

Is That APP-appropriate?

Apps for Weight Loss and Smoking Cessation: A Review and Quality Assessment

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Raja Patel, Lucy Sulzberger, Grace Li, Jonny Mair, Hannah Morley, Merryn Ng-Wai Shing, Charlotte O’Leary, Asha Prakash, Nicholas Robilliard, Merrin Rutherford, Caitlin Sharpe, Caroline Shie, Logitha Sritharan, Julia Turnbull, Imogen Whyte and Helen Yu (Authors are fourth-year medical students at the Wellington School of Medicine, University of Otago)

Abstract

Obesity and tobacco smoking are leading contributors to disease worldwide and in New Zealand (NZ). Obesity and smoking rates are higher in NZ’s Māori and Pacific peoples. Smartphone and app use is readily increasing, and many health apps already exist, although the evidence-base for most of these apps is weak at best.

Aims: To assess the quality of existing evidence, and the quality of existing apps for weight loss and smoking cessation.

Method: We conducted a literature review to evaluate studies looking at app use that employed randomised control trials. We also assessed 120 existing Android and Apple weight-loss and smoking-cessation apps against existing ‘Mobile App Rating Scale’, and weight-loss, smoking-cessation and cultural-appropriateness criteria specifically made for this study, based mainly on NZ literature. We also piloted qualitative research regarding which characteristics of weight-loss apps are advantageous and disadvantageous on ten apps.

Results: We identified five studies of trials regarding effectiveness of weight-loss apps. Some, but not all, of these studies suggested apps may be effective. Only one study was identified regarding effectiveness of smoking-cessation apps, though it was poorly conducted/reported and thus provided us little information. The highest-scoring weight-loss app was ‘Noom Coach: Weight Loss Plan’ (70%), and the highest-scoring smoking-cessation app was ‘Quit Now: My QuitBuddy’ (77%). Overall, apps did not perform well against the specific criteria. Users found apps that had low battery usage, interesting feedback, motivation/encouragement, memory function, and offline functionality were superior. The need for a comprehensive NZ-specific food database was identified.

Conclusions: Apps for weight loss and smoking cessation may be effective interventions, however a lack of substantial evidence remains. In the event of further promising evidence emerging in the near future, we then suggest that NZ health agencies consider developing NZ-specific apps, and commission high-quality RCTs, with an emphasis on effectiveness on the high-risk populations in NZ.

Introduction

In 2012, the World Health Organization reported ischaemic heart disease, stroke and chronic obstructive pulmonary disease (COPD) to be the three leading causes of mortality worldwide.⁽¹⁾ Combined, these illnesses were responsible for 17.2 million deaths in 2012.⁽¹⁾ In 2010, this amounted to a global economic cost of US\$ 863 billion and US\$ 2.1 trillion for cardiovascular illness and COPD respectively.⁽²⁾ Tobacco use, physical inactivity and obesity are amongst the most significant drivers of these illnesses.⁽³⁾ Being modifiable, these risk factors have become the target of many intervention programmes.⁽⁴⁾

New Zealand (NZ) ranks third highest globally for obesity rates⁽⁵⁾ and was among the countries that experienced the largest growth in obesity prevalence between 1980 and 2013.⁽⁶⁾ Within the NZ population the greatest burden of obesity is seen in Māori and Pacific peoples, where rates were 45.5% and 66.7% respectively in 2013.⁽⁷⁾ Smoking rates in NZ, despite considerable investment by government control programmes,⁽⁸⁾ remain less than optimal. NZ's smoking rates are higher than both Australia and USA.⁽⁹⁾ Higher rates are seen in Māori people, where rates were 37% and 42% for Māori men and women respectively in 2013.⁽¹⁰⁾ Both obesity and smoking are a considerable health burden in NZ and drive health inequalities in the country.^(11,12) A reduction in these would be expected to improve the health of New Zealanders. Indeed it is well established that lifestyle changes focusing on weight loss and physical activity improve cardiovascular and diabetes outcomes,^(13,14) while smoking cessation has immediate and long-term health benefits.⁽¹⁵⁻¹⁷⁾ However, weight loss and smoking cessation are not easily achieved, both requiring significant commitment from individuals. Furthermore, interventions that have succeeded and maintained positive outcomes have proved challenging to develop.⁽¹⁸⁻²⁰⁾ Current weight-loss and smoking-cessation interventions have significant barriers: they are resource intensive^(21,22); often require face-to-face counselling with groups or individuals, compromising their accessibility^(21,22); and are not always responsive to individuals' needs.⁽¹⁸⁾

The advent of mobile technology offers an opportunity to design weight-loss and smoking-cessation interventions, which have the potential to overcome these barriers.^(18,21,23,24) Research shows that text-messaging interventions for both weight loss and smoking cessation have had a role in positive health outcomes⁽²³⁻²⁵⁾ and it can be expected that the employment of smartphone apps would have similar or better positive health impacts.^(18,21) The use of smartphones globally has grown increasingly in the last few years⁽²⁶⁾ with 1.82 billion devices in use in 2014.⁽²⁷⁾ Smartphone app usage is also on the rise with over one billion expected downloads in 2014.⁽²⁷⁾ In NZ, smartphone ownership or access by adults is 59% with higher usage in the younger populations: 71% in those aged 18–54 years.⁽²⁸⁾ Access to home Internet by Māori populations is also high at 70%, which is of particular importance in regards to health services and health outcome equity.⁽²⁹⁾ This suggests that delivery of weight-loss and smoking-cessation interventions via smartphone apps will have high population coverage. Furthermore, this is a benefit for groups for whom traditional community-based interventions may be inaccessible, for example rural populations.^(18,21) Further benefits of smartphone apps include continued and immediate availability of the intervention, video and audio capabilities, tailored messages to user characteristics, text capabilities, access without internet connection, connection to online support groups and progress-tracking features.^(18,21)

Although smartphone apps hold considerable promise as a platform for weight-loss and smoking-cessation interventions there is a paucity of research evaluating their efficacy.^(23,30) This is concerning, as with many apps available for weight-loss and smoking-cessation, it becomes difficult for health professionals to know which apps may best help their patients achieve weight loss or to quit smoking.⁽²⁷⁾ Furthermore, it is unclear to researchers which apps would be best to formally evaluate.⁽²⁷⁾ Assessing the utility of apps via download popularity, star-rating systems or app reviews has little to no value regarding app quality.⁽²⁷⁾ There has been some effort to create mobile-health criteria and although each has their limitations it appears to be a step in the right direction towards addressing these issues.⁽²⁷⁾

In light of these issues, this study aimed to 1) conduct a literature review in order to identify all trial-based research regarding smartphone apps as an intervention to aid weight loss or smoking cessation, 2) assess the quality of existing weight-loss and smoking-cessation apps using the newly developed tool ‘Mobile App Rating Scale’, and NZ-specific weight-loss/smoking-cessation and cultural-appropriateness criteria and 3) gain qualitative assessments of the best available apps.

Method

Literature Review: “Are Apps Effective?”

A literature search of PubMed on June 4th 2015 using the search terms (Mobile OR cellphone OR smart phone OR iPhone OR android) AND (app* OR application) AND (diet* OR calorie* OR weight loss OR weight management OR nutrition) OR (smoking OR smoking cessation OR quit OR tobacco OR cigarettes OR nicotine), enabled a comprehensive literature review to address the research question “Are apps effective for weight loss and smoking cessation?” The articles had to meet the following inclusion criteria: 1) be in English language, 2) be either a randomised control trial (RCT) or a quasi-RCT, 3) evaluate use of a smartphone app (as oppose to text-message-based interventions) and 4) demonstrate whether app usage influenced weight or smoking behaviour. Articles were first screened by title, and then by abstract. The full texts of relevant articles were then assessed. Articles that met inclusion criteria were then assessed for quality of information, and external validity for use in NZ populations (particularly high-risk populations).

App Assessment

App Selection

Lists for the four categories of apps (Android weight-loss, Apple weight-loss, Android smoking-cessation and Apple smoking-cessation) were collated using the ‘xyo.net’ app search engine.⁽¹⁸⁾ Search terms used were (weight loss/weight management/lose weight/calorie counting) or (stop smoking/quit smoking/smoking cessation/smoke free) for weight-loss and smoking-cessation apps respectively. Apps were ranked within the four categories (Android weight-loss, Apple weight-loss, Android smoking-cessation and Apple smoking-cessation) according to their download popularity as estimated by xyo.net. At this point inclusion criteria were applied to highest-ranking number of apps of each category until 40–45 apps that met inclusion criteria were identified. To be included, apps had to 1) be in English language; 2) be available in the NZ ‘Google Play’ or ‘App Store’; 3) describe either smoking cessation or weight loss as a key feature/goal of the app within the app description; 4) target patients/consumers (as oppose to health professionals) and 5) cost less than NZ\$4. The 30 highest-ranking apps within each category underwent assessment. If the assessor deemed an app in this top 30 to not meet inclusion criteria once assessment began, it was replaced by the highest-ranking app outside the top 30.

