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Title

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Software – AM, JG, CN, LY.

Validation – CN, LY.

Formal analysis – LY, AM, CN, PSA, CB.

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Writing – original draft – LY, CN, AM, KB, CB.

Writing – review and editing – all authors.

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Funding acquisition – KB.

Competing interests and/or declarations

Nothing to declare.

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Abstract

Introduction

In Aotearoa New Zealand, human papillomavirus (HPV) self-testing was introduced simultaneously with HPV primary screening in September 2023 to improve access and reduce inequities for priority populations, including Indigenous Māori, Pacific and under-screened people. To contribute policy-relevant information, we implemented non-standard engagement and screening strategies, including text message invitation, mailed test kits, at-home self-testing, telehealth support and follow-up by a central nurse-led co-ordination team.

Methods

We partnered with an Auckland primary health organisation (PHO) with high enrolment of priority populations. We invited people eligible for cervical screening aged 30-69 years by text message to receive mailed test kits (April-October 2023); people who did not respond were re-invited (October-November 2023). Offering a financial incentive to return a sample (intervention group) was compared with no offer (control group) in a sub-group of eligible Māori and Pacific who received a repeat mailed test kit in a nested randomised controlled trial (April-May 2024). Self-tested participants were invited by text message to an online survey.

Results

We invited 25,315 people and 24.0% opted in. Lower initial consent rates were increased after additional re-invitation reminders for Māori (20.0% to 30.4%) and Pacific (13.7% to 24.9%), with the final consent rate in Māori equal to European/Other (29.2%; p=0.284). Almost half (48.2%) of consenting participants returned a sample, giving a self-test uptake of 11.6% (n=2,925). Uptake was significantly lower (all p<0.001) for Māori (12.7%) and Pacific (8.4%) vs. European/Other (19.0%), and for those under-screened (10.5%) vs. those overdue by <6 months (19.4%). In the RCT, sample return rate did not differ significantly (p=0.704) between the intervention (7.9%) and control (8.5%) groups. HPV was detected in 7.7% of 3,018 valid results. Follow-up test rates were high (96.8% for cytology,

90.5% for colposcopy). Almost all survey respondents preferred a mailed at-home self-test for their next screen (91.9%; n=193 of 210).

Discussion

Invitation by text message to mailed at-home HPV self-testing engaged priority populations in cervical screening. Central co-ordination support achieved high rates of sample return and follow-up testing where required. A mailed at-home testing option, strongly preferred by survey respondents, warrants consideration in a broader programme to improve access to cervical screening, with additional targeted strategies to improve sample return rates for priority populations.

Clinical trial registration

While the overall study did not reach the ICJME or WHO criteria for clinical trial registration, the nested RCT was retrospectively registered with the Australian New Zealand Clinical Trials Registry (ACTRN12625000798460; WHO UTN U1111-1324-8454).

Key words

Cervical screening; human papillomavirus (HPV); self-sampling; at-home testing; primary care; Māori health; Pacific health; health inequity; text message invitation; opt-in; telehealth; incentives.

Abbreviations

GP: general practice; HPV: human papilloma virus; IT: information technology; NCSP: National Cervical Screening Programme; OR: odds ratio; PHO: Primary Health Organisation; PIS: participant information sheet; RCT: randomised controlled trial.

Declarations

Ethics approval

This study was approved by the New Zealand Health and Disability Ethics Committee (HDEC), reference number 21/STH/141. Data access was approved by the NCSP programme and by the National Kaitiaki Group, which oversees the use of data from wāhine Māori (Māori women) from the NCSP Register. The study was approved through localities research office approvals in the three Auckland districts where the study was conducted. A Māori data sovereignty assessment was conducted and approved as part of ethics and localities approval. A privacy and security assessment was conducted and approved. All individuals in the study provided informed consent. This study adhered to the Declaration of Helsinki.

Consent for publication

The photographs on the cover of the participant instructions (Supplementary file 1) are reproduced with permission.

Availability of data and materials

The data used and analysed during the current study contain identifiable individual patient information, including that of Māori. The data are not publicly available due to the data confidentiality and privacy restrictions and Māori data sovereignty considerations, but are available from the corresponding author on reasonable request and corresponding approvals.

Competing interests

The authors declare that they have no competing interests.

