BMJ Open

Gamification in mobile applications for smoking cessation in the United Kingdom: a review.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-027883
Article Type:	Research
Date Submitted by the Author:	13-Nov-2018
Complete List of Authors:	Rajani, Nikita; Imperial College London School of Public Health, Department of Primary care and Public Health Weth, Dominik; MSU Consulting GmbH, Department of Strategy and Innovation Mastellos , Nikolaos; Imperial College London, Department of Primary Care and Public Health Filippidis, Filippos; Imperial College London, Deaprtment of Primary Care and Public Health, School of Public Health
Keywords:	Smoking cessation, Gamification, Mobile applications, mHealth

Gamification in mobile applications for smoking cessation in the United Kingdom: a review.

Nikita B. Rajani[1], Dominik Weth[2], Nikolaos Mastellos[1], Filippos T. Filippidis[1]

[1] Department of Primary Care and Public Health, School of Public Health, Imperial College London, United Kingdom

[2] Department of Strategy and Innovation, MSU Consulting GmbH, Bad Homburg, Germany

Corresponding author:

Nikita B. Rajani

Address: School of Public Health, Imperial College London, Reynolds Building, St. Dunstan's Road, London W6 8RP, United Kingdom

Email: nikita.rajani14@imperial.ac.uk

Telephone: +447427615928

Word count: 2, 896

ABSTRACT

Objective: Mobile phone-based interventions have been proven to be effective tools for smoking cessation, at least in the short term. Gamification has been associated with increased engagement and motivation, critical success factors for long-term success of mHealth solutions. However, to date no review has examined the use of gamification in smoking cessation mobile apps. Our review aims to examine and quantify the use of gamification strategies and tactics among existing mobile apps for smoking cessation.

Methods: The United Kingdom Android and iOS markets were searched in February 2018 to identify smoking cessation apps. 125 Android and 15 iOS apps were tested independently by two reviewers for primary functionalities, and the adoption of gamification strategies and tactics adapted from Cugelman's framework. Pearson chi square tests were run to examine differences between platforms.

Results: The most common feature of mobile apps for smoking cessation allowed users to track the days since and/or until the user's quit date (86.4%). The most popular gamification strategy across both platforms was performance feedback (91.4%) and the least common was fun and playfulness (7.9%). More than half of mobile apps adopted a medium level of gamification strategies (55.0%) and tactics (64.3%). Only a minority adopted a high level of gamification strategies (6.4%) or tactics (5.0%).

Conclusion: The findings of this review show that a high level of gamification is adopted by a small minority of smoking cessation apps. Further adoption of gamification by mobile app developers, behaviour change researchers and tobacco control policy makers may improve mHealth solutions to smoking cessation.

Keywords: Smoking cessation, gamification, mobile applications, mHealth

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The study had a sample of 140 mobile apps for smoking cessation in the United Kingdom iOS and Google Play store, a market which has been sparsely investigated by past studies.
- Since the framework used to operationalise gamification was developed through review of taxonomies from both academic and non-academic sources, the framework is representative of existing literature.
- The exclusion of apps with less than a 4-star rating or fewer than 5 ratings resulted in the omission of a large number of iOS apps, limiting the generalizability of the findings for the iOS store.
- Certain app functionalities and gamification elements that are only visible or activated upon long-term use may not have been identified by our review.

INTRODUCTION

Smoking is responsible for 16% of all deaths in the United Kingdom (UK) and remains one of the major preventable causes of chronic diseases.[1] According to a recent study, smoking is ranked as the number one risk factor driving death and disability within the UK.[2] Although behavioural support along with pharmacological treatments is evidently the most effective method for smoking cessation, not all individuals seeking to quit are able or willing to seek face-to-face support.[3] The number of individuals using smoking cessation services provided by the National Health Service in the UK is continuously falling,[4] a trend observed in multiple European countries.[5] The decline in use of stop smoking services is likely to be attributed to access issues in light of significant public health budget cuts.[6] On the other hand, due to increased digitalisation and diffusion of technologies, internet and mobile-based interventions are becoming more popular. The use of mobile-delivered support can be initiated independently by smokers, eliminating the need to seek face-to-face support. With their wide reach and low cost of dissemination, mobile health (mHealth) solutions represent a cost-effective method of helping people quit smoking.[7]

mHealth interventions have been identified as useful tools for aiding smoking cessation. A Cochrane review found that mobile-phone based cessation interventions had a beneficial impact on six-month cessation outcomes.[8] The systematic review concluded that smokers who received support from mobile-phone based interventions were 1.7 times more likely to quit in the short-term compared to those who did not receive the mobile-phone based intervention.[8] Although several mobile apps for smoking cessation exist, many suffer from low engagement and retention levels. According to Singh & Bates (2016), attaining high levels of user engagement is critical for the success of mHealth which is why it is an important focus of mHealth solutions.[9]

The application of gamification, the "use of game-design elements in a non-game context",[10] in the field of mHealth is rapidly emerging, with mobile app developers increasingly integrating badges and other elements of gamification to motivate and engage users. There is no shortage of gamification advocates, particularly in the context of health behaviour change and mHealth. Some examples of mHealth apps which use gamification include *Zombies, Run!* to increase physical activity, *SPARX* for battling depression, *Mango Health* for improving retention of medication use, and *FitGame* to increase intake of fruits and vegetables. According to a randomised controlled trial, individuals who had access to a gamified version of a web-based intervention to aid arthritis patients, had a higher level of engagement than those offered the intervention without game elements.[11] Similarly, a study found that participants who utilised a gamified smoking cessation intervention had higher levels of motivation and engagement compared to a non-gamified cohort.[12] Gamification has also been associated positively with self-efficacy and psychological empowerment, among other behavioural and psychological outcomes.[11, 13-15]

Despite the increased application of gamification in the mHealth industry and the promising findings of its benefits for health behaviour change, little research has examined the use of gamification in the context of mHealth and smoking cessation. Although some reviews on mobile apps for smoking cessation have been conducted,[16-20] none explored the application and adoption of gamification. Moreover, existing reviews are outdated and sparsely focus on the UK mobile app market. Since the mobile app market is constantly evolving, it is important that a more up-to-date review is conducted to gain insight on the currently available mobile apps for smokers seeking to quit. Our study investigated mobile apps for smoking cessation currently available in the UK to gain insight on the types of apps available and their functionalities. Moreover, we examined the types of gamification elements and the level of gamification implemented in the mobile apps. The findings of our research can have important

implications for smokers seeking to quit via mHealth, mobile app developers and tobacco policy makers.

METHODS

Sample and Procedure

The methodology of the mobile app review included three stages: identification, screening and testing. To identify mobile apps available on both Android and iOS platforms in the UK, the software 42matters was used.[21] Data on App market Application Programming Interface (API) were extracted using the software on February 19th 2018 using search terms consistent with prior mobile app reviews: "stop smoking" "quit smoking" and "smoking cessation".[16-20]

Apps were then screened independently by two researchers. Apps with duplicate identification numbers were eliminated. Moreover, apps with no rating, a rating of less than four (out of five) or fewer than five individual ratings were eliminated. The cut-off point of five individual ratings is already set forth by the Apple Store. In order to treat apps from both stores equally, we applied the same cut-off point to Android apps. Whilst the methodology used by Android and Apple stores to rank apps is not transparent, it is accepted that the rating, number of ratings, downloads and reviews can be used to determine an app's popularity. Using popularity as an inclusion or exclusion criterion for mobile app reviews is a common methodology adopted in past studies as it ensures that the most widely used and most 'liked' apps are evaluated.[22-24]

Once preliminary criteria had been applied, the remaining apps were screened based on the description and screenshots of mobile apps provided on their main page in the store. The information was used to apply the following exclusion criteria: primary aim was not to help smokers quit; app was not in the English language; app was irrelevant; app focused on hypnosis; and app targeted specific patient groups or healthcare professionals. Further exclusions were conducted upon installation of mobile apps. Additional exclusion criteria upon installation

included: unsuccessful download of the app; software problems upon installation; and requirement for additional devices such as smartwatches. After screening was complete, a total of 140 mobile apps remained of which 125 were Android apps and 15 were iOS apps. The procedure inclusive of the number of apps excluded in each stage of the methodology can be seen in figure 1.

[Insert Figure 1]

Coding and Classification of Mobile Apps

After screening procedures, two reviewers independently tested each app. Every app was installed and reviewed for approximately 30 minutes on the day of installation. The next day, each mobile app was reviewed for the delivery of any additional notifications. Similar to screening, discrepancies not resolved by the two reviewers, led to a consultation and final decision from a third reviewer.

General Functionalities

Functionalities of apps were coded based on categories consistently used by previous mobile app reviews on smoking cessation.[17-19] The categories included: (1) Tracker: the app tracks the number of days elapsed since the user quit smoking and/or the number of days until the user's quit date; (2) Calculator: the app primarily calculates the amount of money a smoker saves by not smoking and/or the health benefits attained by abstaining; (3) Rationing: the app prompts the user to limit the number of cigarettes smoked and/or how often the user can smoke a cigarette (e.g. providing time limits); (4) Informational: app provides information in the form of text and images to provide the user with knowledge on various aspects of smoking cessation; (5) Game: app takes the form of a game to help users quit; (6) Lung Health Monitor: app measures and tracks the user's lung function and health; and (7) Other: all functionalities that did not fit one of the six other categories.

Gamification

To assess gamification, a framework developed by Cugelman (2013) was used.[25] The framework consists of two parts: (1) the persuasive architecture of gamification, also known as the broad principles or strategies of gamification, and (2) the on-screen features of gamification that users interact with, also known as gamification tactics. Cugelman (2013) developed this framework through a review of a number of other taxonomies presented both in academic and non-academic sources.[25] A large amount of overlap existed when compared to other frameworks; Cugelman (2013) captured the active ingredients of gamification as represented in the literature. The framework which was used to operationalise gamification can be seen in figure 2.

[Insert Figure 2]

Data Analysis

To examine the price, ratings and features of mobile apps descriptive statistics were calculated. We classified the level of gamification strategies as none; low (1-2 strategies); medium (3-5 strategies); and high (6-7 strategies). Similarly, we classified the level of gamification tactics as none; low (1-3 tactics); medium (4-7 tactics); and high (8-10 tactics). In order to investigate any differences between the two mobile platforms, we used Pearson chi-square tests for independence. For instances when the frequency count was less than 5, we used Fisher's exact test of independence. A significance level of $p<0.05$ was set to determine statistical significance. All statistical analyses were conducted using STATA 12.1.

Patient and Public Involvement

The study had no patient or public involvement.

RESULTS

App functionalities

Table 1 presents the general characteristics of mobile apps for smoking cessation across both platforms. The most common feature amongst apps across both platforms was the tracker feature which allows users to track the day until and/or since quitting (86.4%). A large majority of apps included a calculator feature which helps users calculate money saved or health benefits accrued since quitting (80.3%). Only 15.7% of apps across both platforms were informational, and only a small number were games or included games to help smokers quit (11.4%). Across both platforms, the majority of apps tested were free (85.0%) and the average user rating across was 4.4 since apps with less than a 4-star rating were excluded.