Development of Criteria

All apps were assessed using the ‘Mobile Application Rating Scale’ (MARS) as developed by Stoyanov et al (2015).⁽²⁷⁾ The MARS assesses the apps for engagement, functionality, aesthetics, information and subjective quality. It was developed by researchers at Queensland University of Technology (Brisbane, Australia), following comprehensive review of website and app assessment criteria within the published literature. The MARS was finalised by psychologists, interface designers and mHealth app developers

with classification and refinement of previously published criteria, development of scale items and the addition of pertinent rating criteria. The MARS was applied here as an objective assessment of health app quality across broad domains, and final scores were calculated using the mean of the two assessors' scores.⁽²⁷⁾

Each app was further assessed against either weight-loss or smoking-cessation criteria as appropriate. Smoking-cessation specific criteria were established according to the methodology used by Abrams et al (2011)⁽³¹⁾ in which assessment criteria were developed according to 'U.S. Public Health Service's 2008 Clinical Practice Guideline for Treating Tobacco Use and Dependence'. Accordingly, smoking-cessation criteria for this study were based on 'The New Zealand Guidelines for Helping People to Stop Smoking' and 'Background and Recommendations of the New Zealand Guidelines for Helping People to Stop Smoking' as published by the NZ Ministry of Health in 2014.^(32,33) Table 1 shows the smoking-cessation criteria.

Table 1: Smoking-Cessation Criteria^(32,33)

S1. Does the app assess smoking history?
S2. Does the app assess past experiences with quitting?
S3. Does the app assess previous use of smoking-cessation medicines?
S4. Does the app give information about the withdrawal symptoms of smoking cessation?
S5. Does the app provide encouragement about the user's decision to quit?
S6. Does the app discuss ways to maintain the user's motivation e.g. goal setting, rewards, risks?
S7. Does the app explain the importance of complete abstinence?
S8. Does the app set a date to stop smoking (quit date)?
S9. Does the app give advice to every user to stop smoking?
S10. Does the app give personalised advice to stop smoking e.g. linking smoking to current medical conditions, dangers of second-hand smoke to friends and family?
S11. Does the app advise problem solving and coping mechanisms for identified barriers, triggers or cues?
S12. Does the app address relapses?
S13. Does the app encourage face-to-face support?
S14. Does the app encourage telephone support?
S15. Does the app suggest multiple support sessions?
S16. Does the app encourage social support?

S17. Does the app offer information about cessation services?
S18. Does the app offer contact details for cessation services?
S19. Are the offered services NZ appropriate?
S20. Are any of NZ’s high-risk groups (e.g. pregnant, Māori, PI peoples) offered information specific to them?
S21. Does the app encourage the use of smoking-cessation medications (any nicotine replacement therapies (NRT), varenicline, bupropion, nortriptyline)?
S22. Does the app give advice on side effects of or gives any other additional information about smoking cessation medications?
S23. Does the app recommend smoking cessation medication use for at least 8 weeks?

Breton et al (2011)⁽³⁴⁾ similarly created weight-loss specific criteria using US specific guidelines. Criteria for the assessment of weight-loss apps in this study were thus developed predominantly according to the ‘Clinical Guidelines for Weight Management in New Zealand Adults’.⁽³⁵⁾ Evidence-based information – from Breton et al (2011) and other articles regarding weight-loss apps specific features – was also incorporated into the criteria.^(34,36–42) Table 2 shows the weight-loss criteria.

Table 2: Weight-Loss Specific Criteria

W1. Does the app calculate body mass index (BMI)? ^(34,35)
W2. Does the app provide an interpretation of the user’s BMI by providing information about health status and risks of related diseases? ^(34,35)
W3. Does the app create realistic weight loss goals that promote steady long-term weight loss (0.5-1kg per week)? ^(34–36)
W4. Does the app track changes in weight? ^(34,35)
W5. Does the app record and track foods eaten? ^(34,37)
W6. Does the app encourage intake of fruits and vegetables? ^(34,35)
W7. Does the app encourage intake of low-glycaemic-index, high-fibre foods? ⁽³⁵⁾
W8. Does the app encourage the substitution of sugar-sweetened beverages for water or low-fat milk? ^(34,35)
W9. Does the app encourage the reduction of saturated fats in the diet? ⁽³⁵⁾
W10. Does the app record and track physical activity? ^(34,35)

W11. Does the app encourage regular physical activity? ^(34,35)
W12. Does the app provide information and means to plan future meals?
W13. Does the app provide information on appropriate portion control for meals and snacks? ^(34,35)
W14. Does the app provide personalised positive reinforcement for regular use and/or accomplishments in the form of tips, points etc. ^(36,38)
W15. Does the app encourage engagement with health services? ^(35,39)
W16. Does the app provide personalised feedback based on tracked information provided? ^(34,35)
W17. Does the app enable communication with other users of the app as a means to provide motivation and social support? ^(34,40)
W18. Does the app enable synchronisation with social-networking sites? ^(34,41)
W19. Does the app measure physical activity automatically by an in-app pedometer or accelerometer? ⁽³⁶⁾
W20. Does the app include the ability to identify foods by scanning the barcode with the camera? ⁽⁴²⁾
W21. Does the app use a food database that is applicable to the NZ food market?
W22. Does the app provide solutions to basic obstacles to physical activity and healthy eating? ^(35,36)

All apps were also assessed according to their level of Māori-specific cultural appropriateness. A literature search identified relevant publications.^(43–46) Cultural guidelines detailed within these publications were summarised to develop criteria relevant to the assessment of smartphone apps.^(43–46) Table 3 shows the cultural-appropriateness criteria.

Table 3: Cultural-Appropriateness Criteria (Specifically for Māori)

C1. Does the app contain Māori words or phrases? ^(43,44)
C2. Does the app emphasise family/whanāu involvement*? ^(43–45)
C3. Does the app include Māori forms of traditional medicine (rongoa)? ^(43,45)
C4. Does the app include elements of whakapono (trust, honesty, integrity)? ⁽⁴⁵⁾
C5. Does the app avoid use of graphic images? ⁽⁴⁵⁾
C6. Does the app include traditional Māori games or practices? ⁽⁴⁶⁾

*This includes an emphasis on motherhood, emphasis on being a role model in the family/whanāu

Assessment criteria specific to smoking cessation, weight loss and cultural appropriateness, were designed on a ‘yes or no’ (1 or 0), objective scale. Accordingly, the two assessors graded each app independently. If the two assessors disagreed about any of the criteria, they collaborated to discuss their reasoning, and came to a final consensus score for each criterion.

Assessors

Two assessors, taken from a pool of 12 medical students, independently assessed each app. Prior to data collection, as suggested by the authors of the MARS; app assessors were trained in application of assessment criteria.⁽²⁷⁾ Before assessing the apps selected for the study all assessors assessed the same two apps (one weight-loss app and one smoking-cessation app that were both excluded from due to low popularity) as a practice run. Assessors' scores of the weight-loss, smoking-cessation and cultural-appropriateness specific criteria, along with their scores of the MARS were compared. Discrepancies were then discussed to maximise consistency between assessors, and ambiguities within the criteria were rephrased for clarity where the need arose.

Data Analysis

All data were double entered and checked. Apps received a score across the MARS domains of functionality, aesthetics, engagement, information and subjective quality. Based on individual items of the MARS, a total MARS score was calculated as a percentage. Where a criteria was rated not applicable (N/A), this was considered a 0 for the mean score calculations. Scores for each of weight-loss, smoking-cessation and cultural-competence criteria were also calculated as a total percentage adherence. The apps were ranked overall based on the scores of the three assessment criteria; MARS, smoking-cessation/weight-loss specific criteria, and cultural-competence criteria were weighted 45%, 45% and 10% respectively. Statistical analysis of inter-rater reliability was not possible in this study due to the low numbers of apps assessed by individual assessors.

Experiential Use

Following the assessment of apps against the above-mentioned criteria, the highest-scoring five weight-loss apps from both the Android and iPhone domains were selected for a pilot study investigating experiential use. From ten assessors, each assessor used one of the apps over a 48-hour period to determine long-term functionality. Assessors focused on providing subjective feedback regarding the apps' ease of use – particularly with required time investment, effect on mobile battery life, ongoing engagement, and effects on pre-established behaviour/habits. The assessors were ten fourth-year medical students. Due to the nature of assessors (all non-smokers), experiential use of smoking-cessation apps was not appropriate.

Results

Literature Review: “Are apps effective?”

The search regarding effectiveness of weight-loss apps yielded 254 results. Of these, the vast majority did not meet inclusion criteria (Figure 1). Among the studies that did, there was no consensus in their findings. Turner-McGrievy et al (2011)⁽⁴⁷⁾ suggest that weight-loss apps as an adjunct to podcasts do not aid weight loss, however Allen et al (2013)⁽²¹⁾ suggest that weight-loss apps are likely an effective adjunct to nutrition and exercise counselling. These studies excluded participants with histories of various conditions associated with obesity,^(21,47) thus reducing the generalisability to the target population in

NZ.^(48,49) Carter et al (2013)⁽⁵⁰⁾ suggest that weight-loss apps are a better intervention than computer websites or paper diary use. All the participants were European and generally well-educated,⁽⁵⁰⁾ thus decreasing the generalisability to high-risk groups in NZ – namely Māori and Pacific peoples, and those of lower socioeconomic status.⁽³⁵⁾ Laing et al (2014)⁽³⁸⁾ suggest that weight-loss apps are not an effective intervention. The inclusion of many non-European people⁽³⁸⁾ may make their result more generalisable to the NZ target population.⁽³⁵⁾ Contamination may also have hidden a statistically significant result (See Table 5 for details).⁽³⁸⁾ These four above-mentioned papers had many more female participants than male.^(21,38,47,50) Allen et al found statistically significant increased weight loss in females compared to males.⁽²¹⁾ The results of these studies are therefore not necessarily generalisable to males. Nollen et al (2014)⁽²²⁾ suggest that weight-loss apps may not be an effective intervention for weight-loss in adolescent girls. The girls had an average BMI of 24 kg/m², thus the study did not test those on which apps would be used, making these results less generalisable to obese girls who need to lose weight.⁽²²⁾ No articles discussed potential harms/inconveniences of using smartphone apps. These five studies and their relevance are described in more detail in Table 5.

