

Impact of funding on influenza vaccine uptake in Australian children

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Key points

- In 2018, most Australian jurisdictions introduced free influenza vaccines for children younger than 5 years
- Self-reported vaccination rates for young children increased by 2.7–4.2-fold in jurisdictions with policies introducing funded vaccines in 2018
- Flow-on effects occurred in children aged 5–17 years, with vaccination rates increasing by 1.2–2.2-fold in this unfunded population
- Our results highlight the importance of funding in increasing the uptake of seasonal influenza vaccines

Abstract

Objectives and importance of study: Young children are at higher risk for serious influenza outcomes but, historically, Australian children aged less than 5 years have had low seasonal influenza vaccine uptake. In 2018, most Australian jurisdictions implemented funded influenza vaccine programs targeted at improving vaccine uptake in this age group. Our aim was to determine how successful these programs were at improving self-reported seasonal influenza vaccine uptake at the community level by comparing vaccination rates in each Australian jurisdiction before and after the introduction of funded vaccines for children aged 6 months to less than 5 years, as well as other age groups.

Study type: Volunteer observational cohort study.

Methods: Flutracking is an email-based surveillance tool for influenza-like illness that collects information about symptoms and influenza vaccination. We used historical data from 2014 to 2017 to estimate baseline vaccination status before funding of childhood influenza vaccines was introduced. We compared self-reported vaccine uptake in children younger than 5 years, children aged 5–17 years and adults (18–64 years, and 65 years and older) in 2018 and 2019 by state or territory. Mixed effects logistic regressions were used to measure the association between vaccination and a number of predictors, including whether the child was eligible for free vaccines, and whether adults resided with children or not.

Results: We found large increases in vaccine uptake for children younger than 5 years in 2018 in all jurisdictions except Western Australia (where vaccines were already funded) and the Northern Territory (where funded vaccines were not introduced until 2019) that coincided with vaccine policy changes. Self-reported vaccination rates for young children in 2018 increased 2.7–4.2-fold in jurisdictions that funded the vaccine (compared with the previous, unfunded period). Being eligible for the funded vaccine was associated with much higher odds (odds ratio [OR] 4.75; 95% confidence interval [CI] 4.57, 4.79) of a young child being vaccinated. Older children

and adults younger than 65 years were also more likely to receive the vaccine following policy changes.

Conclusion: The seasonal influenza vaccine is an important protective measure for those at risk of serious outcomes, including young children. Flutracking data demonstrates that government-funded vaccines can lead to an almost five-fold increase in self-reported vaccine uptake of the targeted age group, as well as previously unreported flow-on effects to older children. This suggests that funded vaccines for young children may encourage caregivers to also vaccinate themselves and their older children.

Introduction

Seasonal influenza is a respiratory infection that has a significant health burden, both worldwide^{1,2} and in Australia.³ Children younger than 5 years have elevated rates of influenza (2–4 times higher than adults aged 25–49 years) and are almost 13 times more likely than adults aged 25–49 years to be hospitalised with the virus.³ Unfortunately, this vulnerable age group has historically been unlikely to receive the seasonal influenza vaccine, with coverage estimates in 2017 of approximately 5% for non-Aboriginal and/or Torres Strait Islander children.⁴ Although vaccine coverage estimates for adults who are not at heightened risk of influenza are scarce, it is likely, based on the most recent random sampling studies available, that about 23% of adults (aged 18–64 years) receive the annual vaccine.⁵ Effectiveness of the influenza vaccine is generally moderate, and can vary between seasons.⁶ However, even when the vaccine is less effective at preventing disease, it may still protect against serious outcomes, including intensive care admission and death.⁷ Despite these benefits, and the increased risks to young Australians, the National Immunisation Program has not historically funded the influenza vaccine for children in Australia (apart from Aboriginal and/or Torres Strait Islander children, and some children with specified risk factors⁸).