Table 1. Overview of mobile apps for smoking cessation

		Platform		
		iOS (n=15)	**Android (n=125)**	**Both Platforms (n=140)**
Features of Apps	Calculator	15 (100%)	99 (79.2%)	114 (80.3%)
	Rationing	1 (6.7%)	24 (19.2%)	25 (17.9%)
	Tracker	15 (100%)	106 (84.8%)	121 (86.4%)
	Informational	4 (26. 7%)	18 (14.4%)	22 (15.7%)
	Game	0 (0%)	16 (12.8%)	16 (11.4%)
	Lung Health Monitor	0 (0%)	0 (0%)	0 (0%)
	Other	1 (6.7%)	4 (3.2%)	5 (3.6%)
Cost	Free	14 (93.3%)	105 (84.0%)	119 (85.0%)
	Paid	1 (6.7%)	20 (16.0%)	21 (15%.0)
	Mean Price (£)	1.0 (0.0 – 0.99)	2.2 (0.0 – 8.6)	2.1 (0.0 – 8.6)
Popularity	Mean User Rating	4.6 (4.1 – 5.0)	4.4 (4.0 – 5.0)	4.4 (4.0 – 5.0)
	Mean Number of Ratings	821 (6 – 6,500)	1,726 (6 – 35,045)	1,629 (6 – 35,045)

Gamification

An overview of the number and percentage of each gamification strategy and tactic adopted by mobile apps is presented in table 2. The most popular gamification strategy across both platforms was feedback on performance (91.4%). A majority of the apps allowed users to track their smoking habits or calculate money and health benefits, hence this gamification strategy

was inherently present. Although almost two thirds of mobile apps across both platforms (64.3%) utilised goal setting to motivate users, only 28.6% of apps provided users with the capacity and support to reach the goals set and the challenges faced. For example, "Smoking Log – Stop Smoking" is an example of an app which was reviewed that enabled the user to set goals with regard to the number of cigarettes the user can smoke that day or the time until the next cigarette can be smoked, but it provides no support or advice to the user on how this goal can be achieved.[26]

Additionally, almost half of the mobile apps across both platforms adopted social connectivity (49.3%). However, most of these achieved this by including share options with popular social media platforms. Only a few of the apps provided users with social communities integrated into the app itself to share thoughts or discuss progress with other smokers trying to quit. Finally, the least common gamification strategy observed in the apps was fun and playfulness (7.9%). This finding is consistent with the low presence of on-screen gamification tactics, such as showing game leaders (4.3%) and including a theme or story within the app (4.3%). No statistically significant differences between the two platforms were found for any of the gamification strategies or tactics (p-value>0.05).

Table 2. Number of gamification principles and strategies

		Platform			Chi-Square
		iOS (n=15)	Android (n=125)	Both (n=140)	P-Value
Gamification Strategies	Goal setting	10 (66.7%)	80 (64.0%)	90 (64.3%)	0.839
	Capacity of overcome challenges	7 (46.7%)	33 (26.4%)	40 (28.6%)	0.101
	Feedback on performance	15 (100.0%)	113 (90.4%)	128 (91.4%)	0.363
	Reinforcement	10 (66.7%)	61 (48.8%)	71 (50.7%)	0.191
	Compare progress	4 (26.7%)	17 (13.6%)	21 (15.0%)	0.242
	Social connectivity	9 (60.0%)	60 (48.0%)	69 (49.3%)	0.380
	Fun and playfulness	1 (6.7%)	10 (8.0%)	11 (7.9 %)	1.000
	Provides clear goals	10 (66.7%)	80 (64.0%)	90 (64.3%)	0.839
	Offers a challenge	10 (66.7%)	80 (64.0%)	90 (64.3%)	0.839
	Uses levels	3 (20.0%)	25 (20.0%)	28 (20.0%)	1.000
	Allocates points	1 (6.7%)	9 (7.2%)	10 (7.1%)	1.000

Gamification Tactics	Shows progress	15 (100.0%)	113 (90.4%)	128 (91.4%)	0.363
	Provides feedback	15 (100.0%)	113 (90.4%)	128 (91.4%)	0.363
	Gives rewards	10 (66.7%)	61 (48.8%)	71 (50.7%)	0.191
	Provides badges for achievements	9 (60.0%)	49 (39.2%)	58 (41.4%)	0.122
	Shows game leaders	1 (6.7%)	5 (4.0%)	6 (4.3%)	0.500
	Gives a story/theme	1 (6.7%)	5 (4.0%)	6 (4.3%)	0.500

*P-value < 0.05

Table 3 presents the level of gamification adopted by mobile apps, in terms of the number of strategies and the number of on-screen features (also known as gamification tactics). Only 7.1% of apps across platforms did not adopt any gamification strategy or tactic. More than half of mobile apps across both platforms had adopted a medium level of gamification strategies (55.0%) and tactics (64.3%). However, only a minority adopted a high level of gamification strategies (6.4%) or a high level of gamification tactics (5.0%). No statistically significant differences between the two platforms were found with relation to the level of gamification strategies or tactics (p-value>0.05).

Table 3. Level of gamification incorporated in mobile apps for smoking cessation.

		Platform			Chi-Square
		iOS (n=15)	**Android (n=125)**	**Both Platforms (n=140)**	**P-Value**
Number of gamification strategies adopted	0 (None)	0 (0.0%)	10 (8.0%)	10 (7.1%)	0.600
	1-2 (Low)	4 (26.7%)	40 (32.0%)	44 (31.4%)	0.776
	3-5 (Medium)	9 (60%)	68 (54.4%)	77 (55.0%)	0.700
	6-7 (High)	2 (13.3%)	7 (5.6%)	9 (6.4%)	0.248
Number of gamification tactics adopted	0 (None)	0 (0.0%)	10 (8.0%)	10 (7.1%)	0.600
	1-3 (Low)	4 (26.7%)	29 (23.2%)	33 (23.6%)	0.753
	4-7 (Medium)	9 (60.0%)	81 (64.8%)	90 (64.3%)	0.714
	8 -10 (High)	2 (13.3%)	5 (4.0%)	7 (5.0%)	0.164

*P-value < 0.05

DISCUSSION

We reviewed mobile apps for smoking cessation available in the UK Android and iOS app stores and found that most of them incorporated a limited number of gamification elements and strategies.

We found that a majority of apps tested in our review allowed users to calculate the money saved or health benefits accrued since quitting. The popularity of this feature amongst mobile apps for smoking cessation is consistent with prior reviews.[17-20] A large proportion of smoking cessation apps available on the UK market also allow users to track the day until and or since quitting. The integration of tracker and calculator features permits users to self-monitor their progress, a technique which has been associated with increased effectiveness for health behaviour change.[27-28]

Across both platforms the most common gamification strategy adopted was feedback on performance, whereas the least common gamification strategy was fun and playfulness. Fun and playfulness require app developers to include on-screen features such as a story or theme for the entertainment and liking of the user. However, most apps do not incorporate such elements likely because they are more difficult to implement in comparison to basic tracker and calculator features which inherently provide feedback on performance. Goal setting was present in more than 60% of apps. This is promising as past research suggests that goal setting is a fundamental component for successful health behaviour change interventions.[29] Although several apps allow users to set goals, not many provide advice or information on how to set realistic and appropriate goals, or how to achieve them.

Nearly half of the apps implement social connectivity as a gamification strategy. However, most do so by providing basic and easily implementable options of sharing results and progress to others via popular social media platforms rather than setting up social communities where thoughts and progress can be discussed with other smokers attempting to quit. Online social communities provide a platform for additional support, as well as a channel to interact with others seeking to quit. This could potentially increase awareness of and user engagement with the app to improve cessation rates.

Regarding the level of gamification, our results indicate that a majority of apps adopt a medium level of gamification strategies and/or tactics, with few adopting no gamification or a high level of gamification. Several gamification elements are inherently present in mobile apps which may be misleading regarding the true extent of gamified design in smoking cessation apps. Several gamification elements such as providing feedback and showing progress are inherently present even in mobile apps that would not be generally perceived as gamified, such as Google Maps and Instagram. Therefore, existing literature and our analysis may overestimate the level of gamification truly present. Refining gamification taxonomies to better measure the true level of gamification would allow researchers to look beyond elements inherently found in mobile apps.

Despite the possible overestimation of the level of gamification in mobile apps, research shows that gamification can positively impact psychological and behavioural outcomes.[11-15] Consequently, mobile apps for smoking cessation which adopt a high level of gamification could provide a potentially cost-effective method for higher smoking cessation rates, thereby achieving a substantial public health impact. By addressing issues of engagement and retention of mHealth solutions through the application of gamification, gamified mHealth interventions could be an effective method of improving cessation rates with wide-reach and low costs of dissemination. Past research has shown the benefits of mobile and internet-based interventions for individuals of lower socioeconomic status;[30-31] hence the provision of effective mobile apps for smoking cessation could reduce health inequalities by increasing cessation rates amongst disadvantaged groups. However, the development of gamified mobile apps for smoking cessation requires collaboration between gaming experts, software developers, behaviour change specialists and tobacco control policy makers. Further research needs to continue to investigate gamified mobile apps for smoking cessation in randomised controlled trials to assess effectiveness on quit rates, as well as the potential benefits.

There are several strengths of our review. The focus on the UK mobile app market, which has not been extensively studied in past literature, helps gain insight on mobile app interventions available in this geographic region. Moreover, we tested apps available in two major app stores, inclusive of apps with a cost. This ensures that our findings are up to date and representative of the entire UK mobile app market.

Our findings are also bound by some limitations. Due to the exclusion criteria, apps with less than a 4-star rating or apps with fewer than 5 ratings were excluded. This particularly led to the exclusion of a large number of iOS apps and therefore could have an effect on the generalizability of the findings. Additionally, since all mobile apps were reviewed for approximately 30 minutes on the day of installation and a few minutes the next day, it could be that certain app functionalities that are only visible or activated upon long-term use would not have been recorded.

CONCLUSION

Our research comprehensively reviewed the UK market for smoking cessation mobile applications in early 2018. Our findings showed that a medium level of gamification is adopted amongst smoking cessation apps and only a minority adopt a high level of gamification or incorporate more complex and difficult to implement gamification features. Since gamification can be used to address critical limitations of mHealth interventions, such as engagement and retention, our research shows that increased effort and collaboration between gaming experts, software developers and behaviour change specialists is essential for the development of gamified mobile apps for smoking cessation.

DECLARATIONS

Ethical approval: Primary data was collected and analysed by the authors from publicly available sources. No participants were involved nor was an intervention administered. No ethical approval was required.

Consent to Publish: Not applicable.

Competing interests: No competing interests.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Data Sharing Statement: All data were extracted from mobile apps available to download on iOS and Google stores. Details of the extracted data are available by the authors upon request.

Author Contributions: NR conducted the mobile app review and produced the first draft of the paper. DW acted as a second reviewer and helped consolidate the results of the review. FF and NM provided guidance on the overall methodology of the review and revised the manuscript for content. All authors contributed to the interpretation of results, read and approved the final manuscript.