The search regarding effectiveness of smoking-cessation apps using the above mentioned search terms yielded 89 results (Figure 2). Of these, only Buller et al (2014)⁽⁵¹⁾ met the inclusion criteria. This study suggested that while smartphone apps may be beneficial, text-messaging systems may be more effective than smartphone apps.⁽⁵¹⁾ Buller et al did not consistently use an intention-to-treat analysis, and intentionally moved 7-day abstainers from the intervention group to the control group.⁽⁵¹⁾ These aspects may limit the relevance of the outcomes of this study. This article and its relevance are described in more detail in Table 6.

App Assessment

Figures 3–6 outline the app selection processes for the four categories of apps. Table 4 shows the five highest-scoring apps of each category. Tables 7–10 show the extended results of all 30 apps assessed in each category.

Table 4: Five Highest-Ranking Apps for Each of the Four Categories

Rank	Android Weight Loss			Apple Weight Loss		
	App	Developer	Score (%)	App	Developer	Score (%)
1	Noom Coach: Weight Loss Plan	Noom Inc.	69.5%	Calorie Counter and Food Diary by MyNetDiary	MyNetDiary Inc.	67.1%
2	Lifesum - The Health Movement	Lifesum	67.8%	Calorie Counter, Dining Out, Food, and Exercise Tracker	Everyday Health, Inc.	64.6%
3	Calorie Counter - MyFitnessPal	MyFitnessPal, Inc.	62.9%	Calorie Counter & Diet Tracker by MyFitnessPal	MyFitnessPal.com	63.5%
4	Calorie Counter & Diet Tracker	SparkPeople	60.9%	5K Runner: 0 to 5K run training, Couch to 5K running, free	Clear Sky Apps LTD	62.0%
5	Lose weight without dieting	Harmonic Soft	60.8%	Jillian Michaels Slim-Down: Weight Loss, Diet, Fitness, Workout & Exercise Solution	Everyday Health, Inc.	60.5%
	Android Smoking Cessation			Apple Smoking Cessation		
	App	Developer	Score (%)	App	Developer	Score (%)
1	My Quit Smoking Coach	Andreas Jopp	62.0%	Quit Now: My QuitBuddy	Australian National Preventive Health Agency	76.9%
2	You Can Quit Smoking	Insplicity	59.4%	LIVESTRONG MyQuit Coach - Dare to quit smoking	Demand Media, Inc.	67.8%
3	STOP Cigarettes - Quit smoking	academiacea	48.6%	Stop-tobacco	Université de Genève	64.9%
4	Quit Pro: stop smoking now	Muslim Pro Limited	47.6%	MyQuitSmokingCoach: Europe's No 1 Quit Smoking APP	Oliver Fuxen	53.7%
5	SmokeLess!	Kroaqs	42.9%	Smoke free- Quit smoking now and stop for good	David Crane	52.7%

Criterion 2 of the weight-loss criteria, concerned providing an interpretation of BMI and the health risks involved. It was only met by the app ‘Tactio Health’. With regards to the smoking-cessation criteria, only one app (not necessarily the same app for each criterion) met criteria 2,3,19 and 23. For example, ‘Smoke Free - Quit smoking now and stop for good’ was the only app that met criteria 19, regarding offering NZ-specific services. Many other criteria were only met by four or less apps out of the 60 that were assessed for smoking cessation. ‘Noom Coach: Weight Loss Plan’ (Android), ‘Lifesum - Calorie Counter’ (Android) and ‘Calorie Counter, Dining Out, Food, and Exercise Tracker’ (Apple) were the highest scoring weight-loss apps, scoring only 68%. ‘Quit Now: My Quit Buddy’ (Apple) was the highest scoring smoking-cessation app, scoring only 70%. Hence, even the highest scoring apps did not perform well against our weight-loss and smoking-cessation specific criteria. All the assessed apps fared poorly against the cultural-appropriateness criteria as a whole, with only two app out of the 120 (‘You Can Quit Smoking’ (Android) and ‘LIVESTRONG: My Quit Coach - Dare to quit smoking’ (Apple)) scoring 50%, with the apps scoring an average of 17%. Tables 10–13 detail how individual criteria from the weight-loss, smoking-cessation and cultural-competence specific criteria performed respectively.

Experiential Use

Following a trial of experiential use over 48 hours, satisfaction in the use of weight-loss apps was most readily achieved by apps that were “user-friendly” – that is, those considered aesthetically appealing and easy to navigate. Features noted to increase app functionality were: offline functionality, low battery usage, and memory functions that reduced the time required for meal/data input. Prompts to log meals/activity were also beneficial in maintaining consistent use of the app. Key requirements were that apps engage users through interesting feedback or presentation of results as well as providing ongoing motivation/encouragement.

The need for internet access to log meals/search databases was reported to limit the usability of the app in a real life setting. Specific to the NZ context, few apps used databases that had a comprehensive coverage of food items available within the NZ market and consequently time required was significantly increased as such items needed to be entered manually. Alternatively where the “next-best fit” was selected, this raised concerns about the accuracy of caloric information. The assessors concluded that whilst functional, use of these apps could be time consuming or frustrating, particularly where meals had many components or where food-item weight was a required data point. Functionality of these apps would be increased by use of more comprehensive databases, and increased offline functionality.

Some assessors suggested that these apps were limited in the contribution they could make to long-term weight loss and management due to limited development of more holistic healthy habits. Rather than simply calorie counting – a task considered by some to encourage detrimental food behaviours – it was thought that dietary interventions should also include qualitative focus on sources of calories consumed rather than employing the concept that ‘a calorie is a calorie’ regardless of its source.⁽⁵²⁾ Table 14 provides more detail about how experiential users found the individual apps.

Discussion

The results from the literature review answering the question “Are apps effective for weight loss?” were not unanimously positive, but were encouraging. However, as previously mentioned, the generalisability to NZ’s high-risk populations was limited by several factors. The results from the literature review

answering the question “Are apps effective for smoking cessation?” yielded only one result, which provided little knowledge for how effective smoking-cessation apps would be in a NZ setting.

With regards to the assessment of existing apps, our assessment of the most popular weight-loss and smoking-cessation apps showed a marked range in quality. Against the NZ-specific weight-loss, smoking-cessation and cultural-appropriateness criteria, even the highest-scoring apps did not perform well. Regarding experiential use of the five top weight-loss apps of each category, assessors found these app factors beneficial: low battery usage, interesting feedback and motivation/encouragement, memory function, and offline functionality. However, assessors found that using the apps was time-consuming and that there was need for a comprehensive NZ-specific food database.

Ultimately, the three aims of our study provide information as to whether or not the NZ Ministry of Health or other NZ health agencies should recommend the use of existing health apps as an intervention for weight loss and smoking cessation, and if not, whether or not evidence warrants these agencies investing in developing and trialling NZ-specific apps. As mobile-health apps become so widespread, this study contributes the first evaluation of weight-loss and smoking-cessation apps according to NZ guidelines. This creates a basis of information for more research and development to follow, to the possible progression of healthcare providers integrating evidence-based health apps into their clinical management of patients where appropriate. As evident through the literature review, there is generally limited evidence. With the increase in app use, in conjunction with published study protocols that were excluded, and the likelihood of unpublished studies being conducted, there may be scope to reassess the effectiveness of these apps in the near future. However, the results of app use as an intervention may be less likely to be generalisable between different populations due to social factors. Thus NZ-specific research would likely need to be completed before implementation of this intervention.

Due to time and resource constraints, individual assessors could not assess enough apps to allow useful inter-rater reliability calculations, to test the consistency of the criteria created for this trial, and to further validate the MARS.⁽²⁷⁾ Additionally each app was only assessed by two assessors, and across all apps, the large pool of assessors may have reduced the consistency of scores between apps. To minimise the disadvantages of these limitations, the created criteria were reasonably straightforward. The MARS was the best existing published tool that we could identify for assessing the broader quality of health apps available, and due to Stoyanov et al’s (2015)⁽²⁷⁾ rigorous method in developing the criteria to be consistent and accurate, this was considered satisfactory for this study. Another limitation was the reliability of the website used to determine apps for assessment. It was decided that the website would be a better alternative to using search order as they appear on ‘Google Play’ or ‘App Store’ due to possible advertising deals influencing the order. Even if the website did not produce perfectly accurate lists, it is very likely that the most popular apps would still have remained amongst the top 30 apps, and thus would not have affected how these apps would be assessed in the integral part of the study.

