Effects of different adult vaccination rates on public health: Australia's National Plan to Transition to COVID-19

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Follow Up Information

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Manuscript, supplementary material and calculations available at: https://osf.io/6j4rd/

Issue

- In July 2021, the Australian Government announced a four-phase national plan to transition Australia's response to the coronavirus disease 2019 (COVID-19) pandemic to a post-vaccination phase.
- When this final phase (Phase D) is reached, likely in 2022, COVID-19 in Australia would be managed like other common respiratory pathogens, akin to ‘living with the virus like the flu’, and the international border would reopen.
- A vaccination target of 80% of persons aged ≥16 years has been set for the penultimate stage (Phase C).

Australia's National Plan to COVID-19

Australian Government

National Plan to transition Australia's National COVID-19 Response

National Cabinet agreed to formulate a national plan to transition Australia's National COVID-19 Response from its current pre vaccination settings, focussing on continued suppression of community transmission, to post vaccination settings focussed on prevention of serious illness, hospitalisation and fatality, and the public health management of other infectious diseases

Phases triggered in a jurisdiction when the average vaccination rates across the nation have reached the threshold and that rate is achieved in a jurisdiction expressed as a percentage of the eligible population (16+), based on the scientific modelling conducted for the COVID-19 Risk Analysis and Response Task Force

~70% vaccination (2 doses) — *≥80% vaccination (2 doses)*

A. Current Phase: Vaccinate, Prepare and Pilot*

Continue to strongly suppress the virus for the purpose of minimising community transmission

Measures may include:

- Accelerate vaccination rates
- Close international borders to keep COVID-19 out
- Early, stringent and short lockdowns if outbreaks occur
- Minimise cases in the community through effective test, trace and isolate capabilities
- Implement the national vaccination plan to offer every Australian an opportunity to be vaccinated with the necessary doses of the relevant vaccine as soon as possible;
- Inbound passenger caps temporarily reduced
- Domestic travel restrictions directly proportionate to lockdown requirements
- Commonwealth to facilitate increased commercial flights to increase international repatriations to Darwin for quarantine at the Centre for National Resilience in Howard Springs;
- International Freight Assistance Mechanism extended
- Trial and pilot the introduction of alternative quarantine options, including home quarantine for returning vaccinated travellers;
- Expand commercial trials for limited entry of student and economic visa holders
- Recognise and adopt the existing digital Medicare Vaccination Certificate (automatically generated for every vaccination registered on AIR);
- Establish digital vaccination authentication at international borders;
- Prepare vaccine booster programme; and
- Undertake a further review of the national hotel quarantine network.

B. Vaccination Transition Phase

Seek to minimise serious illness, hospitalisation and fatality as a result of COVID-19 with low level restrictions

Measures may include:

- Maintain high vaccination rates, encouraging uptake through incentives and other measures
- Minimise cases in the community through ongoing low-level restrictions and effective track and trace
- Lockdowns less likely but possible
- International border caps and low-level international arrivals, with safe and proportionate quarantine to minimise the risk of COVID entering
- Ease restrictions on vaccinated residents (TBD)
- Restore inbound passenger caps at previous levels for unvaccinated returning travellers and larger caps for vaccinated returning travellers;
- Allow capped entry of student and economic visa holders subject to quarantine arrangements and availability;
- Introduce new reduced quarantine arrangements for vaccinated residents; and
- Prepare/implement vaccine booster programme (depending on timing).

C. Vaccination Consolidation Phase

Seek to minimise serious illness, hospitalisations and fatalities as a result of COVID-19 with baseline restrictions

Measures may include:

- Maximise vaccination coverage
- Minimum ongoing baseline restrictions, adjusted to minimise cases without lockdowns
- Highly targeted lockdowns only
- Continue vaccine booster programme;
- Exempt vaccinated residents from all domestic restrictions;
- Abolish caps on returning vaccinated Australians;
- Allow increased capped entry of student, economic, and humanitarian visa holders;
- Lift all restrictions on outbound travel for vaccinated Australians; and
- Extend travel bubble for unrestricted travel to new candidate countries (Singapore, Pacific)
- Gradual reopening of inward and outward international travel with safe countries and proportionate quarantine and reduced requirements for fully vaccinated inbound travellers.

D. Final Post-Vaccination Phase

Manage COVID-19 consistent with public health management of other infectious diseases

Measures may include:

- Open international borders
- Quarantine for high-risk inbound travel
- Minimise cases in the community without ongoing restrictions or lockdowns
- Live with COVID-19: management consistent with influenza or other infectious diseases
- Boosters as necessary
- Allow uncapped inbound arrivals for all vaccinated persons, without quarantine; and
- Allow uncapped arrivals of non-vaccinated travellers subject to pre-flight and on arrival testing.

**No jurisdiction required to increase restrictions beyond current settings*

The Plan is based on the current situation and is subject to change if required

The COVID-19 Risk Analysis and Response Taskforce's report will be available once finalised at: pmc.gov.au.

