Smoking Cessation Apps

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Contributor: María Barroso-Hurtado

Smoking cessation interventions are effective, but they are not easily accessible for all treatment-seeking smokers. Mobile health (mHealth) apps have been used in recent years to overcome some of these limitations. Smoking cessation apps can be used in combination with a face-to-face intervention (FFSC-Apps), or alone as general apps (GSC-Apps). Smartphone apps for smoking cessation could be promising tools. However, more research with an adequate methodological quality is needed to determine its effect. Nevertheless, smartphone apps' high availability and attractiveness represent a great opportunity to reach large populations.

smoking cessation mHealth smartphone mobile phone digital health

1. Introduction

Smoking is the main avoidable cause of morbidity and mortality worldwide [1]. Tobacco components are related to different harmful cardiovascular and respiratory effects [2]. Specifically, the more common physical illnesses related to smoking are cancer, cardiovascular diseases, respiratory diseases, and reproductive problems [3]. Moreover, tobacco use causes around 8 million deaths every year [4]. Smokers also have a poorer quality of life [5] and a higher likelihood of having mental health problems [6], such as depression or anxiety [7].

The U.S. Preventive Services Task Force Recommendation Statement proposes that behavioral interventions are effective for smoking cessation in adults, adolescents, and pregnant women [8]. However, traditional treatments have limitations such as low utilization [9][10], they do not provide fast and tailored responses to smoking urges [11], they require costly resources and health services [12], and smoking cessation services are not easily accessible to all treatment-seeking smokers [13].

Some of these limitations could be minimized or eliminated with the use of ICT (Information and Communication Technology), as it can provide support for quitting smoking through Short Message Service (SMS) [14][15] or smartphone apps [16]. In fact, the relevance and usage of mHealth (mobile Health), defined as the use of a Personal Digital Assistant (PDA), mobile phones, wireless devices, and monitoring devices for clinical practice [12], to quit smoking is increasing.

As over 3.6 billion people have smartphones [20], and more than 204 billion mobile apps have been downloaded in 2019 worldwide [21], the use of smartphone apps provides an opportunity to cope with difficulties in providing smoking cessation treatment and improving its effectiveness.

2. Smoking Cessation Apps

2.1 Effects of Smartphone Apps on Abstinence, Tobacco Use, and Relapse Rates

2.1.1. General Apps for Smoking Cessation (GSC-Apps)

Concerning smoking cessation outcomes (**Table 1**), two studies found significant differences in abstinence rates between conditions at each point-assessment [17][18] and one at the 6-months but not at the 3-months point-assessment [19]. The remaining two studies reported similar quit rates between the experimental and the control group at each point-assessment [20][21]. Regarding cigarettes per day (CPD) outcomes, one study found significant differences between conditions [22] and two studies did not find significant differences [21][19].

Table 1. Main smoking cessation outcomes according to apps classification.

General Smartphone Apps			
Author	**Abstinence**	**Tobacco Use**	**Relapse Rates**
Baskerville et al. (2018) [19]	Significant differences between conditions at 6 months point-assessment in favor of the control group (22.3% vs. 18.3%).	Nonsignificant differences in CPD at 6-month point-assessment between conditions.	Not reported.
BinDhim et al. (2018) [17]	Significant differences between conditions in continuous abstinence rates at 10-days (32.2% vs. 20.8%), 1- (28.5% vs. 16.9%), 3- (23.8% vs. 10.2), and 6-month point-assessments (10.2% vs. 4.8%) in favor of the experimental group.	Not reported.	Not reported.
Bricker et al. (2014) [20]	Nonsignificant differences between conditions at 2-month post-enrollment point-assessment (13% experimental vs. 8% control).	Not reported.	Not reported.
Bricker et al. (2017) [23]	21% for 7-day PPA and 11% for 30-day PPA at 2-month-post-enrollment point-assessment.	75% reduction rate of CPD at 2-month point-assessment.	Not reported.
Buller et al. (2014) [18]	Significant differences between conditions at 6-week point-assessment in favor of the control group (58% vs. 30%).	Not reported.	Not reported.
Dar (2017) [22]	Not reported.	Significant differences in CPD reduction between conditions in favor of the experimental group at the end of the study.	Not reported.