Acknowledgements: Not applicable.

FIGURE LEGEND

Figure 1. Identification, Screening and Testing Stages of the Mobile App Review

Figure 2. Gamification Principles and Tactics Framework

REFERENCES

1. National Health Service [Internet]. Statistics on Smoking – England, 2018 [PAS] 3rd July 2018. Available from: https://digital.nhs.uk/data-and-information/publications/statistical/statistics-on-smoking/statistics-on-smoking-england-2018/content

2. healthdata.org [Internet]. Institute for Health Metrics and Evaluation: United Kingdom. 2016. Available from: http://www.healthdata.org/united-kingdom (accessed 4 Oct 2018)

3. Stead LF, Koilpillai P, Fanshawe TR, Lancaster T. Combined pharmacotherapy and behavioural interventions for smoking cessation. *Cochrane Database Syst Rev* 2016(3). Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD008286.pub3/full (accessed 5 Oct 2018)

4. Lacobucci, G. Stop smoking services: BMJ anaylsis show how councils are stubbing them out. *BMJ* 2018; 362:k3649.

5. Filippidis FT, Laverty AA, Mons U, Jimenez-Ruiz C, Vardavas CI. Changes in smoking cessation assistance in the European Union between 2012 and 2017: pharmacotherapy versus counselling versus e-cigarettes. *Tob Control* [Internet] 2018. Available from: https://tobaccocontrol.bmj.com/content/early/2018/03/21/tobaccocontrol-2017-054117 (accessed 5 Oct)

6. Iacobucci G. Number of people using NHS stop smoking services continues to fall. *BMJ* 2017;358:j3936.

7. World Health Organisation [Internet]. mHealth: Use of appropriate digital technologies for public health. Seventy First World Health Assembly, A71/20. 26th March 2018. Available from: http://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_20-en.pdf

8. Whittaker R, McRobbie H, Bullen C, Rodgers A, Gu Y. Mobile phone-based interventions for smoking cessation. *Cochrane Database of Syst Rev* 2016;4:Cd006611.

9. Singh K, Drouin K, Newmark LP, Rozenblum R, Lee J, Landman A, et al. Developing a Framework for Evaluating the Patient Engagement, Quality, and Safety of Mobile Health Applications. *Issue brief (Commonw Fund)* 2016;5:1-11.

10. Deterding S, Dixon D, Khaled R, et al. From game design elements to gamefulness: defining "gamification". Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments; Tampere, Finland. 2181040: ACM; 2011. p. 9-15.

11. Allam A, Kostova Z, Nakamoto K, Schulz PJ. The effect of social support features and gamification on a Web-based intervention for rheumatoid arthritis patients: randomized controlled trial. *J. Med Internet Res* 2015;17(1):e14.

12. El-Hilly AA, Iqbal SS, Ahmed M, Sherwani Y, Muntasir M, Siddiqui S, et al. Game On? Smoking Cessation Through the Gamification of mHealth: A Longitudinal Qualitative Study. *JMIR Serious Games* 2016;4(2):e18.

13. Harold DJ. A Qualitative Study on the Effects of Gamification on Student Self-Efficacy. International Society for Technology in Education Conference; Philadelphia2015.

14. Banfield J, Wilkerson B. Increasing Student Intrinsic Motivation and Self-Efficacy through Gamification Pedagogy. Contemporary Issues in Education Research. 2014;7(4):291-8.

15. Johnson D, Deterding S, Kuhn K-A, Staneva A, Stoyanov S, Hides L. Gamification for health and wellbeing: A systematic review of the literature. *Internet Interventions* 2016;6:89-106.

16. Choi J, Noh GY, Park DJ. Smoking cessation apps for smartphones: content analysis with the self-determination theory. *J. of Med Internet Res* 2014;16(2):e44.

17. Abroms LC, Lee Westmaas J, Bontemps-Jones J, Ramani R, Mellerson J. A content analysis of popular smartphone apps for smoking cessation. *Am J Prev Med* 2013;45(6):732-6.

18. Abroms LC, Padmanabhan N, Thaweethai L, Phillips T. iPhone apps for smoking cessation: a content analysis. *Am J Prev Med* 2011;40(3):279-85.

19. Hoeppner BB, Hoeppner SS, Seaboyer L, Schick MR, Wu GW, Bergman BG, et al. How Smart are Smartphone Apps for Smoking Cessation? A Content Analysis. *Nicotine & Tobacco Research* 2016;18(5):1025-31.

20. Bennett ME, Toffey K, Dickerson F, Himelhoch S, Katsafanas E, Savage CLG. A Review of Android Apps for Smoking Cessation. *Journal of Smoking Cessation* 2015;10(2):106-15.

21. App Market API [Internet]. Available from: https://42matters.com/.

22. Azar KM, Lesser LI, Laing BY, et al. Mobile applications for weight management: theory-based content analysis. *Am J Prev Med* 2013;45(5):583-9.

23. Breton ER, Fuemmeler BF, Abroms LC. Weight loss—there is an app for that! But does it adhere to evidence-informed practices? *Translational Behavioral Medicine* 2011;1(4):523-9.

24. Cowan LT, Van Wagenen SA, Brown BA, et al. Apps of steel: are exercise apps providing consumers with realistic expectations? A content analysis of exercise apps for presence of behavior change theory. *Health Educ Behav* 2013;40(2):133-9.

25. Cugelman B. Gamification: What It Is and Why It Matters to Digital Health Behaviour Change Developers. *JMIR Serious Games* 2013;1(1): e3.

26. Charlton C. Smoking Log – Stop Smoking. Google Play Store [Internet] Available from: https://play.google.com/store/apps/details?id=com.ccswe.SmokingLog&hl=en (accessed 26 Feb 2018)

27. Greaves CJ, Sheppard KE, Abraham C, et al. Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *BMC Public Health* [Internet] 2011; 11:19. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-11-119 (accessed 1 Oct 2018)

28. van Achterberg T, Huisman-de Waal GG, Ketelaar NA, Oostendorp RA, Jacobs JE, Wollersheim HC. How to promote healthy behaviours in patients? An overview of evidence for behaviour change techniques. *Health Promot Int* 2011;26(2):148-62.

29. Epton T, Currie S, Armitage CJ. Unique effects of setting goals on behavior change: Systematic review and meta-analysis. *J Consult Clin Psychol* [Internet] 2017;85(12):1182-1198. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29189034 (accessed 4 Oct 2018)

30. Hiscock R, Bauld L, Amos A, Platt S. Smoking and socioeconomic status in England: the rise of the never smoker and the disadvantaged smoker. *J Public Health (Oxf)* 2012;34(3):390-6.

31. Hiscock R, Dobbie F, Bauld L. Smoking Cessation and Socioeconomic Status: An Update of Existing Evidence from a National Evaluation of English Stop Smoking Services. *BioMed Res Int* 2015;1-10.

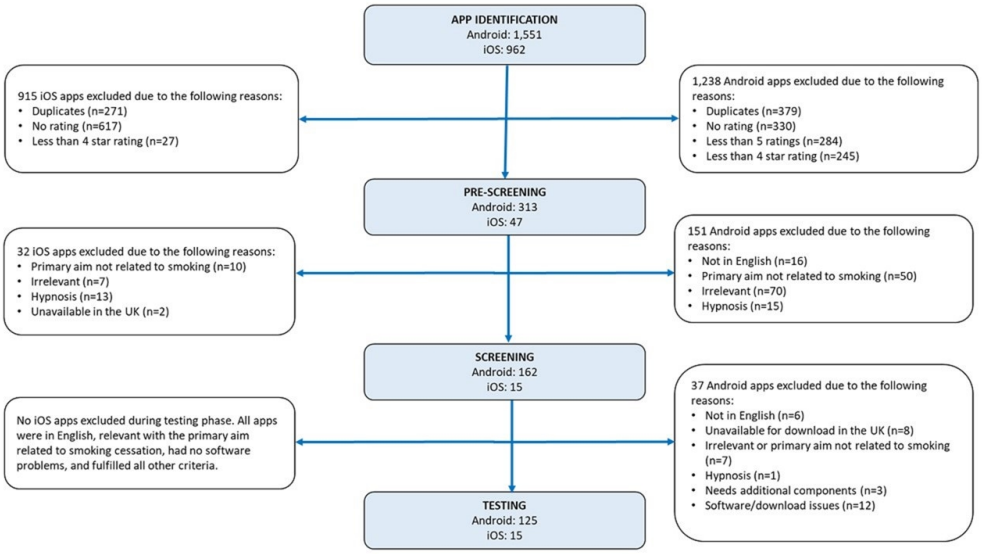
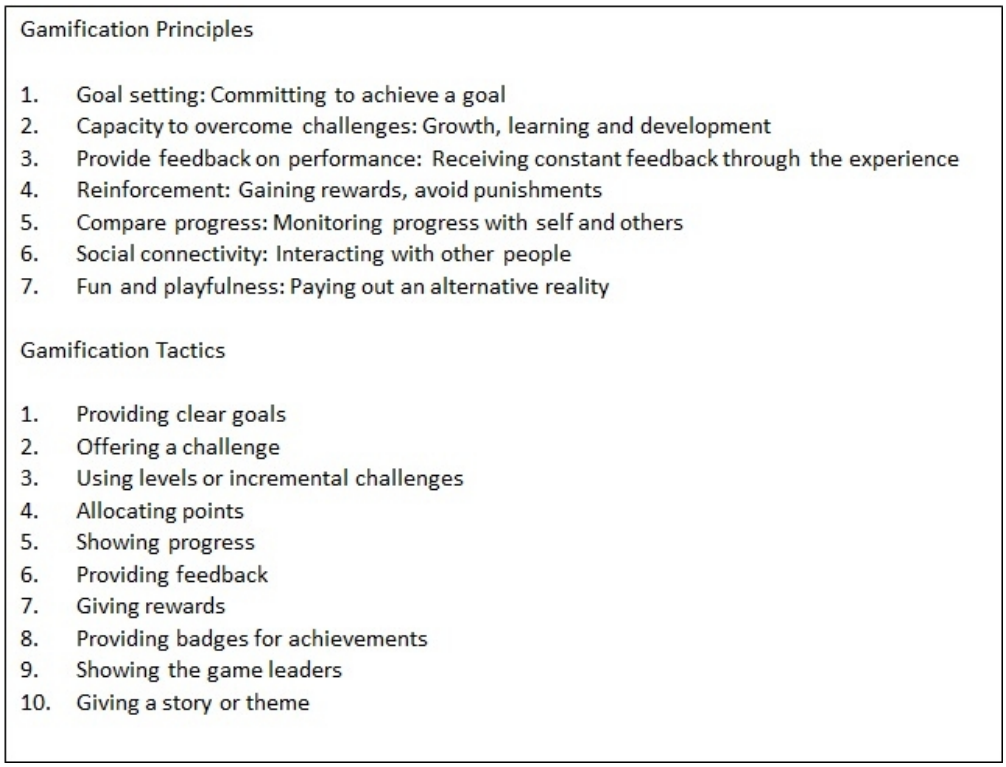


Figure 1. Identification, Screening and Testing Stages

108x60mm (300 x 300 DPI)



Gamification Principles and Tactics Framework

54x41mm (300 x 300 DPI)

BMJ Open

Use of gamification strategies and tactics in mobile applications for smoking cessation: a review of the United Kingdom mobile app market.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-027883.R1
Article Type:	Research
Date Submitted by the Author:	15-Mar-2019
Complete List of Authors:	Rajani, Nikita; Imperial College London School of Public Health, Department of Primary care and Public Health Weth, Dominik; MSU Consulting GmbH, Department of Strategy and Innovation Mastellos , Nikolaos; Imperial College London, Department of Primary Care and Public Health Filippidis, Filippos; Imperial College London, Deaprtment of Primary Care and Public Health, School of Public Health
Primary Subject Heading:	Public health
Secondary Subject Heading:	Smoking and tobacco
Keywords:	Smoking cessation, Gamification, Mobile applications, mHealth

Use of gamification strategies and tactics in mobile applications for smoking cessation: a review of the United Kingdom mobile app market.