Key Assumptions:

Case Hospitalisation Rate (CHR) & Infection Fatality Rate (IFR)

Age class	0-11	12-15	16-29	30-39	40-49	50-59	60-69	70-79	80+
CHR Original	1.0	0.7	1.5	2.6	3.4	4.9	7.1	12.5	16.2
CHR Alpha	0.9	0.7	1.9	3.4	5.0	7.2	10.6	16.9	21.7
CHR Delta	1.8	1.4	3.8	6.8	10.0	14.4	21.2	33.8	43.4
IFR Original	0.001	0.003	0.009	0.036	0.123	0.408	1.334	4.257	17.009
IFR Delta	0.003	0.006	0.022	0.084	0.286	0.947	3.095	9.876	27.169

Sources: Levin et al 2020, Nyberg et al. 2021, Public Health England 2021; Fisman & Tuite 2021

Key Assumptions (Vaccine effectiveness)

	ChAdOx1-S	Comrinaty	Source
VE^I (infection)	0.60	0.79	Sheikh et al, 2021
OR^T (transmission)	0.52	0.54	Harris et al. , 2021
VE^S (symptomatic disease)	0.67	0.88	Stowe et al, 2021
VE^H (hospitalisation)	0.92	0.96	Stowe et al., 2021
VE^D (death)	0.92	0.96	= VE^H (See text).

Key Calculations

Morbidity and mortality calculated from managing COVID-19 at different levels of vaccination coverage based on a susceptible-infectious-recovered (SIR) model which assumes homogeneous mixing and generates steady-state results.

$$NC_j = FSI.N_j.\left(1 - \sum_k FV_{jk}.VE_k^I\right) \quad (1)$$

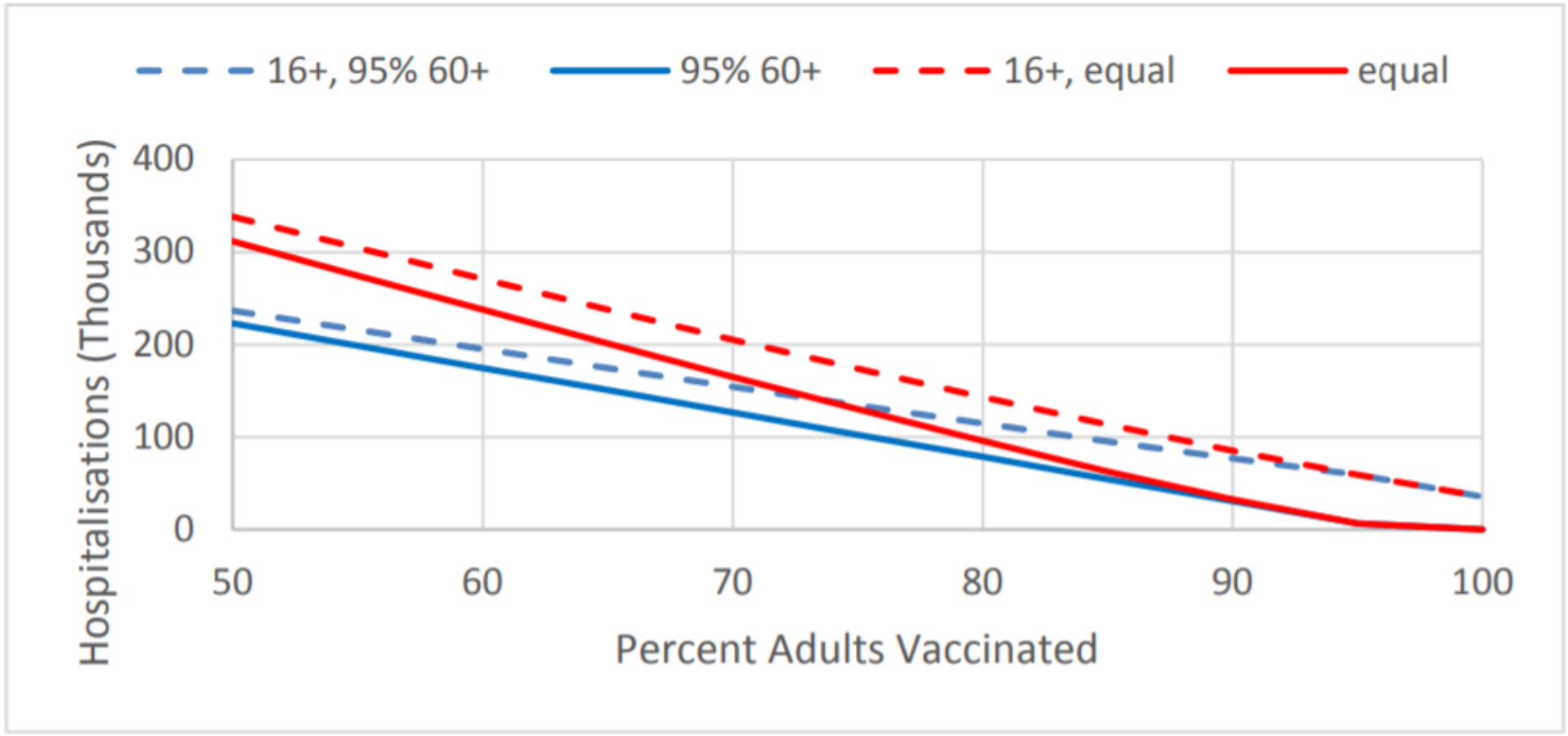
$$NS_j = FSY.FSI.N_j.\left(1 - \sum_k FV_{jk}.VE_k^S\right) \quad (2)$$

