. These latter parameters are estimated assuming a constant number of COVID-19 cases per week (representing the approximate average number of cases per week from January to April 2022 [1]) and published estimates of the number of known close contacts per COVID-19 case [14] and the proportion of COVID-19 cases occurring in known close contacts [15]. The proportion of asymptomatic COVID-19 cases was derived from a published meta-analysis [16].

The mechanism of benefit of testing is through increased isolation, which reduces the expected number of close contacts per COVID-19 case, which reduces the expected number of people infected (the R number). No empirical evidence to inform the effects of isolation on numbers of close contacts or the R number was identified. Reductions in the R number relative to no isolation of 50% and 10% were assumed for early and late isolation in the base case, respectively. Respective reductions of 25% and 0% were tested in the sensitivity analyses.

The final parameters describe the expected healthcare costs and QALY losses associated with each COVID-19 case, which are drawn from Welsh government technical advisory group reports [11, 12]. The estimates represent the expected short- and long-term effects of COVID-19, including hospital admissions, intensive care admissions and deaths for COVID-19 cases occurring in July 2021 (following widespread vaccination). Cost estimates were converted to Australian dollars using the health purchasing power parity [17].

2.2 Model Analysis

The base case analyses of the model applied the parameter values presented in Table 1 to three policy options for government-funded RATs: none, restricted to known close contacts and no restrictions. Each RATs policy was evaluated under three PCR testing scenarios: government funded and < 2-hour wait time; government funded and > 4-h wait time and not government funded. For the non-government-funded PCR testing scenario, it was assumed that people who would have used PCR testing use a RAT and take multiple RATs to confirm a negative initial RAT.

The Incremental Net Monetary Benefits (INMBs) of each policy option are estimated in comparison to the policy of no government-funded COVID-19 testing (i.e., neither PCR testing nor RATs), estimated as

$$\begin{aligned}\text{INMB} &= (\text{QALY losses avoided} \times \text{monetary value per QALY}) \\ &\quad - \text{COVID-19 testing costs} + \text{Healthcare costs avoided}\end{aligned}$$

To estimate the monetary value of a QALY, the empirically estimated opportunity costs of health expenditure (A$28,000 per QALY [21]) was increased to A$50,000 to reflect heightened societal concerns about COVID-19. A range of scenario analyses were undertaken to describe the effects of alternative modelling assumptions on the expected INMBs.

3 Results

Table 3 presents the base case results over a 1-week time horizon. With < 2-h waits for government-funded PCR testing and no government funding of RATs, Australian governments are estimated to spend A$160 million on PCR testing per week, which increases to A$213 million on RATs and PCR testing if governments fund all RATs and PCR tests. Compared with a policy of no government-funded COVID-19 testing, government-funded PCR testing is predicted to avoid around 12,000 COVID-19 cases over a 1-week period.

Table 1 Model input parameters values

	Government funded		Not government funded			
Known close contact	**2-h PCR**	**4-h PCR**	**2-h PCR**	**4-h PCR**	**COVID-19 parameters**	
Pr(Use RAT|close contact)	0.66	0.49	0.35	0.26	Pr(COVID-19|known close contact)	0.056
Pr(Use PCR|close contact)	0.25	0.48	0.49	0.70	Pr(COVID-19|not 'known close contact')	0.0107
Pr(No test|close contact)	0.08	0.03	0.16	0.04	Pr(Symptoms|COVID-19)	0.83
Pr(Single RAT|negative RAT)	0.53	0.51	0.59	0.57	**Test characteristics**	
Pr(Multiple RATs|negative RAT)	0.36	0.40	0.29	0.33	RAT True +ive (sensitivity)|no symptoms	0.58
Pr(PCR to confirm|negative RAT)	0.11	0.09	0.12	0.10	RAT True +ive (sensitivity)|symptoms	0.72
Extra RATs|negative RAT|close contact	3				PCR True +ive (sensitivity)	0.98
COVID-19-like symptoms	**2-h PCR**	**4-h PCR**	**2-h PCR**	**4-h PCR**	**Population parameters**	
Pr(Use RAT|COVID-19-like symptoms)	0.80	0.71	0.53	0.56	Australian population	25,000,000
Pr(Use PCR|COVID-19-like symptoms)	0.10	0.26	0.27	0.37	COVID-19 cases per week	350,000
Pr(No test|COVID-19-like symptoms)	0.09	0.03	0.21	0.07	% cases in known close contacts	45%
Pr(Single RAT|negative RAT)	0.19	0.15	0.20	0.21	Known close contacts per case	8
Pr(Multiple RATs|negative RAT)	0.34	0.48	0.31	0.44	Recent COVID-19 cases (past 12 weeks)	4,200,000
Pr(PCR to confirm|negative RAT)	0.47	0.37	0.48	0.35	Weekly known close contacts	2,800,000
Not known close contact & no COVID-19-like symptoms					Weekly non-recent cases & non-known close contacts	18,000,000
Pr(Use RATs regularly)	0.19		0.04		Reduction in no. people infected w/ early isolation	50%
No. RATs/week|regular RATs	2.78		2.37		Reduction in no. people infected w/ late isolation	10%
Pr(Use RATs if visiting high-risk location)	0.59		0.46		QALYs lost|COVID-19	0.03755
Pr(Early isolation|high-risk RATs)	0.1		0.1		**Cost to the government**	
Pr(No regular nor high-risk testing)	0.23		0.49		RAT	$5
Pr(Isolate) |					PCR	$82
No test|close contact	0.46				Healthcare costs|COVID-19	$468
No test|COVID-19-like symptoms	0.51					

