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SMS reminders increase on-time vaccination in Aboriginal and Torres Strait Islander infants

Jane L Manderson, Nicolas R Smoll, Dianne L Krenske, Lucinda Nedwich, Latoya Harbin, Margaret G Charles, Amanda Wyatt, Connie N Schulz, Jacina Walker, Gulam M Khandaker

Abstract

Timely immunisation is important to protect children from communicable diseases. However, immunisation uptake in Aboriginal and Torres Strait Islander children under the age of two years is often lower than in non-Indigenous children. This contributes to the gap in health outcomes between Aboriginal and Torres Strait Islander children and non-Indigenous children. We have tested the effectiveness of short message service (SMS) reminders in improving timeliness of childhood immunisation in Aboriginal and Torres Strait Islander infants in regional Queensland, Australia. Reminders were sent to parents of Aboriginal and Torres Strait Islander children, at five immunisation age milestones: six weeks, four months, six months, 12 months, and 18 months. There was a significant improvement in the proportion of children vaccinated on-time (within 30 days of the due date), compared to an earlier age cohort, at all milestones except 12 months. The absolute risk difference (ARD) of on-time vaccination between the two cohorts ranged between 4.7% (95% confidence interval [95% CI]: 1.1–8.2%, at six weeks) and 12.9% (95% CI: 7.4–18.5%, at six months). The likelihood of on-time vaccination (rate ratio, RR) in the intervention group compared to the control group ranged from 1.05 (95% CI: 1.01–1.10, at six weeks) to 1.31 (95% CI: 1.14–1.50, at 18 months). SMS reminders were associated with an improvement in immunisation timeliness in Aboriginal and Torres Strait Islander infants at all age milestones measured except 12 months.

Keywords: Immunisation; timeliness; short messaging service; reminders; Indigenous health; Aboriginal and Torres Strait Islander health; child health.

Introduction

Prevention and control of communicable disease is an essential part in reducing the burden of disease that disproportionately affects Australian Aboriginal and Torres Strait Islander peoples.¹ In 2015, the burden of vaccine-preventable disease in the Aboriginal and Torres Strait Islander population was 4.1 times the rate of the burden in non-Indigenous Australians.² High levels of vaccination timeliness are needed to prevent communicable diseases, but immunisation uptake in Australian Aboriginal and Torres Strait Islander infants is frequently lower than in non-Indigenous infants aged two years and under.³ The Australian Government provides free vaccines to all children under five years

old, including some additional vaccines for Aboriginal and Torres Strait Islander children, under the National Immunisation Program. The target coverage rate is 95.0%. Timely vaccination (within 30 days of the due date) is essential to ensure that all children have the best available protection against vaccine-preventable diseases.⁴ Ensuring that all Aboriginal and Torres Strait Islander children receive all the vaccines for which they are eligible, on-time, is an important part of the national strategy to improve health outcomes in the Aboriginal and Torres Strait Islander population and to close the gap in life expectancy between Indigenous and non-Indigenous Australians.

Short message service (SMS) reminders (text messages) sent to the mobile phone have a modest effect in improving vaccination uptake.⁵⁻¹⁸ A Cochrane systematic review and meta-analysis found that an SMS reminder improved likelihood of vaccination by a rate ratio (RR) of 1.29 (95% CI: 1.15–1.44).¹² Several studies have also shown that one or more SMS reminders sent to the parent improved the proportion vaccinated by between 0.5 and 15.7 percentage points.^{5,7,10,11,17-20} Menzies found that SMS reminders can improve timeliness of children's vaccinations alone or in combination with a personalised calendar compared to no intervention,¹⁴ although this was limited to children who had been overdue for one or more previous doses.