$$NH_j = FSY.FSI.N_j.\left(1 - \sum_k FV_{jk}.VE_k^H\right).CHR_j \quad (3)$$

$$NF_j = FSI.N_j.\left(1 - \sum_k FV_{jk}.VE_k^D\right).IFR_j \quad (4)$$

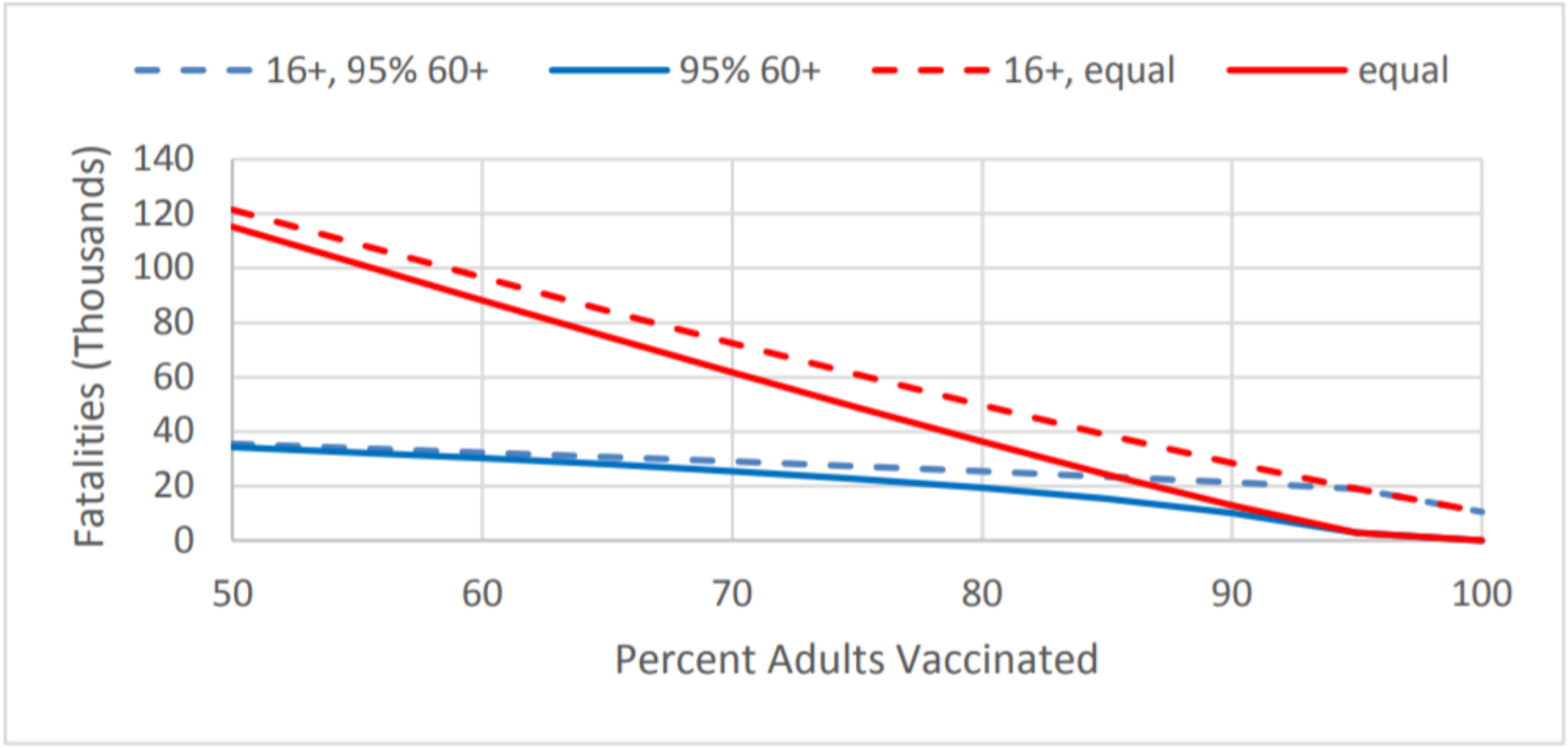
I. Current Vaccination Plan (AZ-mRNA)

Figure 1A. Projected hospitalisations (thousands) under Australia's current AZ-mRNA vaccination strategy at various levels of vaccination coverage.



Note: Blue lines denote a scenario where 95% of those aged ≥60 years are vaccinated, but younger age groups are vaccinated at a lower level (stepped scenario). Red lines denote an equal scenario, where vaccination coverage is uniform across age groups. Dashed lines show the effect of *excluding* children and adolescents from vaccination coverage.

Figure 1B. Projected fatalities (thousands) under Australia's current AZ-mRNA vaccination strategy at various levels of vaccination coverage.



Note: Blue lines denote a scenario where 95% of those aged ≥60 years are vaccinated, but younger age groups are vaccinated at a lower level (stepped scenario). Red lines denote an equal scenario, where vaccination coverage is uniform across age groups. Dashed lines show the effect of *excluding* children and adolescents from vaccination coverage.

II. Comparison of Vaccination Plans:

AZ-mRNA versus mRNA (original strain CHR & IFR)

Figure 2A. Comparison of hospitalisations (thousands) vs adult vaccination level, for the "AZ-mRNA" and "mRNA" strategies, with 95% of adults aged 60+ vaccinated, with and without children under 16 years vaccinated.

