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Effectiveness of Strategies to Recruit Participants to a Smartphone-Delivered Nutrition Intervention Trial

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ABSTRACT

Objectives

Delivery of interventions via smartphone is a relatively new initiative in public health research, and limited evidence exists regarding optimal strategies for study recruitment. We describe the effectiveness of approaches used to recruit participants to a smartphone-enabled intervention trial.

Methods

Internet and social media advertising, mainstream media advertising, and research team networks were used to recruit New Zealand adults to an automated smartphone-delivered nutrition labelling trial. Recruitment of Maori and Pacific participants was a key focus and ethically-relevant recruitment materials and approaches were used where possible. The effectiveness of recruitment strategies was evaluated using Google Analytics, monitoring of study website registrations and randomisations, and self-reported participant data. The cost of the various strategies and associations with participant demographics were assessed.

Results

Over a period of 13 months, there were 2,448 registrations on the study website, and 1,357 eligible individuals were randomised into the study (55%). Facebook campaigns were the most successful recruitment strategy overall (43% of all randomised participants) and for all ethnic groups (Maori 44%, Pacific 44%, Other 43%). Significant associations were observed between recruitment strategy and age ($p<0.001$), household size ($p<0.001$), ethnicity ($p<0.001$), gender ($p=0.005$) and interest in healthy eating ($p=0.022$). Facebook campaigns resulted in the highest absolute numbers of study registrations and randomisations (966 and 584 respectively). Network strategies and Facebook campaigns cost least per randomised participant (NZ$4 and NZ$5, respectively), whilst radio advertising cost most (NZ$179 per participant).

Conclusion

Internet and social media advertising were the most effective and least costly approaches to recruiting participants to a smartphone-delivered trial. These approaches also reached diverse ethnic groups. However, more culturally appropriate recruitment strategies are likely to be necessary in studies where large numbers of participants from specific ethnic groups are sought.

ARTICLE SUMMARY

Strengths and limitations of this study

- Reports on effectiveness and costs of a range of recruitment strategies (internet and social media advertising, mainstream media advertising and research team networks) used for a smartphone-delivered study
- Effectiveness was evaluated using Google Analytics, monitoring of study website registrations and randomisations, and self-reported data
- Information is provided on participant retention rates, and strategies to reduce duplicate and fake registrations
- The broad categorisation of self-reported recruitment source data prevented more precise sub-category analysis
- Staffing costs associated with recruitment strategies were not assessed

INTRODUCTION

Monitoring and reporting of study recruitment strategies and their effectiveness facilitates improvements in design and methods for future randomised controlled trials (RCTs). Systematic reviews provide an indication of successful recruitment strategies and trial design elements such as incentives and open-label design,[1, 2] and their cost-effectiveness.[3] However, applicability and success of various strategies depends on specifics of the trial design, setting, and study population.

Smartphone delivery and measurement of trial interventions [4-6] is a relatively new initiative and presents unique recruitment challenges compared to traditional RCTs. In addition to standard trial eligibility criteria, prospective participants must have smartphone access and be adept at using technology. Moreover, attrition rates are potentially higher because enrolment rates may be augmented by a 'novelty factor' that decays over time.[7] Lack of personal contact with study staff may also increase attrition.[7] Identifying successful recruitment and retention strategies for this type of research is therefore timely and important.

In addition to traditional RCT recruitment methods such as advertising via community fliers, newspapers or media,[8] newer strategies including Internet and social media advertising [9] are being increasingly used. A systematic review found that online recruitment strategies, Facebook in particular, were promising ways to recruit participants for web- and mobile-based studies.[7] However, limited data were available, and specific gaps identified were reporting of participant retention rates, and methods to identify and manage fake and duplicate registrations.

Potential greater reach amongst underserved and diverse population groups is one suggested benefit of online recruitment.[8, 10] In New Zealand (NZ), Maori (indigenous New Zealanders making up 14.9% of population) and Pacific peoples (6.9%) are priority groups for health intervention programmes due to their disproportionately high prevalence of non-communicable diseases and associated risk factors.[11] Adequate representation of these groups in health research is vital but often hard to achieve with generic recruitment strategies, so ethnic-specific tailoring of strategies is recommended.[12, 13]

Our aim was to assess the effectiveness of a range of approaches used to recruit participants to a large smartphone-delivered nutrition labelling RCT,[14] and to

examine associations of recruitment strategy with ethnicity and other participant demographics.

METHODS

The Starlight RCT received ethics approval from the University of Auckland Human Participant Ethics Committee (reference number 011390) and the study protocol was published in 2014.[14] The trial was registered on the Australian New Zealand Clinical Trials Registry (ACTRN12614000644662). All participants provided informed consent via a questionnaire completed on their smartphone.

The aim of the trial was to evaluate the effects of two interpretive nutrition labels, Traffic Light Labels and Health Star Rating Labels, compared with a non-interpretive label, on the healthiness of consumer food purchases. The target was to recruit and randomise 1,500 eligible New Zealand adults, with good representation of Maori, Pacific, and other ethnicities. All components of the trial (screening, consent, registration, randomisation, intervention and data collection) were delivered via a bespoke, automated smartphone application (app).[15] Outcome data were collected in the form of scanned household food purchase records. Completion of a run-in period (week 1) with a requirement to record at least 15 food items was a prerequisite for randomisation. The four-week nutrition labelling intervention comprised randomisation to one of two interpretive nutrition labels (Traffic Lights [16] or Health Star Ratings [17]) or to a control group (Nutrition Information Panel).[18] The primary study outcome was healthiness of all foods and beverages purchased over the intervention period, measured using the Food Standards Australia New Zealand (FSANZ) nutrient profiling scoring criterion.[19]

Recruitment

Recruitment commenced in October 2014. A key focus was to attract Maori and Pacific participants, with advice provided by Maori and Pacific team members. Recruitment was open initially to all ethnic groups, but was closed to non-Maori, non-Pacific individuals after six months when the target for this group (500 participants) was reached. Recruitment of Maori and Pacific individuals continued for a further five months, but at that time it became clear that recruitment targets would not be

met within the study timeframes. Therefore, recruitment was reopened to all ethnicities again for two months and closed finally in November 2015.

Recruitment campaigns directed volunteers to a designated trial website to answer a pre-screening questionnaire, and a link to download the trial app was then provided. Enrolment occurred via the app, but the pre-screening step allowed the study team to monitor registration numbers and ethnicity targets. The trial app was available free of charge in NZ Google Play and iTunes app stores. Information in the app stores also encouraged volunteers to visit the trial website before downloading the app.

Recruitment materials and advertisements were developed by the research team. (Supplementary File 1, a-b). Advertising campaigns were conducted at staggered intervals over the 13-month recruitment period using research team networks, Internet and social media advertising, and mainstream media advertising (Figure 1). The impact of recruitment strategies was assessed continuously by comparison with monthly recruitment targets.

Three media releases were issued by the University communications office (Oct 2014, Nov 2014 and Nov 2015). Promotion via research team networks was undertaken using group email lists, word of mouth, staff intranets, personal Facebook pages, and hard copy recruitment flier distribution. Electronic recruitment fliers were circulated via email lists at several NZ universities, healthcare providers, and relevant non-government organisations. Requests were made to NZ schools, particularly those with high numbers of Maori and Pacific students, to promote the study via their newsletters. Paid internet advertising was undertaken using two Google AdWords campaigns, one LinkedIn campaign, and 14 promoted posts on Facebook (Supplementary Files 2-3). Other paid advertising included an advertisement in a Maori magazine (including a web banner on their website), promotional advertisements on Pacific radio, and representation at relevant events, such as Maori and Pacific cultural festivals and health provider conferences.

Strategies to maintain retention

Participants were sent regular notifications via the study app, SMS text reminders,[15] and email messages. All registered participants received a NZ$10 gift voucher, and those who completed the trial (defined as completion of the follow up

questionnaire at the end of the five-week study) received a further NZ$80 gift voucher.

Registration logic checks

Because incentives (vouchers) were offered for study participation, repeat registrations by the same participants and re-registration by ineligible participants were identified as risks. To prevent duplicate registrations, individual IP address and email address checks were implemented on the study screening website. Within the app, logic checks for unique and valid email address and valid age (18 to 100 years) were also implemented. All registrations were checked daily for duplicate surnames, street addresses, and phone numbers. All suspected duplicate registrations were investigated by research staff. Confirmed duplicate registrations were contacted with the request that they discontinue the trial.

Data Analysis

Information on the demographic characteristics of trial participants was collected via a baseline questionnaire completed in the study app.[14] Self-reported ethnicity was grouped into three categories: Maori, Pacific, and Other. Google Analytics [20] was used to track visits to the study website. Data on self-reported recruitment strategy that attracted participants were collected using the question “How did you find out about the study?” The effectiveness of recruitment strategies was assessed by collating numbers of participants registered, randomised, and completing the trial. Conversion to randomisation was defined as proportion of registered participants randomised and retention rate was defined as proportion of randomised participants retained). Participants who could not be randomised due to technical issues with the app or their phone were excluded from analysis.

Self-reported recruitment data were matched with recorded costs for each strategy. Only broad categories were available in the self-reported data. Thus in the cost analysis, promotion or advertising via community events, research team’s personal and professional network, and coverage in mainstream paper media were combined in one category titled ‘network and paper media’ (Table 1). It was not possible to directly account for the cost of research staff time on each of strategy, and thus only the direct costs of each strategy were assessed. Costs were reported as total per strategy, and cost-per-randomised and per-completed participant (NZ$).

The analysis was conducted in IBM SPSS Statistics 21.0. Simple descriptive statistics were used to describe the numbers of participants registered and randomised by recruitment strategy, and key demographics. Statistical difference between categories was tested using the Chi-square test for categorical variables, and Analysis of Variance (ANOVA) for continuous variables. Statistical tests were two-sided at 5% significance level.

RESULTS

Recruitment summary

There were 2448 study registrations, of which 1035 were excluded prior to randomisation. Reasons for exclusion were not meeting study inclusion criteria (n=205), failure to complete the study run-in phase (n=727), duplicate registration due to a technical problem with the app (n=47), and non-randomisation of eligible individuals due to a technical problem with the app (n=56). A further 56 individuals were excluded from analysis because they were randomised in error (i.e. randomised even though they failed to meet qualifying run-in criteria) as a result of a technical problem with the app. Thus 1357 individuals (55% registrations) were randomised and included in the main study data analysis: 243 (18%) Maori, 87 (6%) Pacific, and 1,027 (76%) other ethnic groups. Of those randomised, 1202 (89%) completed the study: 201 Maori (83%), 75 Pacific (86%) and 926 (90%) other.

The demographic characteristics of randomised participants, overall and by recruitment strategy, are presented in Table 2. The study population was predominantly female (89%) with a mean (SD) age of 33 (9) years. Representation of Maori, Pacific and other ethnicities was similar to their distribution in the NZ population (Table 2). However, more two thirds of trial participants were tertiary educated (vs 26% in 2013 NZ Census), and nearly all (97%) reported that they were moderately to very interested in healthy eating. Household income was also not representative of the general population, with higher income groups over-represented in the sample (Table 2).

Recruitment strategy was significantly associated with participants' demographic characteristics, namely age (p<0.001), household size (p<0.001), ethnicity (p<0.001),

gender (p=0.005) and interest in healthy eating (p=0.022). Participants recruited via Internet/social media were younger on average (31 years), whilst those recruited via radio and newspaper advertising were older (36.5 and 37 years respectively). A larger proportion of male participants was recruited via strategies focused on personal contact, namely word of mouth and email invitations (14% and 17%, respectively, vs 7-9% by other strategies). Finally, radio advertising attracted a greater proportion of participants not interested in healthy eating (7% vs 1-4% by other strategies).

Recruitment effectiveness

A cumulative summary of recruitment over time in response to the various strategies is presented in Figure 1. The largest peaks in registrations were observed in response to Facebook campaigns (up to 600 new registrations per campaign), followed by promotion via schools, and research team networks (50-100 new registrations per campaign).

Analysis of trial registration website visits using data from Google Analytics and self-reported recruitment source is presented in Figure 2. “Social media” and “Paid search” (Google AdWords) brought 55% of the website visits (Figure 2a). This aligns with self-reported data, which showed that almost 50% of registrations were due to “Internet” campaigns (Figure 2b). Further examination showed 98% of such visits to the study registration page came from Facebook, and the remainder were from other social media and paid search, including Google AdWords. Therefore all registrations that reported “Internet” as a source were considered as arising from Facebook. The second highest website traffic acquisition was via the “Direct” chanel (Figure 2a), i.e. direct visits to the trial webiste not redirected from other websites (likely people using the website address provided in fliers, emails, magazines and newspapers). Self-reported data also showed that over 40% registered participants were reached via networks (“Word of Mouth” and “email invitations”) and media coverage (“Newspapers and magazines”).

The effectiveness and cost per strategy are presented in Table 3. Facebook (paid campaigns and free posts) resulted in the highest absolute registration, randomisation and study completion numbers, both overall, and for each ethnic group. However, higher conversion from registration to randomisation rates were

achieved by network/media strategies, such as “Email Invitations” and “Word of Mouth” (66%-71% vs 60% achieved by Facebook). There was a significant association between recruitment strategy and conversion to randomisation (p=0.011), but not retention. There was also a significant association between ethnicity and recruitment strategies used (p<0.001).

Promotions via networks & paper media was the least expensive strategy (NZ$4 per randomised participant, Table 3), closely followed by Facebook posts (NZ$5 per participant). Radio advertising was the most costly strategy used (NZ$179 per randomised participant).

DISCUSSION

This study describes the effectiveness of a range of recruitment strategies used in a smartphone-delivered nutrition labelling trial.

Over a period of 13 months, 2104 participants were registered and provided information on recruitment source, of whom 55% were randomised into the study (n=1357). Facebook campaigns were the most successful recruitment strategy, both overall (43% of all randomised participants) and for Maori and Pacific participants (44% each). Although the conversion rate from registration to randomisation for participants recruited via Facebook was not as high as that achieved by network promotions, the vast reach of Facebook (Supplementary File 3) and ability to target campaigns by demographics, geographic region, and interests led to the greatest absolute number of study registrations (n=966) and randomisations (n=584).

Most types of campaign were used several times during the recruitment period. The Pacific radio campaign and advertising in a Maori magazine (and via their website) were only used once however (due to cost) during the period that study recruitment was open only to Maori and Pacific. Therefore although it’s possible that other ethnic groups might also have been attracted by these campaigns they would have been deemed ineligible on registration, and so these strategies recruited Maori or Pacific participants exclusively.

The study sample was not representative of the general population and contained a high proportion of tertiary educated adults (66%). One possible explanation for this is utilisation of the professional networks of the study team, and university mailing lists. In addition, most of the paid Facebook campaigns were placed on the University of Auckland Facebook page and while the audience was not limited to the subscribers of this page, interest in University Facebook posts is likely to be higher amongst tertiary educated adults.

The overall dropout rate was 11% (completion rate 89%), which is lower than the typical >20% dropout rate expected for lifestyle interventions.[7] This could have been due to a number of reasons including the offer of a financial incentive on completion of the study, the relatively short study duration, and use of a pre-randomisation run-in period. A run-in period allowed participants to become familiar with the smartphone technology, potentially selected more dedicated users, and allowed exclusion of users with incompatible devices. In total, more than 700 people were excluded following the run-in phase.

Overall the results of this study are consistent with previous findings showing that Facebook is an effective research recruitment method,[7] radio advertising is less cost effective,[21] and combined approaches are best.[21] Higher female participation rates, particularly of those with higher income and education levels, is also typical for nutrition research.[22] A previous study that compared demographic characteristics of participants recruited via either social media or traditional methods found no difference between groups other than in age, which was younger in the social media group.[23] A similar association between age and recruitment strategy was apparent in our study ($p<0.001$), with a lower mean age amongst participants recruited via Facebook (31 years), compared with those recruited through newspapers and radio (37 and 36 years, respectively). Our analysis also demonstrated a significant association between recruitment strategy and other important demographic characteristics, such as gender, ethnicity and household size. It is important therefore to tailor study recruitment approaches to the target population.

Despite using a wide range of culturally-targeted media-based strategies and additional resources to recruit Maori and Pacific participants, targets were still not

met. Face-to-face recruitment building on community networks and connections is a strategy commonly used to recruit Maori and Pacific participants into studies,[13] and was strongly recommended by Maori and Pacific team members as a way to enhance recruitment of Maori and Pacific participants. The fact that "Word of mouth" was the second-most effective strategy is an indication of the potential effectiveness of such face-to-face community-based recruitment. However as this trial recruited people from all across New Zealand in-person recruitment was considered to be too logistically challenging and resource-intensive. Furthermore, the potential for in-person recruitment to introduce selection bias was considered a risk to the internal validity of the study since those recruited using face-to-face methods may differ in other important ways from those recruited using alternative strategies as has been observed in other studies.[24] For research to be truly representative of Maori and Pacific peoples, it is clear from this work that in future research, recruitment protocols and indeed study design needs to be carefully planned and adapted to accommodate different cultural perspectives.

Studies focused on recruitment of underserved or hard-to-reach populations consistently report that greater resources, more time and targeted strategies are needed to recruit such populations.[25] On the other hand, recruitment targets for other ethnicities could potentially be achieved with substantially less cost, thus freeing up more time and resources to focus on more priority population recruitment. Facebook recruitment alone achieved 88% (n=440) of the target for non-Maori, non-Pacific participants, almost eliminating the need to use any other recruitment strategies for this group.

To our knowledge this is the first study to examine the success of a range of strategies to recruit participants to a smartphone-delivered study in NZ. Use of diagnostic technology, namely Google Analytics, enabled objective assessment of web-based recruitment strategies and their effectiveness. The current study also provides data on participant retention, which was previously identified as a gap among existing reports on recruitment for web-based and mobile health studies.[7] We also describe strategies for reducing duplicate and fake registrations.

A limitation was the broad grouping used for self-reported recruitment sources, which prevented analysis at a more precise category level. Inability to estimate staffing

costs associated with recruitment strategies was another limitation, likely to be particularly important in assessing research team network promotions, a heterogeneous approach that involved reasonably high resource e.g. distribution of hard copy advertising fliers.

In conclusion, recruitment via the Internet and social media is comparable in cost and substantially more effective than traditional study recruitment strategies such as mainstream media advertising, and is effective in reaching diverse ethnic groups. However, additional targeted strategies should be considered where large numbers of participants from particular ethnic groups are sought.

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AUTHOR CONTRIBUTIONS

EV and CNM formulated the idea and planned the reported post-study analysis; CNM had leadership responsibility for the main study design and execution; EV and HE contributed substantially to design of the main study; EV and JM managed day-to-day conduct of the study and oversaw data collection; EV and YJ performed the statistical analyses of the study data; CC and GS contributed to study design and revised the paper critically from cultural perspectives; EV wrote the paper and had primary responsibility for final content. All authors provided critical review and commentary on the draft manuscript, and approved the final manuscript.

COMPETING INTERESTS

We have no competing interests to declare.