SMS reminders may be more effective in segments of the community that are difficult to reach. These include high-risk groups such as racial minorities, low-income families, and transient groups.^{7,11,17,21-28} People experiencing homelessness, or who have a phone plan that favours text messages over phone calls can be reached more easily than with a letter or call to the home phone.²² Those with low literacy can also access information about immunisations and when they are due more easily.⁷ The SMS also helps parents and caregivers not to forget that their child's immunisations are due.⁷

The literature shows that parents appreciate receiving SMS reminders.^{22,24,26,29-32} A survey of parents of minority ethnicities in inner-city New York, in the United States of America, has shown that there is a strong relationship between reminder systems and influenza vaccination status.³³ Parents have said that reminders and education would be helpful to make the decision to vaccinate and ensuring that it happens on time.⁷ This intervention was identified as the one that would most significantly decrease barriers to their child's immunisation.⁷

SMS reminders have many benefits. They are more effective at improving vaccination uptake compared with usual care.^{13,24} SMS reminders can be received by people on all mobile phone plans.²² Also 40% of Queensland

residents have moved house in the last five years.³⁴ Because mobile phone numbers often remain the same and are checked at every occasion of service at the health service, text message reminders are more likely to reach the whole community. Some US studies have found that centralised reminder systems (such as a state-government based system) or outsourced systems are more effective and cost-effective than general practice-based reminders, particularly if they include the child's healthcare provider's name.^{13,35-37} A centralised reminder system was found to save time and money and was more sustainable.

Tailored or personalised reminders, including from a trusted person, and offers of support to vaccinate have been shown to be more effective than just a simple SMS reminder in Australian children.^{14,16,38} Cashman et al. found that a pre-call from an Aboriginal or Torres Strait Islander Health Worker was effective to close the gap between Indigenous and non-Indigenous children's vaccination coverage rates at the 12 months milestone.³⁸ Menzies et al. found that the combination of an SMS reminder and a personalised calendar was more effective in improving immunisation timeliness than no intervention.¹⁴ Another Australian study has shown that a tailored SMS reminder with the offer of additional support to immunise was more effective in improving immunisation timeliness in infants at three and five months of age than was a simple message and no intervention.¹⁶

Research on the effectiveness of SMS reminders in Australian Aboriginal and Torres Strait Islander peoples is sparse. Our pilot study of SMS reminders in a regional city in Australia improved immunisation timeliness.^{39,40} The benefits were seen in all children, and more so, in Aboriginal and Torres Strait Islander children.

This cohort study measures the effectiveness of SMS reminders on immunisation timeliness, solely in Aboriginal and Torres Strait Islander infants in Central Queensland, a large regional area of Australia.

Methods

Design

This is a quasi-experimental study to test the effectiveness of SMS reminders on immunisation timeliness. The immunisation timeliness of a prospective birth cohort (Aboriginal and Torres Strait Islander infants born in Central Queensland whose parents received SMS reminders just before their child's immunisations were due) was compared with a historical control group of Aboriginal and Torres Strait Islander infants born in Central Queensland whose parents did not receive a reminder. We aimed to include all Aboriginal and Torres Strait Islander infants born in Central Queensland in the study during the control and intervention recruitment periods.

Our Public Health Unit has a designated Indigenous Health Promotion Officer position. This person links us with the community, and we do not do anything in the community without their assistance. When this position was vacant, we were linked to the community by Indigenous Health Workers in the child health teams around the Hospital Health Service (HHS) area. The Indigenous Health Promotion Officer and the Public Health Immunisation Nurse consulted the Traditional Owners from the beginning, when we were investigating how to design the project. This occurred prior to the commencement of the pilot project in Gladstone. Information discussed included how the project would be implemented, the fact that we aimed to recruit all Aboriginal and Torres Strait Islander children in those age groups, and the roles of each team member. Parents were asked for feedback about the promotional materials, according to the usual consumer consultation process at the HHS. General practitioners (GPs) at the local Nhulundu (Aboriginal Controlled) health service in Gladstone were also informed. Prior to the current iteration (sending the reminders to all Aboriginal and Torres Strait Islander children in the relevant age groups), we met with representatives of all the Traditional Owners of the lands on which CQHHS lies. Some attended

via videoconference (our area is quite large) and others were at the meeting in person. Similarly, we used the presentation to indicate what would happen and who would do what. This presentation took place in September 2018 and the Traditional Owners gave us their support. The project was presented to the community at a NAIDOC week celebrationⁱⁱⁱ in Rockhampton in 2018. In addition, the Central Queensland Aboriginal and Torres Strait Islander radio station (100.7FM Radio 4US) included a segment to promote the SMS Precall Project, during the 'Looking Good, Feeling Deadly' radio show.