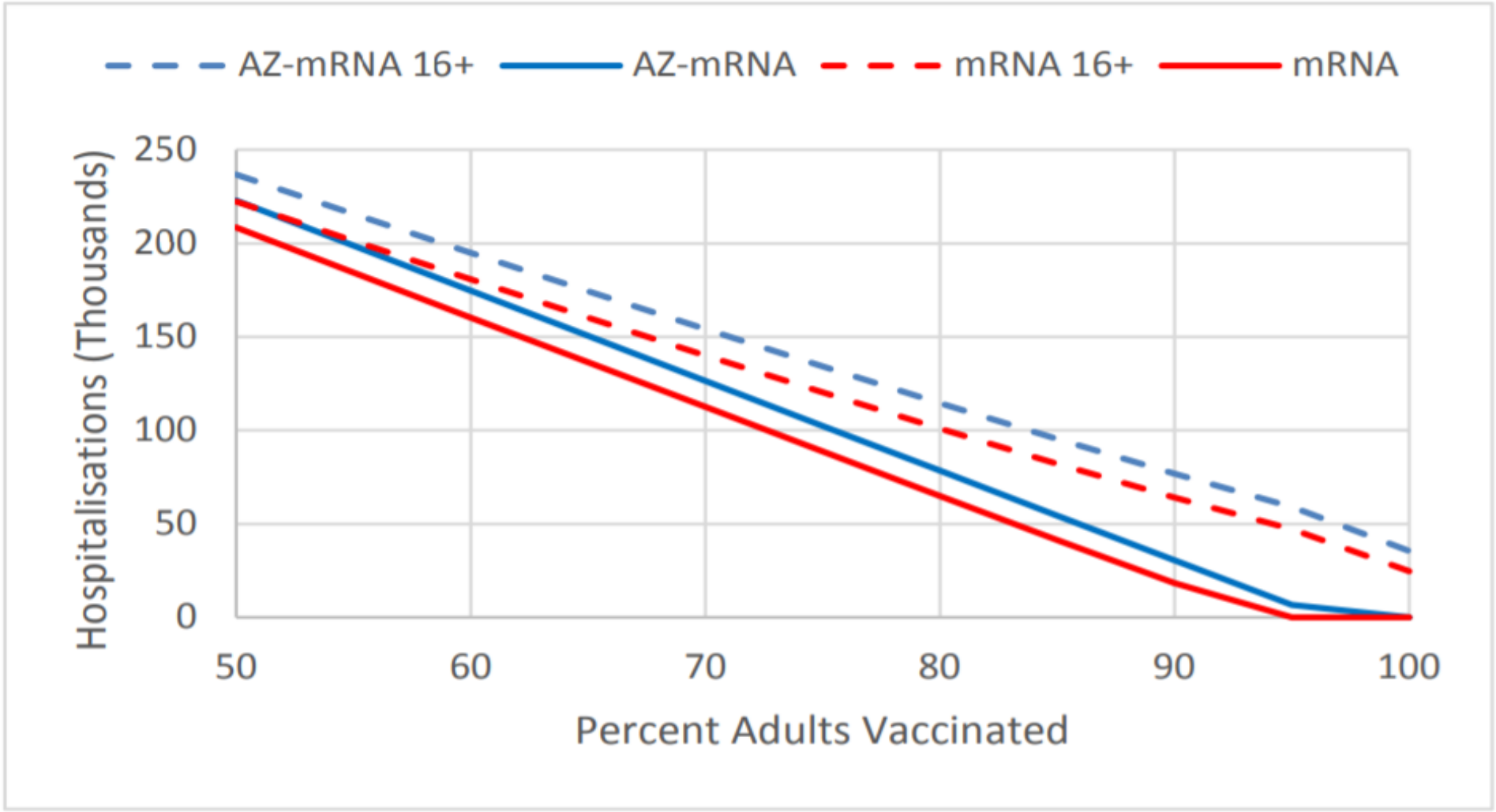
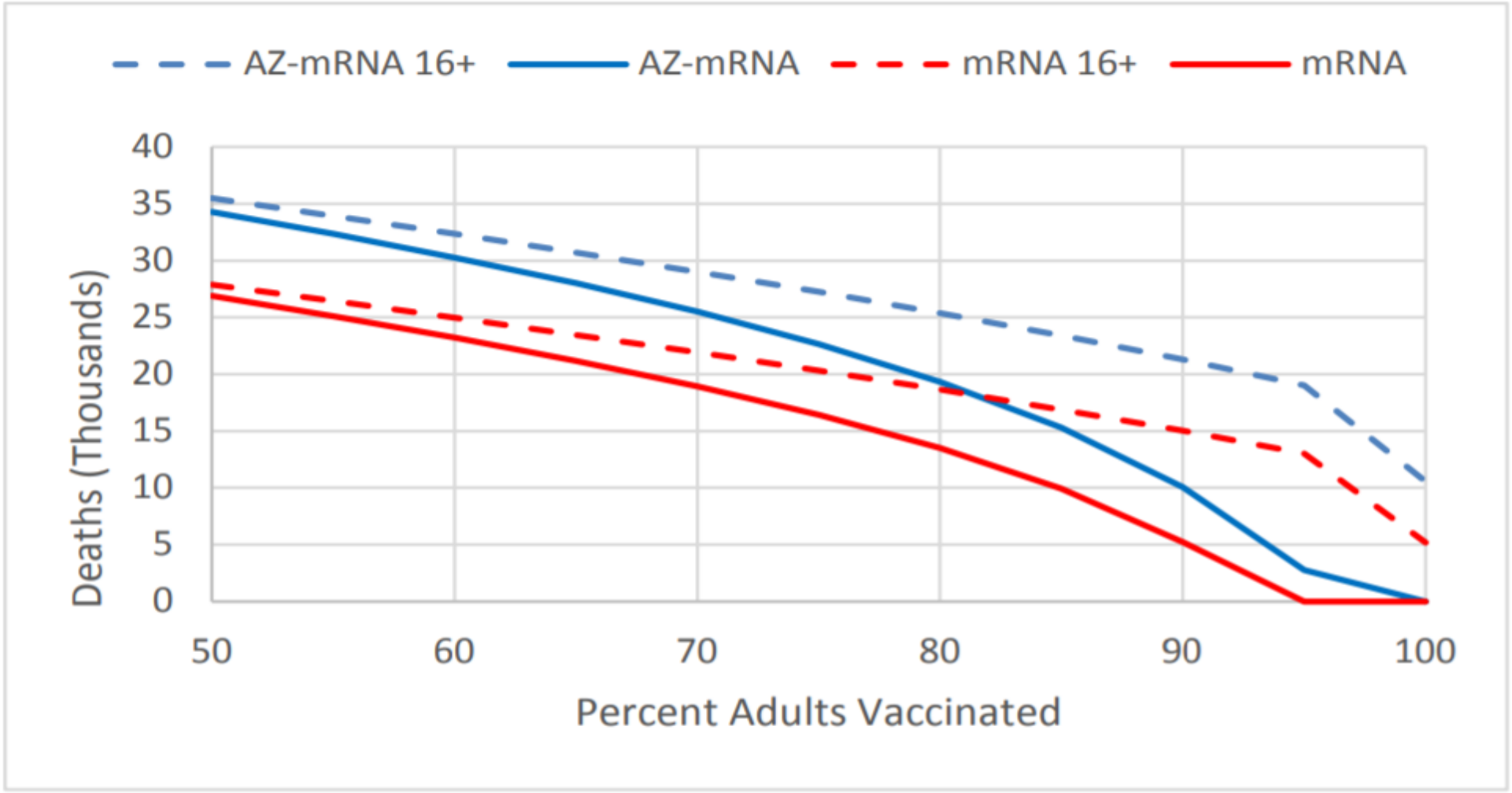