DATA SHARING STATEMENT

Extra data is available by emailing Cliona Ni Mhurchu c.nimhurchu@auckland.ac.nz

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TRIAL REGISTRATION

Australian New Zealand Clinical Trials Registry (Trial Number ACTRN12614000644662 https://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=366446&isReview=true)

ABBREVIATIONS

RCT	Randomized controlled trial
NZ	New Zealand
App	Application
SD	Standard deviation

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Recruitment campaign	Sub-categories	Corresponding response in Baseline survey
Print media and team networks	Personal and professional networks, schools, universities, healthcare providers, non-government organisations, print media, community events, advertising in magazines	"Word of Mouth" "Email Invitations" "Supermarket Advertising" "Newspaper or Newsletter" "Other"
Internet and social media	Facebook, Linkedin, Google Ads	"Internet"
Radio	Advertising on Pacific Radio	"Radio"

Table 1. Study recruitment strategies

Table 2. Demographic characteristics of study participants according to recruitment strategy

	All study participants (n=1,357)	By recruitment strategy*						NZ population according to 2013 Census
		Internet (n=584)	Radio (n=14)	Word of mouth (n=343)	Email invitation (n=150)	Newspaper/newsletter (n=111)	Other (151)	
Age; mean (SD)	32.7 (9.2)	31.2 (8.6)	36.5 (8.5)	32.3 (9.5)	34.3 (9.7)	37.43 (9.72)	33.83 (8.0)	38.0
Household size; mean (SD)	3.6 (1.7)	3.4 (1.6)	5.3 (2.3)	3.6 (1.7)	3.6 (1.5)	4.1 (1.5)	3.8 (2.1)	2.7
Gender; n (%)								
Male	152 (11.2)	54 (9.2)	1 (7.1)	48 (14.0)	26 (17.3)	11 (9.9)	10 (6.6)	48.7%
Female	1205 (88.8)	530 (90.8)	13 (92.9)	295 (86.0)	124 (82.7)	100 (90.1)	141 (93.4)	51.3%
Ethnicity; n (%)								
Maori	243 (17.9)	106 (18.2)	4 (28.6)	45 (13.1)	25 (16.7)	23 (20.7)	39 (25.8)	14.9%
Pacific	87 (6.4)	38 (6.5)	10 (71.4)	20 (5.8)	12 (8.0)	3 (2.7)	4 (2.6)	6.2%
Other	1027 (75.7)	440 (75.3)	0	278 (81.0)	113 (75.3)	85 (76.6)	108 (71.5)	79.0%
Income; n (%)§								
NZD$20,000 or less	111 (10.4)	61 (13.1)	0	31 (11.4)	8 (6.7)	1 (1.3)	9 (7.1)	11.1%
NZD $20,001 - $40,000	154 (14.4)	59 (12.7)	1 (14.3)	42 (15.4)	22 (18.5)	8 (10.4)	22 (17.5)	20.7%
NZD $40,001 - $60,000	193 (18.1)	81 (17.5)	1 (14.3)	48 (17.6)	25 (21.0)	14 (18.2)	23 (18.3)	15.5%
NZD $60,001 - $70,000	114 (10.7)	56 (12.1)	0	28 (10.3)	10 (8.4)	5 (6.5)	14 (11.1)	7.0%
NZD $70,001 - $100,000	284 (26.6)	110 (23.7)	4 (57.1)	71 (26.1)	30 (25.2)	32 (41.6)	37 (29.4)	18.0%
NZD $100, 001 or more	213 (19.9)	97 (20.9)	1 (14.3)	52 (19.1)	24 (20.2)	17 (22.1)	21 (16.7)	27.6%
Qualification; n (%)								
None	28 (2.1)	10 (1.7)	2 (14.3)	8 (2.3)	3 (2.0)	2 (1.8)	3 (2.0)	18.6%
Secondary School Qualification.	338 (24.9)	146 (25.0)	6 (42.9)	94 (27.4)	25 (16.7)	32 (28.8)	34 (22.5)	35.6%
University or polytechnic degree/diploma	893 (65.8)	395 (67.6)	3 (21.4)	213 (62.1)	108 (72.0)	67 (60.4)	104 (68.9)	26.0%
Trade Certificate	48 (3.5)	16 (2.7)	3 (21.4)	15 (4.4)	6 (4.0)	5 (4.5)	3 (2.0)	8.6%
Other	50 (3.7)	17 (2.9)	0	13 (3.8)	8 (5.3)	5 (4.5)	7 (4.6)	11.1%
Interest in healthy eating; n (%)								
Not particularly interested	37 (2.7)	15 (2.6)	1 (7.1)	13 (3.8)	1 (0.7)	1 (0.9)	5 (3.3)	n/a
Moderately to very interested	1320 (97.3)	569 (97.4)	13 (92.9)	330 (96.2)	149 (99.3)	110 (99.1)	146 (96.7)	n/a

* Recruitment source data were missing for n=3 randomised participants

§ Household income data were missing for n=288 randomised participants

Table 3. Effectiveness and cost of study recruitment campaigns

Recruitment campaign *(data missing for n=4 registered participants)*		Participant status	All participants	By ethnicity*			Campaign cost (NZ$)		
				Maori	Pacific	Other	total	per randomised participant	per completed participant
Internet and social media		Registered, n	966	215	73	668			
		Randomised; n (% of registered)	584 (60)	106 (49)	38 (52)	440 (66)			
		Completed; n, (% of randomised	507 (87)	91 (86)	32 (84)	384 (87)	3047	5	6
Radio		Registered, n	25	10	15	0			
		Randomised; n (% of registered)	14 (56)	4 (40)	10 (67)	0			
		Completed; n, (% of randomised	13 (93)	3 (75)	10 (100)	0	2500	179	192
Print media & team networks	Supermarket ad	Registered, n	3	0	0	3			
		Randomised; n (% of registered)	1 (33)	0	0	1 (33)			
		Completed; n, (% of randomised	1 (100)	0	0	1 (100)			
	Word of mouth	Registered, n	506	76	27	394			
		Randomised; n (% of registered)	343 (68)	45 (59)	20 (74)	278 (71)			
		Completed; n, (% of randomised	306 (89)	34 (76)	18 (90)	254 (91)			
	Email invitation	Registered, n	216	42	19	154			
		Randomised; n (% of registered)	150 (69)	25 (60)	12 (63)	113 (73)			
		Completed; n, (% of randomised	141 (94)	22 (88)	10 (83)	109 (96)			
	Newspaper or newsletter	Registered, n	156	29	8	117			
		Randomised; n (% of registered)	111 (71)	23 (79)	3 (38)	85 (73)			
		Completed; n, (% of randomised	99 (89)	20 (87)	2 (67)	77 (91)			
	Other	Registered, n	228	54	11	161			
		Randomised; n (% of registered)	151 (66)	39 (72)	4 (36)	108 (67)			
		Completed; n, (% of randomised	132 (87)	30 (77)	3 (75)	99 (92)	2830	4	4
Total recruited		Registered, n #	2104	427	152	1501			
		Randomised; n (% of registered)	1357 (64)	243 (57)	87 (57)	1027 (68)			
		Completed; n, (% of randomised	1202 (89)	201 (83(	75 (86)	926 (90)	8377	6	7

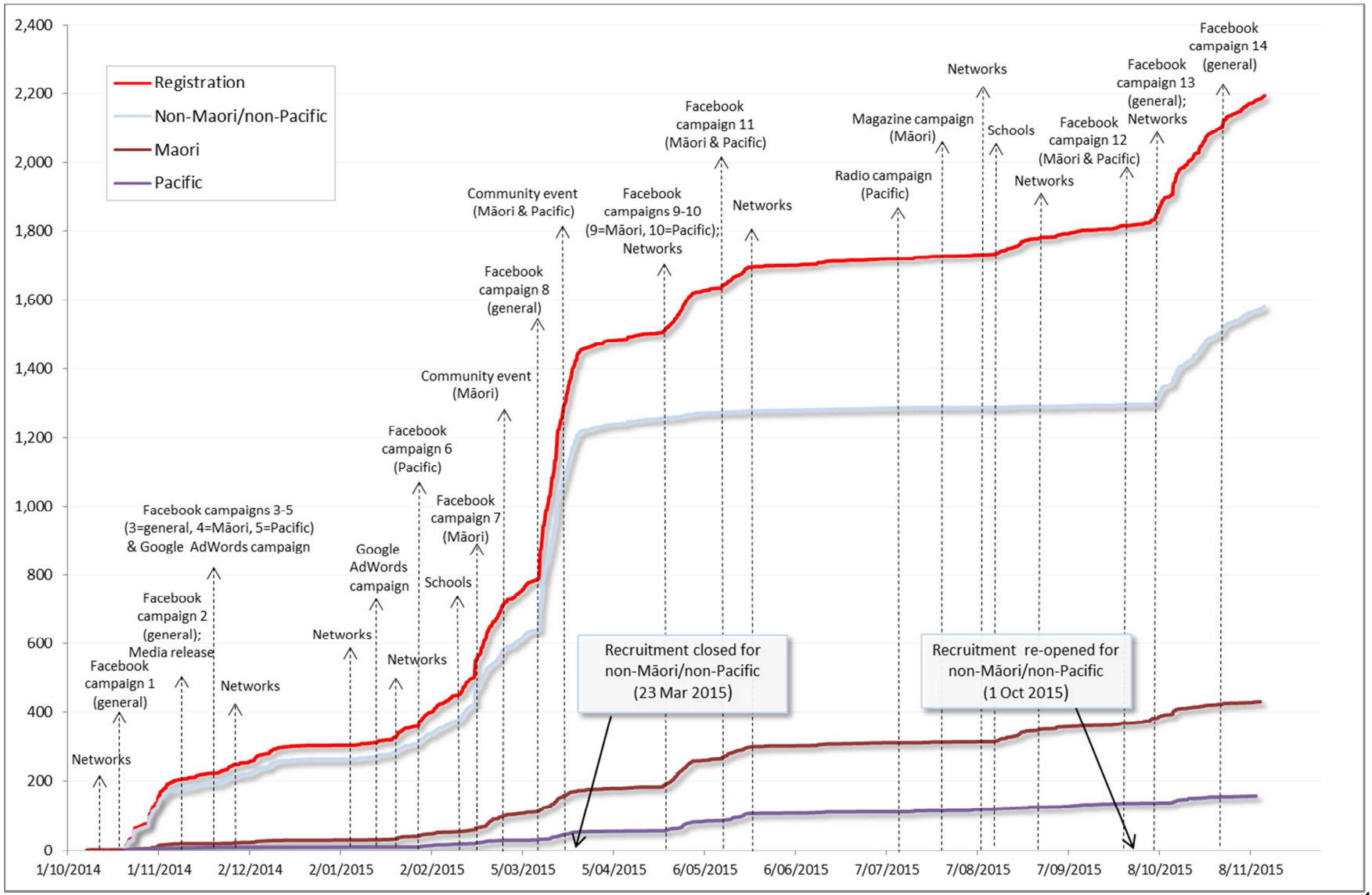
* Ethnicity data were missing for n=24 registered participants

[#] Total number of registrations in the table/analysis (n=2104) is less that that recorded in the study (n=2448) because a number of people did not complete the registration questionnaire so data were not available on recruitment strategy for those participants.

Figures

Figure 1. Recruitment rates in response to implementation of key recruitment strategies over time

Figure 2. Trial website visit and registration numbers by recruitment strategy



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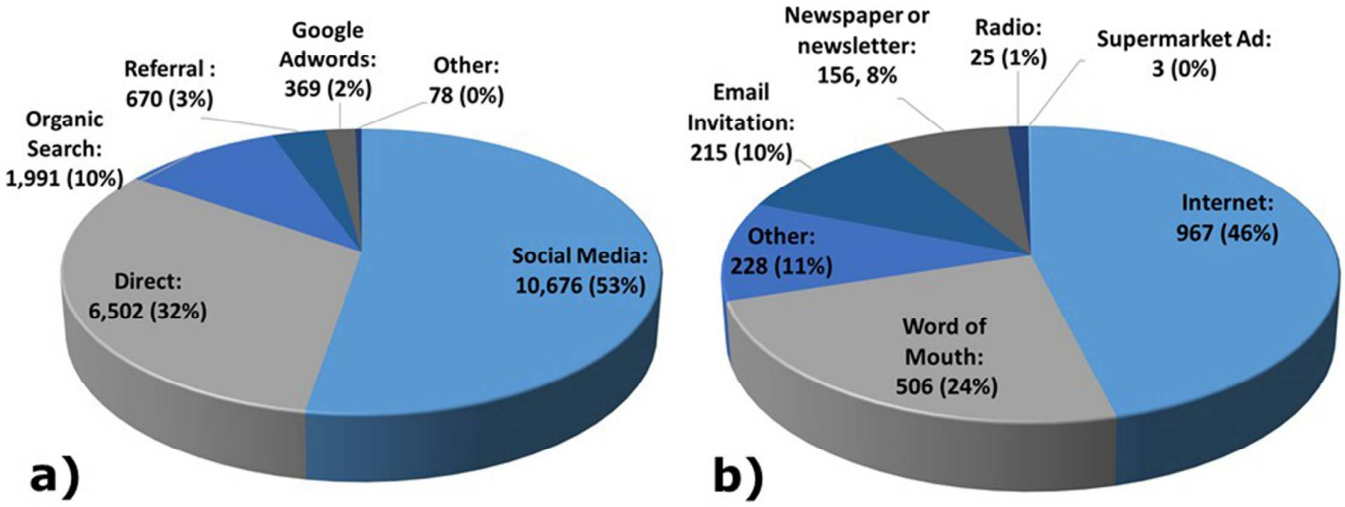

a – Website traffic acquisition channels from the Google Analytics report

b – Self-reported (baseline questionnaire) recruitment source for registered participants

(a)

(b)

Supplementary File 2. Summary of Facebook recruitment campaign reports, Oct 2014 – Nov 2015.

Campaign number	Focus	Dates	Placement	Targeting	Reach (users)	Clicks	Average cost per click (NZD)
1	General	20 - 30 Oct 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	60,960	1,372	$0.15
2	General	14 - 15 Nov 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (over 18)	35,280	460	0.43
3	General	20 Nov – 4 Dec 2014	Sponsored Newsfeed only	Age (18-50), Smartphone owners, New Zealand, Interests(nutrition & fitness-related)	20,598	251	$0.8
4	Māori	20 Nov – 4 Dec 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	53,856	390	$0.51
5	Pacific	20 Nov – 4 Dec 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	39,536	268	$0.75
6	Pacific	28 Jan - 8 Feb 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	1) Age (18-50), Smartphone owners, New Zealand 2) Age (18-50), Smartphone owners, New Zealand, Interests(nutrition & fitness-related) 3) Age (18-50), Smartphone owners, South & West Auckland (high prevalence of Māori and Pacific residents)	44,096	770	$0.26
7	Māori	16 - 26 Feb 2015	Sponsored Newsfeed only	1) Age (18-50), Smartphone owners, New Zealand regions with high Māori and Pacific population 2) Age (18-50), Smartphone owners, South & West Auckland (high prevalence of Māori and Pacific residents) 3) Age (18-50), Smartphone owners, New Zealand	24,014	465	$0.43
8	General	9-22 Mar 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	1) Age (18-50), Smartphone owners, New Zealand, Interests(nutrition & fitness-related) 2) Age (18-50), Smartphone owners, New Zealand	81,504	3,570	$0.06
9	Pacific	22 Apr - 1 May 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, Auckland	49,200	1,053	$0.19
10	Māori	22 Apr - 1 May 2015	Sponsored Newsfeed only	Age (18-50), Smartphone owners, New Zealand regions with high Māori and Pacific population	29,312	532	$0.38
11	Māori & Pacific	11-20 May 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, Auckland and other New Zealand regions with high Māori and Pacific population	60,064	1,170	$0.34
12	Māori & Pacific	23 Sep - 5 Oct 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, Auckland, South Auckland and other New Zealand regions with high Māori and Pacific population	18,862	167	$1.20
13	General	6 -20 Oct 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	20,950	413	$0.48
14	General	30 Oct – 10 Nov 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand (excluding Auckland), Interests(nutrition & fitness-related)	10,220	109	$1.83
				Total	527,854	10,739	n/a
				Average	37,704	767	$0.50

Supplementary File 3. Summary of the Google AdWords campaign performance by top searched keywords

Keyword	Reach (users)	Clicks	Average cost-per-click
volunteer	9,829	195	0.3
volunteers	11,421	158	0.49
diet	1,924	26	2
nutrition diet	3,293	5	3.88
healthy food	581	4	2.42
smartphone	9,287	3	2.77
information about healthy food	1,654	3	2.15
food shopping	3,219	3	0.67
healthy foods	287	2	1.25
healthy food information	170	2	5.98
healthy food choices	32	2	1.62
paid volunteer	24	2	0.2
earn cash	80	2	1.24
earn	43	2	0.22
research	463	2	0.23
diet and nutrition	428	1	1.89
healthy food groups	13	1	3.07
healthy food options	4	1	2.38
information on nutrition	887	1	2.93
food label	2	0	0
about healthy foods	1	0	0
healthy foods to eat	54	0	0
eat healthy food	15	0	0
healthy food articles	1	0	0
participants	77	0	0
food labels	8	0	0
participate in a study	2	0	0
what is healthy food	273	0	0
take part	2	0	0
healthy food to eat	4	0	0
healthy food for	37	0	0
join research	2	0	0
the healthy food	5	0	0
healthy food pictures	3	0	0
healthy eating	81	0	0
what is healthy foods	1	0	0
food labelling	66	0	0
what are healthy foods	1	0	0
earn reward	10	0	0
labels food	271	0	0

healthy foods to buy	1	0	0
healthy food plans	6	0	0
research study	617	0	0
healthy food chart	2	0	0
healthy food habits	13	0	0
food nutrition labels	207	0	0
most healthy foods	0	0	0
food healthy	298	0	0
healthy food products	7	0	0
healthy shopping	72	0	0
which is healthy food	0	0	0
recipes for healthy snacks	6	0	0
healthy food ideas	25	0	0
healthy food menus	2	0	0
earn	98	0	0
volunteer for research studies	1	0	0
best healthy foods	5	0	0
healthy diet	40	0	0
how to make healthy food	6	0	0
eating healthy foods	3	0	0
participant in research	1	0	0
what are some healthy foods	10	0	0
nutrition labels	47	0	0
healthy food labels	18	0	0
healthy food for health	1	0	0
how to eat healthy food	7	0	0
about healthy food	156	0	0
take part	2	0	0
earn cash	14	0	0
participant	6	0	0
participate	9	0	0
paid volunteer	3	0	0
cash	614	0	0
Total	**46,852**	**415**	
Average			**$1.87**

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BMC Public Health

STUDY PROTOCOL Open Access

Effects of interpretive front-of-pack nutrition labels on food purchases: protocol for the Starlight randomised controlled trial

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Abstract

Background: Interpretive front-of-pack nutrition labels are better understood than non-interpretive labels. However, robust evidence on the effects of such labels on consumer food purchases in the real-world is lacking. Our aim is to assess the effects of two interpretive front-of-pack nutrition labels, compared with a non-interpretive label, on the healthiness of consumer food purchases.

Methods/Design: A five-week (1-week baseline and 4-week intervention) three-arm parallel randomised controlled trial will be conducted using a bespoke smartphone application, which will administer study questionnaires and deliver intervention (Multiple Traffic Light and Health Star Rating) and control (Nutrition Information Panel) labels. To view their allocated nutrition label, participants scan the barcode of packaged food products using their smartphone camera. The assigned label is displayed instantly on the smartphone screen.1500 eligible participants (New Zealand adult smartphone owners who shop in a supermarket at least once a week and are main household shoppers) will be randomised in a 1:1:1 ratio to one of the three nutrition label formats, using computer-generated randomisation sequences. Randomisation will be stratified by ethnicity and interest in healthy eating. Food and beverage purchase data will be collected continuously throughout the study via hard copy till receipts and electronic grocery purchase lists recorded and transmitted using the smartphone application. The primary outcome will be healthiness of food purchases in each trial arm, assessed as mean Food Standards Australia New Zealand nutrient profiling score criterion score for all food and beverages purchased over the intervention period. Secondary outcomes will include saturated fat, sugar, sodium and energy content of food purchases; food expenditure; labelling profile of food purchases (i.e. mean number of Health Star Rating stars and proportion of red, green and amber traffic lights); nutrient profiling score over time and by food categories; purchases of unpackaged foods; self-reported nutrition knowledge and recorded use of assigned labelling system.

Discussion: The Starlight randomised, controlled trial will determine the effects of interpretive front-of-pack nutrition labels on the healthiness of consumer food purchases in the real world.

Trial registration: Australian New Zealand Clinical Trials Registry ACTRN12614000644662 (registered 18 June 2014).

Keywords: Nutrition labeling, Mobile applications, Technology, Nutrition policy, Randomized controlled trial (RCT), Traffic-light label, Health star rating label

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Background

Obesity and the burden of associated non-communicable disease has been increasing worldwide [1]. Effective, front-of-pack (FOP) nutrition labelling is potentially one of the most cost-effective interventions [2]. However, traditional numerical nutrition labels are difficult to interpret and have limited influence on the average consumer's food purchasing patterns [3-5].