Setting

The study was conducted by the state government health service in Central Queensland, a regional area of Australia. Aboriginal and Torres Strait Islander Health Workers assisted us to consult the Traditional Owners, link with the community and promote the project. Local public and private maternity units, obstetricians, midwives, and Aboriginal and Torres Strait Islander child health care providers made parents of the intervention group aware of the reminders and why they were sent. Parents could contact the Public Health Unit to opt out.

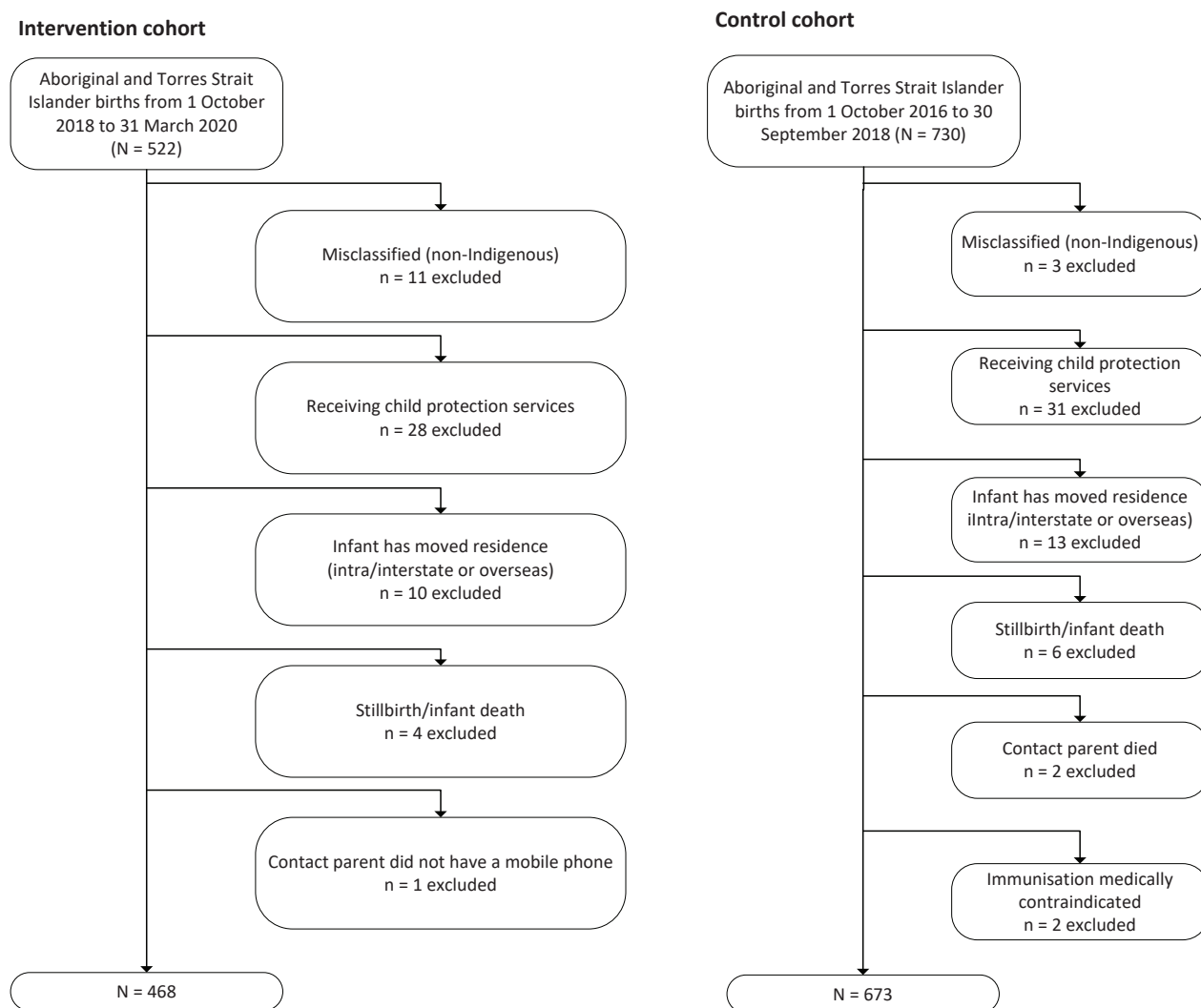
Participants

We aimed to include all infants who were identified by their parent as being of Aboriginal and Torres Strait Islander origin and born in Central Queensland during the intervention or control recruitment periods. Infants in the intervention group were born between 1 October 2018 and 31 March 2020. Infants in the control group were born between 1 October 2016 and 30 September 2018. Inclusion and exclusion criteria are listed in Figure 1. Exclusion criteria include misclassification of Indigenous status (the child was incorrectly recorded as 'Aboriginal and/or Torres Strait Islander' on the Queensland Health database and discussions with local Aboriginal

i NAIDOC: National Aboriginal and Islander Day Observance Committee.

ii <https://www.naidoc.org.au/about/naidoc-week>.

Figure 1: Study population, inclusion and exclusion criteria



and Torres Strait Islander health workers and the child’s family doctor established that the child was clearly non-Indigenous); stillbirth / infant death; medical contraindication to immunisation; or if project staff were unable (or it was inappropriate) to contact the parent. We did not contact families if their children were receiving child protection services; if the contact parent died; if families moved away from Central Queensland; or if parents did not possess a mobile phone. Three infants in the intervention group were late inclusions into the study as we only became aware of their existence after the six-weeks vaccination age milestone had passed. The parents of five children in the intervention group declined their children’s vaccinations at some milestones; these children were included in the analysis. After application

of exclusion criteria, there were 468 infants in the intervention group and 673 eligible infants in the control group.

Data collection

A child’s vaccination status was determined by their Australian Immunisation Register (AIR) record. The final check of the immunisation histories for the intervention group was in May 2022. The intervention group was followed up for an average of 2.9 years per child. The vaccination status of the control group was checked for the last time in December 2021. The control group was followed up for an average of 4.2 years per child.