Increasing influenza vaccine coverage in children could be an important contributor in reducing the risk of serious outcomes in this vulnerable population, and might also reduce influenza transmission to other groups.⁹ One strategy for increasing coverage is for governments to provide the vaccine for free. The Australian Government has provided free influenza vaccines for Aboriginal and/or Torres Strait Islander children (aged 6 months to under 5 years) Australia-wide since 2015⁸, and Western Australia (WA) has funded the influenza vaccine for all children aged 6 months to under 5 years since 2008. Preliminary evidence for the effectiveness of these initiatives in improving vaccination coverage is mixed. Aboriginal and/or Torres Strait Islander children aged 6 months to less than 5 years (funded Australia wide) have approximately three times higher coverage than non-Aboriginal children (14.9% versus 5.0%)¹⁰, suggesting funded vaccine programs might lead to increased vaccine uptake. However, a recent report found

that while non-Aboriginal and/or Torres Strait Islander children had higher coverage in WA (the only jurisdiction with funded childhood influenza vaccine at the time) than other jurisdictions, overall coverage of children aged 6 months to less than 5 years remained low (11.8%).¹⁰ WA may be a unique case due to issues in 2010, where some children suffered severe febrile adverse events related to an influenza vaccine.¹¹

In 2018, New South Wales (NSW), Queensland (QLD), Victoria, South Australia (SA), Tasmania and the Australian Capital Territory (ACT) joined WA in funding the influenza vaccine for children aged 6 months to less than 5 years. The Northern Territory (NT) followed suit in 2019. Preliminary evidence using data in the Australian Immunisation Register (AIR) showed an increase in vaccine coverage from 2017 (unfunded in most jurisdictions) to 2018 (funded in most jurisdictions)¹⁰, and others have reported similar findings.^{12,13} These results are encouraging, suggesting that government funding initiatives can greatly improve influenza vaccine coverage in at-risk populations. However, as noted by both Beard et al.¹⁰ and Moberley et al.¹², it is plausible that the increases reported in earlier studies at least partly resulted from a response to the comparatively severe 2017 influenza season (which received substantial media coverage).¹⁰ Notably, Beard et al. found increased vaccine coverage in all states and territories, despite neither WA nor the NT changing their funding policy in 2018 (it should be noted that the changes in WA and NT were smaller, but vaccination rates still doubled in those states), and Moberley et al. only reported Australia-wide increases. Importantly, the AIR can be susceptible to issues such as underreporting or selective reporting, which motivates a re-examination using alternative data sources.^{14,15}

More recently, significant increases in vaccine uptake in children younger than 5 years were found in jurisdictions where funded vaccines were introduced, using general practitioner surveillance.¹³ However, these data relate only to the subset of patients presenting to a medical practitioner, may not capture all vaccinations (e.g. pharmacy, community health services) and may also be affected by selective reporting.

We aimed to evaluate the success of the 2018 state/territory funding initiatives in increasing self-reported vaccine uptake among different age groups at the

community level using data from Flutracking, to provide a more comprehensive assessment of the impact of funded vaccines on influenza vaccine coverage in both children younger than 5 years and older age groups. Flutracking is a voluntary weekly online survey that monitors levels of influenza-like illness in the community by asking participants whether they have experienced a fever or cough in the preceding week.^{16,17} Unlike other health surveillance systems, Flutracking operates online and captures members of the community independent from the healthcare system, and thus may capture a different population from healthcare-based systems.¹⁶ Flutracking collects age and seasonal influenza vaccine status (asked weekly until vaccination has been reported, or surveys conclude for the season), as well as postcode of residence. For children, data are reported by an older household member (presumably a parent or guardian).

Methods

To assess how vaccination coverage changed with funding initiatives, we used data from Flutracking to compare vaccination rates (based on each participant's latest survey) in 2018 and 2019 against the average rates in the previous 4 years (2014–2017 seasons). We analysed data from each jurisdiction to better attribute changes to policy rather than other factors, extending our earlier preliminary reports.¹² We included vaccination rates for the 2019 season to assess the effect of the NT policy initiatives, which previous reports have not addressed. We report vaccination rates for Flutracking participants who participated between 2014 and 2019, split into four age groups: younger than 5 years, 5–17 years, 18–64 years, and 65 years and older. Australians aged 65 years and older have been eligible for free influenza vaccines for many years.⁸ We present data for this age group for comparison and completeness, but there is little change in year-to-year vaccination in this group.