Manuscript

Introduction

Although cervical cancer is highly preventable, it persists in Aotearoa New Zealand (NZ) mainly due to under-screening (1). Cervical screening, organised centrally by the National Cervical Screening Programme (NCSP), is largely delivered through primary care in NZ. Longstanding inequities in access to primary care are attributed to general barriers (e.g. lack of time for appointments, opportunity costs) and cervical screening-specific barriers (e.g. discomfort, previous negative experience) (1, 2, 3, 4). Unlike breast and bowel screening, cervical screening is not fully funded in NZ, although recent national initiatives included free screening for priority groups (5).

The priority populations underserved by routine screening in NZ include Indigenous Māori, Pacific (people with Pacific Island origins), people overdue for screening by ≥2 years (under-screened), and those living in areas associated with high socioeconomic deprivation (6). Persistent health inequities in primary care are not only unfairly borne by priority populations but contribute to the higher cost of secondary care (7).

In September 2023, HPV primary screening and self-test options were introduced in NZ to further reduce mortality and improve screening access (8). Since then, self-testing has become the option used in the majority of screens (81.3%; February 2025 data) (9) and overall screening coverage has increased (from 67.0% in August 2023 to 75.5% in February 2026) (10). While coverage has improved for all ethnicity groups, inequity in coverage rates remain: 69.5% in Māori and 75.8% in Pacific vs. 82.4% in European/Other (February 2026 data) (10).

Given that the programme change largely replicated the previous primary care access model, new approaches to increase access for priority populations are needed (1). One such alternative strategy not routinely offered in NZ is mailed at-home self-testing, which was widely acceptable to participants in studies prior to the programme change and the most strongly preferred option over in-clinic self-testing, including in priority populations (3, 4, 11, 12). Opt-in strategies, while more effective than standard screening options (such as clinician-taken samples for cytology or HPV testing

(13)), were generally less effective (14, 15), albeit less costly (16, 17), than send-to-all (opt-out) strategies. Meta-analyses of international opt-out studies included those with send-to-all distribution of self-test kits (13, 14). While studies in many countries included mailed approaches for under-screened populations, in 2023, the Netherlands moved to an opt-out, direct mail programme, with increased coverage after one year (42.1% to 49.9%) and the highest increases in younger and under-screened groups (18).

Text message interventions can positively influence engagement with cancer screening, although more data are needed (19). Previously reported opt-in cervical screening studies (predominantly in Europe, with one in NZ (20)) typically invited people by mailed letters (14), whereas invitation and/or acceptance by text message was trialled less frequently (11, 21, 22). Communication regarding HPV self-testing via text message warrants further investigation as text messages (and other digital technologies, e.g. telehealth) are increasingly used in primary care (23) and may be more attractive than mailed letters due to lower costs.

We previously tested invitation to HPV self-testing via text message during COVID-19 lockdown periods and showed this invitation method to be feasible and acceptable to Māori and Pacific participants, with an overall uptake rate of 71% (n=61 of 86) (11). In this and a larger study (n=3,553) (20), we showed that mailed at-home testing was acceptable to priority populations, as one way to improve access to screening in primary care (24).

Financial incentives encouraged healthy behavioural changes, in particular smoking cessation (25, 26). Although the evidence for cancer screening participation is less robust (27, 28), monetary incentives (small sums or transport vouchers) can increase participation in cervical screening by cytology (27, 29, 30) or follow-up testing (31); an HPV self-test study is planned (32). Studies of the use of incentives in the NZ healthcare setting are limited (e.g. smoking cessation in pregnant Māori (33, 34), secondary prophylaxis in young people with rheumatic fever (35)). In NZ, both Māori and Pacific place cultural importance on concepts of respect, generosity, reciprocity and care for others

(36). The concept of offering an incentive[1] could be considered in the screening context to reflect acknowledgement of their decision to be screened (36).

Our current study further investigated invitation via text message on a larger scale to provide policy-relevant findings to inform possible future expansion of screening options to increase access. In addition to text message invitations, we provided mailed kits for at-home self-testing with follow-up and standardised reminders via telehealth delivered by a central nurse-led specialist co-ordination team as an alternative to general practice results management and reminders. We aimed to investigate the acceptability and feasibility of this approach as these engagement strategies are currently not standard practice in NZ. In addition, we sought to contribute to the literature with a nested randomised controlled trial (RCT) comparing the offer of an incentive with no offer for a sub-group of Māori and Pacific participants who did not return an HPV self-test kit.