Figure 2B. Comparison of fatalities (thousands) vs adult vaccination level, for the "AZ-mRNA" and "mRNA" strategies, with 95% of adults aged 60+ vaccinated, with and without children under 16 years vaccinated.



III. Comparison of Vaccination Plans:

AZ-mRNA versus mRNA (preliminary Delta CHR & IFR)

Figure 3A. Predicted hospitalisations (thousands) vs adult vaccination level, for the "AZ-mRNA" strategy, *using CHR and IFR scaled up for the Delta variant*.

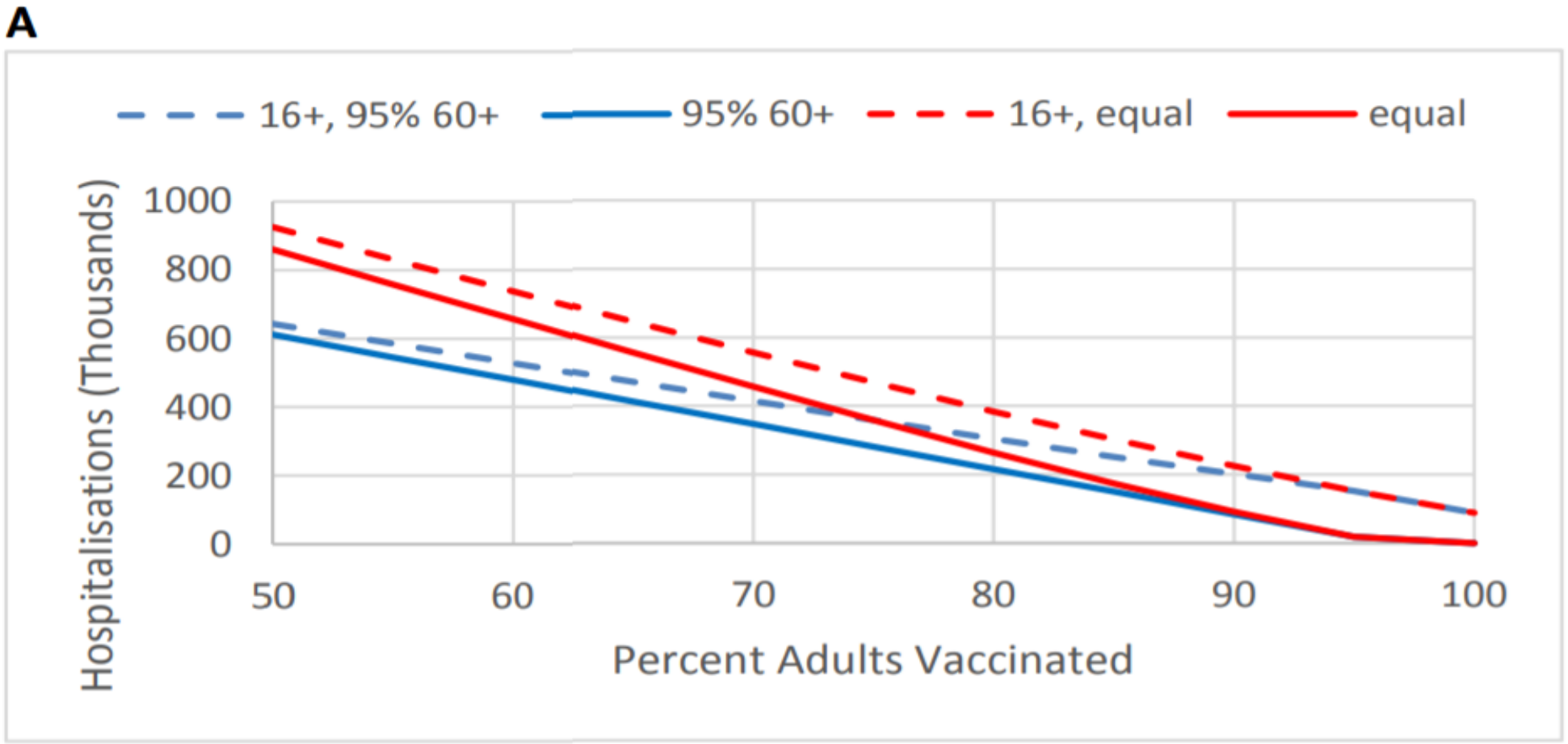