Nikita B. Rajani[1], Dominik Weth[2], Nikolaos Mastellos[1], Filippos T. Filippidis[1]

[1] Department of Primary Care and Public Health, School of Public Health, Imperial College London, United Kingdom

[2] Department of Strategy and Innovation, MSU Consulting GmbH, Bad Homburg, Germany

Corresponding author:

Nikita B. Rajani

Address: School of Public Health, Imperial College London, Reynolds Building, St. Dunstan's Road, London W6 8RP, United Kingdom

Email: nikita.rajani14@imperial.ac.uk

Telephone: +447427615928

Word count: 3,482

ABSTRACT

Objective: Mobile phone-based interventions have been proven to be effective tools for smoking cessation, at least in the short term. Gamification, i.e. the use of game-design elements in a non-game context, has been associated with increased engagement and motivation, critical success factors for long-term success of mHealth solutions. However, to date no app review has examined the use of gamification in smoking cessation mobile apps. Our review aims to examine and quantify the use of gamification strategies (broad principles) and tactics (on-screen features) among existing mobile apps for smoking cessation in the UK.

Methods: The UK Android and iOS markets were searched in February 2018 to identify smoking cessation apps. 125 Android and 15 iOS apps were tested independently by two reviewers for primary functionalities, adherence to Five A smoking cessation guidelines, and adoption of gamification strategies and tactics. We examined differences between platforms with chi-square tests. Correlation coefficients were calculated to explore the relationship between adherence to guidelines and gamification.

Results: The most common functionality of the 140 mobile apps we reviewed allowed users to track the days since/until the quit date (86.4%). The most popular gamification strategy across both platforms was performance feedback (91.4%). The majority of apps adopted a medium level of gamification strategies (55.0%) and tactics (64.3%). Few adopted high levels of gamification strategies (6.4%) or tactics (5.0%). No statistically significant differences between the two platforms were found regarding level of gamification (p-value>0.05) and weak correlations were found between adherence to Five A's and gamification strategies (r=0.38) and tactics r= (0.26).

Conclusion: The findings of this review show that a high level of gamification is adopted by a small minority of smoking cessation apps in the UK. Further exploration of the use of gamification in smoking cessation apps may provide insights into its role in smoking cessation.

Keywords: Smoking cessation, gamification, mobile applications, mHealth

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The study had a sample of 140 mobile apps for smoking cessation in the United Kingdom iOS and Google Play store
- Since the architecture used to operationalise gamification was developed through review of taxonomies from both academic and non-academic sources, the architecture is representative of existing literature.
- The exclusion of apps with less than a 4-star rating or fewer than 5 ratings resulted in the omission of a large number of iOS apps, limiting the generalizability of the findings for the iOS store.
- Certain app functionalities and gamification elements that are only visible or activated upon long-term use may not have been identified by our review.

INTRODUCTION

Smoking is responsible for 16% of all deaths in the United Kingdom (UK) and remains one of the major preventable causes of chronic diseases.[1] According to a recent study, smoking is ranked as the number one risk factor driving death and disability within the UK.[2] Although behavioural support along with pharmacological treatments is evidently the most effective method for smoking cessation, not all individuals seeking to quit are able or willing to seek face-to-face support.[3] The number of individuals using smoking cessation services provided by the National Health Service in the UK is continuously falling,[4] a trend observed in multiple European countries.[5] The decline in use of stop smoking services is likely to be attributed to access issues in light of significant public health budget cuts.[6] On the other hand, due to increased digitalisation and diffusion of technologies, internet and mobile-based interventions are becoming more popular. The use of mobile-delivered support can be initiated independently by smokers, and can complement existing face-to-face support services. With their wide reach and low cost of dissemination, mobile health (mHealth) solutions represent a cost-effective method of helping people quit smoking.[7]

mHealth interventions have been identified as useful tools for aiding smoking cessation. A Cochrane review found that mobile-phone based cessation interventions had a beneficial impact on six-month cessation outcomes.[8] The systematic review concluded that smokers who received support from mobile-phone based interventions were 1.7 times more likely to quit in the short-term compared to those who did not receive the mobile-phone based intervention.[8] Although several mobile apps for smoking cessation exist, many suffer from low engagement and retention levels. According to Singh & Bates (2016), attaining high levels of user engagement is critical for the success of mHealth which is why it is an important focus of mHealth solutions.[9]

The application of gamification, the "use of game-design elements in a non-game context",[10] in the field of mHealth is rapidly emerging, with mobile app developers increasingly integrating badges and other elements of gamification to motivate and engage users. There is no shortage of gamification advocates, particularly in the context of health behaviour change and mHealth. Some examples of mHealth apps which use gamification and have been empirically studied include *Zombies, Run!* to increase physical activity, *SPARX* for battling depression, *Mango Health* for improving retention of medication use, and *FitGame* to increase intake of fruits and vegetables.[11-14] A study on *Zombies, Run!* found the mobile app increases the motivation of participants to run and uplifts their confidence.[11] Likewise, SPARX was found to reduce depression scores and act as a potential alternative to usual treatment in primary care for adolescents suffering from depressive symptoms.[12]

According to a randomised controlled trial, individuals who had access to a gamified version of a web-based intervention to aid arthritis patients, had a higher level of engagement than those offered the intervention without game elements.[15] Similarly, a study found that participants who utilised a gamified smoking cessation intervention had higher levels of motivation and engagement compared to a non-gamified cohort.[16] Gamification has also been associated positively with self-efficacy and psychological empowerment, among other behavioural and psychological outcomes.[15, 17-19]

Despite the increased application of gamification in the mHealth industry and the promising findings of its benefits for health behaviour change,[20] little research has examined the use of gamification in the context of mHealth and smoking cessation. Although some reviews on gamification use in health apps have been conducted, they have not explicitly focused on apps for smoking cessation or the UK app market.[20-21] Of the reviews that have focused on mobile apps for smoking cessation, ,[22-26] none explicitly explored gamification use and only two focused on the UK app market in 2012 and 2014.[27-28] Since the mobile app market is

constantly evolving, it is important that a more up-to-date review is conducted to gain insight on the currently available mobile apps for smokers seeking to quit. Our study investigated mobile apps for smoking cessation currently available in the UK to gain insight on the types of apps available and their functionalities. Moreover, we examined the types of gamification elements and the level of gamification implemented in the mobile apps. The findings of our research can have important implications for smokers seeking to quit via mHealth, mobile app developers and tobacco policy makers.

METHODS

Sample and Procedure

The methodology of the mobile app review included three stages: identification, screening and testing. To identify mobile apps available on both Android and iOS platforms in the UK, the software 42matters was used.[29] 42 matters is an online service that provides app market and audience data to provide insight into the mobile app market to build new products. Data on app market Application Programming Interface (API) were extracted using the software on February 19th 2018 using search terms consistent with prior mobile app reviews: "stop smoking" "quit smoking" and "smoking cessation". [22-26]

Apps were then screened independently by two researchers. Apps with duplicate identification numbers (assigned by the 42matters software to each unique app) were eliminated. Moreover, apps with no rating, a rating of less than four (out of five) or fewer than five individual ratings were eliminated. The cut-off point of five individual ratings is already set forth by the Apple Store. In order to treat apps from both stores equally, we applied the same cut-off point to Android apps. Whilst the methodology used by Android and Apple stores to rank apps is not transparent, it is accepted that the rating, number of ratings, downloads and reviews can be used to determine an app's popularity. Using popularity as an inclusion or exclusion criterion for

mobile app reviews is a common methodology adopted in past studies as it ensures that the most widely used and most 'liked' apps are evaluated.[30-32]

Once preliminary criteria had been applied, the remaining apps were screened based on the description and screenshots of mobile apps provided on their main page in the store. The information was used to apply the following exclusion criteria: primary aim was not to help smokers quit; app was not in the English language; app was irrelevant (i.e. app had nothing to do with smoking cessation but was still captured by the software due to the inputted search terms); app focused on hypnosis; and app targeted specific patient groups or healthcare professionals. Further exclusions were conducted upon installation of mobile apps. Hypnosis apps were excluded because it is not an evidence-based strategy for smoking cessation.[33] Additional exclusion criteria upon installation included: unsuccessful download of the app; software problems upon installation; and requirement for additional devices such as smartwatches. After screening was complete, a total of 140 mobile apps remained of which 125 were Android apps and 15 were iOS apps. Three mobile apps were found in both platforms but were still assessed independently by both reviewers as slight variations between Android and iOS versions exist. The procedure inclusive of the number of apps excluded in each stage of the methodology can be seen in figure 1.

[Insert Figure 1]

Coding and Classification of Mobile Apps

After screening procedures, two reviewers independently tested each app. Every app was installed and reviewed for approximately 30 minutes on the day of installation. The next day, each mobile app was reviewed for approximately 5 minutes for the delivery of any additional notifications. Similar to screening, discrepancies not resolved by the two reviewers, led to a consultation and final decision from a third reviewer.

General Functionalities

Functionalities of apps were coded based on categories consistently used by previous mobile app reviews on smoking cessation.[23-25] The categories included: (1) Tracker: the app tracked the number of days elapsed since the user quit smoking and/or the number of days until the user's quit date; (2) Calculator: the app primarily calculated the amount of money a smoker saved by not smoking and/or the health benefits attained by abstaining; (3) Rationing: the app prompted the user to limit the number of cigarettes smoked and/or how often the user can smoke a cigarette (e.g. providing time limits); (4) Informational: app provided information in the form of text and images to provide the user with knowledge on various aspects of smoking cessation; (5) Game: app took the form of a game to help users quit; (6) Lung Health Monitor: app measured and tracks the user's lung function and health; and (7) Other: all functionalities that did not fit one of the six other categories.

Five A Guidelines

To understand whether apps were developed with scientific input, we assessed them against the Five A's framework (Ask, Assess, Advise, Assist, Arrange) for behaviour change.[34] This framework is globally accepted as a tool to inform and develop health behaviour change interventions (supplementary table 1). It has been applied to various behaviours including smoking cessation.