Furthermore, the generalisability of experiential use finding was limited. The use of fourth-year medical students who were generally of healthy weight to test experiential use is not fully generalisable to the target population. Additionally, these assessors were more likely to have mobile-data plans. However, it should be noted that common problems and inconveniences experienced in this pilot with weight-loss apps are likely similar for everyone, and development of new apps can try to minimise these.

While our study suggests that existing weight-loss and smoking-cessation apps do not closely adhere to NZ guidelines, the use of apps that do adhere closely with NZ guidelines may well show positive results if trialled in NZ. Using high-quality apps to promote weight loss or smoking cessation in NZ may provide a unique opportunity to deliver an intervention programme to individuals of various socioeconomic backgrounds, stages of change and ethnicities. With apps costing anywhere between US\$1,000–250,000 to develop,⁽⁵³⁾ the cost of developing high-quality apps must be considered, and compared with the potential quality-adjusted life-years to be gained. This is particularly in light of the heavy burden that non-communicable diseases related to obesity have on the NZ population.⁽⁵⁾

If found to be effective in NZ, the apps developed to specifically adhere to NZ best practice guidelines are likely to be widely incorporated into intervention programmes by healthcare providers with ease. It is important to note that development of such a tool must consider how it would link to and be used in conjunction with existing interventions within the community/health-care sector to further enhance the success of such intervention e.g. linking an app to Quitline. Using these apps as part of multifactorial intervention programmes may further increase overall cost-effectiveness of interventions. However, due to certain specificities of apps created for the NZ context, they are unlikely to have any scope to create revenue overseas. The risks involved with trialling these apps are likely relatively minor. This makes the potential pathway from development to implementation comparatively easier than many interventions. This adds to the feasibility of the establishment of app use for weight loss and smoking cessation.

As outlined in the introduction, there is high internet access and smartphone use within some of NZ's high-risk populations. If apps are developed to be culturally appropriate for Māori and Pacific peoples, and are marketed well, they may be likely to have significant uptake and benefit within these groups. The accessibility to these groups is a key ethical concern in the process of implementing a new intervention for weight loss and smoking cessation. It is important that any new health initiatives work to decrease the disparities in health outcomes that currently exist between groups in NZ. The 'Health Equity Assessment Tool' (HEAT) is a NZ-specific tool that assesses the appropriateness of implementing interventions that will bring about equitable outcomes.⁽⁵⁴⁾ In particular, the HEAT has a focus on reducing inequities in Māori populations, and thus its use would be relevant for assessing the benefit of any potential app intervention.

Conclusion

There is limited and conflicting scientific evidence for the effectiveness of smartphone health apps, and the generalisability to target NZ populations is overall questionable. The current apps available for both weight loss and smoking cessation do not adhere to NZ-specific guidelines as closely as possible. However, many of these shortcomings may be improved through simple adjustments, thus there remains scope to develop better apps. The development and dissemination of free mobile health apps has the potential to be a cost-effective intervention for weight loss and smoking cessation. Despite limited existing evidence, it is likely that more research in this area will be published in the near future. In light of these conclusions, we recommend that NZ health agencies wait for more research before engaging with potential changes and development in policy regarding the use and recommendations of health apps. However, if motivated patients are interested in using apps for weight loss or smoking cessation, and ask healthcare professionals for recommendations, healthcare professions may suggest the patient trial the

highest-ranking apps from this study, with the caveat that evidence is currently weak, but the risks are likely negligible. If the new evidence proves encouraging, we suggest the development and trial of NZ-specific weight-loss and smoking-cessation apps. Apps may have a beneficial part to play in the improvement of health outcomes in NZ. It would be appropriate to perform high-quality RCTs in the NZ population, with an emphasis on high-risk groups before widespread implementation, in the hope of achieving better and more equitable health outcomes for New Zealanders.

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Table 5: Results From Literature Review For “Are Apps Effective For Weight Loss?”

Author And Date – Study Type	Study Population	Comparison Groups	Outcomes	Main Findings	Limitations And Conclusions	Relevance To Use And Conclusions For Use In New Zealand
Turner-McGrievy et al 2011 ⁽⁴⁷⁾ – RCT	Participants (n = 96) with BMI of 25–45 kg/m ² who owned a smartphone or iPod touch. Participants were recruited through television advertisements and email listservs in metropolitan Raleigh-Durham, North Carolina, USA. Notable exclusions were participants with psychiatric illness or history of myocardial infarction (MI) or stroke. Participants were 75% female, 20% African American, 60% married, and 55% graduate degree holders, with a mean age of 43 years, and a mean BMI of 33 kg/m ² .	Intervention group: podcasts (2 per week for first 3 months, then 2 ‘mini-podcasts’ per day for last 3 months) + mobile media intervention (participants encouraged to download ‘FatSecret’ calorie counter app to monitor energy intake and expenditure and ‘Twitter,’ a social media app where users were encouraged to interact and support each other). Control group: same podcasts without apps	Primary outcomes were changes in body weight from baseline at 3 months and 6 months. Other measures were of diet, physical activity and psychosocial factors.	After 6 months the mean change in body weight in the intervention and control groups was 2.7% (SD = 5.6) and 2.7% (SD = 5.1) respectively. The difference in change in body weight was not statistically significant (p = 0.98)	Those lost to follow-up were more likely to be non-European and significantly younger. Results may have been underestimated due to the final months coinciding with the holiday season (including Thanksgiving, Christmas and the New Year) and may have helped keep of “holiday weight”. They concluded that use of the podcasts might be useful, but suggest the addition of the app is not useful.	This trial suggests that weight-loss apps as an adjunct to podcasts do not aid weight loss. However, in this trial they excluded participants with history of many cardiac conditions and diabetes mellitus, and these people are likely to be at a higher risk of further obesity-related complications, ⁽⁴⁹⁾ and obese people are more likely to suffer psychiatric illnesses, ⁽⁴⁸⁾ so this excluded an important demographic that weight-loss apps would be targeted to in New Zealand. Generalisability may be decreased to the New Zealand population as their participant group was so highly educated, and higher education levels correlate with lower rates of obesity in New Zealand. ⁽⁷⁾ Additionally – in this trial and all the other trial in this literature review – a large proportion of participants were female. More gender balanced, or gender specific research may help decipher if both genders will benefit from this intervention.
Carter et al 2013 ⁽⁵⁰⁾ – Pilot RCT	Participants (n = 129) aged 18–65 years, with BMI of greater than or equal to 27 kg/m ² who were able to access the internet. Participants were recruited from large employers in Leeds, United Kingdom, by advertising through email, intranet, posters, and newsletters. Participants were 77% female, 100% European and 72% tertiary educated, with a mean age of 41 years, and a mean BMI of 34 kg/m ² .	Three-arm study: App group received a ‘HTC Desire’ smartphone with ‘My Meal Mate’ app preloaded, allowing users to monitor energy intake, expenditure and body weight, along with text messages to encourage the user. Website control group was given access to a self-monitoring slimming website. Diary control group received a food diary, a calorie-counting book and a calculator.	Primary outcomes were adherence to the trial and frequency of use of interventions. Secondary outcomes measured were changes in body weight, BMI, body fat and body fat percentage at 6 months.	After 6 months the mean weight change in the app, website control and diary control groups was –4.6 kg (95% CI= –6.2 to –3.0), –1.3 kg (95% CI= –2.7 to 0.1) and –2.9 kg (95% CI= –4.7 to –1.1) respectively. The difference in weight change between the smartphone and website control groups was statistically significant (p = 0.04). The difference in weight change between the app and diary control groups was not statistically significant (p = 0.12).	There was a 38% attrition rate, and it is very likely that those who are dissatisfied with their results are more likely to be lost to follow-up (very high retention rate amongst app group compared to low rates in the diary and website control groups) introducing bias to the trial. They concluded that though the generalisability of this trial is limited, but shows that the app is a feasible and acceptable intervention that needs to be trialled in a large RCT.	This trial suggests that weight-loss apps are a better intervention than computer websites or paper diary use. However this trial only included European people, with relatively high education, thus generalisability to the New Zealand population, where the high-risk groups are Māori and PI peoples, and people of lower socioeconomic/education backgrounds may be limited. We suggest that New Zealand specific research including a significant proportion of high-risk people may be beneficial.
Allen et al 2013 ⁽²¹⁾ – Pilot RCT	Participants (n = 68) aged 21–65 years with a BMI of 28–42 kg/m ² and owned an iPhone or	Four-arm study: Intensive counselling group (arm 1) received healthy eating	Primary outcomes were changes in waist	After six months the mean weight change in arms 1, 2, 3 and 4 were –2.5 kg (SD = 4.1), –5.4 kg (SD =	There was a 37% attrition rate that was not even between the groups, introducing bias to the trial. They concluded that the use of smartphone apps	This trial suggests that weight-loss apps are a useful adjunct to nutrition and exercise counselling. However, as mentioned as Turner-McGrievy et al (2011) ⁽⁴⁷⁾ they