Methods

Study design

This mixed methods study invited eligible people by text message to opt-in to receive mailed HPV self-test kits. We measured uptake after three consecutive offer phases: 1) invitation, 2) re-invitation with additional reminders for Māori and Pacific participants, and 3) a nested RCT to compare the effect of offering a voucher as an incentive (intervention group) with no offer (control group) on sample return for a sub-group of Māori and Pacific participants.

We aimed to determine the acceptability and effectiveness of the invitation and re-invitation approach (by consent and test completion rates), feasibility of the electronic consent (e-consent) and telehealth support processes, the effect of tailored reminders and the offer of an incentive as strategies to improve sample return, and the completion of follow-up testing for participants with an HPV detected test result.

[1] We distinguish between the use of the term incentive and the *te Reo Māori* (Māori language) concept common in New Zealand of *koha*, which is a gift without an expectation of receiving anything in return, such as taking part in cervical screening.

Setting

We partnered with a metropolitan Primary Health Organisation (PHO) with 50 clinics and an enrolled population of around 260,000 ethnically diverse people living in areas associated with high socioeconomic deprivation. Unlike most other PHOs, there was no charge for cervical screening prior to and during the study. Prior to the study, cervical screening rates among the enrolled population of the PHO were 24.2% for Māori, 24.5% for Pacific, 31.3% for Asian, and 39.2% for European/Other (March 2023 data; personal communication from the PHO).

Eligibility

Inclusion criteria were people aged 30-69 years, enrolled with the study PHO and meeting the NCSP clinical practice guidelines as eligible for self-testing (i.e. people with a cervix and due for cervical screening) (8). Exclusion criteria were total hysterectomy, history of cervical cancer, no longer residing in NZ, previous high-grade lesion and no test of cure, symptomatic (e.g. abnormal bleeding or discharge) or never been sexually active. Study eligibility could change over the study period (e.g. as people changed to another PHO, were screened outside of the study, or aged out). We chose a higher minimum screening age (30 years) than the NCSP (25 years) (8) as the majority of HPV infections in younger people are cleared without treatment (37), and to avoid issues related to NCSP policy change on the start age of screening and first screening using an HPV self-test prior to the change to primary HPV. Participant records were refreshed for eligibility prior to each subsequent phase of the study.

Invitation and consent

A list of eligible people was compiled using central NCSP Register and study PHO data by the study team. Invitation text messages were sent in batches, typically 1,000 per week, from 3 April to 11 October 2023; 80% of invitations were sent prior to the national programme change on 12 September 2023 (see Supplementary file S1 for further details). The invitation wording was carefully crafted by team members with specialist Māori and Pacific engagement expertise and included a link to individualised electronic consent (e-consent) forms (available via the study information

technology (IT) platform) with eligibility questions (e.g. recent cervical screening, hysterectomy, symptoms; Supplementary file S2). Invited people could complete the e-consent form directly or with study team support. People who did not respond in 8 days were sent a reminder text message (see Supplementary file S3 for the wording and schedule). Invited people could request support by text messages or toll-free calls to the study team. Support from the co-ordination team via the call centre (see Central nurse-led co-ordination team below) was available at all stages of the study.

Self-test sample return

Self-test kits, including a Copan flocked swab for sample collection, participant information sheet (PIS) (Supplementary file S4), laboratory test form, and return envelope, were posted after consent. The PIS included frequently asked questions and clear instructions, with content developed using findings from workshops with Māori and Pacific (12) and tailored to priority populations; languages available were *te reo Māori* (Māori language), Tongan, Samoan, and English. Participants could return their sample by pre-paid courier pick up, or to a post office or community laboratory. Up to three additional test kits for invalid test results or by participant request were supported. All participants who were sent a self-test kit entered an active follow-up schedule of text message and call reminders to return the sample after 3, 5, 7 and 11 weeks (Supplementary file S3).

HPV laboratory testing

Self-test samples were sent to a single laboratory and processed using the BD Onclarity HPV molecular test, a validated test accepted by the NCSP. Results were sent from the laboratory to the study IT system, the PHO clinical lead, and the NCSP Register.

Central nurse-led co-ordination team

The co-ordination team was led by a small team of four experienced cervical screening nurses supported by female Māori and Pacific engagement staff in a call centre. Nurses provided clinical support during consent (e.g. checked records for hysterectomy, discussed symptoms or answered questions about the study) and HPV results management. Call centre engagement staff were trained

and provided non-clinical support to consent, prepared and sent self-test kits, and individualised participant reminders where scheduled.