Gamification

To assess gamification, an architecture developed by Cugelman (2013) was used.[35] It consists of two parts: (1) the persuasive and broad principles of gamification, also known as gamification strategies, and (2) the on-screen features of gamification that users interact with, also known as gamification tactics. Cugelman (2013) developed this architecture through a review of a number of other taxonomies presented both in academic and non-academic

sources.[35] A large amount of overlap existed when compared to other frameworks; Cugelman (2013) captured the active ingredients of gamification as represented in the literature. The architecture used to operationalise gamification can be seen in figure 2.

[Insert Figure 2]

Data Analysis

To examine the price, ratings and features of mobile apps descriptive statistics were calculated. We classified the level of gamification strategies as none; low (1-2 strategies); medium (3-5 strategies); and high (6-7 strategies). Similarly, we classified the level of gamification tactics as none; low (1-3 tactics); medium (4-7 tactics); and high (8-10 tactics). The cut-off points used were arbitrary, as there is no previous research identifying specific thresholds with meaningful implications. In order to investigate any differences between the two mobile platforms, we used Pearson chi-square tests for independence. For instances when the frequency count was less than 5, we used Fisher's exact test of independence. A significance level of $p<0.05$ was set to determine statistical significance. We also calculated correlation coefficients to explore the association between adherence to Five A guidelines and gamification strategies and tactics. All statistical analyses were conducted using STATA 12.1.

Patient and Public Involvement

The study had no patient or public involvement.

RESULTS

App functionalities

Table 1 presents the general characteristics of mobile apps for smoking cessation across both platforms. The most common feature amongst apps across both platforms was the tracker

feature which allows users to track the day until and/or since quitting (86.4%). A large majority of apps included a calculator feature which helps users calculate money saved or health benefits accrued since quitting (80.3%). Only 15.7% of apps across both platforms were informational, and only a small number were games or included games to help smokers quit (11.4%). Across both platforms, the majority of apps tested were free (85.0%) and the average user rating across was 4.4 since apps with less than a 4-star rating were excluded.

Table 1. Overview of mobile apps for smoking cessation

		Platform		
		iOS (n=15)	**Android (n=125)**	**Both Platforms (n=140)**
Features of Apps	Calculator	15 (100%)	99 (79.2%)	114 (80.3%)
	Rationing	1 (6.7%)	24 (19.2%)	25 (17.9%)
	Tracker	15 (100%)	106 (84.8%)	121 (86.4%)
	Informational	4 (26. 7%)	18 (14.4%)	22 (15.7%)
	Game	0 (0%)	16 (12.8%)	16 (11.4%)
	Lung Health Monitor	0 (0%)	0 (0%)	0 (0%)
	Other	1 (6.7%)	4 (3.2%)	5 (3.6%)
Cost	Free	14 (93.3%)	105 (84.0%)	119 (85.0%)
	Paid	1 (6.7%)	20 (16.0%)	21 (15%.0)
	Mean Price (£)	1.0 (0.0 – 0.99)	2.2 (0.0 – 8.6)	2.1 (0.0 – 8.6)
Popularity	Mean User Rating	4.6 (4.1 – 5.0)	4.4 (4.0 – 5.0)	4.4 (4.0 – 5.0)
	Mean Number of Ratings	821 (6 – 6,500)	1,726 (6 – 35,045)	1,629 (6 – 35,045)

Five A Guidelines

We found that 92 out of 140 (65.7%) mobile apps across both platforms only adhered to 1-2 out of the Five A's. Only 3 out of 140 mobile apps (2.1%) adhered to all Five A guidelines, indicating a low level of scientific and evidence-based development of the mobile apps. Supplementary table 2 displays detailed results regarding adherence to Five A guidelines.

Gamification

An overview of the number and percentage of each gamification strategy and tactic adopted by mobile apps is presented in table 2. The most popular gamification strategy across both platforms was feedback on performance (91.4%). A majority of the apps allowed users to track

their smoking habits or calculate money and health benefits, hence this gamification strategy was inherently present. Although almost two thirds of mobile apps across both platforms (64.3%) utilised goal setting to motivate users, only 28.6% of apps provided users with the capacity and support to reach the goals set and the challenges faced. For example, "Smoking Log – Stop Smoking" is an example of an app which was reviewed that enabled the user to set goals with regard to the number of cigarettes the user can smoke that day or the time until the next cigarette can be smoked, but it provides no support or advice to the user on how this goal can be achieved.[36]

Additionally, 69 out of 140 mobile apps across both platforms adopted social connectivity (49.3%). However, most of these achieved this by including share options with popular social media platforms. Only a few of the apps provided users with social communities integrated into the app itself to share thoughts or discuss progress with other smokers trying to quit. Finally, the least common gamification strategy observed in the apps was fun and playfulness (7.9%). This finding is consistent with the low presence of on-screen gamification tactics, such as showing game leaders (4.3%) and including a theme or story within the app (4.3%). No statistically significant differences between the two platforms were found for any of the gamification strategies or tactics (p-value>0.05).

Table 2. Number of gamification principles and strategies

		Platform			Chi-Square
		iOS (n=15)	Android (n=125)	Both (n=140)	P-Value
Gamification Strategies	Goal setting	10 (66.7%)	80 (64.0%)	90 (64.3%)	0.839
	Capacity of overcome challenges	7 (46.7%)	33 (26.4%)	40 (28.6%)	0.101
	Feedback on performance	15 (100.0%)	113 (90.4%)	128 (91.4%)	0.363
	Reinforcement	10 (66.7%)	61 (48.8%)	71 (50.7%)	0.191
	Compare progress	4 (26.7%)	17 (13.6%)	21 (15.0%)	0.242
	Social connectivity	9 (60.0%)	60 (48.0%)	69 (49.3%)	0.380
	Fun and playfulness	1 (6.7%)	10 (8.0%)	11 (7.9 %)	1.000
	Provides clear goals	10 (66.7%)	80 (64.0%)	90 (64.3%)	0.839
	Offers a challenge	10 (66.7%)	80 (64.0%)	90 (64.3%)	0.839

Gamification Tactics	Uses levels	3 (20.0%)	25 (20.0%)	28 (20.0%)	1.000
	Allocates points	1 (6.7%)	9 (7.2%)	10 (7.1%)	1.000
	Shows progress	15 (100.0%)	113 (90.4%)	128 (91.4%)	0.363
	Provides feedback	15 (100.0%)	113 (90.4%)	128 (91.4%)	0.363
	Gives rewards	10 (66.7%)	61 (48.8%)	71 (50.7%)	0.191
	Provides badges for achievements	9 (60.0%)	49 (39.2%)	58 (41.4%)	0.122
	Shows game leaders	1 (6.7%)	5 (4.0%)	6 (4.3%)	0.500
	Gives a story/theme	1 (6.7%)	5 (4.0%)	6 (4.3%)	0.500

*P-value < 0.05

Table 3 presents the level of gamification adopted by mobile apps, in terms of the number of strategies and the number of on-screen features (also known as gamification tactics). Only 7.1% of apps across platforms did not adopt any gamification strategy or tactic. More than half of mobile apps across both platforms had adopted a medium level of gamification strategies (55.0%) and tactics (64.3%). However, only a minority adopted a high level of gamification strategies (6.4%) or a high level of gamification tactics (5.0%). No statistically significant differences between the two platforms were found with relation to the level of gamification strategies or tactics (p-value>0.05).

Table 3. Level of gamification incorporated in mobile apps for smoking cessation.

		Platform			Chi-Square
		iOS (n=15)	**Android (n=125)**	**Both Platforms (n=140)**	**P-Value**
Number of gamification strategies adopted	0 (None)	0 (0.0%)	10 (8.0%)	10 (7.1%)	0.600
	1-2 (Low)	4 (26.7%)	40 (32.0%)	44 (31.4%)	0.776
	3-5 (Medium)	9 (60%)	68 (54.4%)	77 (55.0%)	0.700
	6-7 (High)	2 (13.3%)	7 (5.6%)	9 (6.4%)	0.248
Number of gamification tactics adopted	0 (None)	0 (0.0%)	10 (8.0%)	10 (7.1%)	0.600
	1-3 (Low)	4 (26.7%)	29 (23.2%)	33 (23.6%)	0.753
	4-7 (Medium)	9 (60.0%)	81 (64.8%)	90 (64.3%)	0.714
	8 -10 (High)	2 (13.3%)	5 (4.0%)	7 (5.0%)	0.164

*P-value < 0.05

Furthermore, we tested whether adherence to Five A guidelines and the number of gamification strategies and tactics incorporated in smoking cessation mobile apps were related by calculating correlation coefficients (supplementary table 3). We found that across all mobile apps (n=140)

the numbers of gamification tactics and strategies were only weakly correlated with adherence to Five A guidelines, an indicator for level of scientific input (r= 0.26 and r=0.38 respectively).

DISCUSSION

We reviewed mobile apps for smoking cessation available in the UK Android and iOS app stores and found that most of them incorporated a limited number of gamification elements and strategies.

We found that a majority of apps tested in our review allowed users to calculate the money saved or health benefits accrued since quitting. The popularity of this feature amongst mobile apps for smoking cessation is consistent with findings from prior reviews conducted outside of the UK market.[23-26] A large proportion of smoking cessation apps available on the UK market also allow users to track the day until and or since quitting. The integration of tracker and calculator features permits users to self-monitor their progress, a technique which has been associated with increased effectiveness for health behaviour change.[37-41]

Across both platforms the most common gamification strategy adopted was feedback on performance. This finding is consistent with another review which found that 60 out of 64 gamified health apps included feedback and monitoring.[21] The least common gamification strategy was fun and playfulness which requires app developers to include on-screen features such as a story or theme for the entertainment and liking of the user. Most apps do not incorporate such elements likely because they are more difficult to implement in comparison to basic tracker and calculator features which inherently provide feedback on performance. Goal setting was present in more than 60% of apps. This is promising as past research suggests that goal setting is a fundamental component for successful health behaviour change interventions.[42] Although several apps allow users to set goals, not many provide advice or information on how to set realistic and appropriate goals, or how to achieve them.

Nearly half of the apps implement social connectivity as a gamification strategy. However, most do so by providing basic and easily implementable options of sharing results and progress to others via popular social media platforms rather than setting up social communities where thoughts and progress can be discussed with other smokers attempting to quit. Online social communities provide a platform for additional support, as well as a channel to interact with others seeking to quit. Two systematic reviews have found that online social networks and features can be effective and have a positive influence on health behaviour change.[43-44] Aside from social support, social connectivity features can drive user engagement via the mechanism of social comparison, which suggests that people compare themselves with others as a method of self-evaluation, which can impact behavioural outcomes.[45].

Regarding the level of gamification, our results indicate that a majority of apps adopt a medium level of gamification strategies and/or tactics, with few adopting no gamification or a high level of gamification. Several gamification elements, such as providing feedback and displaying progress, are inherently present in mobile apps (e.g. Instagram, Google Maps) that would not generally be perceived as gamified. As a consequence of this, existing literature and our analysis may overestimate the level of gamification truly present. Refining gamification taxonomies to better measure the true level of gamification would allow researchers to look beyond elements inherently found in mobile apps.