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	<p>android in the USA. Participants were recruited through flyers, physician referrals, and existing lists of volunteers from prior studies. Notable exclusions were participants with a history of many cardiac conditions, (including diabetes mellitus) conditions that limit exercise, and a 12-month history of psychiatric illness. Participants were 77% female, 49% African American, 69% tertiary educated and 57% married, with a mean age of 45 years, and a mean BMI of 34 kg/m².</p>	<p>and exercise counselling from a nutritionist coach weekly for the first month and biweekly for the second through sixth month. Intensive counselling plus app group (arm 2) also received “Lose It!” app. Less intensive counselling plus app group (arm 3) received the counselling twice during the first month and then monthly from two to six months and “Lose It!” app. App only group (arm 4) (along with “Lose It!” app) received a basic nutrition counselling session with app training.</p>	<p>circumference, BMI and weight from baseline at 6 months. Other outcomes were self-reported changes in diet and physical activity.</p>	<p>4.0), -3.3 kg (SD = 5.9), and -1.8 kg (SD = 3.7) respectively. The difference between the four groups was not statistically significant. Females were more likely to lose weight compared to males (p = 0.005)</p>	<p>as an adjunct to counselling is promising, and indicates the necessity for a large-scale RCT comparing counselling plus app use with current best practice.</p>	<p>excluded participants with history of MI, stroke and psychiatric illness, so this excluded an important demographic that weight-loss apps would be targeted at in New Zealand.^(48,49) They did include a large proportion of African-American people, which may make these results more generalisable to ethnic groups of New Zealand that are at greater risk (Māori and Pacific peoples).⁽³⁵⁾ New Zealand specific research may be a logical progression from the positive findings of this pilot trial. Additionally, this trial found this intervention more effective in females, and further research would have to determine if weight-loss apps would be useful for specific gender groups, or particular groups in New Zealand.</p>
<p>Laing et al 2014⁽³⁸⁾ – RCT</p>	<p>Participants (n = 212) recruited through primary care visits at 2 UCLA primary care clinics that were interested in losing weight. Participants were 73% female, 54% non-European, 80% tertiary educated to some level, with a mean age of 43 years and a mean BMI of 33 kg/m².</p>	<p>Intervention group received usual care plus use of MyFitnessPal app, plus informational sheet on healthy eating over 6 months. Control group received usual care plus informational sheet on healthy eating and told to “choose any activity you’d like to lose weight”.</p>	<p>Primary outcomes were change in weight and change in systolic blood pressure from baseline at 6 months.</p>	<p>After 6 months, mean change in weight in the intervention and control groups was -0.03 kg and 0.27 kg respectively. The difference in change in body weight was not statistically significant (p = 0.63).</p>	<p>There was a high attrition rate, introducing bias to the trial. Despite being blinded to the app name, 14 participants of the control group already used MyFitnessPal. They concluded that the use of weight-loss apps did not result in increased weight loss.</p>	<p>This trial suggests that weight-loss apps are not an effective intervention. Like Allen et al (2013)⁽²¹⁾ they included a large proportion of non-European people, which may make these results slightly more generalisable to the ethnic groups of New Zealand that are at greater risk. Contamination of the control group may have hidden the existence of a significant result.</p>
<p>Nollen et al 2014⁽²²⁾ – Pilot RCT</p>	<p>Female participants (n = 51) aged 9–14 years who could speak and read English and understand program. Participants were recruited through after school programmes in economically disadvantaged neighbourhoods. Participants were 84% African American, had a mean age of 11 years and a mean BMI of 24 kg/m².</p>	<p>Intervention group received a ‘MyPal A626 handheld computer’ with an app that included goal setting, modules on fruit and vegetable consumption, sugar-sweetened beverage consumption and screen-time, with cues and a reward system. Control group received</p>	<p>Primary outcomes were fruit and vegetable consumption at 4 weeks, sugar-sweetened-beverage consumption at 8 weeks, screen-time duration and weight loss</p>	<p>After 12 weeks, the mean change in BMI in the intervention and control groups was -0.21 kg/m² (SD = 2.20) and -0.27 kg/m² (SD = 1.17) respectively. The difference in change in BMI was not statistically significant (p = 0.91). There were no statistically significant differences between the intervention and control groups regarding fruit and vegetable consumption, sugar-sweetened</p>	<p>They suggested that over time the reward system lost its appeal and concluded that a stand-alone weight-loss app may have a small effect on fruit and vegetable and sugar-sweetened beverage consumption, but needs a large-scale trial in high-risk adolescents.</p>	<p>This trial suggests that weight-loss apps may not be an effective intervention for weight-loss in adolescent girls. The inclusion of only those girls that were from economically disadvantaged neighbourhoods correlates with those more at risk of suffering from obesity,⁽⁵⁵⁾ making it more generalisable to those girls that would be targeted in New Zealand. However, the girls included in this trial had a mean BMI of 24 kg/m², and thus the study tested a group of girls that did not need to lose weight, and therefore may have been less motivated to lose weight, potentially hiding a significant result that may have been seen using obese girls. Due to the specific</p>

		manuals with the same content as the app, without cues or reward system.	at 12 weeks.	beverages or screen-time.		participant group, the results of this trial cannot be generalised to weight-loss app use for the general New Zealand public. From a small pilot trial, the existence of a significant result may have been missed. If research suggests some groups may benefit from weight-loss apps more than other groups, it may be beneficial to do targeted research in a New Zealand setting.
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Table 6: Results From Literature Review For “Are Apps Effective For Smoking Cessation?”

Author And Date – Study Type	Study Population	Comparison Groups	Outcomes	Main Findings	Limitations And Conclusions	Relevance To Use And Conclusions For Use In New Zealand
Buller et al 2014 ⁽⁵¹⁾ – RCT	Participants (n = 102) aged 18–30 years who smoked cigarettes, were interested in quitting, were US residents and were proficient in English. Participants were recruited on Google Adwords, Facebook, and Adbrite advertising systems. Participants were 51% female, 74% racially white, 42% married, and 51% educated beyond high school, with a mean age of 25 years, and smoked a mean of 17 cigarettes daily.	Intervention group received ‘REQ-mobile’ app that allowed participants to listen to audio testimonials from former smokers, read short support documents (for example, about Nicotine Replacement Therapies), and set a quit date. Control group received text-messaging system ‘onQ’ based on social cognitive theory, sending text messages regarding tasks to plan, setting and maintaining a quit date, coping with cravings and relapse and consolidation of a non-smoking lifestyle.	Primary outcomes were point-prevalence and 7-day prevalence of abstinence at 6 weeks, and point-prevalence and 30-day prevalence and abstinence at 12 weeks.	After 6 weeks, 7-day point prevalence of abstinence in the intervention and control groups based on completers (n = 66) was 30% (95% CI = 14–47%) and 58% (95% CI = 40–75%) respectively. This difference was statistically significant (p = 0.03). After 12 weeks, 30-day point prevalence of abstinence in the intervention and control groups based on intention-to-treat (n = 102) was 18% (95% CI = 7–28%) and 31% (95% CI = 18–45%) respectively. This difference was not statistically significant (p = 0.30). They also reported that use of either service predicted increased 30-day abstinence at 12 weeks (used, 47%; not used, 20%; p = 0.03)	They concluded that the text-messaging system might be more effective than smartphone apps because of its simplicity, though smartphone apps might be effective for brief community-based smoking cessation. A major limitation of this study is the manner in which results were calculated and presented. The confusing combination of intention-to-treat and per-protocol analyses have been undertaken for measures, and thus their findings are confusing to interpret. Also, once participants in the intervention had been abstinent for 7 days, they were switched to the text-messaging system, due to app not being able to provide the necessary support for this phase of the abstinence process. It was never made clear which group these participants were analysed in.	This trial suggests that smartphone apps may aid in smoking-cessation, though not as well as text-messaging systems might. Mainly due to the confusing nature of the information in this trial, this trial alone provides little generalisability to the target population of New Zealand, and warrants New Zealand specific research to address the effectiveness of smoking-cessation apps.

Table 7: Android Weight-Loss Apps Assessment Results

App Name	App Developer	MARS Score	Weight-Loss Criteria Score	Cultural-Appropriateness Criteria Score	Overall Score (Ranked)
Noom Coach: Weight Loss Plan	Noom Inc.	82.6%	68.2%	16.7%	69.5%
Lifesum - The Health Movement	Lifesum	78.7%	68.2%	16.7%	67.8%
Calorie Counter - MyFitnessPal	MyFitnessPal, Inc.	86.1%	50.0%	16.7%	62.9%
Calorie Counter & Diet Tracker	SparkPeople	72.6%	59.1%	16.7%	60.9%
Lose weight without dieting	Harmonic Soft	77.0%	54.5%	16.7%	60.8%
Freeletics	Freeletics	73.5%	31.8%	33.3%	50.7%
Diet Assistant - Weight Loss ★	Alportela Labs	62.2%	45.5%	16.7%	50.1%
How to loose weight	Reliablesoft.Net	62.2%	40.9%	16.7%	48.1%
My Diet Coach - Weight Loss	InspiredApps (A.L) LTD	60.9%	40.9%	16.7%	47.5%
63 Simple Weight Loss Tips	Insplisity	56.5%	40.9%	33.3%	47.2%
Pedometer & Weight Loss Coach	Pacer Works	68.7%	31.8%	16.7%	46.9%
Calorie Counter	CalorieCount.com	57.0%	40.9%	16.7%	45.7%
RunKeeper - GPS Track Run Walk	FitnessKeeper, Inc.	65.2%	31.8%	16.7%	45.3%
Diet and Weight Loss	NutriSoft Brazil	63.9%	31.8%	16.7%	44.7%
Effective Weight Loss Guide	naveeninfotech	54.3%	40.9%	16.7%	44.5%
My Diet Diary Calorie Counter	MedHelp, Inc - Top Health Apps	60.4%	31.8%	16.7%	43.2%
NexTrack: Making Exercise Fun	Nexercise Apps, Inc	59.1%	31.8%	16.7%	42.6%
Diet Point · Weight Loss	DietPoint Ltd.	55.2%	31.8%	33.3%	42.5%
Workout Trainer	Skimble Inc.	74.3%	18.2%	0.0%	41.6%
Weight Tracker weight loss app	cryofy.com	70.0%	18.2%	16.7%	41.3%
7 minute Workout	ABISHKKING	58.3%	27.3%	16.7%	40.2%
MyFitness Calculator BMI IIFYM	abhinav khanger	76.1%	9.1%	16.7%	40.0%
WalkLogger pedometer	Walklogger	55.7%	18.2%	16.7%	34.9%
Weight Loss Tracker - RecStyle	Recruit Holdings Co.,Ltd.	58.3%	13.6%	16.7%	34.0%
Diet Plan- Weight Loss 7 Days	Gamebaby	49.1%	22.7%	16.7%	34.0%
Noom Walk Pedometer: Fitness	Noom Inc.	51.7%	18.2%	16.7%	33.1%
Daily Yoga - Fitness On-the-Go	IMOB LIFE Co. Ltd	50.4%	13.6%	16.7%	30.5%
Monitor Your Weight	Husain Al-Bustan	53.9%	9.1%	16.7%	30.0%

