

NicOff : A DIGITAL STRATEGY FOR TOBACCO CESSATION- A COMPREHENSIVE REVIEW

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Abstract

Tobacco use remains one of the leading causes of preventable death worldwide, and India bears a disproportionate share of this burden as the world's second-largest consumer of tobacco. Conventional cessation services in India are constrained by inadequate infrastructure, a shortage of trained personnel, and limited reach beyond clinical settings, leaving most tobacco users without access to an effective cessation intervention. The rapid growth of mobile phone ownership and smartphone penetration has created an opportunity to deliver low-cost, scalable, and continuous cessation support outside conventional healthcare settings. This review examines the rationale, evidence base, and design principles underlying mobile health (mHealth)-based tobacco cessation interventions, with particular reference to NicOff, a proposed mobile application-based digital companion for tobacco cessation. The burden of tobacco dependence, established cessation strategies, the evolution and components of cessation-focused mobile applications, behavioural and pharmacological approaches, personalization and user-centred design, engagement and adherence, safety and ethical considerations, and existing research gaps are discussed. The available evidence suggests that digital interventions combining behavioural change techniques, self-monitoring, personalization, and artificial intelligence-enabled support hold considerable

promise for improving tobacco cessation outcomes, although robust long-term efficacy data remain limited.

Keywords: Digital health; mHealth; mobile application; NicOff; nicotine dependence; tobacco cessation

Introduction

Each year, India accounts for approximately 1 million of the 6 million deaths worldwide attributed to tobacco-related causes. With 266.8 million users, India is the world's second-largest consumer and third-largest producer of tobacco. Unlike most other countries, smokeless tobacco is the predominant form of tobacco use in India, used by 21% of the population compared with 11% who smoke. It is estimated that 92% of tobacco users have never received an effective cessation intervention, largely because of the scarcity of cessation programmes outside healthcare settings and the shortage of trained healthcare professionals. Consequently, non-resource-intensive interventions are needed in India and other low- and middle-income countries.¹

The Government of India's existing text-messaging tobacco cessation programme is based on the World Health Organization's (WHO) "Be Healthy, Be Mobile" tobacco cessation manual; however, tobacco users were not actively involved in its development. Furthermore, although the efficacy of other individual- and community-level cessation programmes has been studied in India, most are designed either for smokers alone or as workplace interventions, rather than as individual-level interventions for the general public. To address these gaps, the "To Quit" text-messaging intervention was systematically developed as a contextually appropriate and potentially scalable cessation programme.¹

This review outlines the process leading to the development of To Quit, from the identification of promising behavioural change techniques (BCTs) for tobacco cessation to the final intervention content and the conceptual framework describing the hypothesised pathways to behaviour change.¹

Building on this rationale, NicOff is proposed as a digital companion for tobacco cessation that bridges the gap between conventional cessation services and continuous, user-centred digital support, with the potential to improve accessibility, engagement, adherence, and long-term tobacco abstinence.

Burden of Tobacco Dependence

Around 80% of the 1.2 billion tobacco users worldwide live in low- and middle-income countries,² where the burden of tobacco-related illness and death is heaviest. The tobacco epidemic is among the greatest public health threats the world has faced, responsible for more than 7 million deaths annually and considerable disability and long-term suffering from tobacco-related diseases.² It is a major cause of death and disease in India, accounting for nearly 1.35 million deaths every year; India is also the second-largest consumer and producer of tobacco, with a wide range of tobacco products available at very low cost.

According to the Global Adult Tobacco Survey (GATS) India 2016–17, nearly 267 million adults aged 15 years and above (29% of all adults) in India use tobacco in some form. Smokeless tobacco is the most prevalent form of use, with khaini, gutkha, and betel quid with tobacco being commonly used products; bidi, cigarette, and hookah are the principal smoking forms. Of current tobacco users, 48.8%, 45.6%, and 5.6% were smokers, smokeless tobacco users, and dual users, respectively. Most smokers (61%) and smokeless tobacco users (41%) showed medium dependence, although physical dependence was considerably higher among smokeless tobacco users (41.3%) than among smokers (20.4%).