Intervention

Parents of children in the intervention group received an SMS message to their mobile phone via an appointment reminder system in the Queensland Health administrative database. Reminders were sent five days before each vaccination age milestone (six weeks, four months, six months, 12 months and 18 months). The SMS stated: “Your child is due for their next scheduled vaccination. Please contact your GP [General Practitioner] or Child Health Clinic to make an appointment”. An administration officer was employed in the Public Health Unit to set up virtual ‘clinics’ in the database, and a reminder was sent to the parent’s mobile phone on the appropriate day.

Outcome measures

The aim of the study was to determine whether the SMS reminders increased the proportion of children vaccinated on time. A child was considered vaccinated on time if their milestone vaccinations were given within 30 days of the due date. Immunisations included in the analysis were those indicated for all children, and those indicated for Aboriginal and/or Torres Strait Islander infants, in the National Immunisation Program (NIP) schedule for Queensland (in effect between October 2016 and September 2021). Some vaccinations were excluded from the analysis. Rotavirus vaccinations were excluded because of the strict upper age limits for administration. Influenza vaccinations were not included because they are administered during the flu season only, not at the various age milestones in the schedule. Vaccinations indicated only for children who are ‘medically-at-risk’ (due to comorbidities) were not included as it was not possible to identify medically-at-risk children.

Sample size

The sample size analysis suggested a sample of 577 in each cohort (1,154 in total) was needed to

detect an increase in vaccination coverage from 87.0% to 90.0%, with 90.0% power. This allows the detection of a risk ratio of less than 1.1.

Statistical methods

A Pearson chi square was utilised to look for confounding by sex, Indigenous status (Aboriginal only, Torres Strait Islander only or Both Aboriginal and Torres Strait Islander) and place of birth. Timeliness was measured using proportion vaccinated on time, absolute risk difference (ARD) between the proportion vaccinated in the two groups, likelihood of vaccination (rate ratios (RR)), and the number of parents needing to receive a reminder to vaccinate one child (number needed to remind (NNR), a variant of number needed to treat (NNT)). Analysis was completed using Stata 17 (College Station, Texas), in Microsoft Excel and the OpenEpi online software (www.OpenEpi.com).