Motivate Me to exercise	gray2rgb	37.0%	9.1%	16.7%	22.4%
Weight Loss Dance Workout	PocketFitness	40.9%	0.0%	16.7%	20.1%

Table 8: Apple Weight-Loss Apps Assessment Results

App Name	App Developer	MARS Score	Weight-Loss Criteria Score	Cultural-Appropriateness Criteria Score	Overall Score (Ranked)
Calorie Counter and Food Diary by MyNetDiary	MyNetDiary Inc.	81.7%	63.6%	16.7%	67.1%
Calorie Counter, Dining Out, Food, and Exercise Tracker	Everyday Health, Inc.	71.7%	68.2%	16.7%	64.6%
Calorie Counter & Diet Tracker by MyFitnessPal	MyFitnessPal.com	78.3%	59.1%	16.7%	63.5%
5K Runner: 0 to 5K run training, Couch to 5K running, free	Clear Sky Apps LTD	79.6%	54.5%	16.7%	62.0%
Jillian Michaels Slim-Down: Weight Loss, Diet, Fitness, Workout & Exercise Solution	Everyday Health, Inc.	76.1%	54.5%	16.7%	60.5%
Argus - Pedometer, Run, Cycle achieve your fitness and weight loss goals with the ultimate activity tracker by Azumio	Azumio Inc.	76.1%	45.5%	16.7%	56.4%
Pacer - Pedometer plus Weight and BMI Management and Blood Pressure Tracker	Michael Caldwell	75.7%	45.5%	16.7%	56.2%
My Diet Diary Calorie Counter App	MedHelp	73.0%	45.5%	16.7%	55.0%
RunKeeper - GPS Running, Walk, Cycling, Workout and Weight Tracker	FitnessKeeper, Inc.	80.0%	36.4%	16.7%	54.0%
Tactio Health	Tactio Health Group Inc.	58.3%	54.5%	16.7%	52.4%
Weilos - Health and Wellness Community	Weilos, Inc.	59.1%	40.9%	16.7%	46.7%
Nutrition Menu - Calorie, Exercise, Weight & Water Tracking	Shroomies	65.7%	31.8%	16.7%	45.5%
Noom Coach: Weight Loss	Noom, Inc	62.6%	31.8%	16.7%	44.2%
Running for Weight Loss: interval training plan, GPS, how-to-lose-weight tips by Red Rock Apps	GRINASYC CORP.	63.9%	27.3%	16.7%	42.7%
Walker - Pedometer Lite	Naoya Araki	67.0%	18.2%	16.7%	40.0%
My Diet Coach - Weight loss motivation for women & calorie counter - FREE	InspiredApps	63.9%	18.2%	16.7%	38.6%

Monitor your weight	Husain Al-Bustan	54.8%	18.2%	16.7%	34.5%
Workout Trainer	Skimble	62.6%	9.1%	16.7%	33.9%
Easy Weight Loss Tips! Best Diet Tracker & Mobile Diet Plan	Michael Quach	48.3%	22.7%	16.7%	33.6%
Happy Scale: Simple Weight Loss Tracker with Daily Moving Average Trend Line	Front Pocket Software LLC	61.7%	9.1%	16.7%	33.5%
Simple Weight Loss Tracker - RecStyle - Your Free Diet, Fitness & Beauty for Better Health	Recruit Holdings Co.,Ltd.	61.7%	9.1%	16.7%	33.5%
WeightDrop – Weight Tracker and BMI Control Tool for Weight Loss - Get Fit & Lose Weight	Michael Szumielewski	51.3%	13.6%	16.7%	30.9%
Lose the Belly (Weight Loss for Women)	Pacific Spirit Media	44.8%	18.2%	16.7%	30.0%
Weight Loss for Men (Lose the Belly)	Pacific Spirit Media	44.3%	18.2%	16.7%	29.8%
SimpleWeight - Simple & Powerful Weight Control Tool	Takayoshi Kurachi	45.7%	13.6%	16.7%	28.3%
Visual Diet Diary -Record your weight and photo-	Zanmai Seikatsu Co., Ltd	49.6%	9.1%	16.7%	28.1%
Best Diet Foods!	Michael Quach	40.9%	13.6%	16.7%	26.2%
True Weight Lite	made-up software	41.3%	9.1%	16.7%	24.3%
iBelieve - Weight loss tracker and BMI calculator	Tian Juntao	36.1%	9.1%	16.7%	22.0%
Virtual Weight Loss Model Lite	Pacific Spirit Media	27.0%	4.5%	16.7%	15.8%

Table 9: Android Smoking-Cessation Apps Assessment Results

App Name	App Developer	MARS Score	Smoking-Cessation Criteria Score	Cultural-Appropriateness Criteria Score	Overall Score (Ranked)
My Quit Smoking Coach	Andreas Jopp	82.6%	47.8%	33.3%	62.0%
You Can Quit Smoking	Insplisity	68.7%	52.2%	50.0%	59.4%
STOP Cigarettes - Quit smoking	academiaacea	60.9%	43.5%	16.7%	48.6%
Quit Pro: stop smoking now	Muslim Pro Limited	76.1%	26.1%	16.7%	47.6%
SmokeLess!	Kroaqs	61.3%	30.4%	16.7%	42.9%
Get Rich or Die Smoking	Tobias Gruber	63.9%	21.7%	16.7%	40.2%
Quit smoking - QuitNow!	Fewlaps	61.7%	21.7%	16.7%	39.2%
Quit-Smoking Coach Free	Brainlag Studios	49.6%	30.4%	16.7%	37.7%

myQuitTime - Stop Smoking	Arete Appware	62.6%	17.4%	16.7%	37.7%
Smoke Free, stop smoking help	David Crane	67.0%	13.0%	16.7%	37.7%
Smoking Reducer Quit Smoking	Nochino Digital	63.0%	13.0%	16.7%	35.9%
QuitNow! PRO - Stop smoking	Fewlaps	53.5%	21.7%	16.7%	35.5%
aha!Smokefree	aha!dev	57.0%	17.4%	16.7%	35.1%
QUIT SMOKING	Mastersoft Ltd	58.7%	17.4%	0.0%	34.2%
Stop! Quit Smoking - LITE	CDdevelopment	52.2%	21.7%	0.0%	33.3%
Quit Smoking	Medicus Mundi	39.6%	30.4%	16.7%	33.2%
Stop Smoking	Team Geny	48.7%	17.4%	16.7%	31.4%
Quit Smoking	Azati	46.1%	13.0%	33.3%	29.9%
Quit Smoking	Luis Salcedo	47.8%	13.0%	16.7%	29.1%
Quick Quit	SELA Group	51.3%	4.3%	16.7%	26.7%
Easy Stop Smoking	GLOBUS	46.1%	8.7%	16.7%	26.3%
Free From Smoking - Hypnosis	theOBC	35.2%	17.4%	16.7%	25.3%
Smoke FREE Finally Non Smoking	sg-pages - Marus Steller	39.1%	13.0%	16.7%	25.1%
Kick the Habit: Quit Smoking	IcySpark	42.6%	8.7%	16.7%	24.8%
Quit smoking whith SOLOE	Full Thrust Ignition	47.0%	4.3%	16.7%	24.8%
Quit Smoking Log	Cory Charlton	41.3%	4.3%	16.7%	22.2%
Time To Quit Smoke	VantusMantus	37.0%	8.7%	16.7%	22.2%
Stop Smoking Hypnosis	On Beat Limited	40.9%	0.0%	16.7%	20.1%
I'm Quitting Smoking!	Developers with Balls Company	33.0%	8.7%	0.0%	18.8%
Easy way to stop smoking	Nevermind Developer Team	33.9%	0.0%	16.7%	16.9%