In New Zealand, the Nutrition Information Panel (NIP), usually found on the back of food packages, is mandatory [6]. A review of nutrition label use found that this is poorly understood by most New Zealanders [7]. Further, use of this nutrition label is particularly low among Māori (indigenous New Zealanders), Pacific, and low-income New Zealanders [8], who experience the highest rates of obesity [9]. Therefore, identifying a labelling format that delivers information effectively to these groups is especially important.

A recent review of New Zealand and Australian food labelling policy recommended introduction of interpretative FOP labels that are easy for consumers to understand and act upon [10]. Substantial global evidence indicates that interpretative labels (using graphics, symbols or colours) are better understood than traditional numeric nutrition labels [11]. However, the impact of such labels on food purchase habits is unclear.

Evaluation of nutrition labelling interventions in the real-world is challenging. Two common approaches are to use controlled settings (for example, a workplace cafeteria or one particular retailer), or consumer surveys. Several cafeteria studies support the ability of FOP labels to promote healthy food choices [12-14]. Surveys and choice experiments also report favourable results, suggesting FOP labels help participants to successfully identify healthier options [15] and are used to make food choices [16-18].

A limited number of studies report on the effect of FOP labels in retail settings. A large observational study conducted by Sacks et al. [19] investigated the effect of supplementary traffic-light FOP labels implemented as a voluntary nutrition labelling system in a UK retailer. The study reported no difference between sales of healthy and unhealthy ready meals and sandwiches following introduction of traffic-light FOP labels, compared to the period prior to label administration. The major limitation of this study was the small sample of products included in the study. Another large intervention study assessed the effectiveness of "Guiding Star" shelf labelling system across a chain of 168 US supermarkets [20]. Analysis of supermarket sales data showed a significant increase in proportion of star-rated product sales and corresponding decrease in sales of un-starred products in same food categories [20]. One limitation however was the lack of a control group within the same stores. Randomised controlled trials are needed to provide robust evidence on the effect of the FOP labels on real-world retail food purchases.

The current study assesses two types of FOP nutrition labels. One is the colour-coded traffic-light (TL) FOP label [21]. This label uses colour-coded categories to reflect low (green), medium (amber) and high (red) content of four nutrients: total fat, saturated fat, total sugar and salt. The underpinning algorithm is that recommended by the UK Governments [22]. This FOP label has been shown to have a high level of understanding and acceptance across major ethnic and income groups [23]. The other label to be evaluated is the new Health Star Rating (HSR) system proposed for implementation in Australia. This label assigns a star rating to a food from ½ (least healthy) to 5 (most healthy) stars based on the underpinning HSR score algorithm [24].

The intervention will be delivered using novel smartphone technology, based on the FoodSwitch free smartphone application (app) where users scan the barcode of a packaged food and receive an immediate, interpretive TL nutrition label on their phone screen, and recommendations for healthier options [25]. A similar smartphone app designed for the current study will be used to deliver TL, HSR or NIP nutrition labels to study participants. The primary aim of the trial is to assess the effectiveness of TL and HSR label formats, compared with the standard NIP, on healthiness of consumer food purchases. The null hypothesis of no difference with the control label will be tested for each of the intervention arms.

Methods/Design

Study design

Starlight is a three-arm parallel randomised controlled trial (Figure 1). A total of 1,500 participants will be randomised to receive either one of two FOP labels (TL or HSR; intervention arms) or NIP label (control arm) in a 1:1:1 ratio. All nutrition labels will be delivered via a bespoke "Food Label Trial" smartphone app.

Approval

Ethical approval from the University of Auckland Human Participants Ethics Committee was received on 26 May 2014. The Starlight trial is registered in the Australian New Zealand Clinical Trials Registry (registration number ACTRN12614000644662).

Intervention arms

1) FOP Traffic-Light label (Figure 2a).
2) FOP Health Star Rating label (Figure 2b).

Control arm:

1) Standard New Zealand non-interpretive, numerical NIP (Figure 2c)

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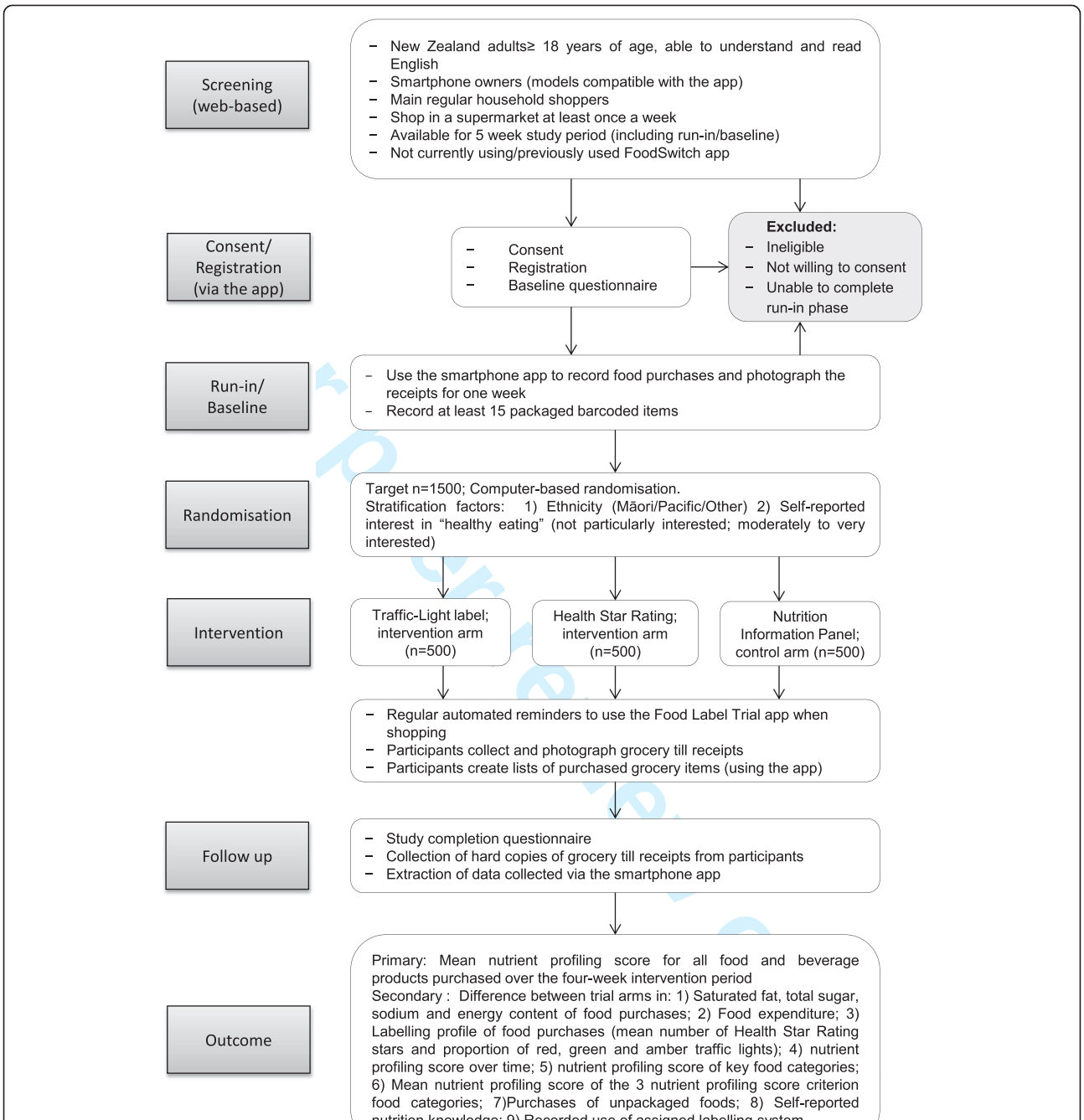

Figure 1 Flow chart for the Starlight trial.

"Food Label Trial" smartphone application

All allocated labels will be delivered via the bespoke "Food Label Trial" smartphone app, which enables participants to view the allocated nutrition label for packaged barcoded products. To view the label, users scan barcodes of packaged food products using the smartphone camera, and assigned labels instantly appear on the phone screen. At the same time the app also displays a random selection of other foods in the same food category with same label format to encourage comparative review of available choices and to better test the influence of the label on purchasing decision. If a food item is missing from the app database, participants will receive a default message and will have an option of providing the details of this product (photographs and barcode) in order for it to be added to the database.

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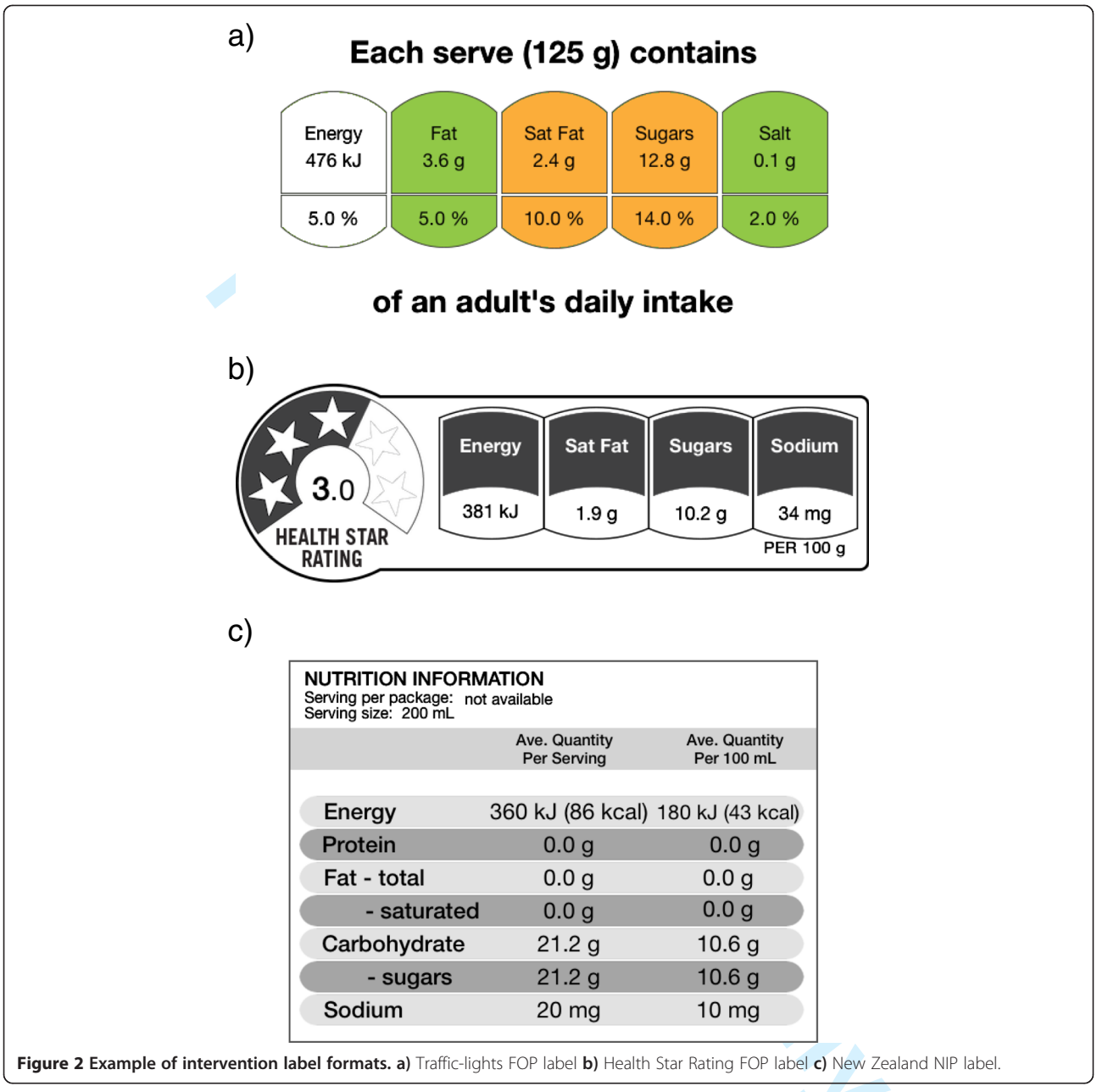

Figure 2 Example of intervention label formats. a) Traffic-lights FOP label **b)** Health Star Rating FOP label **c)** New Zealand NIP label.

Additional app functions enable outcome data collection. Participants will use the app to create electronic lists of purchased food/beverage products and to photograph their grocery till receipts. In order to create the electronic list of purchased items the participants will scan barcodes of the items purchased using their smartphone camera.

Study population

The Starlight trial will recruit 1500 New Zealand adults (aged 18 years and older) who have a smartphone (iPhone or Android), are main household shoppers (i.e. complete 50% or more of the grocery shopping for their household), and shop at a supermarket at least once a week. Participants must be able to read and understand English, and be available for the full duration of the 5-week trial. Only one person per household can participate in the study. Current or previous FoodSwitch app users will be excluded, because FoodSwitch provides TL labels and recommends healthier food options.

Recruitment and run-in phase/baseline

Participants will be recruited across New Zealand via advertising in local newspapers and on social media websites, household mail drops, at community venues including supermarkets, and utilising existing research team networks. The aim is to recruit approximately

equal numbers of Māori (n = 500), Pacific (n = 500) and other ethnic group participants (n = 500).

Eligible participants will be given access to the "Food Label Trial" app. Informed consent and baseline demographic data will be collected from all study participants via the app.

During the run-in/baseline phase participants will record their food and beverage purchases for one week using the app, and collect and photograph the corresponding till receipts using the smartphone app. At least 15 purchased barcoded grocery items will need to be recorded during this period in order to qualify for study entry. Failure to complete the run-in phase will result in ineligibility.

Randomisation

Participants who complete the run-in phase successfully will be randomised in a 1:1:1 ratio to one of the three label formats (TL; HSR or NIP), using a central computer-based randomisation system. Blocked randomisation will be used with variable block sizes, stratified by self-identified ethnic group (Māori, Pacific, Other) and self-reported interest in "healthy eating" (not particularly interested; moderately to very interested).

Blinding

It is not possible to blind trial participants to the intervention. However, participants will only see one type of label for the duration of the trial and will not know what other label formats are being tested in the trial.

Data collection

The baseline questionnaire will collect demographic details (age, gender, ethnicity, income, education level, family size) and self-reported information on interest in nutrition and healthy eating.

Data on participant food and beverage purchases will be collected throughout the one-week baseline and four-week intervention period. Usage of the labelling function will be automatically recorded by the "Food Label Trial" app. Objective purchase data will be supplied by participants in the following modes: 1) electronic list of scanned purchased items ("Food Label Trial" app function); 2) photographs of corresponding grocery till receipts ("Food Label Trial" app function); 3) hard copies of grocery till receipts (returned by participants at the end of the intervention period). The electronic lists of purchased items will be used as the primary data source of packaged food purchases. The till receipts provide information on price and on purchases of non-barcoded items. Photographs of till receipts will be used as a back-up for missing hard copy till receipts.

All data collected via the "Food Label Trial" will be automatically transmitted via Wi-Fi or 3/4G to the app database, hosted on a remote server, and subsequently extracted by researchers to the study database. Hard copies of till receipts will be mailed by participants to the study centre and the additional data manually entered into the study database.

A follow up questionnaire will collect participant feedback on the app (technical issues, usefulness, self-reported impact on food choices), self-reported compliance with the trial protocol (number of shopping events recorded and till receipts returned, usage of the trial app) and perceived changes in participant's nutrition knowledge.

Regular reminder messages (3 times per week) will be sent throughout the intervention period to encourage participants to use the app and submit data, and to minimise attrition. At the end of the study participants will be provided with reward vouchers as a compensation for the time and potential costs associated with taking part in the trial.

Outcomes

The primary outcome of the trial will be the mean nutrient profiling score for all food and beverage products purchased over the four-week intervention period. Nutrient profiling score will be calculated using the Food Standards Australia New Zealand (FSANZ) nutrient profiling standard [26]. Food composition data will be obtained from Nutritrack, a brand-specific processed food composition database that contains comprehensive annually-updated information on New Zealand packaged and fast foods [27]. As a secondary approach, the crude nutrient profiling score will be transformed to a scale of 0–100 consistent across all 3 NPSC category foods. A tertiary approach will also be considered on weighted nutrient profiling score stratified by key food categories.

Secondary outcomes will be the difference between trial arms in:

1) Mean saturated fat, total sugar, sodium and energy content per 100 g food purchases over the four-week intervention period;
2) Mean weekly food expenditure over the four-week intervention period;
3) Labelling profile of food purchases (mean number of HSR stars and proportions of red, green and amber traffic lights) over the four-week intervention period;
4) Mean nutrient profiling score for all food and beverage products purchased each week of the intervention period;
5) Mean nutrient profiling score of key food categories likely to be most impacted by nutrition labelling (e.g. breakfast cereals, cereal bars, pizzas and ready meals);

6) Mean nutrient profiling score of the 3 nutrient profiling score criterion food categories (beverages, fats and oils, all other foods)
7) Mean purchases of unpackaged foods (e.g. fruit and vegetables) in g/100 g;
8) Self-reported nutrition knowledge at follow-up;
9) Use of assigned labelling system as recorded by the Food Label Trial app.

Sample size

A total sample size of 1,500 participants (n = 500 per arm) will have at least 80% power (alpha = 0.05) to detect a minimum 2-unit difference in the mean nutrient profiling score between either of the intervention arms and control with adjustment for multiple comparisons. A 2-unit change in nutrient profiling score is approximately equivalent to the following changes in nutrient content per 100 g food: 78 kJ energy, 0.95 g saturated fat, 1.5 g total sugars and 73 mg sodium (unpublished data). The nutrient profile score will be estimated using the FSANZ nutrient profiling scoring calculator, where food scores span a range of −17 to 53 (a lower score is healthier) [28]. The power estimate assumes a standard deviation of 9.9 based on distribution of >25,000 foods in an Australian food database.

Statistical analyses

Statistical analyses will be performed using SAS version 9.3 (SAS Institute Inc. Cary NC). All statistical tests will be two-tailed and maintained at a 5% significance level. The baseline characteristics of all study participants will be summarised and tabulated using means (standard deviations, medians and ranges) and frequencies (proportions). Analysis of covariance (ANCOVA) regression models will be used to compare mean nutrient profiling score between intervention and control groups, adjusting for baseline nutrient profiling score and stratification factors. A similar approach will be used for continuous secondary outcomes. Generalized linear models will be used for secondary categorical outcomes. No imputation will be undertaken. Repeated measures mixed models will be used to evaluate treatment effects over time. Sub-group analyses will test possible interactions of the labelling intervention with key food categories, ethnicity (Maori, Pacific, Other), income tertile, and baseline self-reported interest in “healthy eating”. Sensitivity analyses will be undertaken using data only from participants who return at least 75% of till receipts/food purchase data based on pre-randomisation usual reported number of shopping episodes. A statistical analysis plan will be prepared by the trial statistician prior to the final data lock. Reporting will adhere to the CONSORT 2010 guidelines for reporting parallel group randomised trials.

Discussion

The aim of the Starlight RCT is to measure the effects of two interpretive FOP nutrition labels, compared with the standard NIP, on the healthiness of food purchases. To our knowledge, this is the first RCT assessing the impact of interpretive FOP labels on objectively measured consumer purchases in real-world retail outlets nationwide, without restriction to a particular store or setting. The unique smartphone app designed for the trial will allow shoppers to view nutrition labels of barcoded food products in any retail outlet. The randomised controlled design of the Starlight trial enables use of the NIP label at an individual level as a control, rather than using a control store. The advantage of this approach is that it minimises confounding effects of patterns of sales in different retailers. Another advantage is that it neutralises any effect of using the smartphone app to scan products. The “Food Label Trial” smartphone app will also allow objective assessment of nutrition label use when shopping since this information will be collected automatically by the app. The Starlight trial will also assess the impact, utility and acceptability of proposed label format for Māori and Pacific adults. This is of particular importance, considering the high prevalence of obesity and nutrition-related disease among those groups [9]. According to study by Signal et al. [8], self-reported use of nutrition labels is low among those groups, and both claim to favour simpler nutrition labels that are easier to understand. Whilst FOP labels are the focus of much government, industry and advocacy group attention worldwide, their impact on consumers’ behaviour is uncertain. This large, randomised, controlled trial will provide robust evidence of the effectiveness and potential cost-effectiveness of FOP labelling as means to improve population diets and health.