PCR polymerase chain reaction, *Pr* probability, *RAT* rapid antigen test,|given, e.g., Pr(Use RAT|close contact) = probability of using a RAT given person is a known close contact of a COVID-19 case

Adding government funding of RATs for known close contacts is predicted to decrease government spending on COVID-19 testing to A$153 million due to the reduction in PCR testing. The reduction in the more accurate PCR testing also results in fewer avoided COVID-19 cases. If waiting for PCR testing is > 4 h, testing costs and COVID-19 cases avoided are reduced due to lower use of PCR testing.

In the base case, funding RATs for close contacts has minor effects on the R numbers, due to the relatively high level of testing of known close contacts in the absence of government-funded RATs and the proportion of survey respondents who indicated they would isolate in the absence of testing if known to be a close contact. Funding RATs for all is estimated to reduce the R number from 1 to between 0.97 and 0.99.

Table 4 describes the use of the R numbers presented in Table 3 to estimate the numbers of COVID-19 cases expected over a 6-month time horizon for each government-funding policy and the associated QALY losses and healthcare costs avoided and testing costs. The results show that all testing strategies have positive INMBs, but the two RATs-for-all funding policies have substantially larger INMBs, at A$14–15 billion. A policy of funding PCR testing and RATs for all maximises INMBs.

Table 5 presents an illustrative set of scenario analyses, noting that as a policy tool, the model should be used in consultation with relevant experts (e.g., clinicians, epidemiologists, behavioural scientists, policy specialists, etc.) to define and interpret the most relevant scenario analyses. The following are our summaries of the presented scenario analyses:

- If smaller effects of early and late isolation are assumed, the INMBs decrease quite substantially and a policy of funding RATs for all, but not PCR testing maximises INMBs.

Table 2 Survey respondent (n = 1586) and Australian population characteristics*

	Survey respondents	Australian population
Age (y)		
18–24	0.08	0.16
25–34	0.15	0.17
35–44	0.30	0.16
45–54	0.26	0.15
55–64	0.14	0.13
65–74	0.07	0.10
75+	0.01	0.13
State and territory		
Tasmania	0.03	0.02
WA	0.09	0.10
NSW	0.22	0.32
Victoria	0.13	0.26
SA	0.42	0.07
NT	0.01	0.01
ACT	0.03	0.02
Queensland	0.08	0.20
Location		
Metropolitan	0.65	0.72
Regional	0.24	0.18
Rural	0.11	0.08
Remote	0.00	0.02
Gender		
Male	0.10	0.49
Female	0.89	0.51
Other	0.01	
Household size (18+ y)		
One	0.22	0.24
Two or more	0.78	0.76
Households with children		
No	0.46	0.59
Yes	0.54	0.41
Adult employment		
Employed	0.84	0.62
Not employed	0.16	0.38
Employer requires COVID-19 testing		
Yes	0.26	n/a
No	0.74	n/a
General health		
Excellent	0.23	0.21
Good	0.60	0.64
Average	0.16	0.11
Poor	0.00	0.04

*Australian population characteristics extracted from the websites of the Australian Bureau of Statistics (http://www.abs.gov.au) and the Australian Institute of Health and Wellbeing (http://www.aihw.gov.au)

- If RAT sensitivity rates are reduced, INMBs increase substantially for the PCR testing policies, but funding PCR testing and RATs for all maximises INMBs.
- If we assume that multiple RATs will not deliver a true positive result following a false negative RAT, the calibrated R number for no government-funded testing increases to 1.073. Funding PCR testing and RATs for all maximises INMBs.
- Reducing the QALY and healthcare cost effects of COVID-19 and decreasing the time horizon to 3 months reduces the INMBs, but they remain substantial. Funding only RATs for all maximises INMBs.
- The final two analyses show the magnitude of the increase and decrease in the value of funding testing if the current R number is above and below 1, respectively. In both scenarios, funding PCR testing and RATs for all maximises INMBs.