Table 10: Apple Smoking-Cessation Apps Assessment Results

App Name	App Developer	MARS Score	Smoking-Cessation Criteria Score	Cultural-Appropriateness Criteria Score	Overall Score (Ranked)
Quit Now: My QuitBuddy	Australian National Preventive Health Agency	93.9%	69.6%	33.3%	76.9%
LIVESTRONG MyQuit Coach - Dare to quit smoking	Demand Media, Inc.	78.7%	60.9%	50.0%	67.8%

Stop-tobacco	Université de Genève	75.2%	65.2%	16.7%	64.9%
MyQuitSmokingCoach: Europe's No 1 Quit Smoking APP	Oliver Fuxen	67.8%	47.8%	16.7%	53.7%
Smoke Free - Quit smoking now and stop for good	David Crane	61.3%	52.2%	16.7%	52.7%
Quit Smoking - Cold Turkey (Lite Version)	Pinch Swipe Tap Pty. Ltd.	50.4%	43.5%	0.0%	42.3%
Quit Pro: stop smoking now	Bitsmedia Pte Ltd	57.4%	26.1%	16.7%	39.2%
Quit smoking now - Quit smoking Buddy!	sander van der graaff	60.4%	21.7%	16.7%	38.6%
Kwit - quit smoking is a game	Geoffrey Kretz	50.4%	26.1%	16.7%	36.1%
Quit It - stop smoking today	digitalsirup GmbH	59.1%	17.4%	16.7%	36.1%
Quit Smoking - QuitNow!	Fewlaps, S.C	57.8%	21.7%	0.0%	35.8%
FREE Stop Smoking Cigarettes Now Quit Smokes Forever Tracker, Counter, & No Smoker Cigarette Quitter Coach App	Ellisapps Inc.	53.9%	21.7%	16.7%	35.7%
My Last Cigarette - Stop Smoking Stay Quit	Mastersoft Ltd	46.5%	21.7%	16.7%	32.4%
Quit It Lite - stop smoking today	digitalsirup GmbH	55.2%	8.7%	16.7%	30.4%
NSMarathon	Is	49.1%	13.0%	16.7%	29.6%
CIGGY: The ill-fated terribly doomed love affair	RescueGirl	51.7%	4.3%	16.7%	26.9%
Stop Smoking Manager - SMOQUIT	Seallab	47.4%	8.7%	16.7%	26.9%
Smoke FREE - Finally Non Smoking	sg-pages	38.3%	13.0%	16.7%	24.8%
Cigarettes Lite	Thomas Kiesel	47.0%	4.3%	16.7%	24.8%
Stop Smoking!	On Beat Limited	41.7%	8.7%	16.7%	24.4%
Stop Smoking Instantly With Chinese Massage Point - FREE Acupressure Trainer	Dr. Jakob Bargak	50.0%	0.0%	16.7%	24.2%
Kick the Habit: Quit Smoking	IcySpark	44.3%	4.3%	16.7%	23.6%
Smoktivation: My motivation to quit smoking	JCD Software	39.6%	8.7%	16.7%	23.4%
Smoking Management	gacha	41.7%	4.3%	16.7%	22.4%
iQuit	JimmySquareBox	36.1%	8.7%	16.7%	21.8%
Cigarettes	Thomas Kiesel	37.4%	4.3%	16.7%	20.4%
The Joy of Quitting Smoking LITE	MUBIQUO	30.4%	8.7%	16.7%	19.3%
Hypnosis ~ Sleep Soundly	Hynotransformations	34.3%	0.0%	16.7%	17.1%
Quit Smoking Helper	Tae-han Kim	29.6%	0.0%	16.7%	15.0%

Gotta Smoke?	Prime73 Inc.	29.6%	0.0%	16.7%	15.0%
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Table 11: Weight-Loss Specific Criteria Results

Weight-Loss Criterion (Criteria Available In Table 1)	Android Apps That Met Criterion (0-30)	Apple Apps That Met Criterion (0-30)
1	8	8
2	0	1
3	11	8
4	13	21
5	8	10
6	9	12
7	8	8
8	4	4
9	13	6
10	15	16
11	12	11
12	11	10
13	14	4
14	11	11
15	2	1
16	14	14
17	15	9
18	18	14
19	4	4
20	6	7
21	7	5
22	6	8

Table 12: Smoking-Cessation Specific Criteria Results

Smoking-Cessation Criterion (Criteria Available In Table 2)	Android Apps That Met Criterion (0-30)	Apple Apps That Met Criterion (0-30)
1	21	20
2	0	1
3	0	1
4	3	5
5	22	16
6	19	10
7	3	5
8	17	17
9	7	10

10	1	5
11	7	10
12	7	4
13	1	2
14	1	3
15	1	2
16	9	11
17	2	2
18	0	3
19	0	1
20	1	3
21	3	3
22	1	2
23	0	1

Table 13: Cultural-Appropriateness Specific Criteria Results (Weigh-Loss Apps)

Cultural-Appropriateness Criterion (Criteria Available In Table 3)	Android Apps That Met Criterion (0-30)	Apple Apps That Met Criterion (0-30)
1	0	0
2	3	0
3	0	0
4	6	0
5	23	30
6	0	0

Table 14: Cultural-Appropriateness Specific Criteria Results (Smoking-Cessation Apps)

Cultural-Appropriateness Criterion (Criteria Available In Table 3)	Android Apps That Met Criterion (0-30)	Apple Apps That Met Criterion (0-30)
1	0	0
2	1	2
3	0	0
4	3	1
5	27	28
6	0	0

Table 15: Experiential Use of Weight-Loss Apps Results

App Provider – App Name	Factors That Increased Functionality	Factors That Decreased Functionality
Android – Calorie Counter and Diet Tracker by Spark People	<ul style="list-style-type: none"> - Easy to use/navigate - Negligible effect on phone battery life - Many options for customisation including Prompts/reminders to log meals/physical activity - Points reward system increases motivation 	<ul style="list-style-type: none"> - Not aesthetically pleasing, dated design - Requires internet access - Time consuming - Food/barcode scanner is not appropriate for the NZ market – requiring manual info entry and lacks cultural foods such as Asian cuisine and common food items such as “Sprite” soft drink
Android – Calorie Counter by MyFitnessPal	<ul style="list-style-type: none"> - Easy to use/navigate, intuitively designed - Negligible effect on phone battery life - Functions offline - Memory function retains previously logged meals/physical activity - Met all expectations 	<ul style="list-style-type: none"> - Food/barcode scanner is not appropriate for the NZ market – requiring manual info entry
Android – Lose weight without Dieting by Harmonic Soft	<ul style="list-style-type: none"> - Easy to use/navigate and operated well - Functions offline 	<ul style="list-style-type: none"> - Interfaced appeared targeted at a younger user – not sophisticated - Significant battery use - Time consuming to use, especially in food/meal preparation with multiple components
Android – Noom Coach: Weight Loss Plan by Noom Inc.	<ul style="list-style-type: none"> - Memory function retains previously logged meals - Prompts/reminders to log meals/physical activity - No advertisements within the app 	<ul style="list-style-type: none"> - Food/barcode scanner is not appropriate for the NZ market - Significant (background) battery use - Requires internet access - Time consuming installation and set up
Android – Lifesum – Calorie Counter by ShapeUp Club AB	<ul style="list-style-type: none"> - Clean interface, simple to use, intuitive - Prompts/reminders to log meals/physical activity - Database comprehensive and appropriate to NZ 	<ul style="list-style-type: none"> - Food/barcode scanner is not appropriate for the NZ market – requiring manual info entry - Barcode scanner/database requires internet access - Time consuming, especially when meals have multiple components
Apple –	<ul style="list-style-type: none"> - Nice layout and good graphics 	<ul style="list-style-type: none"> - Barcode scanner did not work and requires

<p>Calorie Counter, Dining Out, Food and Exercise Tracker</p>	<ul style="list-style-type: none"> - Functions offline - Easy to use - Clear overall goal seemed achievable with motivational tips and quotes 	<ul style="list-style-type: none"> - internet access - Lacks a pedometer which would be useful in measuring exercise - Weight units = pounds
<p>Apple – Jillian Michaels Slim-Down: Weight Loss, Diet, Fitness and Workout & Exercise Solution</p>	<ul style="list-style-type: none"> - Negligible effect on phone battery life 	<ul style="list-style-type: none"> - Not aesthetically pleasing - Most features require internet access - Trouble loading instructional videos - Contents/function of this version of the app was limited with constant encouragement to upgrade to the pro version
<p>Apple – Calorie Counter & Diet Tracker by MyFitnessPal</p>	<ul style="list-style-type: none"> - Aesthetically pleasing: attractive layout, graphics, use of colour and visual information - Negligible effect on phone battery life - Functions offline - Memory function retains previously logged meals - Regularly updated with info/articles on healthy eating 	<ul style="list-style-type: none"> - Some of the more sophisticated features of the app may require time for orientation
<p>Apple – 5K Runner: 0 to 5K Run Training, Couch to 5K Running</p>	<ul style="list-style-type: none"> - Very aesthetically pleasing - Easy to use/navigate - Negligible effect on phone battery life - Enjoyable to use - Modifiable settings 	<ul style="list-style-type: none"> - Requires upgrade to pro version to complete programme - Training plans require the download of other associated apps - Little information on nutritional aspects of weight loss
<p>Apple – Calorie Counter & Food Diary by MyNetDiary</p>	<ul style="list-style-type: none"> - Aesthetically pleasing - Easy to use/navigate, buttons and links logical and worked well - Negligible effect on phone battery life - Functions offline, required internet access only for set up - Memory function retains previously logged meals - In app feedback is motivating/interesting 	<ul style="list-style-type: none"> - Food/barcode scanner is not appropriate for the NZ market, especially in food/meal preparation with multiple components - Time consuming to use -

	- Interesting to use	
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Figure 1: Selection Process From Literature Review For “Are Apps Effective For Weight Loss?”