Results management

Study nurses communicated HPV test results to participants and managed all follow-up testing requirements according to NCSP guidelines (8). Result notification for participants with HPV not detected results was by text message, and for participants with HPV detected results was by phone with a follow-up text message (that also included a link to the NCSP website for further information). Participants with invalid test results were informed by phone and were sent a new test kit. Participants with an HPV 16/18 result were referred for colposcopy at the appropriate local hospital service with an offer of *kaiawhina* support (holistic practical and cultural support from a Māori staff member, e.g. with transport or childcare) to attend appointments. Participants with an HPV Other result could choose to have their triage cytology (liquid-based cytology) performed by their primary care provider or a study nurse at one of six study PHO clinics. Cytology samples were processed by the service routinely used by participating clinics in accordance with NCSP standards. To reflect current NCSP guidelines (8), our analysis included colposcopy data from participants with high-grade cytology findings and excluded low-grade referrals made under previous guidelines.

Re-invitation

Once all of the initial invites were sent, people who were sent all the scheduled reminders but did not consent were sent a re-invite text message in batches from 18 October to 29 November 2023. All re-invited people who did not consent by day 8 were sent a reminder text. To address preliminary data showing lower consent rates in Māori and Pacific, we tested the effect of an additional phone call attempt (with a personalised text message if the call was not answered; Supplementary file S3).

Nested incentive RCT

Māori and Pacific participants who consented and were sent only one self-test kit and did not have an HPV test result at the end of the re-invite phase were eligible for the RCT phase. These participants were individually randomised to the intervention or control groups. Participants in both

groups were sent a second self-test kit with a letter to encourage sample return. The intervention group's letter offered a $50 supermarket voucher once an HPV test result was received, whereas the control group's letter did not offer an incentive (Supplementary file S5). The RCT self-test kits were sent from 30 April to 7 May 2024.

Participant survey

Study participants with a valid HPV result were invited to an online survey of their experience with the HPV self-test as part of their test result text message. The survey asked participants about their main source of information on the HPV self-test, the amount of information received on the self-test, how comfortable they were with their decision to self-test, and how they would like to be tested when next due for cervical screening (Supplementary file S6). Responses were anonymous; ethnicity and age groups were self-identified. Descriptive analysis was performed on quantitative survey responses to present numbers and percentages for individual subgroups and overall. A research question-led inductive thematic approach was undertaken to analysis free text responses.

Study IT system

A bespoke web-based clinical software application was developed for this study. HPV test results were received directly into the system. The system could send and receive text messages, and send follow-up cytology results to participants' primary care provider. The system received cloud risk assessment approval from the Waitematā district Privacy and Security Governance Group, Health New Zealand | Te Whatu Ora for use within the health environment.

Data collection

The invite and re-invite data analysis included all HPV results from samples received at the laboratory from 17 April 2023 to 28 April 2024. The RCT data analysis included all HPV results from samples received at the laboratory from 3 May to 3 September 2024.

Statistical analysis

Descriptive analysis was performed to present numbers and percentages overall and for individual subgroups. Univariable logistic regression was performed to compare the subgroups, and the effect

size was presented using odds ratios and their corresponding 95% confidence intervals and p-values. A p-value of <0.05 was considered statistically significant. The analyses were conducted using Excel (41) and Stata 18 (42).

Variables

Ethnicity data in NZ is self-identified and people can identify with multiple ethnic groups; where participants identified more than one ethnic group, ethnicity was prioritised according to the NZ Health and Disability Ethnicity Data Standards: Māori>Pacific>Asian>European/Other (European/Other includes NZ European, Other European, Middle Eastern Latin American and African (MELAA)) (43).

Data on gender were not collected; eligibility according to the NCSP is for "anyone with a cervix or vagina who has ever been sexually active" and aged 25-69 years (8).

Socioeconomic deprivation status was derived from the 2018 NZ Index of Deprivation (NZDep2018). NZDep is an area-based measure derived from census data. We report NZDep quintile data, where 20% of the population is represented in each category (44).

Time since the last screen (screening status) and age were calculated on the date of initial invite and refreshed for the re-invitation and RCT phases.