Results

A total of 1,141 children were included in the analysis, 468 in the intervention group and 673 in the control group. A total of 2,551 SMS reminders were sent, at \$AU0.25 per reminder, in total \$AU637.75. Table 1 shows the demographic characteristics of the two cohorts. Just under half of intervention infants (48.7%) and control infants (48.1%) were female. Most (84.6% of intervention infants and 83.5% of control infants) were identified as being of Aboriginal origin only. A proportion of infants (4.1% of intervention infants and 3.6% of control infants) were identified as being of Torres Strait Islander origin. The remainder (11.3% of intervention infants and 12.9% of control infants) were of both Aboriginal and Torres Strait Islander origin. Most infants (74.6% of intervention infants and 72.8% of control infants) were born in Rockhampton. One in six (16.5%) of intervention infants and one in five (19.0%) of control infants were born in Gladstone. There were no imbalances and no evidence of confounding between the two

Table 1: Characteristics of included infants

Category	Characteristic	Control group		Intervention group		p value
		n	%	n	%	
Sex	Female	324	48.1	228	48.7	0.8
	Male	349	51.9	240	51.3	
Indigenous status	Aboriginal	562	83.5	396	84.6	0.7
	Torres Strait Islander	24	3.6	19	4.1	
	Both	87	12.9	53	11.3	
Place of birth	Rockhampton	490	72.8	349	74.6	0.5
	Gladstone	128	19.0	77	16.5	
	Other ^a	55	8.2	42	9.0	
Total		673	100.0	468	100.0	

a Emerald, Biloela, or Blackwater.

groups in terms of sex, Indigenous status, or place of birth (Table 1). No parents asked us to stop sending them the SMS reminders.

In this study, the definition of on-time vaccination was having received all NIP vaccinations within 30 days of the due date. Table 2 shows that the proportion of infants vaccinated on time in the intervention group exceeded that of the control group at all five milestones, although the difference was not statistically significant at 12 months. In both cohorts, the proportion vaccinated decreased as the children got older. At six weeks, the proportion vaccinated on time was 91.9% in the intervention group and 87.2% for the control group. By 18 months, the proportion vaccinated on time was below 50.0% in the intervention group and below 40.0% in the control group. The ARD was statistically significant at each milestone except at 12 months (3.4%, $p = 0.3$). The statistically significant differences in ARD ranged between 4.7% at six weeks (95% CI: 1.1–8.2%) and 12.9% at six months (95% CI: 7.4–18.5%). The RR for timely vaccination in the intervention group at each vaccination age milestone showed a statistically significant improvement at all milestones except for 12 months. The RR ranged from 1.05 at six weeks (95% CI: 1.01–1.10) to 1.31 (95% CI: 1.14–1.50) at 18 months. The smallest NNR was at the six months milestone, with eight parents needing to receive an SMS to increase

the number of vaccinated infants by one child, closely followed by the 18 months milestone, where nine parents needed to be reminded. These results show that the SMS is associated with an improvement in timeliness of vaccination (vaccinated with all NIP vaccines within 30 days of the due date) at every milestone except 12 months.

Discussion

We have shown an association between SMS reminders and improvement in immunisation timeliness. SMS reminders have been found to be feasible,⁴¹ cost effective (in terms of higher quality adjusted life years, with associated cost savings or slightly higher but acceptable cost),⁴² and improve physical and mental health,^{42–44} medication adherence, treatment compliance and uptake of screening.^{45–52} However, some evidence regarding the effectiveness of SMS reminders indicates the effects are equivocal, conflicting, short-term, only improve knowledge, or don't work at all. These studies include tests of compliance with treatment (e.g. at sexual health or tuberculosis clinics,^{52–62} or with contraceptives,^{63,64} uptake and continuation of healthy lifestyle habits (diet, physical activity, weight management,⁶⁵ sunscreen use or reducing sunburn)⁶⁶ and preventing patients from missing appointments).⁶⁷

Table 2: Measures of effectiveness relating to proportion of infants, in the control and intervention groups, vaccinated on time