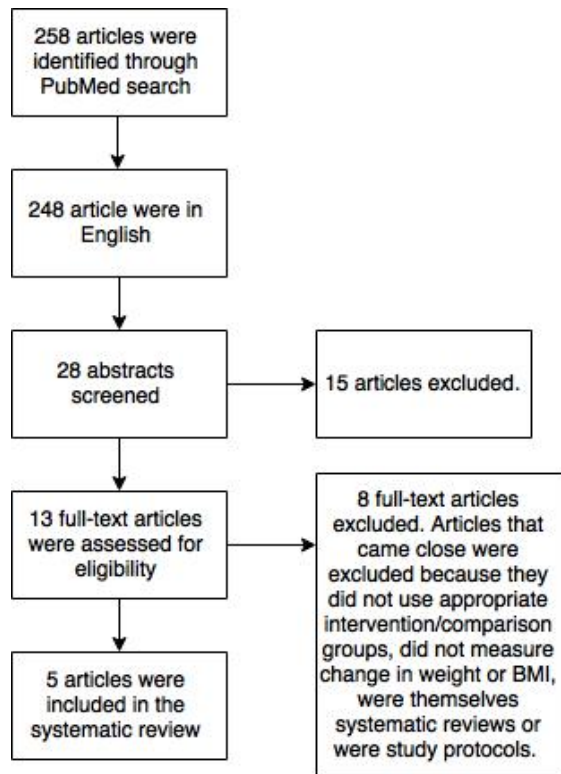


Figure 2: Selection Process From Literature Review For “Are Apps Effective For Smoking Cessation?”

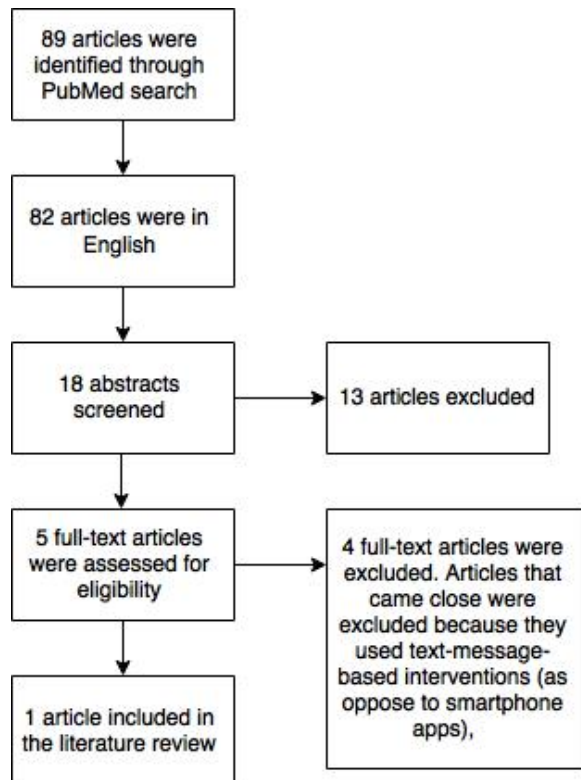


Figure 3: Selection Process For Android Weight-Loss Apps

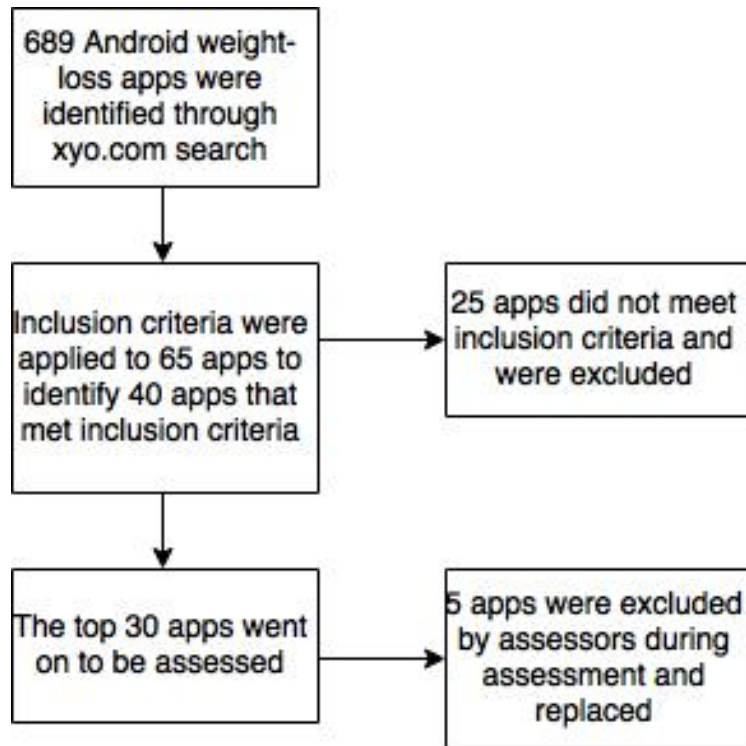


Figure 4: Selection Process For Apple Weight-Loss Apps

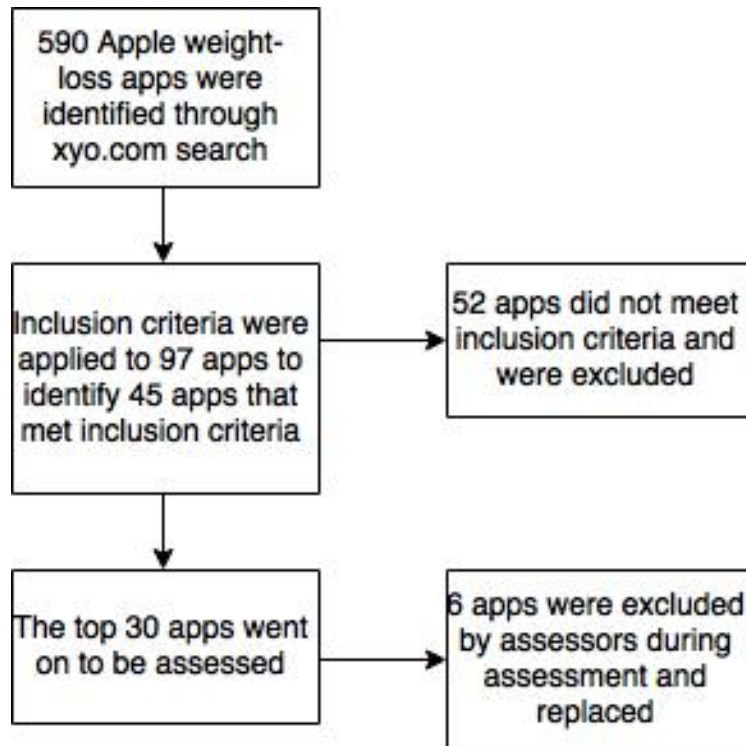


Figure 5: Selection Process For Android Smoking-Cessation Apps

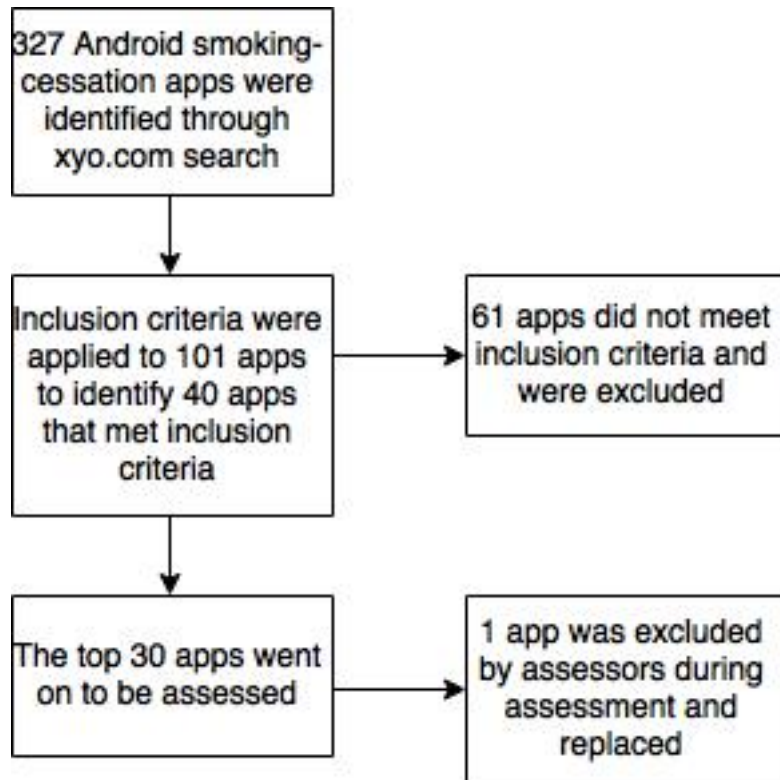


Figure 6: Selection Process For Apple Smoking-Cessation Apps