General Smartphone Apps			
Author	**Abstinence**	**Tobacco Use**	**Relapse Rates**
Garrison et al. (2020) [21]	Nonsignificant differences between conditions at 6-month point-assessment (9.8% experimental vs. 12.1% control).	Nonsignificant differences between conditions in CPD reduction. Significant reductions in CPD from baseline to the 6-month point-assessment.	Not reported.
Iacoviello et al. (2017) [24]	45.2% for 7-day PPA and 26.2% for 30-day PPA at the end of the study.	Not reported.	Not reported.
Marler et al. (2019) [25]	32.0% for 7-day PPA and 27.6% for 30-day PPA at the end of the study.	Nonabstinent participants reduced 29.1% in CPD at the end of the study.	Not reported.
Combine apps with face-to-face contact			
Author	**Abstinence**	**Tobacco use**	**Relapse rates**
Businelle et al. (2016) [26]	41% at quit date, 17% at 1-week, 31% at 2-week, 27% at 3-week, 22% at 4-week, and 20% at 12-week point-assessment.	Not reported.	Not reported.
Carpenter et al. (2015) [27]	50% at 4 weeks. Of these, 65% at 3-months and 60% at 6-months point-assessment remained abstinent.	Not reported.	Not reported.
Dan et al. (2016) [28]	3% at baseline, 42% at tapering, 55% at treatment, and 42% at thinning. 0% at 1-week follow-up were abstinent.	Not reported.	Not reported.
Hébert et al. (2020) [29]	Nonsignificant differences between conditions. 22% Smart-T2, 26% QuitGuide, 30% usual care at 4 weeks point-assessment. 22% Smart-T2, 15% QuitGuide, 15% usual care at 12-weeks point-assessment.	Not reported.	Not reported.
Hertzberg et al. (2013) [30]	Nonsignificant differences between conditions at 4-week point-assessment (82% experimental vs. 45% control).	Not reported.	Not reported.

General Smartphone Apps			
Author	**Abstinence**	**Tobacco Use**	**Relapse Rates**
Hicks et al. (2017) [31]	Nonsignificant differences between conditions at post-treatment (60% experimental vs. 100% control) and at 2-week point-assessment (60% experimental vs. 67% control).	Not reported.	Not reported.
Janes et al. (2019) [32]	Not reported.	Nonsignificant differences between conditions in CPD reduction. Significant reductions in CPD from baseline to 1-month follow-up under both conditions.	Not reported.
Krishnan et al. (2019) [33]	Nonsignificant differences between conditions at 30-day point-assessment (3% experimental vs. 2% control).	Nonsignificant differences in CPD between baseline and 30-day point-assessment.	Not reported.
Masaki et al. (2019) [34]	64% from weeks 9 to 24, 76% from weeks 9 to 12, and 58% from 9 to 52 weeks in continuous abstinence rate.	Not reported.	Not reported.
Masaki et al. (2020) [35]	Significant differences between conditions in continuous abstinence rates from weeks 9 to 12 (75.4% vs. 66.2%), 9 to 24 (63.9% vs. 50.5%), and 9 to 52 (52.3% vs. 41.5%) in favor of the experimental group.	Not reported.	Significant differences between conditions in time to the first lapse after the quit date in favor of the experimental group.
McClure et al. (2018) [36]	25% at the quit date and 0% at the 5-day follow-up.	Not reported.	Not reported.
Minami et al. (2018) [37]	12.5% at 2-week, 4-week, and 3-months point-assessment.	All participants reported reductions in CPD from baseline to 2-week, 4-week, and 3-month point-assessments.	Not reported.
O'Connor et al. (2020) [38]	Nonsignificant differences between conditions at post-treatment (36% combined group, 20% ACT, and 24% behavioral support). Nonsignificant differences between conditions at 6-month follow-up (24%	Significant differences in CPD reduction in favor of the combined condition.	Not reported.