Despite the possible overestimation of the level of gamification in mobile apps, research shows that gamification can positively impact psychological and behavioural outcomes.[12-19] Consequently, gamification can be an important part of persuasive design of mobile apps for smoking cessation which can result in higher user engagement and could thus provide a potentially cost-effective method to improve smoking cessation rates, thereby achieving a substantial public health impact Past research has shown the benefits of mobile and internet-based interventions for individuals of lower socioeconomic status;[46-47] hence the provision

of effective mobile apps for smoking cessation could reduce health inequalities by increasing cessation rates amongst disadvantaged groups. However, the development of gamified mobile apps for smoking cessation requires collaboration between gaming experts, software developers, behaviour change specialists and smoking cessation experts. . Further research needs to continue to investigate gamified mobile apps for smoking cessation in randomised controlled trials to assess effectiveness on quit rates, as well as the potential benefits.

There are several strengths of our review. The focus on the UK mobile app market, which has not been extensively studied in past literature, helps gain insight on mobile app interventions available in this geographic region. Moreover, we tested apps available in two major app stores, inclusive of apps with a cost. Past mobile app reviews focusing on smoking cessation apps available in the UK did not examine apps available on the Android app store nor apps that have to be paid for.[27-28] Our findings are up to date and representative of the entire UK mobile app market

Our findings are also bound by some limitations. Due to the exclusion criteria, apps with less than a 4-star rating or apps with fewer than 5 ratings were excluded. This particularly led to the exclusion of a large number of iOS apps and therefore could have an effect on the generalizability of the findings. Future research could evaluate apps with lower ratings and explore whether gamification levels are correlated with user ratings as such research can have important implications for app developers and health researchers during the design and development of health apps. Additionally, since all mobile apps were reviewed for approximately 30 minutes on the day of installation and a few minutes the next day, it could be that certain app functionalities that are only visible or activated upon long-term use would not have been recorded. Future studies could explore app functionalities and gamification features for a longer period of time to ensure that apps that have multiday cessation programmes are accurately assessed. Although our review examined adherence to cessation guidelines as an

indicator of scientific input, we did not assess the overall quality of mobile apps and hence were not able to correlate level of gamification to app quality. Such analyses would require rigorous assessment of app quality with evidence-based tools, such as the Mobile App Rating Scale.[48]

CONCLUSION

Our research comprehensively reviewed the UK market for smoking cessation mobile applications in early 2018. Our findings showed that a medium level of gamification was adopted by just over half of the smoking cessation apps and only a minority adopted a high level of gamification or incorporate more complex and difficult to implement gamification features. Since gamification can be used to address critical limitations of mHealth interventions, such as engagement and retention, our research shows that increased effort and collaboration between gaming experts, software developers and smoking cessation specialists is essential for the development of gamified mobile apps for smoking cessation.

DECLARATIONS

Ethical approval: Primary data was collected and analysed by the authors from publicly available sources. No participants were involved nor was an intervention administered. No ethical approval was required.

Consent to Publish: Not applicable.

Competing interests: No competing interests.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Data Sharing Statement: All data were extracted from mobile apps available to download on iOS and Google stores. Details of the extracted data are available by the authors upon request.

Author Contributions: NR conducted the mobile app review and produced the first draft of the paper. DW acted as a second reviewer and helped consolidate the results of the review. FF

and NM provided guidance on the overall methodology of the review and revised the manuscript for content. All authors contributed to the interpretation of results, read and approved the final manuscript.

Acknowledgements: Not applicable.

FIGURE LEGEND

Figure 1. Identification, Screening and Testing Stages of the Mobile App Review

Figure 2. Gamification Principles and Tactics Framework

REFERENCES

1. National Health Service [Internet]. Statistics on Smoking – England, 2018 [PAS] 3rd July 2018. Available from: https://digital.nhs.uk/data-and-information/publications/statistical/statistics-on-smoking/statistics-on-smoking-england-2018/content

2. healthdata.org [Internet]. Institute for Health Metrics and Evaluation: United Kingdom. 2016. Available from: http://www.healthdata.org/united-kingdom (accessed 4 Oct 2018)

3. Stead LF, Koilpillai P, Fanshawe TR, et al. Combined pharmacotherapy and behavioural interventions for smoking cessation. *Cochrane Database Syst Rev* 2016(3). Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD008286.pub3/full (accessed 5 Oct 2018)

4. Lacobucci, G. Stop smoking services: BMJ anaylsis show how councils are stubbing them out. *BMJ* 2018; 362:k3649.

5. Filippidis FT, Laverty AA, Mons U, Jimenez-Ruiz C, Vardavas CI. Changes in smoking cessation assistance in the European Union between 2012 and 2017: pharmacotherapy versus counselling versus e-cigarettes. *Tob Control* [Internet] 2018;28(1):95-100. Available from: https://tobaccocontrol.bmj.com/content/early/2018/03/21/tobaccocontrol-2017-054117 (accessed 5 Oct)

6. Iacobucci G. Number of people using NHS stop smoking services continues to fall. *BMJ* 2017;358:j3936.

7. World Health Organisation [Internet]. mHealth: Use of appropriate digital technologies for public health. Seventy First World Health Assembly, A71/20. 26th March 2018. Available from: http://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_20-en.pdf

8. Whittaker R, McRobbie H, Bullen C, Rodgers A, et al. Mobile phone-based interventions for smoking cessation. *Cochrane Database of Syst Rev* 2016;4:Cd006611.

9. Singh K, Drouin K, Newmark LP, et al. Developing a Framework for Evaluating the Patient Engagement, Quality, and Safety of Mobile Health Applications. *Issue brief (Commonw Fund)* 2016;5:1-11.

10. Deterding S, Dixon D, Khaled R, et al. From game design elements to gamefulness: defining "gamification". Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments; Tampere, Finland. 2181040: ACM; 2011. p. 9-15.

11. Moran MJ & Coons JM. Effects of a Smart-phone Application on Psychological, Physiological, and Performance Variables in College-Aged Individuals While Running. *Int J of Exerc Sci* 2015 8(2):104-111

12. Merry SN, Stasiak K, Shepherd M, et al. The effectiveness of SPARX; a computerised self-help intervention for adolescents seeking help for depression: randomised controlled non-inferiority trial. *BMJ Open* [Internet] 2012. Available from: https://www.bmj.com/content/344/bmj.e2598

13. Nguyen E, Bugno L, Kandah C, et al. Is there a good app for that? Evaluating m-Health apps for strategies that promote pediatric medication adherence. *Telemedicine and e-health* 2015;22(11):929-937. Available from: https://www.ncbi.nlm.nih.gov/pubmed/27070837

14. Jones BA, Madden GJ & Wengreen HJ. The FIT Game: preliminary evaluation of a gamification approach to increasing fruit and vegetable consumption in school. *Prev Med* 2016;68:76-79.

15. Allam A, Kostova Z, Nakamoto K, Schulz PJ. The effect of social support features and gamification on a Web-based intervention for rheumatoid arthritis patients: randomized controlled trial. *J. Med Internet Res* 2015;17(1):e14.

16. El-Hilly AA, Iqbal SS, Ahmed M, et al. Game On? Smoking Cessation Through the Gamification of mHealth: A Longitudinal Qualitative Study. *JMIR Serious Games* 2016;4(2):e18.

17. Harold DJ. A Qualitative Study on the Effects of Gamification on Student Self-Efficacy. International Society for Technology in Education Conference; Philadelphia2015.

18. Banfield J & Wilkerson B. Increasing Student Intrinsic Motivation and Self-Efficacy through Gamification Pedagogy. *Contemporary Issues in Education Research* 2014;7(4):291-8.

19. Johnson D, Deterding S, Kuhn K-A, et al. Gamification for health and wellbeing: A systematic review of the literature. *Internet Interventions* 2016;6:89-106.

20. Lister C, West JH, Cannon B, et al. Just a fad? Gamification in health and fitness apps. *JMIR serious games* 2014;2(2):e9-e.

21. Edwards EA, Lumsden J, Rivas C, et al. Gamification for health promotion: systematic review of behaviour change techniques in smartphone apps. *BMJ Open* 2016;6(10):e012447.

22. Choi J, Noh GY, Park DJ. Smoking cessation apps for smartphones: content analysis with the self-determination theory. *J of Med Internet Res* 2014;16(2):e44.

23. Abroms LC, Lee Westmaas J, Bontemps-Jones J, et al. A content analysis of popular smartphone apps for smoking cessation. *Am J Prev Med* 2013;45(6):732-6.

24. Abroms LC, Padmanabhan N, Thaweethai L, et al. iPhone apps for smoking cessation: a content analysis. *Am J Prev Med* 2011;40(3):279-85.

25. Hoeppner BB, Hoeppner SS, Seaboyer L, et al. How Smart are Smartphone Apps for Smoking Cessation? A Content Analysis. *Nicotine Tob Res* 2016;18(5):1025-31.

26. Bennett ME, Toffey K, Dickerson F, et al. A Review of Android Apps for Smoking Cessation. *Journal of Smoking Cessation* 2015;10(2):106-15.

27. Ubhi KH, Kotz D, Michie S, et al. Comparative analysis of smoking cessation smartphone applications available in 2012 versus 2014. *Addict Behav* 2016;58:175-181.

28. Ubhi KH, Michie S, Kotz D, et al. Characterising smoking cessation smartphone applications in terms of behaviour change techniques, engagement and ease-of-use features. *Transl Behav Med* 2016;6(3): 410-417.

29. App Market API [Internet]. Available from: https://42matters.com/.

30. Azar KM, Lesser LI, Laing BY, et al. Mobile applications for weight management: theory-based content analysis. *Am J Prev Med* 2013;45(5):583-9.

31. Breton ER, Fuemmeler BF, Abroms LC. Weight loss—there is an app for that! But does it adhere to evidence-informed practices? *Transl Behav Med* 2011;1(4):523-9.

32. Cowan LT, Van Wagenen SA, Brown BA, et al. Apps of steel: are exercise apps providing consumers with realistic expectations? A content analysis of exercise apps for presence of behavior change theory. *Health Educ Behav* 2013;40(2):133-9.

33. Barnes J, Dong CY, McRobbie H, et al. Hypnotherapy for smoking cessation. *Cochrane Database Syst Rev* 2010(10). Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD001008.pub2/full

34. World Health Organisation. (2014) Toolkit for delivering the 5A's and 5R's brief tobacco interventions in primary care. Geneva. Available from: http://www.who.int/tobacco/publications/smoking_cessation/9789241506946/en/ (accessed 8th Sept 2018)

35. Cugelman B. Gamification: What It Is and Why It Matters to Digital Health Behaviour Change Developers. *JMIR Serious Games* 2013;1(1):e3.