Since Flutracking is a longitudinal study, many participants participate over multiple years (in the present data, 62.9% of participants completed surveys in more than 1 year). In addition, one participant responds for all household members. Generally, regression models assume independence of observations, and repeat participation would violate this assumption (as participants and their household members may be more or less likely to receive the vaccine for unobserved reasons). We therefore used a mixed-effects logistic regression to measure the association between vaccination in children (yes/no), and funded vaccines (accounting for state/year, and Aboriginal and/or Torres Strait Islander status), with household as a random effect to account for potential repeat participation between years. We also analysed adults aged 18–64 years from all states except WA and the NT (so that “year” was a proxy for “policy change”) based on whether they reported

having any child younger than 18 years in their household for the given year(s). We included children up to 17 years because we found increased policy-linked vaccination rates in children up to 17 years old in the first analysis. We conducted a mixed-effects logistic regression to measure the association between vaccination in *adults* (yes/no) and having a child younger than 18 years in the household, adjusting for age and socio-economic status¹⁸ as covariates, survey year and whether the adult worked face-to-face with patients as additional predictors, and accounting for potential repeat participation across years (and dependencies between household members) using household as a random effect.

Flutracking received ethics approval from the University of Newcastle (# 06/03/22.403) in 2006. In 2009 the program applied to the University of Newcastle to exit the ethics committee review as Flutracking had been incorporated into the national influenza surveillance system.

Results

From 2014 to 2019 we captured 191 202 records (6870 younger than 5 years, 21 202 aged 5–17 years, 135 070 aged 18–64 years, and 28 060 aged 65 years and older). These numbers include repeat participation – that is, a participant who completed surveys in 3 years will be counted three times. All analyses were on individual records and adjusted for repeat participation using random effects models. In 2018 we observed a marked increase (from the previous 4-year average) in caregiver-reported influenza vaccination rates for children younger than 5 years in all jurisdictions (an additional 31.1–66.7% of the cohort vaccinated), except for WA and the NT (5.1% and –8.7%, respectively). In jurisdictions where an increase was observed, coverage rates increased 2.7–4.2-fold. The percentage vaccinated in all jurisdictions by age group and year are provided in Table 1 and depicted in Figure 1.

In 2019, vaccination coverage for all age groups except those older than 65 years increased in most jurisdictions; however, the largest change was observed in children younger than 5 years in the NT (50% compared with median change of 13.8% across all jurisdictions and ages). For all children younger than 5 years who participated in Flutracking between 2014 and 2019, those eligible for the funded vaccine (at the time of survey, including national- and state-based programs) had coverage rates 3.75 times higher than those of their unfunded counterparts (mean = 60% versus mean = 16%). This result was statistically significant when accounting for repeated participation over survey years using a mixed-effects logistic regression (odds ratio [OR_{Funded}] 4.75; 95% confidence interval [CI] 4.57, 4.79; $p < 0.001$).

Figure 1 shows there is evidence of an increase in vaccination rates of the 5–17-year age group in 2018.

Table 1. Percentage vaccinated and standard error for each jurisdiction by age and year

State/ territory	Age, years	Percentage vaccinated (standard error)		
		2014–2017	2018	2019
NSW	0–4	13.58 (1.98)	57.82 (2.11)	63.80 (1.94)
	5–17	17.30 (1.27)	31.32 (1.11)	44.24 (1.11)
	18–64	59.74 (0.66)	64.78 (0.49)	69.01 (0.45)
	65+	82.56 (1.20)	86.48 (0.67)	87.70 (0.56)
VIC	0–4	16.64 (3.08)	59.51 (2.92)	70.12 (2.53)
	5–17	18.21 (2.06)	40.82 (1.71)	59.23 (1.57)
	18–64	64.19 (0.91)	68.33 (0.67)	75.15 (0.57)
	65+	82.65 (2.00)	88.59 (0.84)	89.88 (0.68)
QLD	0–4	15.94 (3.63)	51.72 (3.52)	65.35 (3.36)
	5–17	19.61 (2.32)	35.44 (1.90)	49.36 (1.89)
	18–64	61.13 (1.22)	67.50 (0.85)	71.88 (0.78)
	65+	85.65 (2.13)	85.78 (1.18)	87.26 (1.04)
SA	0–4	18.45 (4.15)	49.52 (4.90)	72.73 (3.60)
	5–17	19.02 (2.44)	33.33 (2.43)	56.43 (2.36)
	18–64	70.84 (0.97)	70.21 (0.85)	78.94 (0.72)
	65+	88.50 (1.89)	89.28 (1.19)	93.48 (0.83)
TAS	0–4	14.02 (4.00)	55.26 (4.68)	71.07 (4.14)
	5–17	17.42 (2.48)	30.65 (2.52)	44.96 (2.41)
	18–64	66.94 (1.14)	71.32 (0.96)	73.72 (0.85)
	65+	83.43 (2.61)	86.60 (1.57)	90.27 (1.23)
ACT	0–4	16.91 (5.47)	83.51 (3.79)	75.21 (3.94)
	5–17	21.84 (3.94)	33.64 (3.21)	48.88 (3.06)
	18–64	65.13 (1.78)	67.90 (1.31)	73.68 (1.15)
	65+	87.94 (3.53)	93.24 (1.24)	93.79 (1.05)
NT	0–4	19.09 (8.13)	10.34 (5.76)	55.00 (7.97)
	5–17	13.76 (3.58)	16.98 (3.66)	35.45 (4.58)
	18–64	63.97 (1.86)	66.11 (1.69)	69.12 (1.65)
	65+	82.57 (4.56)	84.67 (3.09)	84.44 (3.13)
WA	0–4	38.16 (4.82)	43.26 (3.72)	68.42 (3.09)
	5–17	23.66 (2.53)	26.83 (1.85)	56.09 (1.93)
	18–64	62.32 (1.10)	64.04 (0.80)	71.25 (0.72)
	65+	83.71 (2.57)	82.11 (1.46)	85.19 (1.25)