Another factor to consider is the benefit-to-cost ratio (BCR), for example, if a current R number of 0.95 is assumed, the BCR for funding PCR testing and RATs for all is 2.5 compared with a BCR of 3.25 for funding only RATs for all. The BCR is highest for funding RATs for all in all of the analyses presented in Table 5.

4 Discussion

This paper has reported the findings of an economic evaluation of government-funded RATs for the early detection of COVID-19. A decision tree model estimated the weekly numbers of COVID-19 cases in Australia for which isolation is early, late or not at all for alternative government policies regarding the funding of testing for COVID-19. R numbers for early, late and no isolation were calibrated such that a weighted R number of 1 was estimated for the current testing policy (PCR testing funded), reflecting the relatively constant weekly number of COVID-19 cases in Australia over 2022 [1]. Aggregate R numbers for alternative testing policies were estimated based on the expected numbers of early, late and no isolated COVID-19 cases. The estimated R numbers were used to estimate the cumulative effects of the alternative policy options on COVID-19 cases over a 6-month time horizon. Healthcare costs and QALY losses were applied to COVID-19 cases, from which incremental net monetary benefits of the alternative policy options were estimated in comparison to a policy of no government-funded COVID-19 testing. The model structure is likely to be generalisable to other countries and many of the input parameters are drawn from the international literature, though a population survey was undertaken within

Table 3 Base case results: 1-week time horizon

	COVID-19 testing costs (A$m)	Early isolated weekly cases	Late isolated weekly cases	No isolated weekly cases	New COVID-19 cases	R number
<2 h wait for PCR testing[a]						
No RATs government funded (current policy)	160	142,693	167,033	40,275	350,000	1.000
RATs government funded for close contacts	153	140,164	168,146	41,690	351,541	1.004
All RATs government funded	213	158,324	155,989	35,687	341,033	0.974
4-h wait for PCR testing[a]						
No RATs government funded	108	133,117	168,913	47,970	356,146	1.018
RATs government funded for close contacts	120	136,083	170,070	43,847	354,010	1.011
All RATs government funded	181	154,243	158,086	37,670	343,479	0.981
PCR testing not government funded[b]						
No RATs government funded	0	123,840	171,853	54,307	361,951	1.034
RATs government funded for close contacts	45	132,949	170,536	46,515	356,041	1.017
All RATs government funded	106	151,109	158,823	40,068	345,474	0.987

PCR polymerase chain reaction, *RAT* rapid antigen test

[a]PCR testing is government funded in these scenarios

[b]Assumes people who would have used PCR now use RAT and take multiple RATs to confirm a negative RAT

Australia to estimate the testing utilisation parameters in different scenarios.

Key policy implications of the analyses presented in this paper include that government-funded PCR testing and RATs for all is predicted to maximise INMBs in most tested scenarios, though funding RATs for all and not PCR tests has similar INMBs in many scenarios and generates higher benefits to costs ratios.

Other published economic evaluations of COVID-19 testing strategies include a study of rapid antigen testing of the entire population at different frequencies compared with a status quo testing strategy over a 150-day time horizon [18]. Weekly to monthly surveillance testing strategies were found to be cost effective for transmission scenarios representing reproductive numbers (R) between 1.1 and 3. Published in March 2021, the model represents pre-vaccination COVID-19 transmission rates and effects, which limits comparison with the current model. A more recent (preprint) economic evaluation of protocols for ending COVID-19 isolation focussed on the use of RATs to inform the duration of isolation, compared with a default scenario of 5-day isolation for all [19]. This evaluation modelled effects on secondary infections, for which the optimal testing strategy (test on day 6) cost an additional $1300 per secondary infection averted. The focus on the duration of isolation for confirmed cases of COVID-19 is different to the broader focus of the analyses reported in this paper.

Limitations of the presented analyses include the use of a relatively simple extrapolation model, which assumed the estimated R numbers for each strategy remain constant over a 6-month time horizon. This assumption likely overestimates differences in effects between the strategies because, for example, decreasing case numbers are likely to reduce public attention to managing transmission risks, and vice versa. The choice of time horizon also affects the estimated INMBs. A 6-month time horizon was selected as this is the period over which the R number has remained relatively stable in Australia to date, alongside relatively stable COVID-19 government policy. The presented sensitivity analyses, including reducing the time horizon to 3 months, indicate that the findings are not sensitive to uncertainty around the model structure nor key input parameter values.