Screening status is categorised (and calculated as the time interval from the next screen due date) by the NCSP as: due (from >0 to <6 months after last recorded due date on the NCSP Register), overdue (from ≥6 months to <2 years after due date), under-screened (≥2 years since due date), and un-screened (no recorded screen date in NZ).

Ethics approval

This study was approved by the NZ Health and Disability Ethics Committee (HDEC; reference number 21/STH/141). Access to data was agreed by the NCSP programme and the National Kaitiaki Group, which oversees the use of NCSP Register data from wāhine Māori (Māori women). A Māori data sovereignty assessment was conducted and approved as part of ethics and localities approval. Localities research office approvals in the three Auckland districts where the study was conducted

was obtained. A privacy and security assessment was conducted and approved. All individuals in the study provided informed consent. This study adhered to the Declaration of Helsinki. In terms of patient and public involvement, the overall research programme was initiated via a prior co-design process with Māori, Pacific and Asian under-screened participants who self-tested (12), with their feedback on process and materials directly informing this study. Participant feedback via the study contact centre and survey feedback also informed the process for the nested RCT.

Results

Demographics

We invited 25,315 people aged 30 to 69 years old and due for cervical screening via text message to HPV self-testing (**Error! Reference source not found.**a). Almost half (47.6%) of the invited population was Māori or Pacific (14.8% and 32.9%, respectively), and a further third was Asian (38.7%) (**Error! Reference source not found.**). Almost half (46.0%) was under-screened (overdue for screening by ≥2 years) and a large proportion (58.7%) lived in areas associated with higher deprivation.

Almost one quarter (24.0%) of invited people consented to take part in the study and receive a mailed self-test kit (**Error! Reference source not found.**). This comprised participants who consented to the initial invite (16.6%) and to the re-invite (a further 7.3%).

The highest overall consent rates were seen in Māori (30.4%) and European/Other (29.2%, p=0.284; **Error! Reference source not found.**). Although consent to the initial invite was significantly lower (p<0.001) in Māori (20.0%) and Pacific (13.7%) than European/Other (25.0%), the increase in consent after the re-invite was significantly higher (p<0.001) in both groups (who received additional reminders; 10.4% in Māori, 11.2% in Pacific) than in European/Other (4.2%).

Under-screened people (17.0% of all invited vs. 22.9%) and those living in areas associated with high socioeconomic deprivation (14.6% vs. 18.2%) had some of the lowest consent rates to the initial invite (p<0.001) than the people who were due or living in areas associated with low deprivation, respectively; these groups had large increases in consent after re-invitation, although the between-

group differences were not significant (8.4% vs. 6.4% for under-screened vs. due, and 9.3% vs. 5.5% for high vs. low deprivation).

Among the consented participants (n=6,067), most Māori and Pacific were under-screened (60% and 57%, respectively, vs. 44% in European/Other) and living in areas of high deprivation (67% and 76%, respectively, vs. 36% in European/Other.

Support to e-consent, time to consent

Thirteen percent (n=3,372) of invited people were supported during the e-consent process by the central co-ordination team. Of consented participants (n=6,067), 36.5% were supported; half of the supported and consented participants (50.0% of n=2,212) were Māori (15.5%) and Pacific (34.5%).

Most participants who consented (62.5%) did so within 2 weeks of being invited or re-invited, with 29.4% on the first day and 4.5% on the second. Aside from 13.4% who consented on day 9, as a response to the day 8 reminder, there is a long tail of <3.0% consenting per week, up to 47 weeks. Forty-two percent of participants consented prior to invitation or re-invitation reminders.

Sample return

Almost half (48.2%) of the consented participants returned a sample for testing (**Error! Reference source not found.**a). Therefore, overall uptake of the HPV self-test in our study was 11.6% of 25,315 invited people (**Error! Reference source not found.**). Significantly lower sample return rates (all p<0.001) were seen in Māori (41.7%), Pacific (33.8%), under-screened (41.6%) and high deprivation (40.2%) groups than each of the respective comparators (65.2% in European/Other, 66.3% in those due for screening, 57.2% in those living in areas associated with low deprivation; **Error! Reference source not found.**a).

In under-screened people (n=1,224), the mean time overdue was 5.8 years, and the maximum time was 29.1 years; 39.5% of this group (n=483) were ≥5 years overdue, or 16.5% of all self-tested participants.