NSW = New South Wales; VIC = Victoria; QLD = Queensland; SA = South Australia; TAS = Tasmania; ACT = Australian Capital Territory; NT = Northern Territory; WA = Western Australia

This change was smaller than in 0–4-year-olds – the median proportion increase for the 0–4-year-olds in 2018 (3.76) was 2.1 times higher than the median proportion increase for 5–17-year-olds (1.78) in jurisdictions that introduced funding in 2018. In 2019, vaccination coverage among 5–17-year-olds increased further, and, by the end of the year, had increased between 2.2 (ACT) to 3.3 (Victoria) times. In children aged 0–4 years,

vaccination rates had increased between 2.9 (NT) to 5.1 (Tasmania) times compared with pre-funding levels.

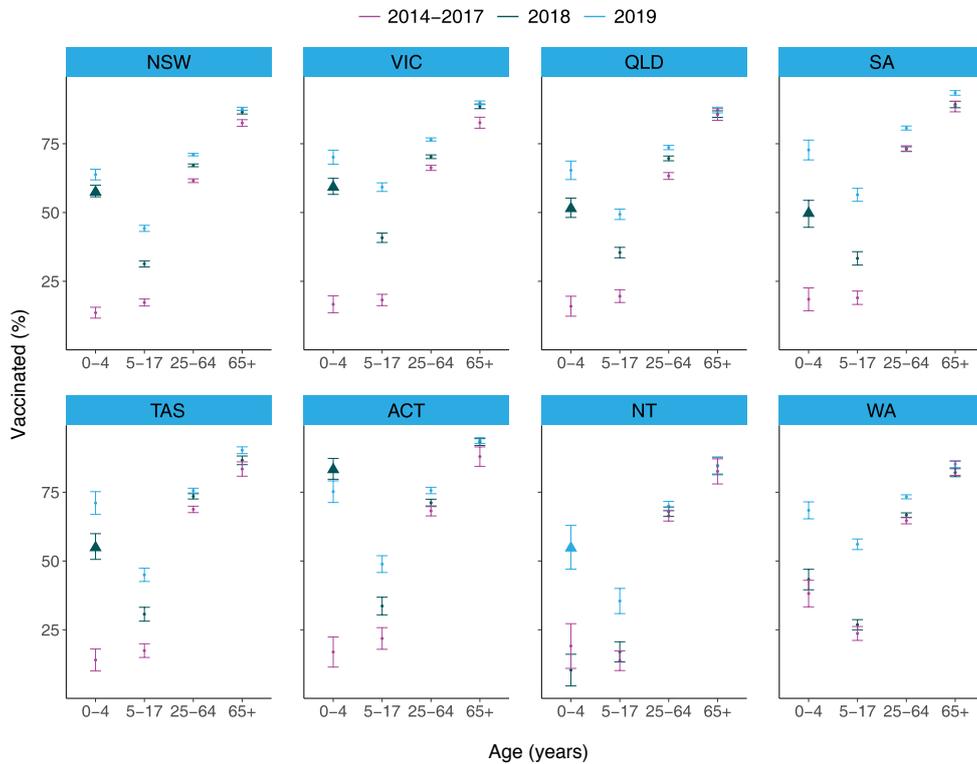
Change in adult vaccination rates is less apparent. However, adults with at least one child (younger than 18 years) in their household showed a much larger increase in vaccination rates than adults without children residing in their household in the year funded vaccines for children younger than 5 years were introduced (Figure 2 – the values plotted are marginal means from the regression reported below). The interaction of year and child-in-household on vaccination rates was significant ($F = 15.97$; $p < 0.001$), and, overall, adults with children in their household were less likely to be vaccinated than adults without children in their household ($OR_{\text{Child-in-household}} 0.963$; 95% CI 0.952, 0.973; $p < 0.001$). Before 2018 the difference in vaccination between adults with and without children in their household was 5.3% after accounting for covariates; this almost halved – to a 2.4% difference – after the introduction of funded vaccines for young children.