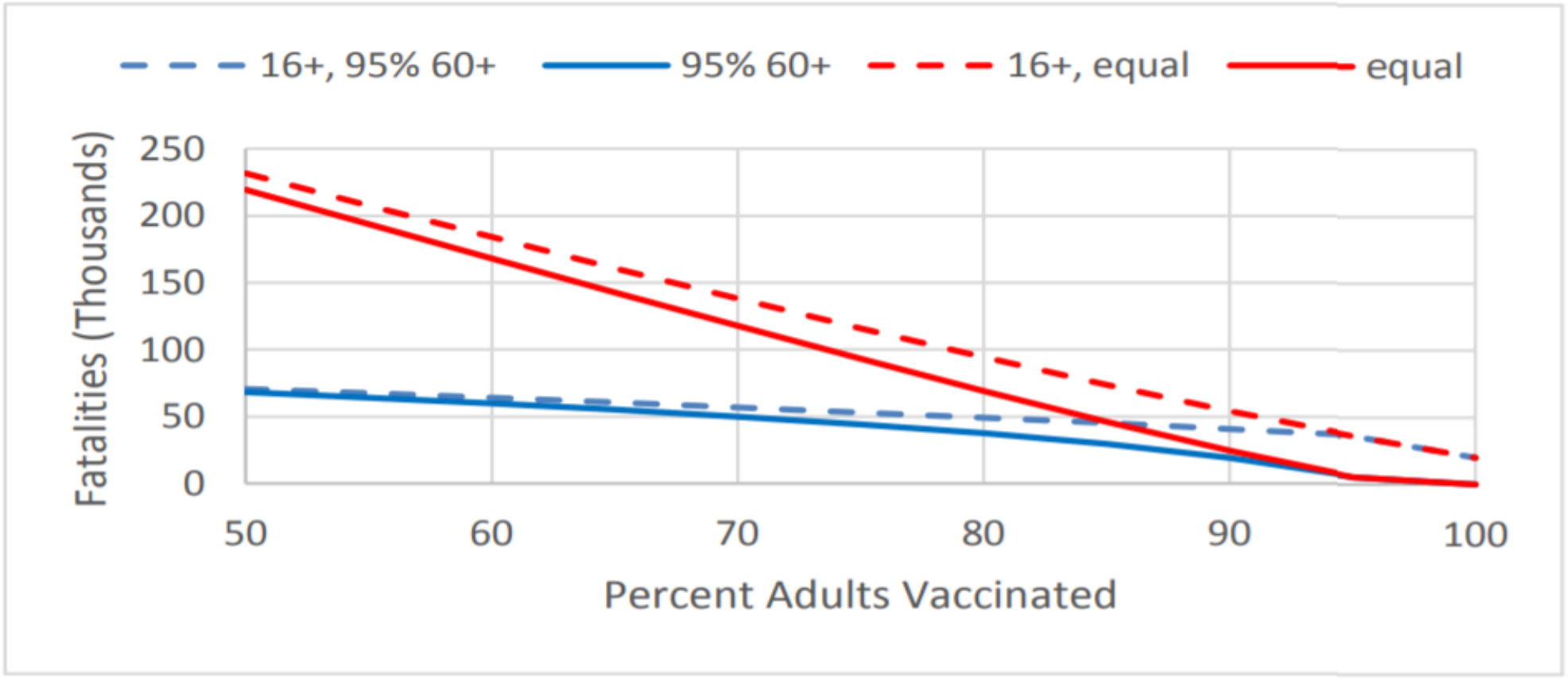


Figure 3B. Predicted fatalities (thousands) vs adult vaccination level, for the "AZ-mRNA" strategy, *using CHR and IFR scaled up for the Delta variant*.



IV. Comparison of Vaccination Plans:

Percentage Affected within Age Cohort

Figure 4A. Percentage of population in each age cohort of hospitalisations for 50, 60, 70, 80, 90 and 95% of adults vaccinated. Assumes the "AZ-mRNA" vaccination strategy, 95% of adults aged 60+ vaccinated, children under 16 *NOT* vaccinated.