Of consented participants, 9.9% (n=601) were sent at least one more self-test kit for any reason. Of participants who requested another test kit, 68% were Māori and Pacific (23.1% and 45.1%,

respectively). Of all participants who returned their sample for testing, 8.7% (n=254) was from those who requested additional test kits.

In the RCT phase (Figure 1b), offering an incentive did not affect sample return rate, with no significant difference between the intervention and control groups (7.9% vs. 8.5%; p=0.704; **Error! Reference source not found.**b). Sample return rates did not differ significantly between the intervention and control groups by ethnicity (**Error! Reference source not found.**b).

Time to sample return

For most (76.5%) self-tested participants (excluding those as part of the RCT), their samples were received at the laboratory within 8 weeks from the date of their first test kit being sent. In participants who returned their sample, 41.7% did so within 3 weeks of being sent their first test kit, prior to any reminder prompts. A further 20.9% returned samples after 4-5 weeks and 1 reminder, 13.9% after 6-7 weeks and 2 reminders, and 12.0% after 8-11 weeks and 3 reminders; the remaining 11.5% returned samples between 12 and 68 weeks (after the final reminder). More than half of the returned samples (58.3%) were received after at least one reminder was sent.

The majority (85.9%) of study participants returned their completed samples via free courier pick up or to a local post office, with fewer (14.1%) choosing to return to a community laboratory.

HPV results

HPV was detected in 7.6% of people who returned a sample for testing (**Error! Reference source not found.**), of which 18.2% (n=42) were HPV 16/18 and 81.8% HPV Other (n=189). The total rate of invalid results was 0.7% (n=21) of all test results received.

Follow-up test completion

In participants with an HPV Other result (n=189), the majority (96.8%; n=183) completed follow-up cytology. Just over half (53.0%) chose cytology with their own GP clinic staff and the remainder chose the study nurse option. The median time from the date that participants were notified of their HPV Other result until the date of their completed cytology test was 12.0 days (mean 18.6 days; range <1.0 to 144.8 days) in those with available data (n=178); this included repeat sampling for

participants who had invalid cytology results (n=3). Participants who did not complete follow-up cytology as part of the study after the scheduled reminders and contact attempts were discharged back to their GP with a text message (to participants) and letter (to participants and GPs) (n=6). The reasons for not completing cytology were study withdrawals, discharged back to GP by participant request and repeated non-attendance of appointment (n=2 each).

In participants with an HPV 16/18 result (n=42) and HPV Other with high grade cytology findings (n=7), most (93.9%; n=46 of 49) were seen and discharged by the colposcopy service by study end (n=41), or awaiting a repeat colposcopy appointment (n=4) or their discharge letter (n=1). The median time from the date that participants (n=46) were notified of the requirement for colposcopy until the date that they were first seen at colposcopy was 36.9 days (mean 64.1 days; range 5.3 to 315.0 days). The reason that participants were not seen at colposcopy was study withdrawal (n=3).

Participant survey

There were 210 survey responses representing a response rate of 7.3%. Survey respondents were diverse in terms of self-reported ethnicity and age (Supplementary file S7).

Most (96.2%) survey respondents stated a preference for the self-test when they are next due for cervical screening, with 2.9% preferring traditional cytology. Of the preferences for the self-test, the majority (95.5%; n=193 of 202) specified a preference for a mailed test kit to do at home. See Supplementary file S7 for other survey findings.

Discussion

Our study tested engagement and screening strategies not currently part of routine practice in the NZ NCSP, including text invitation, opt-in, mailed at-home HPV self-testing, support to participate in self-screening, reminders for sample return, results notification and overseeing results management via telehealth by a nurse-led coordination team.

Consent rates

Several study design aspects contributed to the high consent rates for Māori and Pacific in our study. While face-to-face engagement was not part of recruitment and test kit provision, we provided multiple contact and sample return options, toll-free support with a culturally concordant call centre team, and telehealth management by experienced nursing staff. Based on early data, the reminder strategy prioritised phone call attempts for Māori and Pacific during the re-invitation phase. If call attempts were unsuccessful, follow-up text messages were sent. The text message wording was developed by cultural engagement specialists and used respectful, nuanced, inclusive and everyday language with selected in-language wording tailored to priority populations; the missed call follow-up text messages were personalised with each participant's first name. Where participants encountered difficulties (e.g. digital literacy, internet access, needing further explanation) and requested support, the central coordination team completed the e-consent form with the participant during the phone call. Participants were offered multiple ways to contact to the study team (toll-free phone number, text message, email). The PIS content was specifically developed for use with Māori and Pacific (12) and was available in *te reo Māori*, Tongan and Samoan. Some of these strategies could be adopted by the NCSP. Concordance between participants and study team staff (in terms of ethnicity and gender) may promote engagement by fostering a sense of cultural safety for participants (38, 39, 40). In another study, uptake of cervical screening by cytology was associated, in descending order of frequency, with recall contact made via a phone call, text message, letter and registered letter (45).