Discussion

Our results clearly show that caregiver-reported influenza vaccine uptake in children aged 6 months to less than 5 years substantially increased in 2018 in all jurisdictions that introduced a funded vaccine policy that year. The remaining jurisdictions (WA and NT) showed little to no change in vaccination coverage in the same age group, strongly suggesting the change in vaccination was related to the funding initiatives. Vaccination coverage increased across the board in 2019, but especially so in the NT. The magnitude of the NT changes suggest that they can be attributed, at least in part, to the policy change in 2019. When accounting for all funding initiatives (2018, 2019 and Aboriginal and/or Torres Strait Islander-focused funding schemes), funded vaccines were associated with a 4.75-fold increase in vaccine uptake for children aged less than 5 years in the Flutracking data, reflecting the magnitude and immediacy of the change observed in the targeted group, concurring with earlier findings.^{10,12,13} These large changes in vaccination rates alongside policy changes highlight the success of the state-based policy changes introduced in 2018 and 2019.

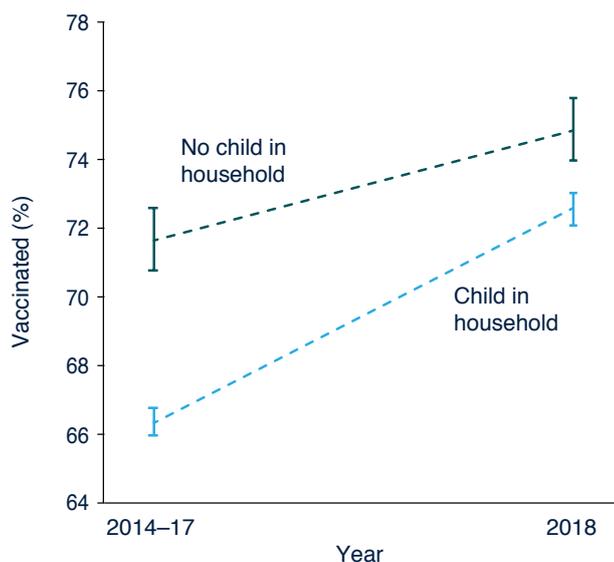
In earlier work, we reported “flow-on” effects to older age groups (5–17 years – that is, ages that were not funded).¹² Here we more closely connect these changes to policy; only jurisdictions introducing a policy change had increases in 5–17-year-old vaccination rates in 2018 (consistent with the changes in children younger than 5 years). This suggests that funding a relatively small cohort (6 months to less than 5 years) can increase immunisation coverage across a much wider range of ages (although the magnitude of the increase was approximately half that of the funded ages). Given the potential herd immunity benefits of vaccinating school-aged children⁹, these results are particularly encouraging.

Figure 1. Flutracking self- or caregiver-reported influenza vaccine coverage by jurisdiction, year and age group; triangles denote the year funded vaccination was introduced for children younger than 5 years in each jurisdiction



NSW = New South Wales; VIC = Victoria; QLD = Queensland; SA = South Australia; TAS = Tasmania; ACT = Australian Capital Territory; NT = Northern Territory; WA = Western Australia
 Note: NT introduced funding in 2019, and WA introduced funding before 2014 and did not change policies between 2014 and 2019.

Figure 2. Vaccination rates of adults aged 18–64 years, by survey year(s) and presence of children younger than 18 years in household



Note: These values are marginal means from the mixed-effect logistic regression reported in the text, adjusted for age, socioeconomic status, whether works with patients, and household.