Trial status

Recruiting.

Abbreviations

FOP: Front-of-pack; NIP: Nutrition information panel; App: Application; TL: Traffic-light; HSR: Health star rating; RCT: Randomised controlled trial.

Competing interests

The authors declare that they have no competing interests.

Authors’ contributions

CNM, HE, BN, MR and BS contributed significantly to conceptualisation of the project. CNM is the principal investigator for the trial. YJ contributed to statistical design and power calculations. KV, CNM, BN JM and HE contributed to study design and smartphone app development. KV and CNM jointly led the writing of the manuscript. All authors have read, provided input to, and approved the final version of manuscript.

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Effectiveness of Recruitment to a Smartphone-Delivered Nutrition Intervention in New Zealand: Analysis of a Randomised Controlled Trial

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ABSTRACT

Objectives

Delivery of interventions via smartphone is a relatively new initiative in public health, and limited evidence exists regarding optimal strategies for recruitment. We describe the effectiveness of approaches used to recruit participants to a smartphone-enabled nutrition intervention trial.

Methods

Internet and social media advertising, mainstream media advertising, and research team networks were used to recruit New Zealand adults to a fully automated smartphone-delivered nutrition labelling trial (no face-to-face visits were required). Recruitment of Maori and Pacific participants was a key focus and ethically-relevant recruitment materials and approaches were used where possible. The effectiveness of recruitment strategies was evaluated using Google Analytics, monitoring of study website registrations and randomisations, and self-reported participant data. The cost of the various strategies and associations with participant demographics were assessed.

Results

Over a period of 13 months, there were 2,448 registrations on the study website, and 1,357 eligible individuals were randomised into the study (55%). Facebook campaigns were the most successful recruitment strategy overall (43% of all randomised participants) and for all ethnic groups (Maori 44%, Pacific 44%, Other 43%). Significant associations were observed between recruitment strategy and age ($p<0.001$), household size ($p<0.001$), ethnicity ($p<0.001$), gender ($p=0.005$) and interest in healthy eating ($p=0.022$). Facebook campaigns resulted in the highest absolute numbers of study registrations and randomisations (966 and 584 respectively). Network strategies and Facebook campaigns cost least per randomised participant (NZ$4 and NZ$5, respectively), whilst radio advertising cost most (NZ$179 per participant).

Conclusion

Internet and social media advertising were the most effective and least costly approaches to recruiting participants to a smartphone-delivered trial. These approaches also reached diverse ethnic groups. However, more culturally appropriate recruitment strategies are likely to be necessary in studies where large numbers of participants from specific ethnic groups are sought.

ARTICLE SUMMARY

Strengths and limitations of this study

- Reports on effectiveness and costs of a range of recruitment strategies (internet and social media advertising, mainstream media advertising and research team networks) used for a smartphone-delivered study
- Effectiveness was evaluated using Google Analytics, monitoring of study website registrations and randomisations, and self-reported data
- Information is provided on participant retention rates, and strategies to reduce duplicate and fake registrations
- The broad categorisation of self-reported recruitment source data prevented more precise sub-category analysis
- Staffing costs associated with recruitment strategies were not assessed

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INTRODUCTION

Monitoring and reporting of study recruitment strategies and their effectiveness facilitates improvements in design and methods for future randomised controlled trials (RCTs). Systematic reviews provide an indication of successful recruitment strategies and trial design elements such as incentives and open-label design,[1, 2] and their cost-effectiveness.[3] However, applicability and success of various strategies depends on specifics of the trial design, setting, and study population.

Smartphone delivery and measurement of trial interventions [4-6] is a relatively new initiative and presents unique recruitment challenges compared to traditional RCTs. In addition to standard trial eligibility criteria, prospective participants must have smartphone access and be adept at using technology. Moreover, attrition rates are potentially higher because enrolment rates may be augmented by a 'novelty factor' that decays over time.[7] Lack of personal contact with study staff may also increase attrition.[7] Such challenges are also relevant to public health and health promotion interventions that increasingly deliver programme components using smartphone technology. Identifying successful recruitment and retention strategies for this type of intervention is therefore timely and important.

In addition to traditional RCT recruitment methods such as advertising via community fliers, newspapers or media,[8] newer strategies including Internet and social media advertising [9] are being increasingly used. A systematic review found that online recruitment strategies, Facebook in particular, were promising ways to recruit participants for internet and mobile health (mHealth) studies.[7] However, limited data were available, and specific gaps identified were reporting of participant retention rates, and methods to identify and manage fake and duplicate registrations.

Potential greater reach amongst underserved and diverse population groups is one suggested benefit of online recruitment.[8, 10] In New Zealand (NZ), Maori (indigenous New Zealanders making up 14.9% of population) and Pacific peoples (7.4%) are priority groups for health intervention programmes due to their disproportionately high prevalence of non-communicable diseases and associated risk factors.[11] Adequate representation of these groups in health research is vital but often hard to achieve with generic recruitment strategies, so ethnic-specific tailoring of strategies is recommended.[12, 13]

Our aim was to assess the effectiveness of a range of approaches used to recruit participants to a large smartphone-delivered nutrition labelling RCT,[14] and to examine associations of recruitment strategy with ethnicity and other participant demographics.

METHODS

The Starlight RCT received ethics approval from the University of Auckland Human Participant Ethics Committee (reference number 011390) and the study protocol was published in 2014.[15] The trial was registered on the Australian New Zealand Clinical Trials Registry (ACTRN12614000644662). All participants provided informed consent via a questionnaire completed on their smartphone.

The aim of the trial was to evaluate the effects of two interpretive nutrition labels, Traffic Light Labels and Health Star Rating Labels, compared with a non-interpretive label, on the healthiness of consumer food purchases. The target was to recruit and randomise 1,500 eligible New Zealand adults, comprised of approximately equal numbers of Maori, Pacific, and other ethnicities. Eligible participants were aged 18 years or older, owned a smartphone, were the main household shopper, and could read and understand English. All components of the trial (screening, consent, registration, randomisation, intervention and data collection) were delivered via a bespoke, automated smartphone application (app).[16] Outcome data were collected in the form of scanned household food purchase records. Completion of a run-in period (week 1) with a requirement to record at least 15 food items was a prerequisite for randomisation. The four-week nutrition labelling intervention comprised randomisation to one of two interpretive nutrition labels (Traffic Lights [17] or Health Star Ratings [18]) or to a control group (Nutrition Information Panel).[19] The primary study outcome was healthiness of all foods and beverages purchased over the intervention period, measured using the Food Standards Australia New Zealand (FSANZ) nutrient profiling scoring criterion.[20]

Recruitment

Recruitment commenced in October 2014. A key focus was to attract 500 Maori and 500 Pacific participants, with advice provided by Maori and Pacific team members. Recruitment was open initially to all ethnic groups, but was closed to non-Maori, non-

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Pacific individuals after six months when the target for this group (500 participants) was reached. Recruitment of Maori and Pacific individuals continued for a further five months, but at that time it became clear that recruitment targets would not be met within the study timeframes. Therefore, recruitment was reopened to all ethnicities again for two months and closed finally in November 2015.

Recruitment campaigns directed volunteers to a designated trial website to answer a pre-screening questionnaire, and a link to download the trial app was then provided. Enrolment occurred via the app, but the pre-screening step allowed the study team to monitor registration numbers and ethnicity targets. The trial app was available free of charge in NZ Google Play and iTunes app stores. Information in the app stores also encouraged volunteers to visit the trial website before downloading the app.

Recruitment materials and advertisements were developed by the research team. (Supplementary File 1, a-b). Advertising campaigns were conducted at staggered intervals over the 13-month recruitment period using research team networks, Internet and social media advertising, and mainstream media advertising (Figure 1). The impact of recruitment strategies was assessed continuously by comparison with monthly recruitment targets.

Three media releases were issued by the University communications office (Oct 2014, Nov 2014 and Nov 2015). Promotion via research team networks was undertaken using group email lists, word of mouth, staff intranets, personal Facebook pages, and hard copy recruitment flier distribution. Electronic recruitment fliers were circulated via email lists at several NZ universities, healthcare providers, and relevant non-government organisations. Requests were made to NZ schools, particularly those with high numbers of Maori and Pacific students, to promote the study to via their newsletters with the aim of recruiting parents of students. Paid internet advertising was undertaken using two Google AdWords campaigns, one LinkedIn campaign, and 14 promoted posts on Facebook (Supplementary Files 2-3). Other paid advertising included an advertisement in a Maori magazine (including a web banner on their website), promotional advertisements on Pacific radio, and representation at relevant events, such as Maori and Pacific cultural festivals and health provider conferences.

Strategies to maintain retention

Participants were sent regular notifications via the study app, SMS text reminders,[16] and email messages. All registered participants received a NZ$10 gift voucher, and those who completed the trial (defined as completion of the follow up questionnaire at the end of the five-week study) received a further NZ$80 gift voucher.

Registration logic checks

Because incentives (vouchers) were offered for study participation, repeat registrations by the same participants and re-registration by ineligible participants were identified as risks. To prevent duplicate registrations, individual IP address and email address checks were implemented on the study screening website. Within the app, logic checks for unique and valid email address and valid age (18 to 100 years) were also implemented. All registrations were checked daily for duplicate surnames, street addresses, and phone numbers. All suspected duplicate registrations were investigated by research staff. Confirmed duplicate registrations were contacted with the request that they discontinue the trial.

Data Analysis

Information on the demographic characteristics of trial participants was collected via a baseline questionnaire completed in the study app.[15] Self-reported ethnicity was grouped into three categories: Maori, Pacific, and Other. Google Analytics [21] was used to track visits to the study website. Data on self-reported recruitment strategy that attracted participants were collected using the question “How did you find out about the study?” The effectiveness of recruitment strategies was assessed by collating numbers of participants registered, randomised, and completing the trial. Conversion to randomisation was defined as proportion of registered participants randomised and retention rate was defined as proportion of randomised participants retained. Participants who could not be randomised due to technical issues with the app or their phone were excluded from analysis.

Self-reported recruitment data were matched with recorded costs for each strategy. Only broad categories were available in the self-reported data. Thus in the cost analysis, promotion or advertising via community events, research team’s personal and professional network, and coverage in mainstream paper media were combined

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in one category titled 'network and paper media' (Table 1). It was not possible to directly account for the cost of research staff time on each of strategy, and thus only the direct costs of each strategy were assessed. Costs were reported as total per strategy, and cost-per-randomised and per-completed participant (NZ$).

The analysis was conducted in IBM SPSS Statistics 21.0. Simple descriptive statistics were used to describe the numbers of participants registered and randomised by recruitment strategy, and key demographics. Statistical difference between categories was tested using the Chi-square test for categorical variables, and Analysis of Variance (ANOVA) for continuous variables. Statistical tests were two-sided at 5% significance level.

RESULTS

Recruitment summary

There were 2448 study registrations, of which 1035 were excluded prior to randomisation. Reasons for exclusion were ineligibility based on study inclusion criteria (n=205), failure to complete the study run-in phase (n=727), duplicate registration due to a technical problem with the app (n=47), and non-randomisation of eligible individuals due to a technical problem with the app (n=56). A further 56 individuals were excluded from analysis because they were randomised in error (i.e. randomised even though they failed to meet qualifying run-in criteria) as a result of a technical problem with the app. Thus 1357 individuals (55% registrations) were randomised and included in the main study data analysis: 243 (18%) Maori, 87 (6%) Pacific, and 1,027 (76%) other ethnic groups. Of those randomised, 1202 (89%) completed the study: 201 Maori (83%), 75 Pacific (86%) and 926 (90%) other.

The demographic characteristics of randomised participants, overall and by recruitment strategy, are presented in Table 2. The study population was predominantly female (89%) with a mean (SD) age of 33 (9) years. Representation of Maori, Pacific and other ethnicities was similar to their distribution in the NZ population (Table 2). However, more two thirds of trial participants were tertiary educated (vs 26% in 2013 NZ Census),[22] and nearly all (97%) reported that they were moderately to very interested in healthy eating. Household income was also not

representative of the general population, with higher income groups over-represented in the sample (Table 2).

Recruitment strategy was significantly associated with participants' demographic characteristics, namely age (p<0.001), household size (p<0.001), ethnicity (p<0.001), gender (p=0.005) and interest in healthy eating (p=0.022). Participants recruited via Internet/social media were younger on average (31 years), whilst those recruited via radio and newspaper advertising were older (36.5 and 37 years respectively). A larger proportion of male participants was recruited via strategies focused on personal contact, namely word of mouth and email invitations (14% and 17%, respectively, vs 7-9% by other strategies). Finally, radio advertising attracted a greater proportion of participants not interested in healthy eating (7% vs 1-4% by other strategies).

Recruitment effectiveness

A cumulative summary of recruitment over time in response to the various strategies is presented in Figure 1. The largest peaks in registrations were observed in response to Facebook campaigns (up to 600 new registrations per campaign), followed by promotion via schools, and research team networks (50-100 new registrations per campaign).

Analysis of trial registration website visits using data from Google Analytics and self-reported recruitment source is presented in Figure 2. "Social media" and "Paid search" (Google AdWords) brought 55% of the website visits (Figure 2a). This aligns with self-reported data, which showed that almost 50% of registrations were due to "Internet" campaigns (Figure 2b). Further examination showed 98% of such visits to the study registration page came from Facebook, and the remainder were from other social media and paid search, including Google AdWords. Therefore all registrations that reported "Internet" as a source were considered as arising from Facebook. The second highest website traffic acquisition was via the "Direct" chanel (Figure 2a), i.e. direct visits to the trial webiste not redirected from other websites (likely people using the website address provided in fliers, emails, magazines and newspapers). Self-reported data also showed that over 40% registered participants were reached via networks ("Word of Mouth" and "email invitations") and media coverage ("Newspapers and magazines").

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The effectiveness and cost per strategy are presented in Table 3. Facebook (paid campaigns and free posts) resulted in the highest absolute registration, randomisation and study completion numbers, both overall, and for each ethnic group. However, higher conversion from registration to randomisation rates were achieved by network/media strategies, such as “Email Invitations” and “Word of Mouth” (66%-71% vs 60% achieved by Facebook). There was a significant association between recruitment strategy and conversion to randomisation (p=0.011), but not retention. There was also a significant association between ethnicity and recruitment strategies used (p<0.001).

Promotions via networks & paper media was the least expensive strategy (NZ$4 per randomised participant, Table 3), closely followed by Facebook posts (NZ$5 per participant). Radio advertising was the most costly strategy used (NZ$179 per randomised participant).

DISCUSSION

This study describes the effectiveness of a range of recruitment strategies used in a smartphone-delivered nutrition labelling intervention trial. Over a period of 13 months, 2104 participants were registered and provided information on recruitment source, of whom 55% were randomised into the study (n=1357). Facebook campaigns were the most successful recruitment strategy, both overall (43% of all randomised participants) and for Maori and Pacific participants (44% each). Although the conversion rate from registration to randomisation for participants recruited via Facebook was not as high as that achieved by network promotions, the vast reach of Facebook (Supplementary File 3) and ability to target campaigns by demographics, geographic region, and interests led to the greatest absolute number of study registrations (n=966) and randomisations (n=584).

Most types of campaign were used several times during the recruitment period. The Pacific radio campaign and advertising in a Maori magazine (and via their website) were only used once however (due to cost) during the period that study recruitment was open only to Maori and Pacific. Therefore although it’s possible that other ethnic groups might also have been attracted by these campaigns they would have been

deemed ineligible on registration, and so these strategies recruited Maori or Pacific participants exclusively.

The study sample was not representative of the general population and contained a high proportion of tertiary educated adults (66%). One possible explanation for this is utilisation of the professional networks of the study team, and university mailing lists. In addition, most of the paid Facebook campaigns were placed on the University of Auckland Facebook page and while the audience was not limited to the subscribers of this page, interest in University Facebook posts is likely to be higher amongst tertiary educated adults.

The overall dropout rate was 11% (completion rate 89%), which is lower than the typical >20% dropout rate expected for lifestyle interventions.[7] This could have been due to some of the unique characteristics of this study, including the offer of a quite substantial (NZ$80) financial incentive on completion, the relatively short five-week study duration, the automated nature of the intervention which removed the need to travel to attend appointments, and use of a pre-randomisation run-in period. A run-in period allowed participants to become familiar with the smartphone technology, potentially selected more dedicated users, and allowed exclusion of users with incompatible devices. In total, more than 700 people were excluded following the run-in phase.

Overall the results of this study are consistent with previous findings showing that Facebook is an effective research recruitment method,[7] radio advertising is less cost effective,[23] and combined approaches are best.[23] Higher female participation rates, particularly of those with higher income and education levels, is also typical for nutrition research.[24] A previous study that compared demographic characteristics of participants recruited via either social media or traditional methods found no difference between groups other than in age, which was younger in the social media group.[25] A similar association between age and recruitment strategy was apparent in our study ($p<0.001$), with a lower mean age amongst participants recruited via Facebook (31 years), compared with those recruited through newspapers and radio (37 and 36 years, respectively). Our analysis also demonstrated a significant association between recruitment strategy and other important demographic characteristics, such as gender, ethnicity and household

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size. It is important therefore to tailor study recruitment approaches to the target population. Our findings also have broader relevance for the health promotion and public health fields which increasingly uses smartphone technology and applications to deliver and monitor healthcare interventions, for education, and to support consumer behaviour change.[26, 27]

Despite using a wide range of culturally-targeted media-based strategies and additional resources to recruit Maori and Pacific participants, targets were still not met. Face-to-face recruitment building on community networks and connections is a strategy commonly used to recruit Maori and Pacific participants into studies,[13] and was strongly recommended by Maori and Pacific team members as a way to enhance recruitment of Maori and Pacific participants. The fact that “Word of mouth” was the second-most effective strategy is an indication of the potential effectiveness of such face-to-face community-based recruitment. However as this trial recruited people from all across New Zealand in-person recruitment was considered to be too logistically challenging and resource-intensive. Furthermore, the potential for in-person recruitment to introduce selection bias was considered a risk to the internal validity of the study since those recruited using face-to-face methods may differ in other important ways from those recruited using alternative strategies as has been observed in other studies.[28] For research to be truly representative of Maori and Pacific peoples, it is clear from this work that in future research, recruitment protocols and indeed study design needs to be carefully planned and adapted to accommodate different cultural perspectives.

Studies focused on recruitment of underserved or hard-to-reach populations consistently report that greater resources, more time and targeted strategies are needed to recruit such populations.[29] On the other hand, recruitment targets for other ethnicities could potentially be achieved with substantially less cost, thus freeing up more time and resources to focus on more priority population recruitment. Facebook recruitment alone achieved 88% (n=440) of the target for non-Maori, non-Pacific participants, almost eliminating the need to use any other recruitment strategies for this group.

To our knowledge this is the first study to examine the success of a range of strategies to recruit participants to a smartphone-delivered study in NZ. Use of

diagnostic technology, namely Google Analytics, enabled objective assessment of web-based recruitment strategies and their effectiveness. The current study also provides data on participant retention, which was previously identified as a gap among existing reports on recruitment for web-based and mobile health studies.[7] We also describe strategies for reducing duplicate and fake registrations.

A limitation was the broad grouping used for self-reported recruitment sources, which prevented analysis at a more precise category level. Inability to estimate staffing costs associated with recruitment strategies was another limitation, likely to be particularly important in assessing research team network promotions, a heterogeneous approach that involved reasonably high resource e.g. distribution of hard copy advertising fliers.