36. Charlton C. Smoking Log – Stop Smoking. Google Play Store [Internet] Available from: https://play.google.com/store/apps/details?id=com.ccswe.SmokingLog&hl=en (accessed 26 Feb 2018)

37. Greaves CJ, Sheppard KE, Abraham C, et al. Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *BMC Public Health* [Internet] 2011;11:19. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-11-119 (accessed 1 Oct 2018)

38. van Achterberg T, Huisman-de Waal GG, Ketelaar NA, et al. How to promote healthy behaviours in patients? An overview of evidence for behaviour change techniques. *Health Promot Int* 2011;26(2):148-62.

39. Bartlett YK, Sheeran P & Hawley MS. Effective behaviour change techniques in smoking cessation interventions for people with chronic obstructive pulmonary disease: A meta-anaylsis. *Br J Health Psychol* 2014;19(1):181-203. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4253323/

40. Vries HD, Eggers SM & Bolman C. The role of action planning and plan enactment for smoking cessation. *BMC Public Health* 2013;13(1):393. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-13-393

41. Lorencatto F, West R & Michie S. Specifying evidence-based behaviour change techniques to aid smoking cessation in pregnancy. *Nicotine Tob Res* 2012;14(9):1019-1026. Available from:

42. Epton T, Currie S, Armitage CJ. Unique effects of setting goals on behavior change: Systematic review and meta-analysis. *J Consult Clin Psychol* [Internet] 2017;85(12):1182-1198. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29189034 (accessed 4 Oct 2018)

43. Laranjo L, Arguel A, Neves AL, et al. The influence of social networking sites on health behavior change: a systematic review and meta-analysis. *JAMIA* 2015;22(1):243-56.

44. Maher CA, Lewis LK, Ferrar K, et al. Are health behavior change interventions that use online social networks effective? A systematic review. *J Med Internet Res* 2014;16(2):e40-e.

45. Festinger L. A Theory of Social Comparison Processes. *Human Relations* 1954;7(2):117-40.

46. Hiscock R, Bauld L, Amos A, et al. Smoking and socioeconomic status in England: the rise of the never smoker and the disadvantaged smoker. *J Public Health (Oxf)* 2012;34(3):390-6.

47. Hiscock R, Dobbie F, Bauld L. Smoking Cessation and Socioeconomic Status: An Update of Existing Evidence from a National Evaluation of English Stop Smoking Services. *BioMed Res Int* 2015;1-10.

48. Stoyanov SR, Hides L, Kavanagh DJ, et al. Mobile App Rating Scale: A new tool for assessing the quality of health mobile apps. *JMIR MHealth and Uhealth* [Internet] 2015;3(1):e27. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4376132/#__ffn_sectitle (accessed 10 Mar 2019)

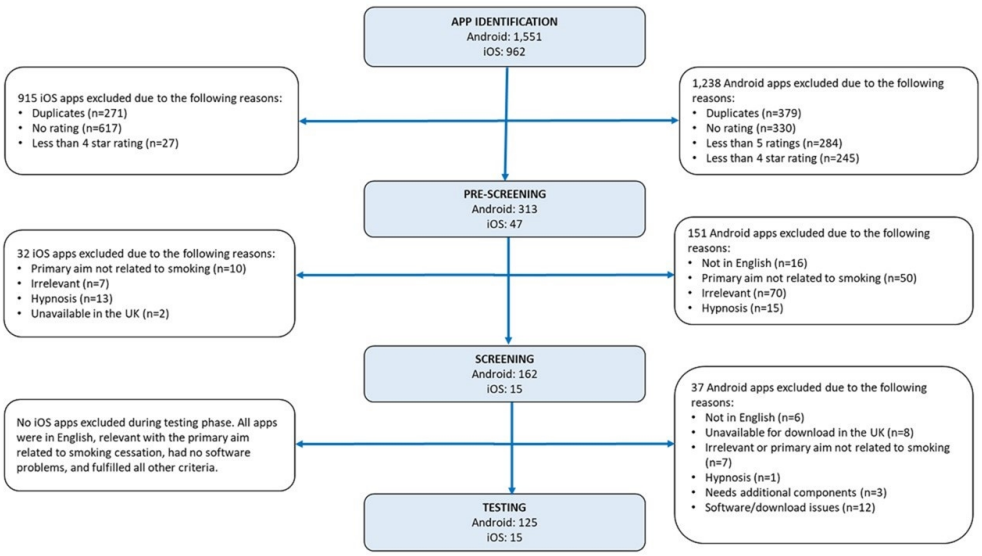
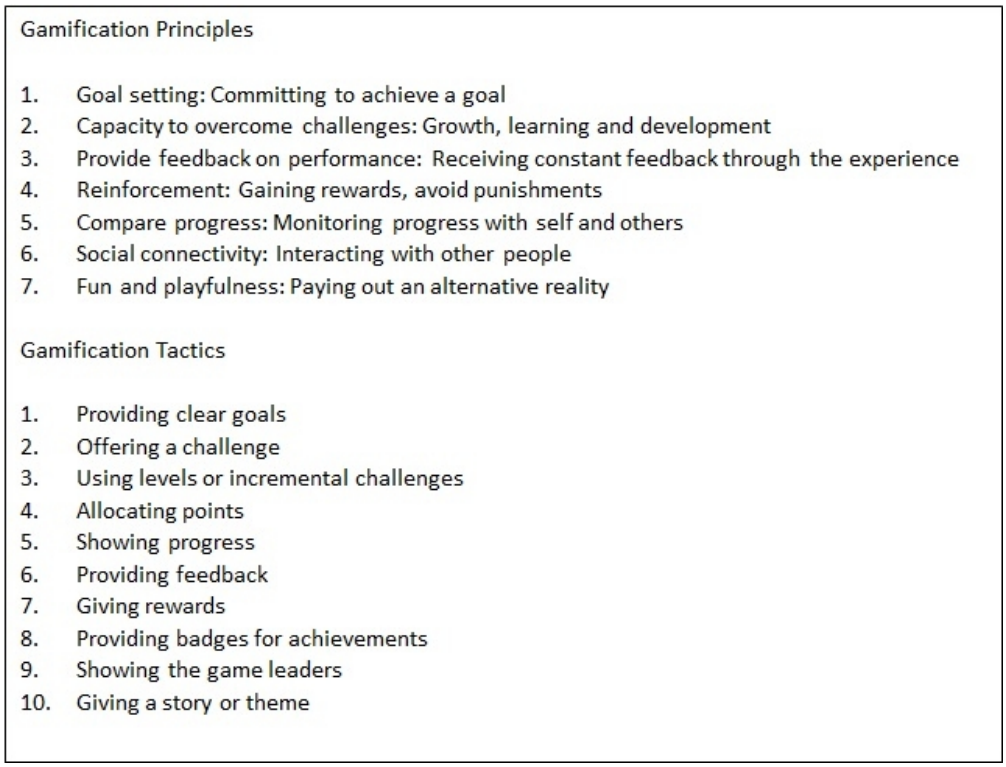


Figure 1. Identification, Screening and Testing Stages

108x60mm (300 x 300 DPI)



Gamification Principles and Tactics Framework

54x41mm (300 x 300 DPI)

Supplementary Tables

Five A's Guidelines for Smoking Cessation	
ASK	The mobile app asks the user whether or not they smoke cigarettes and/or use other tobacco products
ADVISE	The mobile app persuades and advises all tobacco users to quit
ASSESS	The mobile app assesses the user's readiness to make a quit attempt. For example, the app can do this by asking questions related to importance or quitting and a self-efficacy.
ASSIST	The mobile app assists or helps the user quit. It can do this in various ways: helping create a quit plan, providing counselling, providing support, recommending medications etc.
ARRANGE	The mobile app arranges follow-up contact with the user or provides referral to specialist support.

Supplementary table 1. Five A's Guidelines for Smoking Cessation

Supplementary table 2. Adherence to Five A Guidelines for Smoking Cessation

Smoking Cessation Guidelines		Platform		
		iOS (n=15)	Android (n=125)	Both (n=140)
Five A Guidelines	ASK	12 (80.0%)	106 (84.8%)	118 (84.3%)
	ADVISE	9 (60.0%)	60 (48.0%)	69 (49.3%)
	ASSESS	3 (20.0%)	12 (9.6%)	15 (10.7%)
	ASSIST	6 (40.0%)	40 (32.0%)	46 (32.9%)
	ARRANGE	5 (33.3%)	9 (7.2%)	14 (10.0%)
Level of Adherence	None (0)	0 (0.0%)	9 (7.2%)	9 (6.4%)
	Low (1-2)	8 (53.3%)	84 (67.2%)	92 (65.7%)
	Medium (3-4)	6 (40.0%)	30 (24.0%)	36 (25.7%)
	High (5)	1 (6.7%)	2 (1.6%)	3 (2.1%)

Supplementary Table 3. Characteristics of all mobile applications included in the review.

Name of App	App Developer	Platform	Price (Euro)	Rating	No. Of Ratings	Total no. gamification strategies (out of 7)	Total no. of gamification tactics (out of 9)	Adherence Five As (out of 5)
QuitNow! Quit smoking	Fewlaps	Android	0	4.29	35045	5	7	3
Smoke Free, quit smoking now and stop for good	The Quit Smoking Specialists	Android	0	4.66	32875	4	7	4
Quit Tracker: Stop Smoking	despDev	Android	0	4.59	29512	4	7	2
Stop Smoking - EasyQuit free	Mario Hanna	Android	0	4.80	28823	5	6	4
Get Rich or Die Smoking	Tobias Gruber	Android	0	4.56	12363	5	7	1
Stop Smoking - quit smoking, be smoke free	The Quit Smoking Professionals	Android	0	4.38	6353	5	6	2
QuitNow! PRO - Stop smoking	Fewlaps	Android	2.95	4.58	5718	5	7	3
aha!Smokefree	aha!dev	Android	0	4.29	3534	2	6	1
STOP Cigarettes - Quit smoking	academiacea	Android	0	4.11	2395	4	6	4
Quit Smoking Now: Quit Buddy!	HQmedia	Android	0	4.04	1296	3	6	2
Quit Smoking Tracker GOLD - stop smoking app	The Quit Smoking Professionals	Android	3.49	4.49	1080	5	6	2
Breathe Now -Stop Smoking Free	Peytu	Android	0	4.13	976	4	6	1
Smoking Log	Cory Charlton	Android	0	4.30	724	4	5	1
I Give Up Smoking	BamyaSoft	Android	0	4.50	672	4	6	2
Quit smoking	Andeko	Android	0	4.38	580	3	5	3
Quit Smoking with Stop Tobacco Mobile Trainer	Iteration Mobile & Vialsoft Apps	Android	0	4.44	463	7	10	4
Quit Genius ⊘ Best way to quit smoking for good	Digital Therapeutics	Android	0	4.62	351	7	8	5
Quitify for quit smoking!	SpanishApps	Android	0	4.34	345	6	6	4
Stop Smoking - EasyQuit Pro	Mario Hanna	Android	3.09	4.71	327	5	6	4
Get Rich or Die Smoking Gold	Tobias Gruber	Android	2.44	4.49	224	5	7	1