General Smartphone Apps			
Author	**Abstinence**	**Tobacco Use**	**Relapse Rates**
	combined group, 24% ACT, and 20% behavioral support).		
Raiff et al. (2017) [39]	1.25% at baseline, 13.8% at tapering, 35.5% at abstinence induction, and 0% at 1-month follow-up.	Not reported.	Not reported.
Wilson et al. (2019) [40]	Cohort 1: 40% at post-treatment and 20% at 3-months follow-up. Cohort 2: 38% at post-treatment and 15% at 3-months follow-up.	Cohort 1: 20% reduced CPD at post-treatment. Cohort 2: 38% reduced CPD at post-treatment	Not reported.

ACT acceptance and commitment therapy, App smartphone application, CPD cigarettes per day, PPA point prevalence abstinence.

2.1.2. Combine Apps with Face-to-Face Contact (FFSC-Apps)

Of the seven studies that used comparison groups, four were RCTs [29][38][35][32] and three were CCTs [30][31][33]. Four studies compared two mobile apps [30][31][35][32], one compared the use of a mobile app (experimental group) to brief advice (control group) [33], and two studies compared three treatment conditions [29][38]. Regarding smoking cessation outcomes (**Table 1**), one showed significant differences in abstinence rates between groups [35]. Regarding CPD outcomes, one study found significant reductions in CPD from baseline to the 1-month follow-up [32], and one study showed that participants who had not stopped smoking in the combined condition (app combined with Acceptance and Commitment Therapy (ACT) face-to-face treatment) reported significantly less CPD at post-treatment compared to the other two conditions. Finally, one study found no significant differences between study arms [33]. The remaining studies did not report CPD outcomes.

2.2. Effects of Smartphone Apps on Abstinence, Tobacco Use, and Relapse Rates Regarding the Methodological Quality of the Studies

Regarding methodological quality, six studies obtained a strong quality in the EPHPP tool [17][20][29][18][38][35]. All of them (6/6) measured abstinence outcomes [17][20][29][18][38][35], one of them (1/6) also measured CPD outcomes [38], and one (1/6) also measured relapse rate outcomes [35]. In addition, all of them used active comparison groups (e.g., apps, SMS). Of these studies, two obtained significantly higher abstinence rates in the experimental group compared to the control group [17][35], and one found significantly higher abstinence rates in the control group compared to the experimental group [18] (see **Figure 1**). Moreover, the study that also measured CPD [38] showed significantly higher reductions in CPD in the experimental group. In the same vein, the study that also measured relapse outcomes [35] obtained a significantly higher time to the first lapse after the quit date in favor of the experimental group compared with the control condition.