In conclusion, recruitment via the Internet and social media is comparable in cost and substantially more effective than traditional study recruitment strategies such as mainstream media advertising, and is effective in reaching diverse ethnic groups. However, additional targeted strategies should be considered where large numbers of participants from particular ethnic groups are sought.

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AUTHOR CONTRIBUTIONS

EV and CNM formulated the idea and planned the reported post-study analysis; CNM had leadership responsibility for the main study design and execution; EV and HE contributed substantially to design of the main study; EV and JM managed day-to-day conduct of the study and oversaw data collection; EV and YJ performed the statistical analyses of the study data; CC and GS contributed to study design and revised the paper critically from cultural perspectives; EV wrote the paper and had primary responsibility for final content. All authors provided critical review and commentary on the draft manuscript, and approved the final manuscript.

COMPETING INTERESTS

We have no competing interests to declare.

DATA SHARING STATEMENT

Extra data is available by emailing Cliona Ni Mhurchu c.nimhurchu@auckland.ac.nz

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TRIAL REGISTRATION

Australian New Zealand Clinical Trials Registry (Trial Number ACTRN12614000644662 https://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=366446&isReview=true)

ABBREVIATIONS

RCT	Randomized controlled trial
NZ	New Zealand
App	Application
SD	Standard deviation

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Recruitment campaign	Sub-categories	Corresponding response in Baseline survey
Print media and team networks	Personal and professional networks, schools, universities, healthcare providers, non-government organisations, print media, community events, advertising in magazines	"Word of Mouth" "Email Invitations" "Supermarket Advertising" "Newspaper or Newsletter" "Other"
Internet and social media	Facebook, Linkedin, Google Ads	"Internet"
Radio	Advertising on Pacific Radio	"Radio"

Table 1. Study recruitment strategies

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Table 2. Demographic characteristics of study participants according to recruitment strategy

	All study participants (n=1,357)	By recruitment strategy*						NZ population according to 2013 Census
		Internet (n=584)	Radio (n=14)	Word of mouth (n=343)	Email invitation (n=150)	Newspaper/newsletter (n=111)	Other (151)	
Age; mean (SD)	32.7 (9.2)	31.2 (8.6)	36.5 (8.5)	32.3 (9.5)	34.3 (9.7)	37.43 (9.72)	33.83 (8.0)	38.0
Household size; mean (SD)	3.6 (1.7)	3.4 (1.6)	5.3 (2.3)	3.6 (1.7)	3.6 (1.5)	4.1 (1.5)	3.8 (2.1)	2.7
Gender; n (%)								
Male	152 (11.2)	54 (9.2)	1 (7.1)	48 (14.0)	26 (17.3)	11 (9.9)	10 (6.6)	48.7%
Female	1205 (88.8)	530 (90.8)	13 (92.9)	295 (86.0)	124 (82.7)	100 (90.1)	141 (93.4)	51.3%
Ethnicity; n (%)								
Maori	243 (17.9)	106 (18.2)	4 (28.6)	45 (13.1)	25 (16.7)	23 (20.7)	39 (25.8)	14.9%
Pacific	87 (6.4)	38 (6.5)	10 (71.4)	20 (5.8)	12 (8.0)	3 (2.7)	4 (2.6)	7.4%
Other	1027 (75.7)	440 (75.3)	0	278 (81.0)	113 (75.3)	85 (76.6)	108 (71.5)	74.0%
Income; n (%)§								
NZD$20,000 or less	111 (10.4)	61 (13.1)	0	31 (11.4)	8 (6.7)	1 (1.3)	9 (7.1)	11.1%
NZD $20,001 - $40,000	154 (14.4)	59 (12.7)	1 (14.3)	42 (15.4)	22 (18.5)	8 (10.4)	22 (17.5)	20.7%
NZD $40,001 - $60,000	193 (18.1)	81 (17.5)	1 (14.3)	48 (17.6)	25 (21.0)	14 (18.2)	23 (18.3)	15.5%
NZD $60,001 - $70,000	114 (10.7)	56 (12.1)	0	28 (10.3)	10 (8.4)	5 (6.5)	14 (11.1)	7.0%
NZD $70,001 - $100,000	284 (26.6)	110 (23.7)	4 (57.1)	71 (26.1)	30 (25.2)	32 (41.6)	37 (29.4)	18.0%
NZD $100, 001 or more	213 (19.9)	97 (20.9)	1 (14.3)	52 (19.1)	24 (20.2)	17 (22.1)	21 (16.7)	27.6%
Qualification; n (%)								
None	28 (2.1)	10 (1.7)	2 (14.3)	8 (2.3)	3 (2.0)	2 (1.8)	3 (2.0)	18.6%
Secondary School Qualification.	338 (24.9)	146 (25.0)	6 (42.9)	94 (27.4)	25 (16.7)	32 (28.8)	34 (22.5)	35.6%
University or polytechnic degree/diploma	893 (65.8)	395 (67.6)	3 (21.4)	213 (62.1)	108 (72.0)	67 (60.4)	104 (68.9)	26.0%
Trade Certificate	48 (3.5)	16 (2.7)	3 (21.4)	15 (4.4)	6 (4.0)	5 (4.5)	3 (2.0)	8.6%
Other	50 (3.7)	17 (2.9)	0	13 (3.8)	8 (5.3)	5 (4.5)	7 (4.6)	11.1%
Interest in healthy eating; n (%)								
Not particularly interested	37 (2.7)	15 (2.6)	1 (7.1)	13 (3.8)	1 (0.7)	1 (0.9)	5 (3.3)	n/a
Moderately to very interested	1320 (97.3)	569 (97.4)	13 (92.9)	330 (96.2)	149 (99.3)	110 (99.1)	146 (96.7)	n/a

* Recruitment source data were missing for n=3 randomised participants

§ Household income data were missing for n=288 randomised participants

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Table 3. Effectiveness and cost of study recruitment campaigns

Recruitment campaign *(data missing for n=4 registered participants)*		Participant status	All participants	By ethnicity*			Campaign cost (NZ$)		
				Maori	Pacific	Other	total	per randomised participant	per completed participant
Internet and social media		Registered, n	966	215	73	668			
		Randomised; n (% of registered)	584 (60)	106 (49)	38 (52)	440 (66)			
		Completed; n, (% of randomised	507 (87)	91 (86)	32 (84)	384 (87)	3047	5	6
Radio		Registered, n	25	10	15	0			
		Randomised; n (% of registered)	14 (56)	4 (40)	10 (67)	0			
		Completed; n, (% of randomised	13 (93)	3 (75)	10 (100)	0	2500	179	192
Print media & team networks	Supermarket ad	Registered, n	3	0	0	3			
		Randomised; n (% of registered)	1 (33)	0	0	1 (33)			
		Completed; n, (% of randomised	1 (100)	0	0	1 (100)			
	Word of mouth	Registered, n	506	76	27	394			
		Randomised; n (% of registered)	343 (68)	45 (59)	20 (74)	278 (71)			
		Completed; n, (% of randomised	306 (89)	34 (76)	18 (90)	254 (91)			
	Email invitation	Registered, n	216	42	19	154			
		Randomised; n (% of registered)	150 (69)	25 (60)	12 (63)	113 (73)			
		Completed; n, (% of randomised	141 (94)	22 (88)	10 (83)	109 (96)			
	Newspaper or newsletter	Registered, n	156	29	8	117			
		Randomised; n (% of registered)	111 (71)	23 (79)	3 (38)	85 (73)			
		Completed; n, (% of randomised	99 (89)	20 (87)	2 (67)	77 (91)			
	Other	Registered, n	228	54	11	161			
		Randomised; n (% of registered)	151 (66)	39 (72)	4 (36)	108 (67)			
		Completed; n, (% of randomised	132 (87)	30 (77)	3 (75)	99 (92)	2830	4	4
Total recruited		Registered, n #	2104	427	152	1501			
		Randomised; n (% of registered)	1357 (64)	243 (57)	87 (57)	1027 (68)			
		Completed; n, (% of randomised	1202 (89)	201 (83(	75 (86)	926 (90)	8377	6	7

* Ethnicity data were missing for n=24 registered participants

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[#] Total number of registrations in the table/analysis (n=2104) is less that that recorded in the study (n=2448) because a number of people did not complete the registration questionnaire so data were not available on recruitment strategy for those participants.

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Figures

Figure 1. Recruitment rates in response to implementation of key recruitment strategies over time

Figure 2. Trial website visit and registration numbers by recruitment strategy

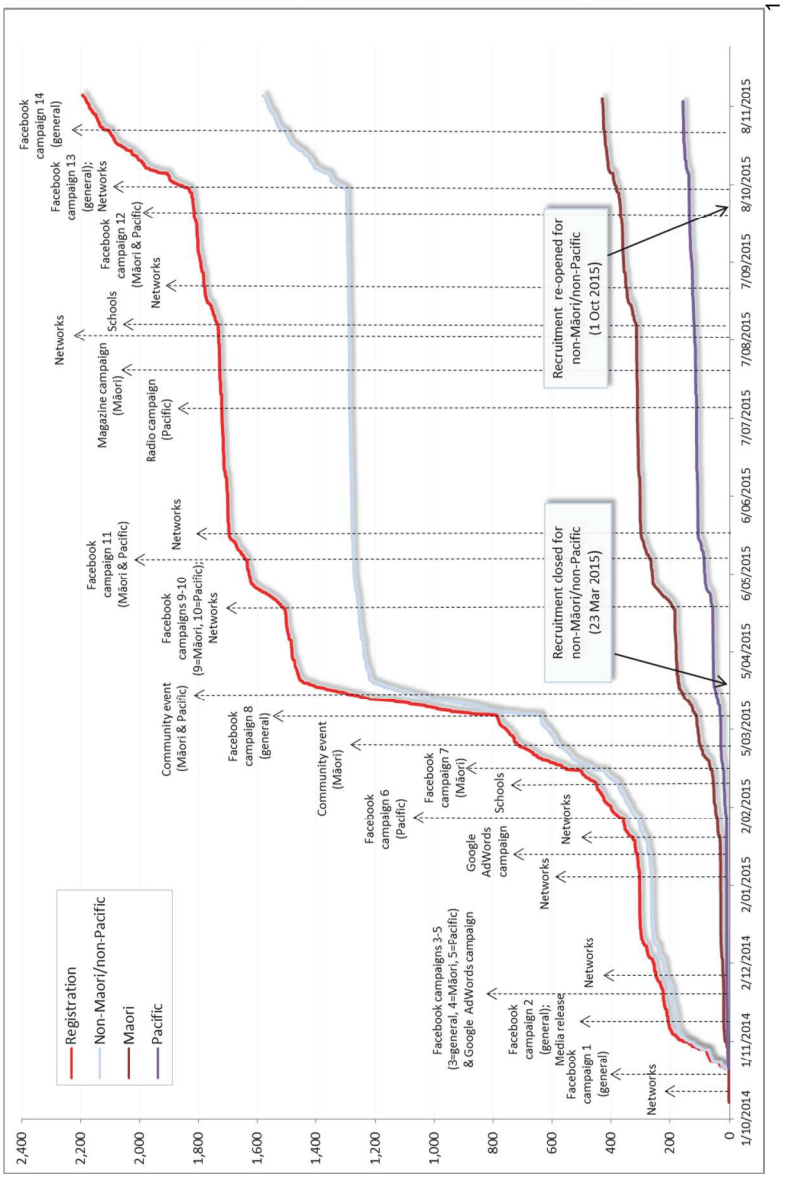
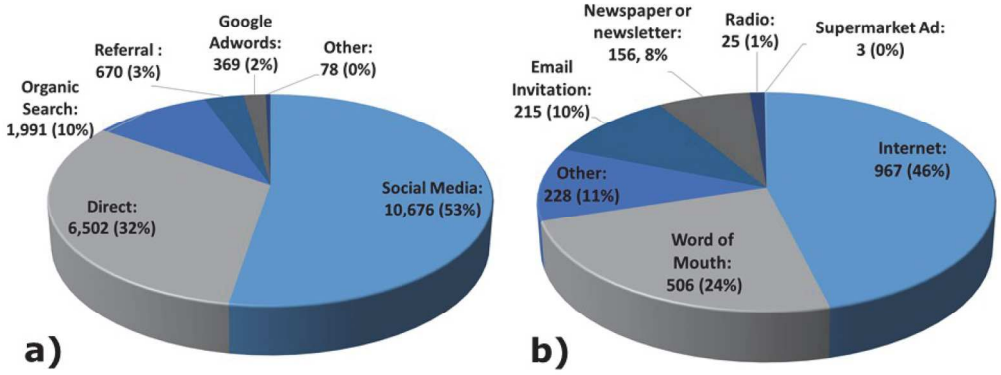


Figure 1. Recruitment rates in response to implementation of key recruitment strategies over time

169x251mm (300 x 300 DPI)



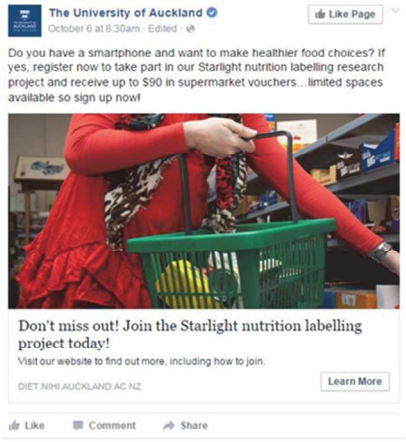
a – Website traffic acquisition channels from the Google Analytics report

b – Self-reported (baseline questionnaire) recruitment source for registered participants

Figure 2. Trial website visit and registration numbers by recruitment strategy

189x126mm (300 x 300 DPI)

(a)



(b)

165x96mm (300 x 300 DPI)

Supplementary File 2. Summary of Facebook recruitment campaign reports, Oct 2014 – Nov 2015.

Campaign number	Focus	Dates	Placement	Targeting	Reach (users)	Clicks	Average cost per click (NZD)
1	General	20 - 30 Oct 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	60,960	1,372	$0.15
2	General	14 - 15 Nov 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (over 18)	35,280	460	0.43
3	General	20 Nov – 4 Dec 2014	Sponsored Newsfeed only	Age (18-50), Smartphone owners, New Zealand, Interests(nutrition & fitness-related)	20,598	251	$0.8
4	Māori	20 Nov – 4 Dec 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	53,856	390	$0.51
5	Pacific	20 Nov – 4 Dec 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	39,536	268	$0.75
6	Pacific	28 Jan - 8 Feb 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	1: Age (18-50), Smartphone owners, New Zealand 2: Age (18-50), Smartphone owners, New Zealand, Interests(nutrition & fitness-related) 3: Age (18-50), Smartphone owners, South & West Auckland (high p'evalence of Māori and Pacific residents)	44,096	770	$0.26
7	Māori	16 - 26 Feb 2015	Sponsored Newsfeed only	1: Age (18-50), Smartphone owners, New Zealand regions with high Māori and Pacific population 2: Age (18-50), Smartphone owners, South & West Auckland (high p'evalence of Māori and Pacific residents) 3: Age (18-50), Smartphone owners, New Zealand	24,014	465	$0.43
8	General	9-22 Mar 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	1: Age (18-50), Smartphone owners, New Zealand, Interests(nutrition & fitness-related) 2: Age (18-50), Smartphone owners, New Zealand	81,504	3,570	$0.06
9	Pacific	22 Apr - 1 May 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, Auckland	49,200	1,053	$0.19
10	Māori	22 Apr - 1 May 2015	Sponsored Newsfeed only	Age (18-50), Smartphone owners, New Zealand regions with high Māori and Pacific population	29,312	532	$0.38
11	Māori & Pacific	11-20 May 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, Auckland and other New Zealand regions with high Māori and Pacific population	60,064	1,170	$0.34
12	Māori & Pacific	23 Sep - 5 Oct 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, Auckland, South Auckland and other New Zealand regions with high Māori and Pacific population	18,862	167	$1.20
13	General	6 -20 Oct 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	20,950	413	$0.48
14	General	30 Oct – 10 Nov 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand (excluding Auckland), Interests(nutrition & fitness-related)	10,220	109	$1.83
				Total	527,854	10,739	n/a
				Average	37,704	767	$0.50

182x279mm (300 x 300 DPI)

Supplementary File 3. Summary of the Google AdWords campaign performance by top searched keywords

Keyword	Reach (users)	Clicks	Average cost-per-click
volunteer	9,829	195	0.3
volunteers	11,421	158	0.49
diet	1,924	26	2
nutrition diet	3,293	5	3.88
healthy food	581	4	2.42
smartphone	9,287	3	2.77
information about healthy food	1,654	3	2.15
food shopping	3,219	3	0.67
healthy foods	287	2	1.25
healthy food information	170	2	5.98
healthy food choices	32	2	1.62
paid volunteer	24	2	0.2
earn cash	80	2	1.24
earn	43	2	0.22
research	463	2	0.23
diet and nutrition	428	1	1.89
healthy food groups	13	1	3.07
healthy food options	4	1	2.38
information on nutrition	887	1	2.93
food label	2	0	0
about healthy foods	1	0	0
healthy foods to eat	54	0	0
eat healthy food	15	0	0
healthy food articles	1	0	0
participants	77	0	0
food labels	8	0	0
participate in a study	2	0	0
what is healthy food	273	0	0
take part	2	0	0
healthy food to eat	4	0	0
healthy food for	37	0	0
join research	2	0	0
the healthy food	5	0	0
healthy food pictures	3	0	0
healthy eating	81	0	0
what is healthy foods	1	0	0
food labelling	66	0	0
what are healthy foods	1	0	0
earn reward	10	0	0
labels food	271	0	0

165x260mm (300 x 300 DPI)

healthy foods to buy	1	0	0
healthy food plans	6	0	0
research study	617	0	0
healthy food chart	2	0	0
healthy food habits	13	0	0
food nutrition labels	207	0	0
most healthy foods	0	0	0
food healthy	298	0	0
healthy food products	7	0	0
healthy shopping	72	0	0
which is healthy food	0	0	0
recipes for healthy snacks	6	0	0
healthy food ideas	25	0	0
healthy food menus	2	0	0
earn	98	0	0
volunteer for research studies	1	0	0
best healthy foods	5	0	0
healthy diet	40	0	0
how to make healthy food	6	0	0
eating healthy foods	3	0	0
participant in research	1	0	0
what are some healthy foods	10	0	0
nutrition labels	47	0	0
healthy food labels	18	0	0
healthy food for health	1	0	0
how to eat healthy food	7	0	0
about healthy food	166	0	0
take part	2	0	0
earn cash	14	0	0
participant	6	0	0
participate	9	0	0
paid volunteer	3	0	0
cash	614	0	0
Total	**46,852**	**415**	
Average			**$1.87**

165x260mm (300 x 300 DPI)

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BMC Public Health

STUDY PROTOCOL Open Access

Effects of interpretive front-of-pack nutrition labels on food purchases: protocol for the Starlight randomised controlled trial

Ekaterina Volkova[1*], Bruce Neal[2], Mike Rayner[3], Boyd Swinburn[4], Helen Eyles[1], Yannan Jiang[1], Jo Michie[1] and Cliona Ni Mhurchu[1]

Abstract

Background: Interpretive front-of-pack nutrition labels are better understood than non-interpretive labels. However, robust evidence on the effects of such labels on consumer food purchases in the real-world is lacking. Our aim is to assess the effects of two interpretive front-of-pack nutrition labels, compared with a non-interpretive label, on the healthiness of consumer food purchases.

Methods/Design: A five-week (1-week baseline and 4-week intervention) three-arm parallel randomised controlled trial will be conducted using a bespoke smartphone application, which will administer study questionnaires and deliver intervention (Multiple Traffic Light and Health Star Rating) and control (Nutrition Information Panel) labels. To view their allocated nutrition label, participants scan the barcode of packaged food products using their smartphone camera. The assigned label is displayed instantly on the smartphone screen.1500 eligible participants (New Zealand adult smartphone owners who shop in a supermarket at least once a week and are main household shoppers) will be randomised in a 1:1:1 ratio to one of the three nutrition label formats, using computer-generated randomisation sequences. Randomisation will be stratified by ethnicity and interest in healthy eating. Food and beverage purchase data will be collected continuously throughout the study via hard copy till receipts and electronic grocery purchase lists recorded and transmitted using the smartphone application. The primary outcome will be healthiness of food purchases in each trial arm, assessed as mean Food Standards Australia New Zealand nutrient profiling score criterion score for all food and beverages purchased over the intervention period. Secondary outcomes will include saturated fat, sugar, sodium and energy content of food purchases; food expenditure; labelling profile of food purchases (i.e. mean number of Health Star Rating stars and proportion of red, green and amber traffic lights); nutrient profiling score over time and by food categories; purchases of unpackaged foods; self-reported nutrition knowledge and recorded use of assigned labelling system.