Other issues to be considered when interpreting the study findings include the survey sample, the evaluation scope and perspective, and health equity effects. A de novo population survey was used to estimate key model parameters describing the use of RATs and PCR testing under alternative scenarios. There were some marked differences in the sample compared with the general Australian adult population. The sample was more likely to be female, employed, aged 35–54 years, and living in South Australia than the general Australian population. The direction and magnitude of the effects of this apparent selection bias is unknown. It is possible that the survey overestimated the use of RATs amongst known close contacts and the likelihood of early isolation without testing. However, the analysis of the model indicates that the testing of known close contacts is not a key driver of the results and so the uncertainty around these parameters is unlikely to affect the robustness of the study findings.

The evaluation represented health-related effects on individuals developing COVID-19 and associated government-funded healthcare expenditure. Utility effects on close

Table 4 Extrapolation analyses (base case)

Funding Policy	No PCR testing, no RATs				PCR testing, no RATs				PCR testing, KCC RATs	PCR testing, all RATs	No PCR testing, KCC RATs	No PCR testing, all RATs
R number	1.03415				1				1.004	0.97	1.017	0.987
Week	COVID-19 cases	QALY losses	Health costs	Testing costs	COVID-19 cases	QALY losses avoided	Health costs avoided	Testing costs	COVID-19 cases	COVID-19 cases	COVID-19 cases	COVID-19 cases
1	361,951	13,591	169	0	350,000	449	6	160	351,541	341,033	356,041	345,474
2	374,310	14,055	175	0	350,000	913	11	160	353,088	332,295	362,187	341,007
3	387,091	14,535	181	0	350,000	1393	17	160	354,642	323,782	368,438	336,597
4	400,308	15,032	187	0	350,000	1889	24	160	356,203	315,487	374,798	332,245
5	413,976	15,545	194	0	350,000	2402	30	160	357,771	307,404	381,267	327,949
6	428,112	16,076	200	0	350,000	2933	37	160	359,346	299,528	387,848	323,708
7	442,730	16,625	207	0	350,000	3482	43	160	360,928	291,854	394,542	319,522
8	457,847	17,192	214	0	350,000	4050	50	160	362,517	284,376	401,352	315,390
9	473,480	17,779	222	0	350,000	4637	58	160	364,113	277,091	408,280	311,312
10	489,647	18,386	229	0	350,000	5244	65	160	365,715	269,991	415,327	307,286
11	506,366	19,014	237	0	350,000	5872	73	160	367,325	263,074	422,495	303,313
12	523,656	19,663	245	0	350,000	6521	81	160	368,942	256,334	429,788	299,391
13	541,537	20,335	254	0	350,000	7192	90	160	370,566	249,767	437,206	295,519
14	560,028	21,029	262	0	350,000	7887	98	160	372,197	243,368	444,753	291,698
15	579,150	21,747	271	0	350,000	8605	107	160	373,836	237,132	452,429	287,926
16	598,925	22,490	280	0	350,000	9347	117	160	375,481	231,057	460,238	284,203
17	619,375	23,258	290	0	350,000	10,115	126	160	377,134	225,137	468,182	280,528
18	640,524	24,052	300	0	350,000	10,909	136	160	378,794	219,369	476,263	276,900
19	662,395	24,873	310	0	350,000	11,730	146	160	380,461	213,749	484,484	273,320
20	685,013	25,722	321	0	350,000	12,580	157	160	382,136	208,272	492,846	269,786
21	708,403	26,601	332	0	350,000	13,458	168	160	383,818	202,936	501,353	266,297
22	732,591	27,509	343	0	350,000	14,366	179	160	385,508	197,737	510,007	262,854
23	757,606	28,448	355	0	350,000	15,306	191	160	387,205	192,671	518,810	259,455
24	783,474	29,419	367	0	350,000	16,277	203	160	388,909	187,735	527,765	256,100
25	810,226	30,424	379	0	350,000	17,281	215	160	390,621	182,925	536,874	252,788
26	837,891	31,463	392	0	350,000	18,320	228	160	392,341	178,238	546,141	249,519
Sum	14.8m	554,862	6918		9.1m	213,157	2658	4155	9.7m	6.5m	11.6m	7.7m
INMBs					9160				7782	14,926	6057	14,096

All costs and INMBs presented as A$m

INMBs incremental monetary net benefits, *KCC* known close contacts, *PCR* polymerase chain reaction, *RATs* rapid antigen tests