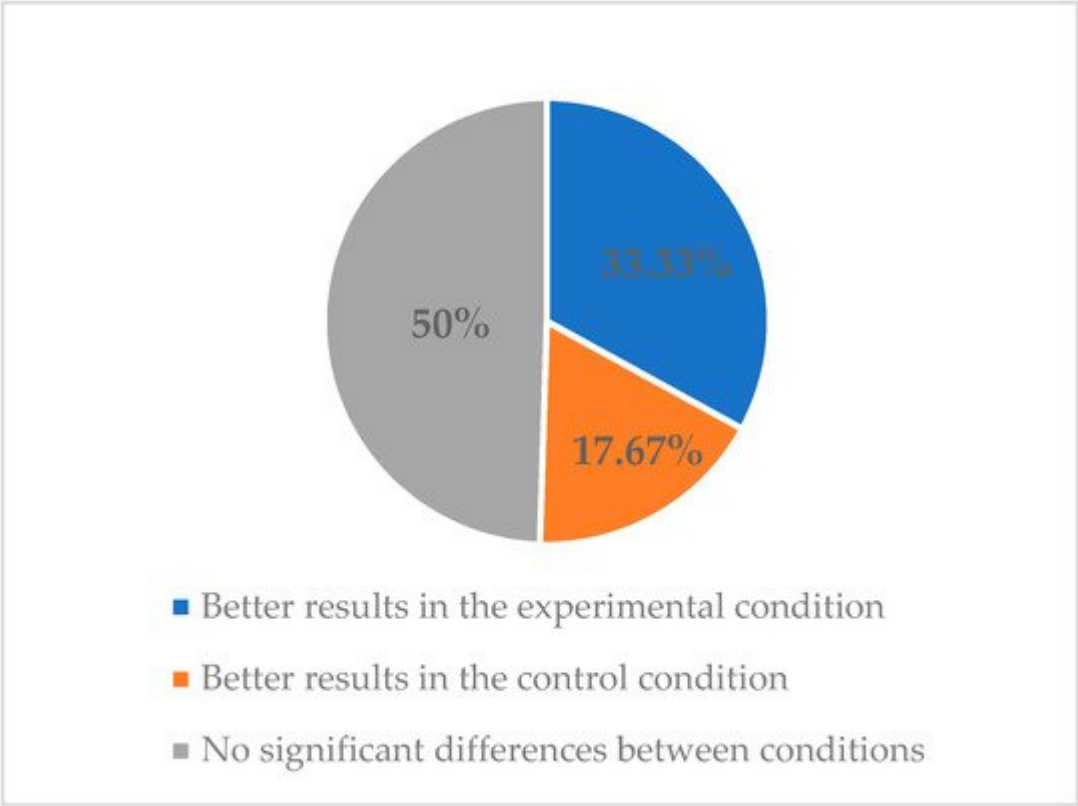

Figure 1. Classification of articles with strong methodological quality based on the abstinence results obtained.

2.3. Features of Smartphone Apps for Smoking Cessation

Regarding the features of smoking cessation apps (**Table 3**), we clustered them into the following groups depending on the content of the apps: CO; set a quit date; EMAS; self-tracking or smoking self-report; mindfulness content; and ACT content.

3. Summary

Overall, smoking cessation apps are useful tools for smoking cessation. Most studies using a comparison group showed that smartphone apps were at least as useful as the control conditions (e.g., brief advice, other mobile apps), obtaining abstinence rates at the end of treatment ranging from 36 to 100%. Regarding before-and-after studies, the abstinence rates obtained ranged between 12.5 and 51.5%. Despite these abstinence outcomes being lower than those obtained in conventional psychological and pharmacological interventions [41], the possibility of increasing treatment access to a wider population of smokers makes them promising tools in terms of public health impact. Additionally, results from studies measuring CPD suggest that smoking cessation apps are also as effective as control groups (e.g., print-based self-help materials, other mobile apps) in reducing cigarette use. More research is needed to obtain more accurate conclusions about relapse rates, because only one study assessed this outcome.

In summary, smoking cessation apps are promising tools that could be easily integrated into smoking cessation treatments. They may be able to improve some clinical aspects such as motivation and treatment adherence. Moreover, professionals can use these apps to facilitate communication with the patient, provide content in an easier way, and obtain different data that can improve the effectiveness of treatments.

More research with strong methodological quality is needed to determine more accurately the effect of mobile apps, combined or not with face-to-face contact, on smoking cessation outcomes. Moreover, future studies should design smoking cessation apps adhering to standard guidelines [42][43] and using rigorous methodologies, including sample size calculations, intention-to-treat analysis, and longer follow-up periods. Due to the emerging development of this field, it is expected that future research will resolve the current limitations to draw clear conclusions.

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