Discussion: The Starlight randomised, controlled trial will determine the effects of interpretive front-of-pack nutrition labels on the healthiness of consumer food purchases in the real world.

Trial registration: Australian New Zealand Clinical Trials Registry ACTRN12614000644662 (registered 18 June 2014).

Keywords: Nutrition labeling, Mobile applications, Technology, Nutrition policy, Randomized controlled trial (RCT), Traffic-light label, Health star rating label

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Background

Obesity and the burden of associated non-communicable disease has been increasing worldwide [1]. Effective, front-of-pack (FOP) nutrition labelling is potentially one of the most cost-effective interventions [2]. However, traditional numerical nutrition labels are difficult to interpret and have limited influence on the average consumer's food purchasing patterns [3-5].

In New Zealand, the Nutrition Information Panel (NIP), usually found on the back of food packages, is mandatory [6]. A review of nutrition label use found that this is poorly understood by most New Zealanders [7]. Further, use of this nutrition label is particularly low among Māori (indigenous New Zealanders), Pacific, and low-income New Zealanders [8], who experience the highest rates of obesity [9]. Therefore, identifying a labelling format that delivers information effectively to these groups is especially important.

A recent review of New Zealand and Australian food labelling policy recommended introduction of interpretative FOP labels that are easy for consumers to understand and act upon [10]. Substantial global evidence indicates that interpretative labels (using graphics, symbols or colours) are better understood than traditional numeric nutrition labels [11]. However, the impact of such labels on food purchase habits is unclear.

Evaluation of nutrition labelling interventions in the real-world is challenging. Two common approaches are to use controlled settings (for example, a workplace cafeteria or one particular retailer), or consumer surveys. Several cafeteria studies support the ability of FOP labels to promote healthy food choices [12-14]. Surveys and choice experiments also report favourable results, suggesting FOP labels help participants to successfully identify healthier options [15] and are used to make food choices [16-18].

A limited number of studies report on the effect of FOP labels in retail settings. A large observational study conducted by Sacks et al. [19] investigated the effect of supplementary traffic-light FOP labels implemented as a voluntary nutrition labelling system in a UK retailer. The study reported no difference between sales of healthy and unhealthy ready meals and sandwiches following introduction of traffic-light FOP labels, compared to the period prior to label administration. The major limitation of this study was the small sample of products included in the study. Another large intervention study assessed the effectiveness of "Guiding Star" shelf labelling system across a chain of 168 US supermarkets [20]. Analysis of supermarket sales data showed a significant increase in proportion of star-rated product sales and corresponding decrease in sales of un-starred products in same food categories [20]. One limitation however was the lack of a control group within the same stores. Randomised controlled trials are needed to provide robust evidence on the effect of the FOP labels on real-world retail food purchases.

The current study assesses two types of FOP nutrition labels. One is the colour-coded traffic-light (TL) FOP label [21]. This label uses colour-coded categories to reflect low (green), medium (amber) and high (red) content of four nutrients: total fat, saturated fat, total sugar and salt. The underpinning algorithm is that recommended by the UK Governments [22]. This FOP label has been shown to have a high level of understanding and acceptance across major ethnic and income groups [23]. The other label to be evaluated is the new Health Star Rating (HSR) system proposed for implementation in Australia. This label assigns a star rating to a food from ½ (least healthy) to 5 (most healthy) stars based on the underpinning HSR score algorithm [24].

The intervention will be delivered using novel smartphone technology, based on the FoodSwitch free smartphone application (app) where users scan the barcode of a packaged food and receive an immediate, interpretive TL nutrition label on their phone screen, and recommendations for healthier options [25]. A similar smartphone app designed for the current study will be used to deliver TL, HSR or NIP nutrition labels to study participants. The primary aim of the trial is to assess the effectiveness of TL and HSR label formats, compared with the standard NIP, on healthiness of consumer food purchases. The null hypothesis of no difference with the control label will be tested for each of the intervention arms.

Methods/Design

Study design

Starlight is a three-arm parallel randomised controlled trial (Figure 1). A total of 1,500 participants will be randomised to receive either one of two FOP labels (TL or HSR; intervention arms) or NIP label (control arm) in a 1:1:1 ratio. All nutrition labels will be delivered via a bespoke "Food Label Trial" smartphone app.

Approval

Ethical approval from the University of Auckland Human Participants Ethics Committee was received on 26 May 2014. The Starlight trial is registered in the Australian New Zealand Clinical Trials Registry (registration number ACTRN12614000644662).

Intervention arms

1) FOP Traffic-Light label (Figure 2a).
2) FOP Health Star Rating label (Figure 2b).

Control arm:

1) Standard New Zealand non-interpretive, numerical NIP (Figure 2c)

Volkova *et al. BMC Public Health* 2014, **14**:968
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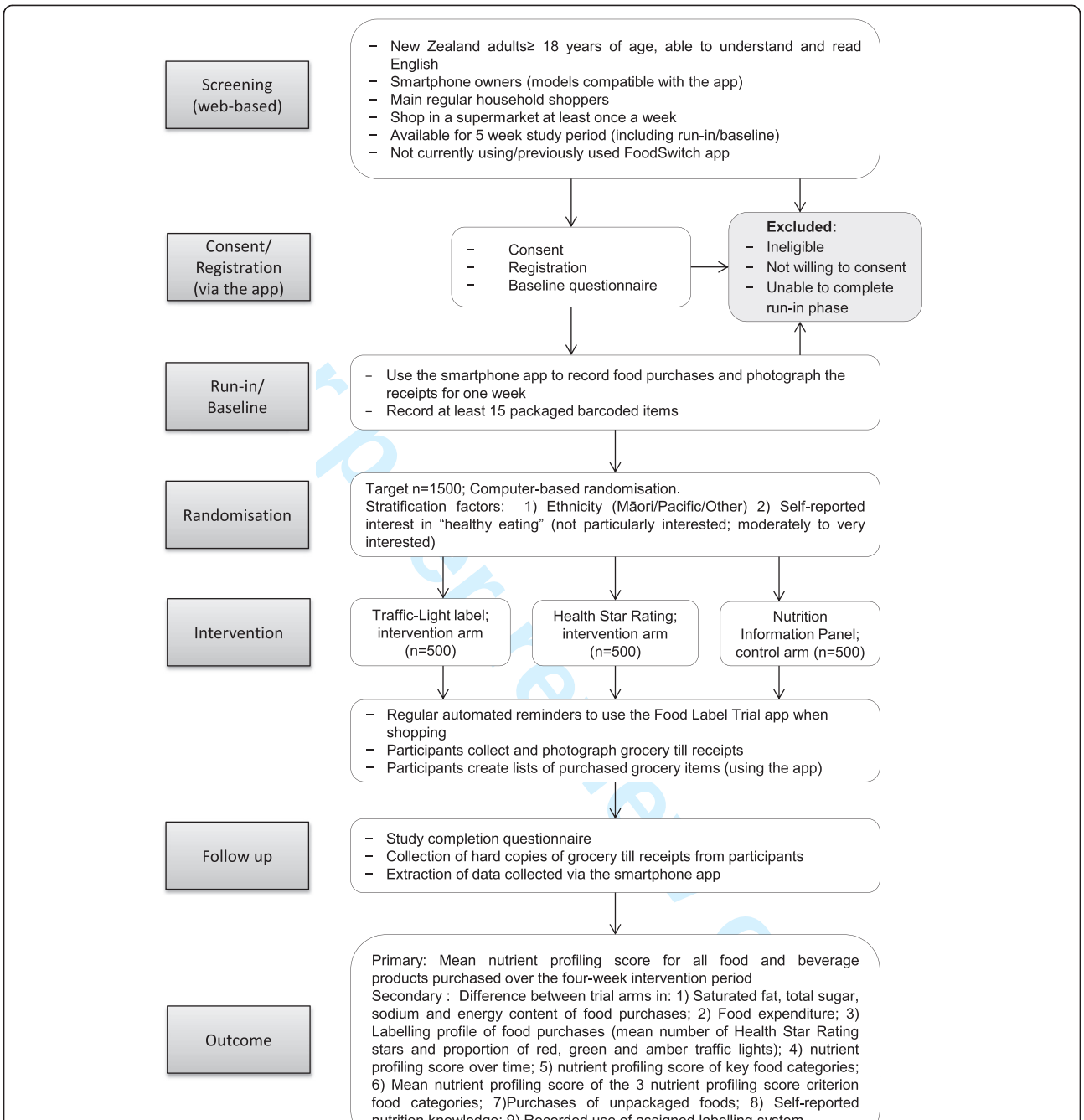

Figure 1 Flow chart for the Starlight trial.

"Food Label Trial" smartphone application

All allocated labels will be delivered via the bespoke "Food Label Trial" smartphone app, which enables participants to view the allocated nutrition label for packaged barcoded products. To view the label, users scan barcodes of packaged food products using the smartphone camera, and assigned labels instantly appear on the phone screen. At the same time the app also displays a random selection of other foods in the same food category with same label format to encourage comparative review of available choices and to better test the influence of the label on purchasing decision. If a food item is missing from the app database, participants will receive a default message and will have an option of providing the details of this product (photographs and barcode) in order for it to be added to the database.

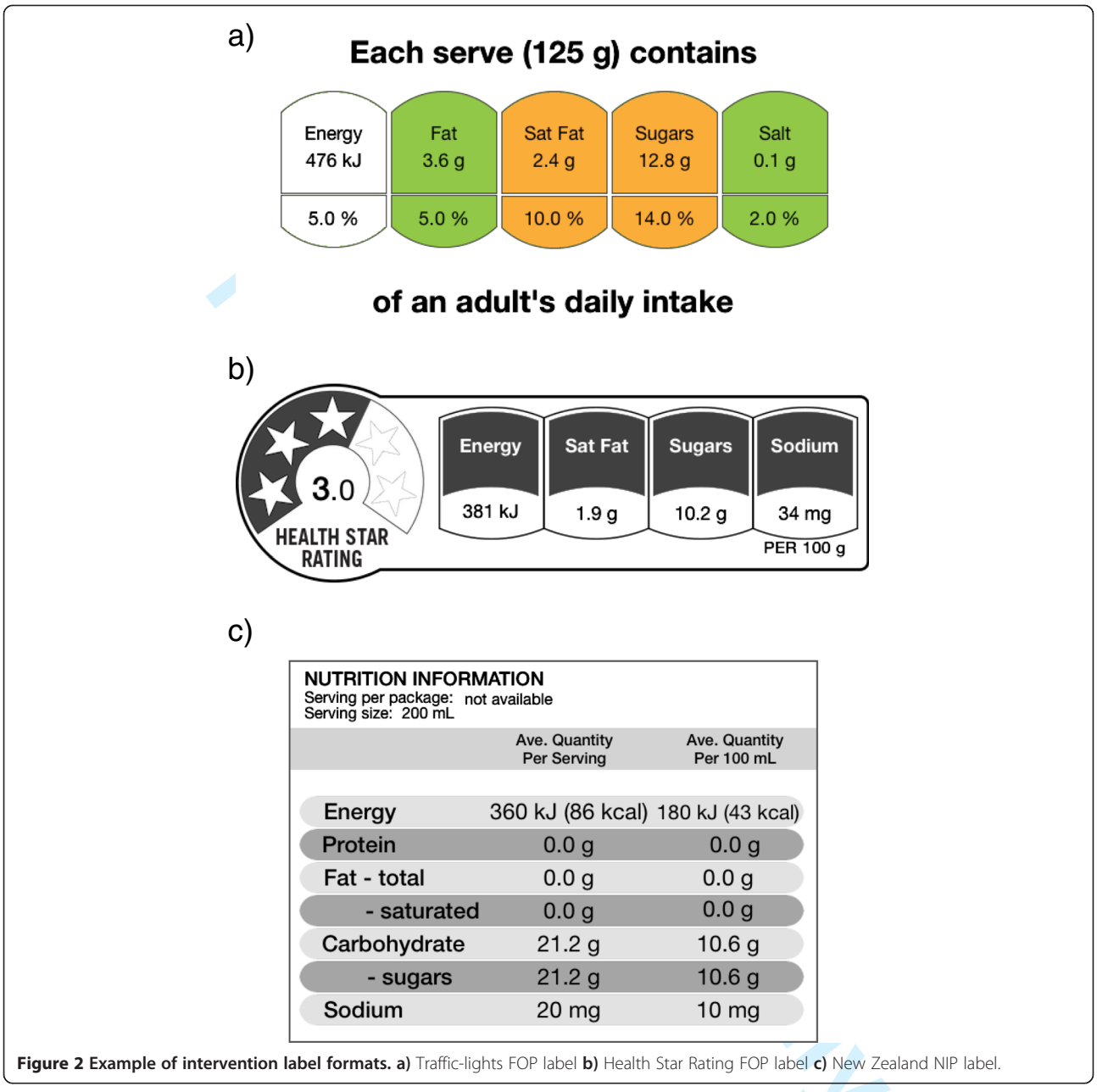

Figure 2 Example of intervention label formats. a) Traffic-lights FOP label **b)** Health Star Rating FOP label **c)** New Zealand NIP label.

Additional app functions enable outcome data collection. Participants will use the app to create electronic lists of purchased food/beverage products and to photograph their grocery till receipts. In order to create the electronic list of purchased items the participants will scan barcodes of the items purchased using their smartphone camera.

Study population

The Starlight trial will recruit 1500 New Zealand adults (aged 18 years and older) who have a smartphone (iPhone or Android), are main household shoppers (i.e. complete 50% or more of the grocery shopping for their household), and shop at a supermarket at least once a week. Participants must be able to read and understand English, and be available for the full duration of the 5-week trial. Only one person per household can participate in the study. Current or previous FoodSwitch app users will be excluded, because FoodSwitch provides TL labels and recommends healthier food options.

Recruitment and run-in phase/baseline

Participants will be recruited across New Zealand via advertising in local newspapers and on social media websites, household mail drops, at community venues including supermarkets, and utilising existing research team networks. The aim is to recruit approximately

equal numbers of Māori (n = 500), Pacific (n = 500) and other ethnic group participants (n = 500).

Eligible participants will be given access to the "Food Label Trial" app. Informed consent and baseline demographic data will be collected from all study participants via the app.

During the run-in/baseline phase participants will record their food and beverage purchases for one week using the app, and collect and photograph the corresponding till receipts using the smartphone app. At least 15 purchased barcoded grocery items will need to be recorded during this period in order to qualify for study entry. Failure to complete the run-in phase will result in ineligibility.

Randomisation

Participants who complete the run-in phase successfully will be randomised in a 1:1:1 ratio to one of the three label formats (TL; HSR or NIP), using a central computer-based randomisation system. Blocked randomisation will be used with variable block sizes, stratified by self-identified ethnic group (Māori, Pacific, Other) and self-reported interest in "healthy eating" (not particularly interested; moderately to very interested).

Blinding

It is not possible to blind trial participants to the intervention. However, participants will only see one type of label for the duration of the trial and will not know what other label formats are being tested in the trial.

Data collection

The baseline questionnaire will collect demographic details (age, gender, ethnicity, income, education level, family size) and self-reported information on interest in nutrition and healthy eating.

Data on participant food and beverage purchases will be collected throughout the one-week baseline and four-week intervention period. Usage of the labelling function will be automatically recorded by the "Food Label Trial" app. Objective purchase data will be supplied by participants in the following modes: 1) electronic list of scanned purchased items ("Food Label Trial" app function); 2) photographs of corresponding grocery till receipts ("Food Label Trial" app function); 3) hard copies of grocery till receipts (returned by participants at the end of the intervention period). The electronic lists of purchased items will be used as the primary data source of packaged food purchases. The till receipts provide information on price and on purchases of non-barcoded items. Photographs of till receipts will be used as a back-up for missing hard copy till receipts.

All data collected via the "Food Label Trial" will be automatically transmitted via Wi-Fi or 3/4G to the app database, hosted on a remote server, and subsequently extracted by researchers to the study database. Hard copies of till receipts will be mailed by participants to the study centre and the additional data manually entered into the study database.

A follow up questionnaire will collect participant feedback on the app (technical issues, usefulness, self-reported impact on food choices), self-reported compliance with the trial protocol (number of shopping events recorded and till receipts returned, usage of the trial app) and perceived changes in participant's nutrition knowledge.

Regular reminder messages (3 times per week) will be sent throughout the intervention period to encourage participants to use the app and submit data, and to minimise attrition. At the end of the study participants will be provided with reward vouchers as a compensation for the time and potential costs associated with taking part in the trial.

Outcomes

The primary outcome of the trial will be the mean nutrient profiling score for all food and beverage products purchased over the four-week intervention period. Nutrient profiling score will be calculated using the Food Standards Australia New Zealand (FSANZ) nutrient profiling standard [26]. Food composition data will be obtained from Nutritrack, a brand-specific processed food composition database that contains comprehensive annually-updated information on New Zealand packaged and fast foods [27]. As a secondary approach, the crude nutrient profiling score will be transformed to a scale of 0–100 consistent across all 3 NPSC category foods. A tertiary approach will also be considered on weighted nutrient profiling score stratified by key food categories.

Secondary outcomes will be the difference between trial arms in:

1) Mean saturated fat, total sugar, sodium and energy content per 100 g food purchases over the four-week intervention period;
2) Mean weekly food expenditure over the four-week intervention period;
3) Labelling profile of food purchases (mean number of HSR stars and proportions of red, green and amber traffic lights) over the four-week intervention period;
4) Mean nutrient profiling score for all food and beverage products purchased each week of the intervention period;
5) Mean nutrient profiling score of key food categories likely to be most impacted by nutrition labelling (e.g. breakfast cereals, cereal bars, pizzas and ready meals);

6) Mean nutrient profiling score of the 3 nutrient profiling score criterion food categories (beverages, fats and oils, all other foods)
7) Mean purchases of unpackaged foods (e.g. fruit and vegetables) in g/100 g;
8) Self-reported nutrition knowledge at follow-up;
9) Use of assigned labelling system as recorded by the Food Label Trial app.

Sample size

A total sample size of 1,500 participants (n = 500 per arm) will have at least 80% power (alpha = 0.05) to detect a minimum 2-unit difference in the mean nutrient profiling score between either of the intervention arms and control with adjustment for multiple comparisons. A 2-unit change in nutrient profiling score is approximately equivalent to the following changes in nutrient content per 100 g food: 78 kJ energy, 0.95 g saturated fat, 1.5 g total sugars and 73 mg sodium (unpublished data). The nutrient profile score will be estimated using the FSANZ nutrient profiling scoring calculator, where food scores span a range of −17 to 53 (a lower score is healthier) [28]. The power estimate assumes a standard deviation of 9.9 based on distribution of >25,000 foods in an Australian food database.

Statistical analyses

Statistical analyses will be performed using SAS version 9.3 (SAS Institute Inc. Cary NC). All statistical tests will be two-tailed and maintained at a 5% significance level. The baseline characteristics of all study participants will be summarised and tabulated using means (standard deviations, medians and ranges) and frequencies (proportions). Analysis of covariance (ANCOVA) regression models will be used to compare mean nutrient profiling score between intervention and control groups, adjusting for baseline nutrient profiling score and stratification factors. A similar approach will be used for continuous secondary outcomes. Generalized linear models will be used for secondary categorical outcomes. No imputation will be undertaken. Repeated measures mixed models will be used to evaluate treatment effects over time. Sub-group analyses will test possible interactions of the labelling intervention with key food categories, ethnicity (Maori, Pacific, Other), income tertile, and baseline self-reported interest in “healthy eating”. Sensitivity analyses will be undertaken using data only from participants who return at least 75% of till receipts/food purchase data based on pre-randomisation usual reported number of shopping episodes. A statistical analysis plan will be prepared by the trial statistician prior to the final data lock. Reporting will adhere to the CONSORT 2010 guidelines for reporting parallel group randomised trials.