Milestone	Proportion of infants vaccinated on time ^a					
	Control	Intervention	ARD ^b (95% CI)	p value	RR ^c (95% CI)	NNR ^d
6 weeks	587 (87.2%)	430 (91.9%)	4.7% (1.1–8.2%) ^e	0.013	1.05 (1.01–1.10) ^e	22
4 months	520 (77.3%)	401 (85.7%)	8.4% (3.9–12.9%) ^f	<0.001	1.11 (1.05–1.17) ^f	12
6 months	389 (57.8%)	331 (70.7%)	12.9% (7.4–18.5%) ^f	<0.001	1.22 (1.12–1.34) ^f	8
12 months	364 (54.1%)	269 (57.5%)	3.4% (-2.5–9.2%)	0.3	1.06 (0.96–1.18)	30
18 months	250 (37.1%)	227 (48.5%)	11.4% (5.5–17.2%) ^f	<0.001	1.31 (1.14–1.50) ^f	9

- a Vaccination on time (timely vaccination) is defined as having received all milestone vaccines within 30 days of the due date for that milestone.
- b ARD: absolute risk difference in proportion vaccinated on time in each group.
- c RR: rate ratio of control versus intervention cohorts vaccinated on time.
- d NNR: number needed to remind to vaccinate one child.
- e Statistical significance: $p < 0.05$.
- f Statistical significance: $p < 0.001$.

The way in which the SMS reminder is implemented may determine effectiveness. Poor patient engagement may impair the success and effectiveness of mobile phone health interventions.⁶⁸ These interventions are more effective if they are personalised,⁶⁹ use motivational interviewing strategies,⁷⁰ and have a theoretical basis.^{69,71} Tailored SMS reminders are more effective than simple messages in priority groups including ethnic minorities.⁷⁰ Kerrigan has suggested the following for developing the content of the text message: formative research (such as literature reviews, interviews, focus groups and surveys of patients and providers, and working with behavioural change experts) and tailoring or targeting the message to patient preferences, including determining appropriate timing and frequency of messaging.⁷¹ Proposed content should be reviewed by experts. Reminder systems that incorporate accountability are more likely to engage the patient and improve adherence to medication regime than just a simple reminder.⁷² In our Australian Aboriginal and Torres Strait Islander population this could perhaps include a tailored SMS or a phone call

from a health worker or nurse navigator, with the content developed in consultation with the Traditional Owners (as we did).

Our results have shown that SMS reminders are associated with an increase in immunisation timeliness in Aboriginal and Torres Strait Islander children in a regional area of Australia. The effect sizes seen in this study are comparable to the published international research in children in terms of the increase in proportion vaccinated, and the likelihood of vaccination (RR), at one month past the due date. The improvements do not occur at the same milestones as ours, however. In our study, a single SMS reminder sent on, or just prior to, the due date was associated with a statistically significant improvement in proportion vaccinated at two months, six months, and 18 months, but not 12 months. Another Australian research paper on SMS reminders and timeliness found that an SMS reminder was effective at 12 months, but only in children who received previous doses late.¹⁴ The reasons are not clear for the disparity

in the milestones where an effect was detected, although our effect sizes are comparable to other research, including studies performed overseas.

Some Australian studies have found that extra support for parents of Aboriginal and Torres Strait Islander children is required to improve vaccination coverage and timeliness. O'Grady et al. found that a tailored SMS reminder using an educational message combined with additional support for mothers to vaccinate their children was effective at improving timeliness in infants at five and seven months of age.¹⁶ A simple SMS reminder had no statistically significant difference to the controls (who received no intervention). Cashman et al. found that additional support in the form of a call from an Aboriginal immunisation officer prior to the child's immunisation due date (a pre-call) was associated with a statistically significant improvement, to a degree that closed the gap between coverage for Aboriginal and Torres Strait Islander children and non-Indigenous children.³⁸ It is not clear to us why this extra support or contact from the health service was necessary to detect a statistically significant result, particularly since our simple text message showed an improvement at four out of five milestones. As mentioned early in the Discussion, it is possible that the standard practice of updating contact details, the crafting of the message, the timing and number of reminders, involvement of an Indigenous health worker, and efforts to engage the community may all influence how effective the SMS reminders are and, indeed, whether there is a statistically significant change. We spent considerable time, in the project's early stages, engaging with the Traditional Owners to determine how the project would be implemented. More research is needed to determine the characteristics of a successful SMS reminder service and the effect at the various age milestones.