Factors that may have negatively influenced the overall consent rates include unfamiliarity with text message invitation to cervical screening and with HPV self-testing in general, concerns accessing web links received by text message, and not wanting to participate in a study. Despite these potential limitations, participant survey results from this and previous (3, 12, 20) studies indicate high levels of acceptability and preference for mailed test kits, and we anticipate a positive influence on uptake rates as people become more familiar with HPV self-testing and, if adopted, mailed at-home testing. It is likely that the introduction of primary HPV screening including self-testing to the NCSP during

the latter stages of our active recruitment period, and familiarity with self-testing (for COVID-19 during the pandemic) may have encouraged people to engage with and participate in our study. Additional re-invitation reminders for Māori and Pacific increased consent rate in both groups, achieving an equal consent rate between Māori and European/Other. We used one set of text message wording for all participants, which included a *te reo Māori* greeting commonly used in NZ; the re-invitation reminder messages included *te reo Māori*, Tongan and Samoan greetings. Further refinement of wording or reminder strategies may be of benefit. Providing re-invitation reminders to Māori and Pacific also increased the consent rate in other priority populations, i.e. under-screened people and those living in areas associated with high socioeconomic deprivation. Although re-invite reminders did not specifically target these other priority groups, they are likely to have intersectionality with Māori and Pacific ethnic groups (6) due to the high proportions of these ethnicities in the other priority groups.

Sample return rates

Half of the people who consented to HPV self-testing completed a self-test (sample return rate of 48.2%). Providing sample return reminders and replacement test kits contributed to the sample return rate; more than half (58.3%) of samples returned were received after at least one reminder was sent, and 8.3% of HPV results received were from participants who were sent additional test kits. These findings demonstrate the value of a sustained schedule of reminders and providing additional time for people to respond. Other studies reported a smaller impact of reminders on sample return (6% (46) and 10% (21)), although we used a more intensive schedule of reminders that began closer to the initial invitation. The benefit of additional contact attempts was shown in another equity-focused screening project for breast cancer (47). Currently, notifications are managed by both primary care and the NCSP. Primary care notify people as they become due for cervical screening, with or without subsequent reminders, according to individual service delivery models and supported by PHO data on overdue patients; the NCSP provides an additional letter-based national

reminder schedule. Specific reminder campaigns are possible and under active consideration by the NCSP with the technology advancements available with the new population register.

After the invitation and re-invitation phases, and additional equity interventions (including the nested RCT), the sample return rate was significantly lower in all priority groups. These findings indicate that additional targeted strategies are needed to convert interest in self-testing (i.e. consent to participate) into completion of the self-test, ideally determining their effectiveness separately. The higher proportion of additional self-test kits for Māori and Pacific may reflect the effect of the targeted reminders for these groups. Exploration of underlying factors or 'moderators' in the intention-behaviour relationship (48), particularly in priority populations, may provide additional insights. Our trial of offering a supermarket voucher incentive in eligible Māori and Pacific participants did not influence sample return. This is in line with the pre-print findings of another at-home HPV self-test study that the offer of a financial incentive did not reverse non-response to screening invitation and that it can be a demotivating factor to participation (49); no other studies of offering financial incentives in HPV self-testing were found. Although the RCT participants had consented, they had not responded to the full schedule of sample return reminders prior to the RCT phase; future studies could investigate the effect of offering an incentive to participants earlier in the invitation process.