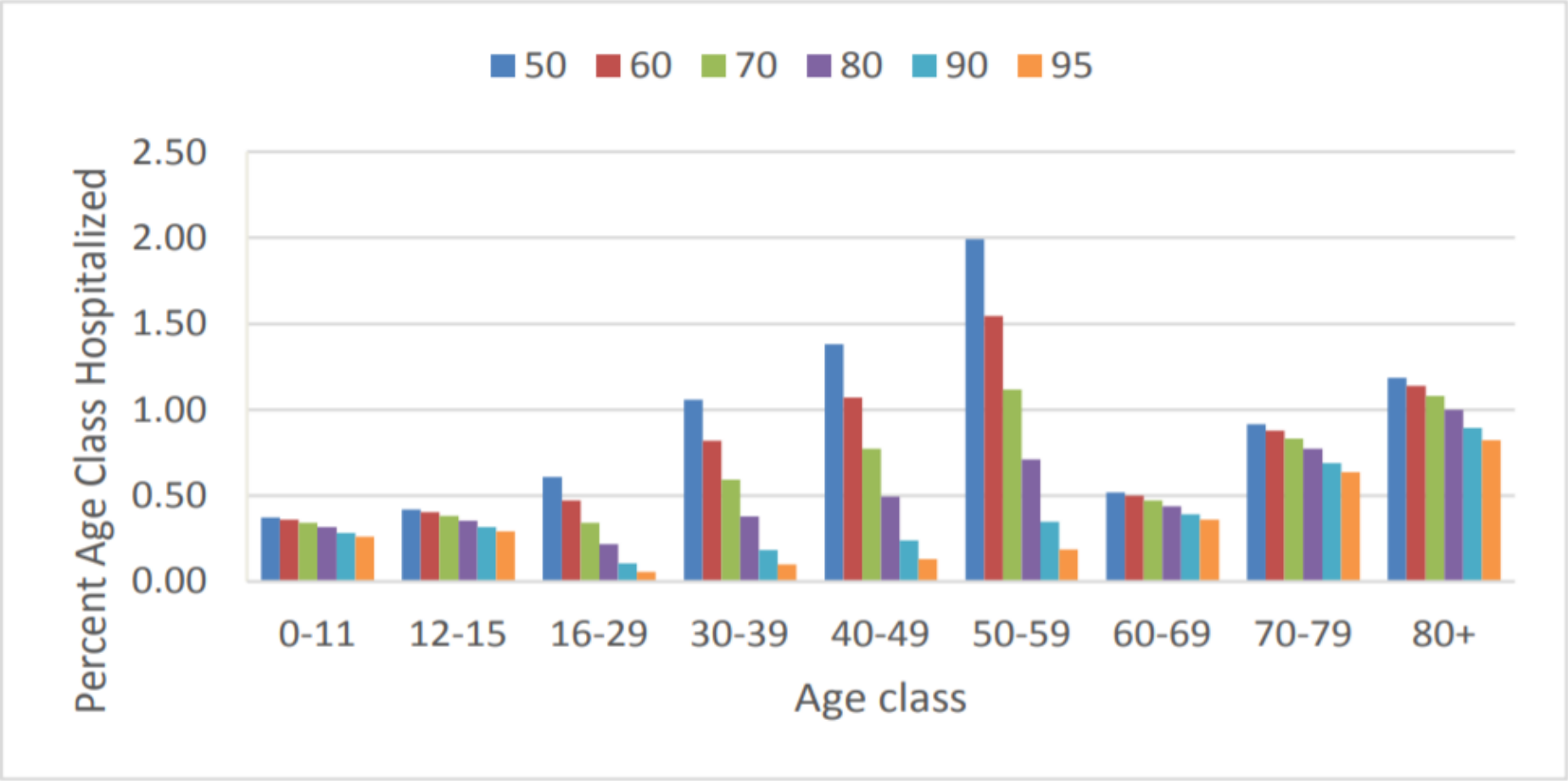
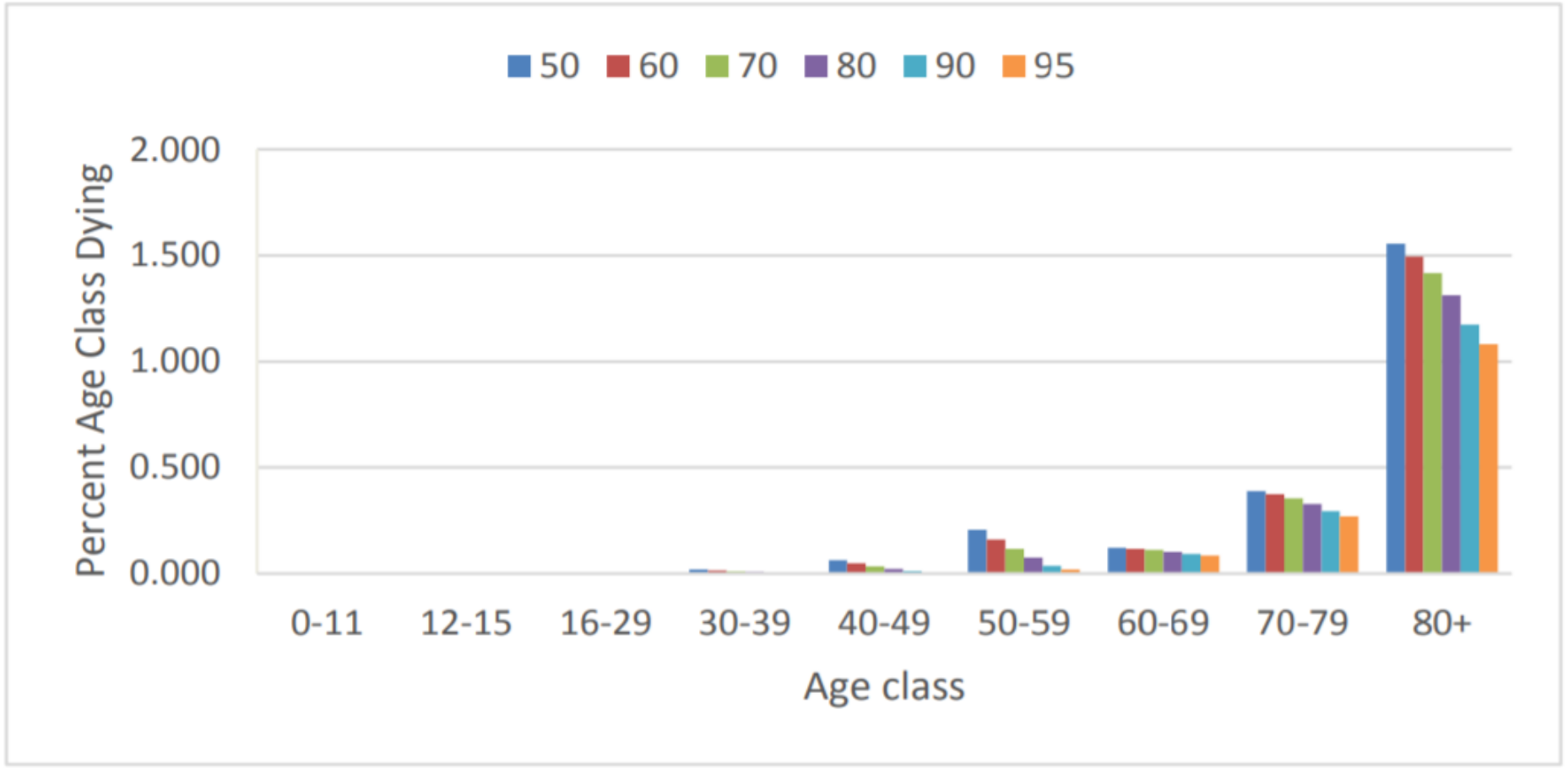