Table 5 Scenario analyses results

	Base case			25% & 0% reduced R number w/ early & late isolation		
	R number	Testing costs	INMBs	*R* number	Testing costs	INMBs
PCR and No RATs	1.000	$4155	$9160	1.000	$4155	$758
PCR and CC RATs	1.004	$4218	$7782	1.002	$4082	$241
PCR and all RATs	0.974	$4412	$14,926	0.988	$4931	$3220
No PCR and no RATs	1.034	$0	$0	1.015	$0	$0
No PCR and CC RATs	1.017	$1489	$6057	1.008	$1303	$1226
No PCR and all RATs	0.987	$2574	$14,096	0.993	$2658	$4081
	RAT sensitivity: no symptoms 40%, symptoms 64%			False-negative RATs: no early isolation		
	R number	Testing costs	INMBs	R number	Testing costs	INMBs
PCR and No RATs	1.000	$4169	$16,038	1.000	$4164	$38,088
PCR and CC RATs	1.011	$4667	$11,971	1.020	$4975	$30,311
PCR and all RATs	0.989	$5010	$18,118	0.990	$4854	$40,005
No PCR and no RATs	1.046	$0	$0	1.073	$0	$0
No PCR and CC RATs	1.029	$1789	$7517	1.069	$992	$2949
No PCR and all RATs	1.007	$2883	$15,282	1.037	$2193	$25,048
	Costs & QALY losses|Covid: halved			3-Month time horizon		
	R number	Testing costs	INMBs	R number	Testing costs	INMBs
PCR and No RATs	1.000	$4155	$2502	1.000	$1918	$567
PCR and CC RATs	1.004	$4218	$1782	1.004	$1887	$312
PCR and all RATs	0.974	$4412	$5257	0.974	$2275	$1706
No PCR and no RATs	1.034	$0	$0	1.034	$0	$0
No PCR and CC RATs	1.017	$1489	$2284	1.017	$606	$701
No PCR and all RATs	0.987	$2574	$5761	0.987	$1230	$2046
	Current, aggregate *R* number: 1.05			Current, aggregate *R* number: 0.95		
	R number	Testing costs	INMBs	*R* number	Testing costs	INMBs
PCR and No RATs	1.050	$8577	$25,366	0.950	$2236	$3229
PCR and CC RATs	1.055	$8809	$21,867	0.954	$2242	$2665
PCR and all RATs	1.023	$7048	$41,476	0.926	$3208	$4895
No PCR and no RATs	1.086	$0	$0	0.982	$0	$0
No PCR and CC RATs	1.068	$3215	$16,243	0.966	$763	$2288
No PCR and all RATs	1.036	$3555	$38,593	0.938	$2137	$4778

Net Monetary Benefits = (QALY losses avoided × A$50,000) − COVID-19 testing costs + healthcare costs avoided

Number of infections per non-isolated case for PCR testing, no RATs (current policy) calibrated for each analysis

INMBs incremental monetary net benefits, *PCR* polymerase chain reaction, *QALY* quality-adjusted life-year, *RATs* rapid antigen tests

contacts who do not develop COVID-19, but who experience disutility from being in isolation were not represented. Productivity costs were not included in the presented analyses, in line with Commonwealth government guidelines for the conduct of economic evaluation for medical services [20]. Both issues would be expected to reduce INMBs in the short-term due to increased isolation. However, the inclusion of these effects over the longer term would be expected to improve the cost effectiveness of more government-funded COVID-19 testing.

The modelled analysis did not explicitly represent potential equity impacts of the assessed government policies. If individuals with lower socioeconomic status are less likely to test for COVID-19 without government funding, health and economic inequities would be expected to increase. The application of a monetary value of a QALY substantially higher than the empirical, opportunity cost-based cost-effectiveness threshold [21] reflected issues such as equity, but the strength of societal preference for the avoidance of

COVID-19 may justify a higher monetary value for COVID-19-related QALY losses.

5 Conclusion

Considering the study results and these factors, our interpretation of the modelled analysis is that at the time of writing (July 2022) with high vaccination uptake and few other public health measures in place, Australian governments should consider reducing funding of PCR testing, for example, limiting capacity to essential workers and individuals with known risk factors for serious symptoms, and fund RATs for all. The presented decision analytic model should be updated and re-evaluated as new data to estimate the model's input parameter values become available. To directly inform government policy, model analyses and the interpretation of model outputs should reflect the informed views of relevant experts, including clinical experts, epidemiologists, behavioural scientists, policy specialists, etc.

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Consent for publication (from patients/participants) Not applicable (all survey responses were anonymous).

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Code availability (i.e. the model) The model is available upon request.

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