Follow-up test rates

High rates of follow-up test completion (96% combined for cytology and colposcopy) were achieved in this current study and in our study of opportunistic offers in primary care (50, 51), which we attribute to the dedicated nurse-led central co-ordination team that included culturally concordant call centre and *kaiawhina* staff to provide culturally appropriate support to enable a culturally safe pathway[2]. A central co-ordination team could reduce the burden on primary care by assuming key

[2] The terms cultural appropriateness, competence and safety are often used interchangeably, although their meanings differ. We use cultural concordance to highlight that the call centre staff included the same ethnic groups as the participants (Māori and Pacific), and that this, among a range of other aspects of the design and delivery of the study, contributed to supporting cultural safety for

responsibilities such as confirmation of screening eligibility, test kit dispatch (including sending out reminders) and HPV result notification and management. Our central team provided continuity of care for the screening episode, particularly for people who require colposcopy. In addition, because the study nurses were the responsible clinicians who ordered the laboratory tests and managed the results, this model could be used to offer HPV self-testing to people not enrolled with primary care. Text message invitations and reminders are an important consideration in the context of a wider screening strategy, one that offers multiple ways for people, including those not currently enrolled with primary care, to access HPV self-testing. Very few cervical screening studies explored the use of text messages with an incentive. A structured text message intervention (with and without transport vouchers) had a modest effect on cervical screening uptake compared with a control text message of the location and hours of their nearest screening clinic (29). The use of text messages to offer screening including e-consent and test kit requests enabled translation of participant motivation to screening uptake. These additional approaches may help to overcome known barriers to primary care and potentially improve programme efficiency for priority groups. The NZ Parliamentary review (1) recommended consideration of alternative community models of care, which is supported by our current and previous (3, 12, 20) research, with very strong participant support for mailed, at-home self-testing. However, implementation of new models of healthcare delivery needs careful consideration to avoid introducing disadvantages to people currently underserved and further unintended health inequities (52). Access to mobile devices, mobile data or internet, digital literacy to use mobile devices, and a general preference for in-person communication rather than telehealth, are important considerations for Māori and Pacific people (52).

Strengths and limitations

A key strength of this study was the inclusion of populations who experience substantial barriers across the cervical screening, diagnostic and treatment pathways. The study's focus on priority

participants. We utilise the Curtis et al. definition of cultural safety in use in NZ [42, 43]. We note that only participants could determine whether they were in receipt of culturally safe services.

groups included specifically developed communication wording and additional reminders, and a central study team that comprised female Māori and Pacific staff; ethnic diversity in staff is linked to the quality of healthcare and cultural safety (38, 40). Implementation of offering HPV self-testing via telehealth was measured end to end, including monitoring of test kits sent out, sample return and completion of follow-up testing with central result management.

Our findings may be limited in terms of generalisability to other populations and different study designs. For example, the Auckland population demographic differs from that of the overall NZ population and we tested non-standard service delivery components. While our study may not be directly comparable with others, our overall uptake rate of 11.6% (n=2,925) is within the range reported in a recent pooled analysis of opt-in strategies for HPV self-testing (mean 8.5%; range 1.5-17.5%; 95% CI 5.6-11.8%) (14).

For Māori, *te whare tangata* (the womb) has particular sacred significance, thus sensitivity and privacy are likely to influence cervical screening participation. Now that the HPV self-test is established as usual care in NZ rather than offered through research, overall cervical screening uptake has increased, including in Māori. However, inequities persist, as shown by lower coverage rates in priority populations following the introduction of HPV self-testing (e.g. 69.5% in Māori and 75.8% in Pacific vs. 82.4% in European/Other in February 2026 (10)). The challenge remains to improve uptake in people from the most underserved groups. Additional alternative strategies are needed to improve access for people who are not enrolled or rarely attend primary care, and to support community-based models of access with non-clinical culturally concordant support staff (such as *kaiawhina*) to engage with people face to face. Equitable coverage improvements are most likely with a flexible screening programme that provides people with multiple options to access cervical screening (53). As part of our wider HPV self-testing implementation research programme, we evaluated opportunistic offer of HPV self-tests in primary care (50, 51) and provision in various community settings, including pharmacies (54). While opportunistic offers engaged people, including

priority populations, who were due for cervical screening in these settings, further strategies to address inequities are needed.

Conclusion

We report that invitation by text message to HPV self-testing with mailed at-home test kits and a central co-ordination team to provide support and results management by telehealth was feasible and engaged priority populations in cervical screening in NZ. Additional contact attempts were successful in achieving equal consent rates for Māori compared with European/Other. High follow-up rates for cytology and colposcopy were achieved with dedicated, flexible and culturally appropriate support to enable a culturally safe pathway. Further investigation of additional strategies to increase self-test return, particularly for priority populations, are warranted.

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