It is noted that national childhood immunisation coverage rates in Australia in general, and in Aboriginal and Torres Strait Islander infants in particular, have increased over the study period.³ Some authors have found a statistically significant improvement in coverage associated with the introduction of the 'No Jab, No Pay'

Australian Federal Government initiative to withhold social security payments if a child is not vaccinated.¹⁴ This initiative started in January 2016.⁷³ Our Central Queensland coverage rates among Aboriginal and Torres Strait Islander infants (e.g., as measured at 12 months of age and two years of age) increased gradually between 2013 and 2017, and then remained relatively stable between 2018 and 2019 (the control infants). There was a gradual increase between 2020 and 2021 (the intervention group). The corresponding non-Indigenous children's immunisation coverage rates remained stable, at just above or below the 95.0% target between 2016 and 2021. The increase seen in this study may be due to the SMS reminders or may be confounded by other factors, such as 'No Jab No Pay'. It's not possible to say, because the control and intervention cohorts come due for their vaccinations in different years. The other relevant Australian study in Aboriginal and/or Torres Strait Islander peoples, mentioned above,¹⁶ found an improvement with an educational message and additional support to vaccinate, but no effect with only a simple SMS reminder.

It should be noted that about 20% of Aboriginal and Torres Strait Islander people living in Australia reside in remote and very remote areas,⁷⁴ where mobile phone coverage may be absent, or patchy at best. Most discrete Aboriginal or Torres Strait Islander communities in rural and remote Queensland have 4G coverage indoors and outdoors,⁷⁵ but a small number only have 3G and some communities have limited signal and require an antenna all the time. Coverage is impacted by many things, including the technology available and local conditions.⁷⁶ People on low incomes (for example, those who are unemployed and/or have a disability) are overrepresented in these communities and may not be able to afford the phone plans and/or technology needed to access the internet in their discrete community. Internet access and mobile coverage may not be in existence in rural and remote areas outside these discrete communities, affecting whether people can receive text messages when they are

away from the community. These factors may prevent access to the internet and mobile phone technology in general.

While Aboriginal and Torres Strait Islander children living in rural and remote locations may have immunisation coverage rates of less than the 95.0% target, the local child health nurses working in Central Queensland and Central West HHS areas are proactive about ensuring that immunisation coverage rates are as high as is humanly possible. Experience shows that in these small communities, when children are found to be overdue, it is almost exclusively because the child is out of town at the time that the vaccinations come due. With some providers, the SMS reminder may only be able to be downloaded to the phone for one month after sending. If the parent / caregiver is not in range during this time, the reminder will not be received. Crucially, it may be the only way to contact families who have left the area, to remind them that their child's vaccinations are due. We have created some photo frame magnets for parents to record their child's immunisation due dates, to assist in remembering when the vaccinations are due, but obviously a better solution is needed to enable us to achieve 95.0% coverage rates. Perhaps as mobile phone coverage technology continues to improve and to be rolled out across the country, the SMS reminders will become more effective.

Limitations

One limitation of the study was its quasi-experimental design. The birth rate of Aboriginal and Torres Strait Islander infants in Central Queensland is such that we would need to run for three to four years to obtain a large enough sample with sufficient statistical power. We did not have sufficient funding to extend the project for this length of time, nor to implement a randomised controlled trial. The Central Queensland Aboriginal and Torres Strait Islander community have expressed support for the SMS reminders. The promising results in this study, together with the support of the community, call for further research such as a randomised controlled trial with a larger cohort.

Acknowledgements

We recognise our Aboriginal and Torres Strait Islander people and cultures, within our Central Queensland Hospital and Health Service area, and we pay our respects to elders: past, present, and emerging.

Declaration of Competing Interest

Researchers have no conflicts of interest to declare.

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Ethics approval

The Central Queensland Hospital and Health Service Human Research Ethics Committee gave approval in December 2020 (HREA 57710).

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