We have also identified that funded vaccines for children younger than 5 years were associated with a significant increase in the vaccination rates of adults when they reported children younger than 18 years residing in their household. This is another promising benefit that has not previously been reported. Importantly, the funded vaccines seemed to reduce a potential disparity in vaccination rates between adults with and without children, evidenced by the interaction effect (see Figure 2). Although our data cannot speak to why this might be the case, it is encouraging nonetheless.

In light of the coronavirus disease (COVID-19) pandemic, our results may contribute valuable insight that can help drive the rollout of a vaccine. However, we caution against generalising learnings from seasonal influenza to the unprecedented pandemic conditions. Taken alongside other measures^{10,13} our results suggest that funding the seasonal influenza vaccine for children aged 6 months to less than 5 years can be effective at encouraging vaccine uptake across children of all ages, and parents/caregivers as well. Recently, WA announced the introduction of funded influenza vaccines for all primary school-aged children.¹⁹ Determining the effect of this additional funding could prove important for future influenza policy decisions (in particular, whether the additional cost provides sufficient increases in

coverage compared with the flow-on effect we report here). Additional focus should also be given to the reasons underlying the lower rates of vaccination for adults with children. This effect was notable (5.3% lower vaccination rates after correcting for covariates) before 2018 and persisted (albeit reduced) after the funded vaccine programs. It is also interesting that, in 2018, the newly funded states generally showed higher rates of vaccination than WA, which has had funded vaccines since 2008. Whether this suggests funded vaccines provide only a temporary boost (presumably due to increased messaging when the funded vaccines first become available), or if WA is a special case (due to the aforementioned severe febrile adverse events related to an influenza vaccine¹¹) is yet to be determined, and should be monitored closely.

Our adult data highlights general increases in vaccination rates in 2019, which may in part reflect the heightened awareness of influenza driven by media reports of the “summer flu” and the 2019 season in general.²⁰ This suggests that 2020 may see even greater increases, given the heightened focus on respiratory illness due to the COVID-19 pandemic. Indeed, our data as at 15 November 2020 shows record-high vaccination rates of 83.5% across the Flutracking cohort. One unresolved question is what caused the large, age-independent increase in vaccination we observed for WA in 2019.

Finally, a few caveats should be noted. The Flutracking program is a voluntary, self-sign-up, online survey. This sets it apart from other health surveillance systems, enabling access to generally healthy participants who self-report their vaccinations (which may mitigate some reporting issues found in other surveillance systems).^{14,15} However, this opens up the possibility for selection bias (e.g. individuals who sign up for Flutracking may be more health conscious). Flutracking is also based entirely on self-reported data. The latest annual Flutracking report¹⁷ contrasts the Flutracking population with the Australian population, and typically finds an underrepresentation of Aboriginal and Torres Strait Islander peoples, and an overrepresentation of women, healthcare workers, and those with higher education and socio-economic status. These caveats trade off against the unique insights that can be gained from these data. Flutracking data reliably correspond to other illness surveillance systems¹⁷, and the results we report here corroborate earlier findings from other systems^{10,13} (while providing additional insights). It is important that future investigations draw from the strengths of different surveillance systems.

Conclusion

Flutracking-based results demonstrate encouraging novel evidence of the success of government-funded influenza vaccination programs in increasing coverage in the targeted childhood age group and other children.

We replicated early findings of increased vaccination in children aged 6 months to less than 5 years in 2018, and showed very clearly that these increases were specific to jurisdictions that introduced funded vaccination for those ages in 2018. These analyses help clarify earlier results and extend the finding to the community setting. These results are important, especially when considering maximising COVID-19 vaccine coverage when a vaccine becomes widely available, and suggest that funding vaccines is an effective tool for increasing community vaccination coverage. We highlighted that funding young children may lead to a flow-on increase in vaccinations for older children (5–17 years), and perhaps also for adults living with vaccinated children. Future research should monitor the stability of increased influenza vaccine coverage over time to determine whether funded vaccination leads to sustained higher vaccination uptake, or only a temporary boost.

Peer review and provenance

Externally peer reviewed, not commissioned.

Competing interests

None declared.

Author contributions

ZH led the analysis and preparation of the manuscript. SC and ZB led the data collection and assisted with manuscript preparation. CD and DD led the project, provided expert input and assisted with manuscript preparation.

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