Discussion

The aim of the Starlight RCT is to measure the effects of two interpretive FOP nutrition labels, compared with the standard NIP, on the healthiness of food purchases. To our knowledge, this is the first RCT assessing the impact of interpretive FOP labels on objectively measured consumer purchases in real-world retail outlets nationwide, without restriction to a particular store or setting. The unique smartphone app designed for the trial will allow shoppers to view nutrition labels of barcoded food products in any retail outlet. The randomised controlled design of the Starlight trial enables use of the NIP label at an individual level as a control, rather than using a control store. The advantage of this approach is that it minimises confounding effects of patterns of sales in different retailers. Another advantage is that it neutralises any effect of using the smartphone app to scan products. The “Food Label Trial” smartphone app will also allow objective assessment of nutrition label use when shopping since this information will be collected automatically by the app. The Starlight trial will also assess the impact, utility and acceptability of proposed label format for Māori and Pacific adults. This is of particular importance, considering the high prevalence of obesity and nutrition-related disease among those groups [9]. According to study by Signal et al. [8], self-reported use of nutrition labels is low among those groups, and both claim to favour simpler nutrition labels that are easier to understand. Whilst FOP labels are the focus of much government, industry and advocacy group attention worldwide, their impact on consumers’ behaviour is uncertain. This large, randomised, controlled trial will provide robust evidence of the effectiveness and potential cost-effectiveness of FOP labelling as means to improve population diets and health.

Trial status

Recruiting.

Abbreviations

FOP: Front-of-pack; NIP: Nutrition information panel; App: Application; TL: Traffic-light; HSR: Health star rating; RCT: Randomised controlled trial.

Competing interests

The authors declare that they have no competing interests.

Authors’ contributions

CNM, HE, BN, MR and BS contributed significantly to conceptualisation of the project. CNM is the principal investigator for the trial. YJ contributed to statistical design and power calculations. KV, CNM, BN JM and HE contributed to study design and smartphone app development. KV and CNM jointly led the writing of the manuscript. All authors have read, provided input to, and approved the final version of manuscript.

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Effectiveness of Recruitment to a Smartphone-Delivered Nutrition Intervention in New Zealand: Analysis of a Randomised Controlled Trial

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ABSTRACT

Objectives

Delivery of interventions via smartphone is a relatively new initiative in public health, and limited evidence exists regarding optimal strategies for recruitment. We describe the effectiveness of approaches used to recruit participants to a smartphone-enabled nutrition intervention trial.

Methods

Internet and social media advertising, mainstream media advertising, and research team networks were used to recruit New Zealand adults to a fully automated smartphone-delivered nutrition labelling trial (no face-to-face visits were required). Recruitment of Maori and Pacific participants was a key focus and ethically-relevant recruitment materials and approaches were used where possible. The effectiveness of recruitment strategies was evaluated using Google Analytics, monitoring of study website registrations and randomisations, and self-reported participant data. The cost of the various strategies and associations with participant demographics were assessed.

Results

Over a period of 13 months, there were 2,448 registrations on the study website, and 1,357 eligible individuals were randomised into the study (55%). Facebook campaigns were the most successful recruitment strategy overall (43% of all randomised participants) and for all ethnic groups (Maori 44%, Pacific 44%, Other 43%). Significant associations were observed between recruitment strategy and age ($p<0.001$), household size ($p<0.001$), ethnicity ($p<0.001$), gender ($p=0.005$) and interest in healthy eating ($p=0.022$). Facebook campaigns resulted in the highest absolute numbers of study registrations and randomisations (966 and 584 respectively). Network strategies and Facebook campaigns cost least per randomised participant (NZ$4 and NZ$5, respectively), whilst radio advertising cost most (NZ$179 per participant).

Conclusion

Internet and social media advertising were the most effective and least costly approaches to recruiting participants to a smartphone-delivered trial. These approaches also reached diverse ethnic groups. However, more culturally appropriate recruitment strategies are likely to be necessary in studies where large numbers of participants from specific ethnic groups are sought.

ARTICLE SUMMARY

Strengths and limitations of this study

- Reports on effectiveness and costs of a range of recruitment strategies (internet and social media advertising, mainstream media advertising and research team networks) used for a smartphone-delivered study
- Effectiveness was evaluated using Google Analytics, monitoring of study website registrations and randomisations, and self-reported data
- Information is provided on participant retention rates, and strategies to reduce duplicate and fake registrations
- The broad categorisation of self-reported recruitment source data prevented more precise sub-category analysis
- Staffing costs associated with recruitment strategies were not assessed

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INTRODUCTION

Monitoring and reporting of study recruitment strategies and their effectiveness facilitates improvements in design and methods for future randomised controlled trials (RCTs). Systematic reviews provide an indication of successful recruitment strategies and trial design elements such as incentives and open-label design,[1, 2] and their cost-effectiveness.[3] However, applicability and success of various strategies depends on specifics of the trial design, setting, and study population.

Smartphone delivery and measurement of trial interventions [4-6] is a relatively new initiative and presents unique recruitment challenges compared to traditional RCTs. In addition to standard trial eligibility criteria, prospective participants must have smartphone access and be adept at using technology. Moreover, attrition rates are potentially higher because enrolment rates may be augmented by a 'novelty factor' that decays over time.[7] Lack of personal contact with study staff may also increase attrition.[7] Such challenges are also relevant to public health and health promotion interventions that increasingly deliver programme components using smartphone technology. Identifying successful recruitment and retention strategies for this type of intervention is therefore timely and important.

In addition to traditional RCT recruitment methods such as advertising via community fliers, newspapers or media,[8] newer strategies including Internet and social media advertising [9] are being increasingly used. A systematic review found that online recruitment strategies, Facebook in particular, were promising ways to recruit participants for internet and mobile health (mHealth) studies.[7] However, limited data were available, and specific gaps identified were reporting of participant retention rates, and methods to identify and manage fake and duplicate registrations.

Potential greater reach amongst underserved and diverse population groups is one suggested benefit of online recruitment.[8, 10] In New Zealand (NZ), Maori (indigenous New Zealanders making up 14.9% of population) and Pacific peoples (7.4%) are priority groups for health intervention programmes due to their disproportionately high prevalence of non-communicable diseases and associated risk factors.[11] Adequate representation of these groups in health research is vital but often hard to achieve with generic recruitment strategies, so ethnic-specific tailoring of strategies is recommended.[12, 13]

Our aim was to assess the effectiveness of a range of approaches used to recruit participants to a large smartphone-delivered nutrition labelling RCT,[14] and to examine associations of recruitment strategy with ethnicity and other participant demographics.

METHODS

The Starlight RCT received ethics approval from the University of Auckland Human Participant Ethics Committee (reference number 011390) and the study protocol was published in 2014.[15] The trial was registered on the Australian New Zealand Clinical Trials Registry (ACTRN12614000644662). All participants provided informed consent via a questionnaire completed on their smartphone.

The aim of the trial was to evaluate the effects of two interpretive nutrition labels, Traffic Light Labels and Health Star Rating Labels, compared with a non-interpretive label, on the healthiness of consumer food purchases. The target was to recruit and randomise 1,500 eligible New Zealand adults, comprised of approximately equal numbers of Maori, Pacific, and other ethnicities. Eligible participants were aged 18 years or older, owned a smartphone, were the main household shopper, and could read and understand English. All components of the trial (screening, consent, registration, randomisation, intervention and data collection) were delivered via a bespoke, automated smartphone application (app).[16] Outcome data were collected in the form of scanned household food purchase records. Completion of a run-in period (week 1) with a requirement to record at least 15 food items was a prerequisite for randomisation. The four-week nutrition labelling intervention comprised randomisation to one of two interpretive nutrition labels (Traffic Lights [17] or Health Star Ratings [18]) or to a control group (Nutrition Information Panel).[19] The primary study outcome was healthiness of all foods and beverages purchased over the intervention period, measured using the Food Standards Australia New Zealand (FSANZ) nutrient profiling scoring criterion.[20]

Recruitment

Recruitment commenced in October 2014. A key focus was to attract 500 Maori and 500 Pacific participants, with advice provided by Maori and Pacific team members. Recruitment was open initially to all ethnic groups, but was closed to non-Maori, non-

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Pacific individuals after six months when the target for this group (500 participants) was reached. Recruitment of Maori and Pacific individuals continued for a further five months, but at that time it became clear that recruitment targets would not be met within the study timeframes. Therefore, recruitment was reopened to all ethnicities again for two months and closed finally in November 2015.

Recruitment campaigns directed volunteers to a designated trial website to answer a pre-screening questionnaire, and a link to download the trial app was then provided. Enrolment occurred via the app, but the pre-screening step allowed the study team to monitor registration numbers and ethnicity targets. The trial app was available free of charge in NZ Google Play and iTunes app stores. Information in the app stores also encouraged volunteers to visit the trial website before downloading the app.

Recruitment materials and advertisements were developed by the research team. (Supplementary File 1, a-b). Advertising campaigns were conducted at staggered intervals over the 13-month recruitment period using research team networks, Internet and social media advertising, and mainstream media advertising (Figure 1). The impact of recruitment strategies was assessed continuously by comparison with monthly recruitment targets.

Three media releases were issued by the University communications office (Oct 2014, Nov 2014 and Nov 2015). Promotion via research team networks was undertaken using group email lists, word of mouth, staff intranets, personal Facebook pages, and hard copy recruitment flier distribution. Electronic recruitment fliers were circulated via email lists at several NZ universities, healthcare providers, and relevant non-government organisations. Requests were made to NZ schools, particularly those with high numbers of Maori and Pacific students, to promote the study to via their newsletters with the aim of recruiting parents of students. Paid internet advertising was undertaken using 14 promoted posts on Facebook (Supplementary File 2), two Google AdWords campaigns (Supplementary File 3 part 1 and part 2), and one LinkedIn campaign. Other paid advertising included an advertisement in a Maori magazine (including a web banner on their website), promotional advertisements on Pacific radio, and representation at relevant events, such as Maori and Pacific cultural festivals and health provider conferences.

Strategies to maintain retention

Participants were sent regular notifications via the study app, SMS text reminders,[16] and email messages. All registered participants received a NZ$10 gift voucher, and those who completed the trial (defined as completion of the follow up questionnaire at the end of the five-week study) received a further NZ$80 gift voucher.

Registration logic checks

Because incentives (vouchers) were offered for study participation, repeat registrations by the same participants and re-registration by ineligible participants were identified as risks. To prevent duplicate registrations, individual IP address and email address checks were implemented on the study screening website. Within the app, logic checks for unique and valid email address and valid age (18 to 100 years) were also implemented. All registrations were checked daily for duplicate surnames, street addresses, and phone numbers. All suspected duplicate registrations were investigated by research staff. Confirmed duplicate registrations were contacted with the request that they discontinue the trial.

Data Analysis

Information on the demographic characteristics of trial participants was collected via a baseline questionnaire completed in the study app.[15] Self-reported ethnicity was grouped into three categories: Maori, Pacific, and Other. Google Analytics [21] was used to track visits to the study website. Data on self-reported recruitment strategy that attracted participants were collected using the question “How did you find out about the study?” The effectiveness of recruitment strategies was assessed by collating numbers of participants registered, randomised, and completing the trial. Conversion to randomisation was defined as proportion of registered participants randomised and retention rate was defined as proportion of randomised participants retained. Participants who could not be randomised due to technical issues with the app or their phone were excluded from analysis.

Self-reported recruitment data were matched with recorded costs for each strategy. Only broad categories were available in the self-reported data. Thus in the cost analysis, promotion or advertising via community events, research team’s personal and professional network, and coverage in mainstream paper media were combined

in one category titled 'network and paper media' (Table 1). It was not possible to directly account for the cost of research staff time on each of strategy, and thus only the direct costs of each strategy were assessed. Costs were reported as total per strategy, and cost-per-randomised and per-completed participant (NZ$).

The analysis was conducted in IBM SPSS Statistics 21.0. Simple descriptive statistics were used to describe the numbers of participants registered and randomised by recruitment strategy, and key demographics. Statistical difference between categories was tested using the Chi-square test for categorical variables, and Analysis of Variance (ANOVA) for continuous variables. Statistical tests were two-sided at 5% significance level.

RESULTS

Recruitment summary

There were 2448 study registrations, of which 1035 were excluded prior to randomisation. Reasons for exclusion were ineligibility based on study inclusion criteria (n=205), failure to complete the study run-in phase (n=727), duplicate registration due to a technical problem with the app (n=47), and non-randomisation of eligible individuals due to a technical problem with the app (n=56). A further 56 individuals were excluded from analysis because they were randomised in error (i.e. randomised even though they failed to meet qualifying run-in criteria) as a result of a technical problem with the app. Thus 1357 individuals (55% registrations) were randomised and included in the main study data analysis: 243 (18%) Maori, 87 (6%) Pacific, and 1,027 (76%) other ethnic groups. Of those randomised, 1202 (89%) completed the study: 201 Maori (83%), 75 Pacific (86%) and 926 (90%) other.

The demographic characteristics of randomised participants, overall and by recruitment strategy, are presented in Table 2. The study population was predominantly female (89%) with a mean (SD) age of 33 (9) years. Representation of Maori, Pacific and other ethnicities was similar to their distribution in the NZ population (Table 2). However, more than two thirds of trial participants were tertiary educated (vs 26% in 2013 NZ Census),[22] and nearly all (97%) reported that they were moderately to very interested in healthy eating. Household income was also not

representative of the general population, with higher income groups over-represented in the sample (Table 2).

Recruitment strategy was significantly associated with participants' demographic characteristics, namely age (p<0.001), household size (p<0.001), ethnicity (p<0.001), gender (p=0.005) and interest in healthy eating (p=0.022). Participants recruited via Internet/social media were younger on average (31 years), whilst those recruited via radio and newspaper advertising were older (36.5 and 37 years respectively). A larger proportion of male participants was recruited via strategies focused on personal contact, namely word of mouth and email invitations (14% and 17%, respectively, vs 7-9% by other strategies). Finally, radio advertising attracted a greater proportion of participants not interested in healthy eating (7% vs 1-4% by other strategies).

Recruitment effectiveness

A cumulative summary of recruitment over time in response to the various strategies is presented in Figure 1. The largest peaks in registrations were observed in response to Facebook campaigns (up to 600 new registrations per campaign), followed by promotion via schools, and research team networks (50-100 new registrations per campaign).

Analysis of trial registration website visits using data from Google Analytics and self-reported recruitment source is presented in Figure 2. "Social media" and "Paid search" (Google AdWords) brought 55% of the website visits (Figure 2a). This aligns with self-reported data, which showed that almost 50% of registrations were due to "Internet" campaigns (Figure 2b). Further examination showed 98% of such visits to the study registration page came from Facebook, and the remainder were from other social media and paid search, including Google AdWords. Therefore all registrations that reported "Internet" as a source were considered as arising from Facebook. The second highest website traffic acquisition was via the "Direct" chanel (Figure 2a), i.e. direct visits to the trial webiste not redirected from other websites (likely people using the website address provided in fliers, emails, magazines and newspapers). Self-reported data also showed that over 40% registered participants were reached via networks ("Word of Mouth" and "email invitations") and media coverage ("Newspapers and magazines").

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The effectiveness and cost per strategy are presented in Table 3. Facebook (paid campaigns and free posts) resulted in the highest absolute registration, randomisation and study completion numbers, both overall, and for each ethnic group. However, higher conversion from registration to randomisation rates were achieved by network/media strategies, such as “Email Invitations” and “Word of Mouth” (66%-71% vs 60% achieved by Facebook). There was a significant association between recruitment strategy and conversion to randomisation (p=0.011), but not retention. There was also a significant association between ethnicity and recruitment strategies used (p<0.001).

Promotions via networks & paper media was the least expensive strategy (NZ$4 per randomised participant, Table 3), closely followed by Facebook posts (NZ$5 per participant). Radio advertising was the most costly strategy used (NZ$179 per randomised participant).

DISCUSSION

This study describes the effectiveness of a range of recruitment strategies used in a smartphone-delivered nutrition labelling intervention trial. Over a period of 13 months, 2104 participants were registered and provided information on recruitment source, of whom 55% were randomised into the study (n=1357). Facebook campaigns were the most successful recruitment strategy, both overall (43% of all randomised participants) and for Maori and Pacific participants (44% each). Although the conversion rate from registration to randomisation for participants recruited via Facebook was not as high as that achieved by network promotions, the vast reach of Facebook (Supplementary File 3) and ability to target campaigns by demographics, geographic region, and interests led to the greatest absolute number of study registrations (n=966) and randomisations (n=584).

Most types of campaign were used several times during the recruitment period. The Pacific radio campaign and advertising in a Maori magazine (and via their website) were only used once however (due to cost) during the period that study recruitment was open only to Maori and Pacific. Therefore although it’s possible that other ethnic groups might also have been attracted by these campaigns they would have been

deemed ineligible on registration, and so these strategies recruited Maori or Pacific participants exclusively.

The study sample was not representative of the general population and contained a high proportion of tertiary educated adults (66%). One possible explanation for this is utilisation of the professional networks of the study team, and university mailing lists. In addition, most of the paid Facebook campaigns were placed on the University of Auckland Facebook page and while the audience was not limited to the subscribers of this page, interest in University Facebook posts is likely to be higher amongst tertiary educated adults.

The overall dropout rate was 11% (completion rate 89%), which is lower than the typical >20% dropout rate expected for lifestyle interventions.[7] This could have been due to some of the unique characteristics of this study, including the offer of a quite substantial (NZ$80) financial incentive on completion, the relatively short five-week study duration, the automated nature of the intervention which removed the need to travel to attend appointments, and use of a pre-randomisation run-in period. A run-in period allowed participants to become familiar with the smartphone technology, potentially selected more dedicated users, and allowed exclusion of users with incompatible devices. In total, more than 700 people were excluded following the run-in phase.

Overall the results of this study are consistent with previous findings showing that Facebook is an effective research recruitment method,[7] radio advertising is less cost effective,[23] and combined approaches are best.[23] Higher female participation rates, particularly of those with higher income and education levels, is also typical for nutrition research.[24] A previous study that compared demographic characteristics of participants recruited via either social media or traditional methods found no difference between groups other than in age, which was younger in the social media group.[25] A similar association between age and recruitment strategy was apparent in our study ($p<0.001$), with a lower mean age amongst participants recruited via Facebook (31 years), compared with those recruited through newspapers and radio (37 and 36 years, respectively). Our analysis also demonstrated a significant association between recruitment strategy and other important demographic characteristics, such as gender, ethnicity and household

size. It is important therefore to tailor study recruitment approaches to the target population. Our findings also have broader relevance for the health promotion and public health fields which increasingly uses smartphone technology and applications to deliver and monitor healthcare interventions, for education, and to support consumer behaviour change.[26, 27]

Despite using a wide range of culturally-targeted media-based strategies and additional resources to recruit Maori and Pacific participants, targets were still not met. Face-to-face recruitment building on community networks and connections is a strategy commonly used to recruit Maori and Pacific participants into studies,[13] and was strongly recommended by Maori and Pacific team members as a way to enhance recruitment of Maori and Pacific participants. The fact that "Word of mouth" was the second-most effective strategy is an indication of the potential effectiveness of such face-to-face community-based recruitment. However as this trial recruited people from all across New Zealand in-person recruitment was considered to be too logistically challenging and resource-intensive. Furthermore, the potential for in-person recruitment to introduce selection bias was considered a risk to the internal validity of the study since those recruited using face-to-face methods may differ in other important ways from those recruited using alternative strategies as has been observed in other studies.[28] For research to be truly representative of Maori and Pacific peoples, it is clear from this work that in future research, recruitment protocols and indeed study design needs to be carefully planned and adapted to accommodate different cultural perspectives.