Quit-Smoking Coach	Brainlag Studios	Android	1.29	4.37	167	4	6	3
Quit Smoking	Lydia Games	Android	0	4.42	154	3	4	2
ExSmoker - Stop Smoking Now	Antonio Sánchez Díaz	Android	0	4.11	133	6	7	1
Kwit - quit smoking for good - smoking cessation	Kwit SAS	Android	0	4.16	126	5	7	1
Quit Smoking	Morisson Software	Android	0	4.07	122	2	4	1
STOPCigarettesPRO Quit Smoking	academiacea	Android	2.9	4.51	106	4	6	4
Breathe Now - Stop smoking	Peytu	Android	1.29	4.47	75	4	6	1
Reduce and Stop Smoking	Limpla	Android	0	4.17	69	4	6	3
QuitGuide - Quit Smoking	ICF International	Android	0	4.15	65	5	6	4
Tobacco Kills	liger	Android	0	4.00	61	3	7	1
Quit Smoking - Goodbye Tobacco	Your Health	Android	0	4.39	57	3	6	2
Quit smoking	AGI Applications	Android	0	4.29	56	3	4	2
Smoke - quit Pro	NikNormSoft	Android	1.69	4.87	55	4	6	2
Vapertrack	Incoherent Solutions	Android	0	4.39	54	3	6	1
Just Quit Smoking Hyperactive	Kostyantin Petrov	Android	0	4.38	34	5	6	1
Stop-tobacco	Université de Genève	Android	0	4.74	23	3	6	3
Quit Smoking 3D!	UD4M Games	Android	0.59	4.42	19	5	9	2
Quit Smoking Forever	pi9soft	Android	0	4.11	18	5	6	2
Quit smoking Pro	Led Scrolling App	Android	1.19	4.53	17	3	6	1
SmokeOut	Asier Murciego	Android	0	4.29	17	4	9	0
Beat Smoking - Quit Smoking	Prodocity	Android	0	4.07	14	4	5	4
Quit Smoking Now	SwiftKay Development	Android	0	4.07	14	4	6	1
Quit smoking	ZeroZig	Android	0.59	4.31	13	5	7	1
Quit For Treats - Stop Smoking	SelaSela	Android	0	4.36	11	5	5	2
Quit Smoking Helper App	osthoro	Android	0	4.44	9	4	6	2
Quitty	Playing for Health	Android	2.09	4.50	8	4	8	0
StopSmoking - Quit smoking	Optimum Design	Android	0	4.38	8	6	7	0
SimpleQuit: Quit Smoking App	Alex Elarbee	Android	0	4.38	8	3	6	1

Quit Smoking smartly - quit smoking app free	Zexa Software	Android	0	4.43	7	2	3	3
ExSmoker - Stop Smoking Now	Antonio Sánchez Díaz	Android	3.49	4.17	6	6	7	1
Done with Smoking	Abdulkarim Alrahili	Android	0	4.83	6	3	4	2
Peer Challenge	SliderNet	Android	0	4.20	5	7	5	3
Quit Smoking ! Smoking Kills	Groax Technology	Android	0	5.00	5	3	4	3
Give up smoking	mochiba	Android	0	4.40	5	2	3	3
IHaveBeenSmokeFreeFor...	Anacletus	Android	0	4.40	5	3	4	2
Quit Smoke	Utkarsh Khare	Android	0	4.80	5	5	6	2
Stop smoking helper	Roxoft	Android	0	4.47	88	4	6	3
100 Tips to stop	Cap morco studio	Android	0	4.40	89	5	7	1
Stop Smoking B Happy	Jeffrey Forte	Android	0	4.11	9	4	5	3
I'm Free	Bellotti Alessandro	Android	0	4.29	7	5	6	1
FitSmoke	D@v Consulting	Android	0	4.00	6	5	7	3
Qwit (Quit Smoking)	Team Geny	Android	0	4.05	9217	3	4	2
SmokeFree - quit smoking slowly	MotiveBite Studio	Android	0	4.39	6724	2	5	2
Quit Smoking: Cessation Nation	Ron Horner	Android	0	4.52	6383	1	4	1
Time To Quit Smoke	VantusMantus	Android	0	4.25	5417	1	3	1
QUIT SMOKING	Mastersoft Ltd	Android	0	4.36	4350	2	3	2
Quit Smoking	HC	Android	0	4.73	3497	2	3	1
Quit smoking - Smokerstop	Titus J. Brinker	Android	0	4.54	3154	2	5	1
No smoking	antonfil84	Android	0	4.62	2722	1	3	2
Qwit Pro LICENSE, Stop Smoking	Team Geny	Android	0.59	4.30	2247	3	4	2
Cigarette Analytics	Alvakos	Android	0	4.35	1324	1	2	2
Smokenote - Quit Smoking	NXCARE	Android	0	4.09	748	2	2	1
SmokeLess!	Kroaqs	Android	0	4.41	704	2	2	1
smoke less	David M.	Android	0	4.32	692	1	2	1
Drop It! Quit Smoking	Nikola Mladenovic	Android	0	4.64	496	2	2	2
Stop Smoking	Drd	Android	0	4.15	496	3	4	1
Kick the Habit: Quit Smoking	IcySpark	Android	0	4.00	223	2	2	1

myQuitTime - Stop Smoking	Arete Appware	Android	0	4.06	218	3	4	1
Smoke - quit	NikNormSoft	Android	0	4.62	188	2	2	2
Smokenote Pro - Quit Smoking	NXCARE	Android	2.09	4.16	183	2	2	1
Quit Smoking -No smoking day	PIONE STUDIO	Android	0	4.15	179	3	2	1
Tracy: Quit smoking!	RSTeam Apps	Android	0	4.53	109	1	2	2
Cigarette Control & Counter	vostrop	Android	0.79	4.21	106	2	4	1
Smotivator - Quit Smoking	Balauris	Android	0	4.17	76	2	4	1
SOS Challenge	Les Évadés	Android	0	4.25	69	1	2	1
Quit Smoking Save Life	Dubai Games Studio	Android	0	4.07	54	1	2	1
Puff Away-Stop Smoking Today	Hexpress Healthcare Ltd	Android	0	4.26	42	2	2	2
No Smoking - The Game	S.O.S. Games	Android	0	4.47	36	4	4	1
Stop Smoking (Wear support)	TedSoft	Android	0	4.44	34	3	4	2
Smoke Meter	Kotrots	Android	0	4.32	28	1	2	1
Smoke TherApp	Basicks Studio	Android	0	4.22	27	3	5	3
Smoking Timer (Free)	Mogilas	Android	0	4.04	27	1	2	2
Quit smoking today!	PWR Developers	Android	0	4.48	23	3	4	1
Quit Smoking, NeverSmoking P	SR Mind	Android	8.56	4.10	21	3	4	3
Smoking-Counter App	Mobile Computing Team	Android	0	5.00	20	1	2	1
Quit Smoking (Save Health)	WRP Solution	Android	0	4.31	16	2	4	1
Quit Tobacco	Memsta Apps	Android	0	4.31	13	3	4	2
Left Smoke! free	LumisiAppsAndroid	Android	0	4.23	13	2	4	3
Good Bye Smoking	Milind Audichya	Android	0	4.82	11	3	4	1
Quit4GoodLife (Smoking Cessation - Quit Smoking)	technology Digest inc	Android	0	4.18	11	5	4	3
Smokifree :How to quit smoking	CZ GAMES	Android	0	4.60	10	1	2	1
Quit smoking forever - Easy Way App	studio FX	Android	0	4.11	9	2	4	1
Quit smoking	Plmn Pn	Android	0	4.13	8	2	4	1
Quit Smoking Slowly - Gradually	Software Freelancer	Android	0	5.00	8	3	4	2
Smokestop - Quit Smoking	Twenty1Media	Android	0	4.29	7	1	2	3

Smoking Statistics	Vivek.V	Android	0	4.50	6	1	2	3
Quit smoking: iQuitSmoking App	SBLMNL	Android	0	4.33	6	4	4	1
Stay Quit Coach	US Department of Veterans Affairs (VA)	Android	0	4.50	6	4	4	4
20 to Quit Best smoking app	Quit smoking	Android	0.59	4.00	6	4	4	2
Cigarette calculator	ShakeJ	Android	0	4.62	55	1	2	1
Smokefree 2017	Oliver Seibert	Android	0	4.41	29	2	4	1
Smoke Log	develophamar	Android	0	4.42	19	1	2	1
DONT SMOKE ! Free Game	insprino	Android	0	4.20	10	2	5	0
Quit Smoking	BlindheartCreations	Android	0	4.07	46	0	0	0
Stop Smoking with Allen Carr	Arcturus Digital Ltd	Android	2.99	4.13	39	3	2	2
How To Quit Smoking	AXON	Android	0	4.29	28	0	0	1
Quit Smoking Counter	MindSaver.ru	Android	0	4.09	23	0	0	0
Stop Smoking (How To Guide)	Simov	Android	0	4.50	18	0	0	1
Quit Smoking	Expert Health Studio	Android	0	4.25	8	0	0	3
Quit Smoking Helper	Parobin Apps	Android	0	4.25	8	0	0	2
Quit Smoking	VorteX	Android	0	4.00	8	0	0	0
Smoker	RealAppsEs	Android	0	4.38	8	1	2	0
Smoking Cessation - SRIOR	MAGNA HEALTH SOLUTIONS	Android	0	4.00	6	0	0	5
Cigarette Counter	BR Consulting	Android	0.6	4.00	6	0	0	1
SmokingTimer	PSYLEN	Android	0	4.00	17	0	0	0
Smoke Free - Quit Smoking Now	David Crane	iOS	0	4.70	6500	5	6	4
LIVESTRONG MyQuit Coach	LIVESTRONG.COM	iOS	0	4.50	68	5	5	1
My Last Cigarette - Stop Smoking, Stay Quit!	Mastersoft Ltd	iOS	0.99	4.70	153	1	2	1
Smokefree	Public Health England	iOS	0	4.50	2500	5	6	3
Stoptober	Public Health England	iOS	0	4.40	2100	5	6	3
Quit Smoking - My Last Cigarette	Mastersoft Ltd	iOS	0	4.50	323	1	2	1
Quit It Lite - stop smoking today	digitalsirup GmbH	iOS	0	4.70	9	3	7	2
Kwit - Quit smoking cigarettes	KWIT	iOS	0	4.60	135	5	8	1

Quit Genius - quit smoking	Digital Therapeutics Ltd	iOS	0	4.50	120	7	8	5
Quit Smoking Now: Stop Forever	TreePie LLC	iOS	0	5.00	7	4	6	3
The Stop Switch Lite	Tim smale	iOS	0	5.00	8	3	4	3
Smoke FREE - Non Smoking	sg-pages	iOS	0	4.30	223	4	4	1
QuitNow!	Fewlaps, S.C	iOS	0	4.60	144	6	6	3
Quit Smoking - Butt Out	Ellisapps Inc.	iOS	0	4.30	6	1	2	2
Quit Smoking !!!	Dennis Ebbinghaus	iOS	0	4.10	13	1	2	2