Figure 4B. Percentage of population in each age cohort of fatalities for 50, 60, 70, 80, 90 and 95% of adults vaccinated. Assumes the "AZ-mRNA" vaccination strategy, 95% of adults aged 60+ vaccinated, children under 16 *NOT* vaccinated.



V. Benefit versus Costs of Increasing Vaccination Coverage

Costs of National Lockdowns (A$billion/week)

	Strict	Moderate	Low	Baseline
	3.2	2.35	0.65	0.1

Australian Treasury estimates national lockdown costs per week for different adult vaccination rates under a 'managed transition strategy' where there are high ongoing case numbers:

50-60% adult vaccination coverage = $2.7 billion/week
60-70% adult vaccination coverage = $2.1 billion/week
70-80% adult vaccination coverage = $1.6 billion/week
80%+ adult vaccination coverage = $0.59 billion/week

Benefit-Cost Ratios

Benefit-Cost Ratios (BCR) can be calculated assuming it takes up to 3 months to vaccinate 90% (including 95% 60 ≥ years, vaccinating children) population ***versus*** 80% adult population (Phase C of National Plan).

1. Value Statistical Life sourced from Australian Government = A$5 million and discounted to A$3.5 million VSL.

2. 20,000 fatalities avoided at $3.5 million per life = $70 billion

	Strict Lockdowns	**Moderate Lockdowns**	**Low Lockdowns**	**Baseline Lockdowns**
Benefit (avoided fatalities)	$70 billion	$70 billion	$70 billion	$70 billion
Costs of waiting 12 weeks	$38.4 billion	$28.2 billion	$7.8 billion	$1.2 billion
BCR	1.83	2.48	8.97	58.33

Key Findings

- National Cabinet has set a vaccination target of 80% of Australians aged >= 16 years for the transition to Phase C of the National Plan. If Australia transitions to Phase D *without* vaccinating more people (i.e., it remains at that vaccination rate) , we project there will eventually be 114,000 hospitalisations and 25,000 fatalities.
- These morbidities and mortalities can be reduced to 18,000 hospitalisations and 5,000 fatalities if a 90% vaccination coverage in children, adolescents and adults (with 95% coverage in those aged ≥60 years), an mRNA vaccine booster is given to persons who previously received the ChAdOx1-S vaccine, and future booster doses are used in the entire population as required (to mitigate waning immunity) is achieved **before** transitioning to Phase D.
- Benefit Cost Ratios from maintaining national lockdowns (if required to suppress community transmission) to vaccinate 90% population (with children & boosters) *versus* 80% of adult population varies from 1.8 to 8.97.

‘Acceptable’ Fatalities & National Plan, Phase D

A Guardian Australia Essential Poll released 31 August 2021 found that:

- “61% of respondents say fewer than 100 deaths per year, 25% say between 100 and 1,000 deaths per year, 10% say between 1,000 and 3,000 deaths per year, 2% say between 3,000 and 5,000 deaths per year, and 3% say more than 5,000 deaths per year.”

- “58% of respondents say lockdowns and other restrictions should continue until a substantial proportion of children are fully vaccinated.”

This polling implies that most Australians (at least at present and not considering the trade-offs) would *not* approve of the eventual fatalities implied in Phase D of the current National Plan.

Key Recommendations

Robust vaccination and national transition strategy to 'live with the virus' should:

1. Start from transparent **'maximum tolerable'** levels of morbidity and mortality, **including long COVID** cases, as determined by National Cabinet;
2. Identify the **minimum vaccination levels** for the total population and vulnerable groups required to achieve public health goals, noting that vaccination levels and relaxation criteria should be **fully informed by comprehensive risk analyses**, accounting for scientific uncertainty in key parameters; and
3. **Fully evaluate public health and economic trade-offs** at different vaccination rates.

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