Studies focused on recruitment of underserved or hard-to-reach populations consistently report that greater resources, more time and targeted strategies are needed to recruit such populations.[29] On the other hand, recruitment targets for other ethnicities could potentially be achieved with substantially less cost, thus freeing up more time and resources to focus on more priority population recruitment. Facebook recruitment alone achieved 88% (n=440) of the target for non-Maori, non-Pacific participants, almost eliminating the need to use any other recruitment strategies for this group.

To our knowledge this is the first study to examine the success of a range of strategies to recruit participants to a smartphone-delivered study in NZ. Use of

diagnostic technology, namely Google Analytics, enabled objective assessment of web-based recruitment strategies and their effectiveness. The current study also provides data on participant retention, which was previously identified as a gap among existing reports on recruitment for web-based and mobile health studies.[7] We also describe strategies for reducing duplicate and fake registrations.

A limitation was the broad grouping used for self-reported recruitment sources, which prevented analysis at a more precise category level. Inability to estimate staffing costs associated with recruitment strategies was another limitation, likely to be particularly important in assessing research team network promotions, a heterogeneous approach that involved reasonably high resource e.g. distribution of hard copy advertising fliers.

In conclusion, recruitment via the Internet and social media is comparable in cost and substantially more effective than traditional study recruitment strategies such as mainstream media advertising, and is effective in reaching diverse ethnic groups. However, additional targeted strategies should be considered where large numbers of participants from particular ethnic groups are sought.

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AUTHOR CONTRIBUTIONS

EV and CNM formulated the idea and planned the reported post-study analysis; CNM had leadership responsibility for the main study design and execution; EV and HE contributed substantially to design of the main study; EV and JM managed day-to-day conduct of the study and oversaw data collection; EV and YJ performed the statistical analyses of the study data; CC and GS contributed to study design and revised the paper critically from cultural perspectives; EV wrote the paper and had primary responsibility for final content. All authors provided critical review and commentary on the draft manuscript, and approved the final manuscript.

COMPETING INTERESTS

We have no competing interests to declare.

DATA SHARING STATEMENT

Extra data is available by emailing Cliona Ni Mhurchu c.nimhurchu@auckland.ac.nz

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TRIAL REGISTRATION

Australian New Zealand Clinical Trials Registry (Trial Number ACTRN12614000644662 https://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=366446&isReview=true)

ABBREVIATIONS

RCT	Randomized controlled trial
NZ	New Zealand
App	Application
SD	Standard deviation

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Recruitment campaign	Sub-categories	Corresponding response in Baseline survey
Print media and team networks	Personal and professional networks, schools, universities, healthcare providers, non-government organisations, print media, community events, advertising in magazines	"Word of Mouth" "Email Invitations" "Supermarket Advertising" "Newspaper or Newsletter" "Other"
Internet and social media	Facebook, Linkedin, Google Ads	"Internet"
Radio	Advertising on Pacific Radio	"Radio"

Table 1. Study recruitment strategies

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Table 2. Demographic characteristics of study participants according to recruitment strategy

	All study participants (n=1,357)	By recruitment strategy*						NZ population according to 2013 Census
		Internet (n=584)	Radio (n=14)	Word of mouth (n=343)	Email invitation (n=150)	Newspaper/newsletter (n=111)	Other (151)	
Age; mean (SD)	32.7 (9.2)	31.2 (8.6)	36.5 (8.5)	32.3 (9.5)	34.3 (9.7)	37.43 (9.72)	33.83 (8.0)	38.0
Household size; mean (SD)	3.6 (1.7)	3.4 (1.6)	5.3 (2.3)	3.6 (1.7)	3.6 (1.5)	4.1 (1.5)	3.8 (2.1)	2.7
Gender; n (%)								
Male	152 (11.2)	54 (9.2)	1 (7.1)	48 (14.0)	26 (17.3)	11 (9.9)	10 (6.6)	48.7%
Female	1205 (88.8)	530 (90.8)	13 (92.9)	295 (86.0)	124 (82.7)	100 (90.1)	141 (93.4)	51.3%
Ethnicity; n (%)								
Maori	243 (17.9)	106 (18.2)	4 (28.6)	45 (13.1)	25 (16.7)	23 (20.7)	39 (25.8)	14.9%
Pacific	87 (6.4)	38 (6.5)	10 (71.4)	20 (5.8)	12 (8.0)	3 (2.7)	4 (2.6)	7.4%
Other	1027 (75.7)	440 (75.3)	0	278 (81.0)	113 (75.3)	85 (76.6)	108 (71.5)	74.0%
Income; n (%)§								
NZD$20,000 or less	111 (10.4)	61 (13.1)	0	31 (11.4)	8 (6.7)	1 (1.3)	9 (7.1)	11.1%
NZD $20,001 - $40,000	154 (14.4)	59 (12.7)	1 (14.3)	42 (15.4)	22 (18.5)	8 (10.4)	22 (17.5)	20.7%
NZD $40,001 - $60,000	193 (18.1)	81 (17.5)	1 (14.3)	48 (17.6)	25 (21.0)	14 (18.2)	23 (18.3)	15.5%
NZD $60,001 - $70,000	114 (10.7)	56 (12.1)	0	28 (10.3)	10 (8.4)	5 (6.5)	14 (11.1)	7.0%
NZD $70,001 - $100,000	284 (26.6)	110 (23.7)	4 (57.1)	71 (26.1)	30 (25.2)	32 (41.6)	37 (29.4)	18.0%
NZD $100, 001 or more	213 (19.9)	97 (20.9)	1 (14.3)	52 (19.1)	24 (20.2)	17 (22.1)	21 (16.7)	27.6%
Qualification; n (%)								
None	28 (2.1)	10 (1.7)	2 (14.3)	8 (2.3)	3 (2.0)	2 (1.8)	3 (2.0)	18.6%
Secondary School Qualification.	338 (24.9)	146 (25.0)	6 (42.9)	94 (27.4)	25 (16.7)	32 (28.8)	34 (22.5)	35.6%
University or polytechnic degree/diploma	893 (65.8)	395 (67.6)	3 (21.4)	213 (62.1)	108 (72.0)	67 (60.4)	104 (68.9)	26.0%
Trade Certificate	48 (3.5)	16 (2.7)	3 (21.4)	15 (4.4)	6 (4.0)	5 (4.5)	3 (2.0)	8.6%
Other	50 (3.7)	17 (2.9)	0	13 (3.8)	8 (5.3)	5 (4.5)	7 (4.6)	11.1%
Interest in healthy eating; n (%)								
Not particularly interested	37 (2.7)	15 (2.6)	1 (7.1)	13 (3.8)	1 (0.7)	1 (0.9)	5 (3.3)	n/a
Moderately to very interested	1320 (97.3)	569 (97.4)	13 (92.9)	330 (96.2)	149 (99.3)	110 (99.1)	146 (96.7)	n/a

* Recruitment source data were missing for n=3 randomised participants

§ Household income data were missing for n=288 randomised participants

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Table 3. Effectiveness and cost of study recruitment campaigns

Recruitment campaign *(data missing for n=4 registered participants)*		Participant status	All participants	By ethnicity*			Campaign cost (NZ$)		
				Maori	Pacific	Other	total	per randomised participant	per completed participant
Internet and social media		Registered, n	966	215	73	668			
		Randomised; n (% of registered)	584 (60)	106 (49)	38 (52)	440 (66)			
		Completed; n, (% of randomised	507 (87)	91 (86)	32 (84)	384 (87)	3047	5	6
Radio		Registered, n	25	10	15	0			
		Randomised; n (% of registered)	14 (56)	4 (40)	10 (67)	0			
		Completed; n, (% of randomised	13 (93)	3 (75)	10 (100)	0	2500	179	192
Print media & team networks	Supermarket ad	Registered, n	3	0	0	3			
		Randomised; n (% of registered)	1 (33)	0	0	1 (33)			
		Completed; n, (% of randomised	1 (100)	0	0	1 (100)			
	Word of mouth	Registered, n	506	76	27	394			
		Randomised; n (% of registered)	343 (68)	45 (59)	20 (74)	278 (71)			
		Completed; n, (% of randomised	306 (89)	34 (76)	18 (90)	254 (91)			
	Email invitation	Registered, n	216	42	19	154			
		Randomised; n (% of registered)	150 (69)	25 (60)	12 (63)	113 (73)			
		Completed; n, (% of randomised	141 (94)	22 (88)	10 (83)	109 (96)			
	Newspaper or newsletter	Registered, n	156	29	8	117			
		Randomised; n (% of registered)	111 (71)	23 (79)	3 (38)	85 (73)			
		Completed; n, (% of randomised	99 (89)	20 (87)	2 (67)	77 (91)			
	Other	Registered, n	228	54	11	161			
		Randomised; n (% of registered)	151 (66)	39 (72)	4 (36)	108 (67)			
		Completed; n, (% of randomised	132 (87)	30 (77)	3 (75)	99 (92)	2830	4	4
Total recruited		Registered, n #	2104	427	152	1501			
		Randomised; n (% of registered)	1357 (64)	243 (57)	87 (57)	1027 (68)			
		Completed; n, (% of randomised	1202 (89)	201 (83(	75 (86)	926 (90)	8377	6	7

* Ethnicity data were missing for n=24 registered participants

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[#] Total number of registrations in the table/analysis (n=2104) is less that that recorded in the study (n=2448) because a number of people did not complete the registration questionnaire so data were not available on recruitment strategy for those participants.

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Figures

Figure 1. Recruitment rates in response to implementation of key recruitment strategies over time

Figure 2. Trial website visit and registration numbers by recruitment strategy

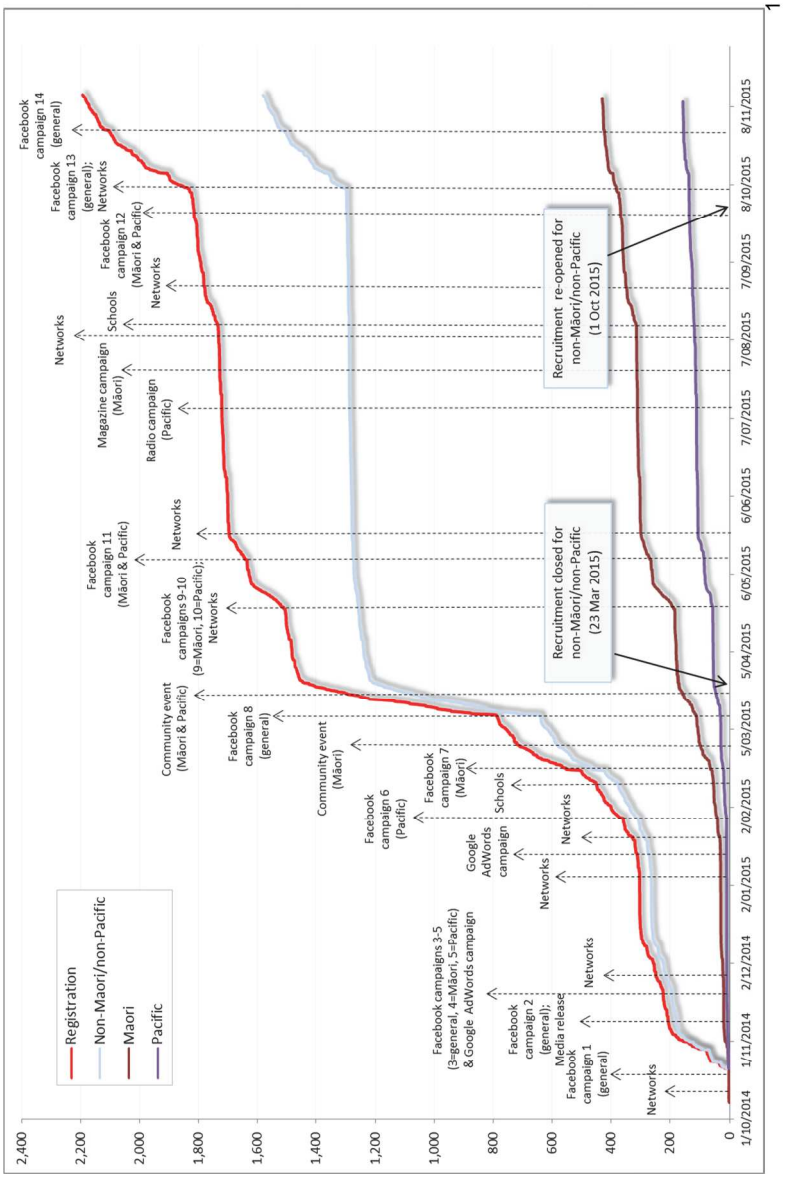
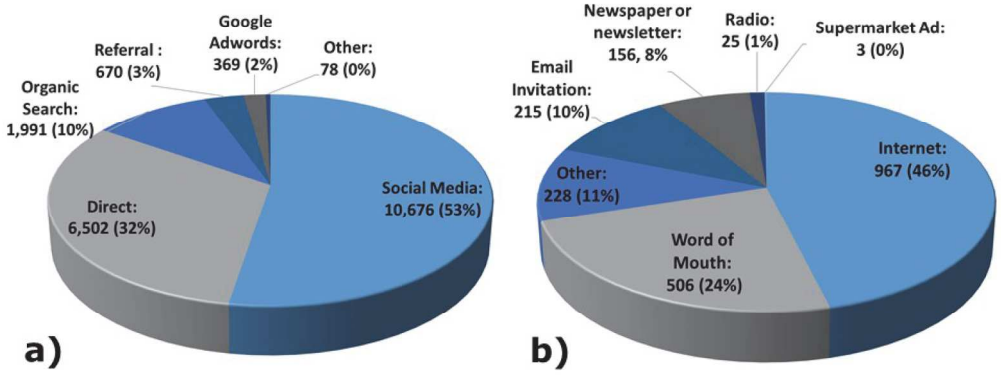


Figure 1. Recruitment rates in response to implementation of key recruitment strategies over time

169x251mm (300 x 300 DPI)



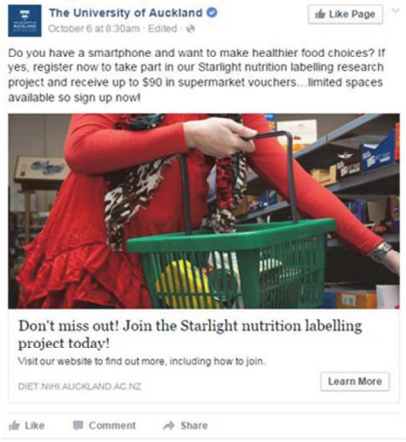
a – Website traffic acquisition channels from the Google Analytics report

b – Self-reported (baseline questionnaire) recruitment source for registered participants

Figure 2. Trial website visit and registration numbers by recruitment strategy

189x126mm (300 x 300 DPI)

(a)



(b)

165x96mm (300 x 300 DPI)

Supplementary File 2. Summary of Facebook recruitment campaign reports, Oct 2014 – Nov 2015.

Campaign number	Focus	Dates	Placement	Targeting	Reach (users)	Clicks	Average cost per click (NZD)
1	General	20 - 30 Oct 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	60,960	1,372	$0.15
2	General	14 - 15 Nov 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (over 18)	35,280	460	0.43
3	General	20 Nov – 4 Dec 2014	Sponsored Newsfeed only	Age (18-50), Smartphone owners, New Zealand, Interests(nutrition & fitness-related)	20,598	251	$0.8
4	Māori	20 Nov – 4 Dec 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	53,856	390	$0.51
5	Pacific	20 Nov – 4 Dec 2014	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	39,536	268	$0.75
6	Pacific	28 Jan - 8 Feb 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	1: Age (18-50), Smartphone owners, New Zealand 2: Age (18-50), Smartphone owners, New Zealand, Interests(nutrition & fitness-related) 3: Age (18-50), Smartphone owners, South & West Auckland (high p'evalence of Māori and Pacific residents)	44,096	770	$0.26
7	Māori	16 - 26 Feb 2015	Sponsored Newsfeed only	1: Age (18-50), Smartphone owners, New Zealand regions with high Māori and Pacific population 2: Age (18-50), Smartphone owners, South & West Auckland (high p'evalence of Māori and Pacific residents) 3: Age (18-50), Smartphone owners, New Zealand	24,014	465	$0.43
8	General	9-22 Mar 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	1: Age (18-50), Smartphone owners, New Zealand, Interests(nutrition & fitness-related) 2: Age (18-50), Smartphone owners, New Zealand	81,504	3,570	$0.06
9	Pacific	22 Apr - 1 May 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, Auckland	49,200	1,053	$0.19
10	Māori	22 Apr - 1 May 2015	Sponsored Newsfeed only	Age (18-50), Smartphone owners, New Zealand regions with high Māori and Pacific population	29,312	532	$0.38
11	Māori & Pacific	11-20 May 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, Auckland and other New Zealand regions with high Māori and Pacific population	60,064	1,170	$0.34
12	Māori & Pacific	23 Sep - 5 Oct 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, Auckland, South Auckland and other New Zealand regions with high Māori and Pacific population	18,862	167	$1.20
13	General	6 -20 Oct 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand	20,950	413	$0.48
14	General	30 Oct – 10 Nov 2015	Post on the University of Auckland Facebook page and Sponsored Newsfeed	Age (18-50), Smartphone owners, New Zealand (excluding Auckland), Interests(nutrition & fitness-related)	10,220	109	$1.83
				Total	527,854	10,739	n/a
				Average	37,704	767	$0.50

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Supplementary File 3. Summary of the Google AdWords campaign performance by top searched keywords

Keyword	Reach (users)	Clicks	Average cost-per-click
volunteer	9,829	195	0.3
volunteers	11,421	158	0.49
diet	1,924	26	2
nutrition diet	3,293	5	3.88
healthy food	581	4	2.42
smartphone	9,287	3	2.77
information about healthy food	1,654	3	2.15
food shopping	3,219	3	0.67
healthy foods	287	2	1.25
healthy food information	170	2	5.98
healthy food choices	32	2	1.62
paid volunteer	24	2	0.2
earn cash	80	2	1.24
earn	43	2	0.22
research	463	2	0.23
diet and nutrition	428	1	1.89
healthy food groups	13	1	3.07
healthy food options	4	1	2.38
information on nutrition	887	1	2.93
food label	2	0	0
about healthy foods	1	0	0
healthy foods to eat	54	0	0
eat healthy food	15	0	0
healthy food articles	1	0	0
participants	77	0	0
food labels	8	0	0
participate in a study	2	0	0
what is healthy food	273	0	0
take part	2	0	0
healthy food to eat	4	0	0
healthy food for	37	0	0
join research	2	0	0
the healthy food	5	0	0
healthy food pictures	3	0	0
healthy eating	81	0	0
what is healthy foods	1	0	0
food labelling	66	0	0
what are healthy foods	1	0	0
earn reward	10	0	0
labels food	271	0	0

165x260mm (300 x 300 DPI)

healthy foods to buy	1	0	0
healthy food plans	6	0	0
research study	617	0	0
healthy food chart	2	0	0
healthy food habits	13	0	0
food nutrition labels	207	0	0
most healthy foods	0	0	0
food healthy	298	0	0
healthy food products	7	0	0
healthy shopping	72	0	0
which is healthy food	0	0	0
recipes for healthy snacks	6	0	0
healthy food ideas	25	0	0
healthy food menus	2	0	0
earn	98	0	0
volunteer for research studies	1	0	0
best healthy foods	5	0	0
healthy diet	40	0	0
how to make healthy food	6	0	0
eating healthy foods	3	0	0
participant in research	1	0	0
what are some healthy foods	10	0	0
nutrition labels	47	0	0
healthy food labels	18	0	0
healthy food for health	1	0	0
how to eat healthy food	7	0	0
about healthy food	166	0	0
take part	2	0	0
earn cash	14	0	0
participant	6	0	0
participate	9	0	0
paid volunteer	3	0	0
cash	614	0	0
Total	**46,852**	**415**	
Average			**$1.87**

165x260mm (300 x 300 DPI)