The prevalence of smoking among Indian adults aged 15 years and above rose from 8.1% in 2020 to 9.3% in 2024. This increase was driven largely by male smokers, among whom prevalence rose from 14.4% in 2020 to 16.7% in 2024, compared with 1.4% among adult females in 2024. The total number of smokers in India increased from approximately 80.48 million in 2020 to 100.2 million in 2024. Smoking-related mortality remains a major concern, with 1,048,266 deaths recorded in India in 2021 (8.92% of all deaths), including 233,679 female deaths (4.59% of all female deaths) and 814,587 male deaths (12.23% of all male deaths).³

Globally, tobacco use was estimated to be responsible for 7.36 million (95% uncertainty interval [UI] 6.37–8.30 million) deaths in 2023, comprising 5.59 million (4.85–6.30 million) deaths among men and 1.77 million (1.47–2.04 million) among women, along with 203.5 million (175.0–231.7 million) disability-adjusted life-years (DALYs) lost. These figures represent increases of 24.4% in deaths and 8.3% in DALYs since 1990. Tobacco exposure remained the leading risk factor for death among men in 2023, accounting for 17.3% of all-cause male mortality.⁴

Principles and Strategies of Tobacco Cessation

Having examined the efficacy of cessation programmes and the factors influencing their success, this section outlines the two principal approaches to implementation: hospital-based and community-based interventions.

Hospital-based interventions

Hospitalisation offers a unique opportunity for clinicians to encourage smoking cessation. Brief advice delivered during admission is beneficial but must be combined with structured cessation treatment for long-term effectiveness. Staff education- engaging doctors, nurses, volunteers, and other frontline personnel is central to ensuring competent delivery and to sustaining cessation programmes over the medium to long term. This can be supported through electronic medical records, provider alerts, and prompts flagging known smokers in patient charts. Increasing the number of staff dedicated to cessation services, or allocating existing staff more time for this purpose, along with adequate funding, is essential for successful implementation. Investment in multi-strategic approaches is key to achieving sustained reductions in smoking prevalence.⁵

Community-based interventions

Community-based interventions use behavioural strategies to address harmful tobacco-related behaviours. The Courage-to-Quit (CTQ) programme is one such intervention, evaluated in a cohort study assessing its feasibility and efficacy in a racially diverse urban smoking population. It is a semi-structured intervention comprising orientation and psycho-education sessions of set duration. Reported quit rates of around 36% are consistent with tobacco treatment guidelines, while feasibility (75%) and acceptability (95%) rates, together with favourable economic outcomes, highlight its pragmatic value. Other community-based approaches include quit classes, telephone quit-lines, and individual cessation counselling. Multi-strategic community interventions of this kind can help lower smoking prevalence, increase quit rates, and sustain long-term abstinence.⁵

Emergence of Mobile Health Interventions

According to the International Telecommunication Union (ITU), there were more than seven billion mobile phone subscriptions worldwide in 2015—approximately 96.8 per 100 people, ranging from 120.6 per 100 in high-income countries to 91.8 per 100 in low-income countries.

Mobile broadband access was also expanding rapidly, with an estimated 47% of the world's population subscribed to mobile broadband compared with 29% with fixed broadband connections.¹ Smartphones—mobile phones with a computer operating system—are increasingly becoming the preferred, or most accessible, computing device in many countries. Smartphones are reported to account for approximately 45% of all mobile phone subscriptions worldwide, and this proportion is expected to rise further given that they represent 75% of new mobile phone sales.⁶

NicOff, the mobile intervention discussed in this review, employs behaviour-change strategies such as goal-setting, self-monitoring, reminders, feedback, motivational messaging, educational content, and progress tracking—features that are particularly relevant to behavioural health interventions such as tobacco cessation, where sustaining motivation and managing cravings are essential for long-term success.

Mobile Applications as a Tool for Tobacco Cessation

Research on smoking-cessation applications has identified a variety of distinctive, purpose-built mobile applications across platforms, most delivered via smartphone app stores, with one tablet-based programme designed for hospital inpatients.² Some studies were confined to a single platform (e.g., iPhone), while others delivered cessation support through existing social media platforms such as WhatsApp or Facebook. Automated data-extraction features were used in several studies, and automated motivational messaging and structured daily educational content were common. One study incorporated exercise as a strategy for managing post-cessation relapse and withdrawal symptoms. Overall, most applications combined social support, cost-saving calculators, coping-skills training, visual and audio-visual aids, and structured quit plans.²

Essential Components of Tobacco Cessation Apps

A systematic content analysis of 48 versions of 42 tobacco-cessation apps, incorporating 1,414 associated user reviews, identified five key themes: supportive features and tools; usability; influence on smoking behaviour; perceived benefits of quitting; and the app's role as a supplementary aid to quitting. Among 36 free, publicly accessible apps assessed using the Mobile

App Rating Scale (MARS), the mean score was 3.10 (SD 0.71; range 2.00–4.47), with an inverse relationship observed between MARS scores and average user star ratings.³

Participants in one mobile-app cohort study reported high acceptability, rating the app 4.40–4.76 on a 5-point scale across three cohorts, and engaged with app features for an average of 89–159 minutes over 35 days. The most valued features were the quit plan, tracking tools, reminders and notifications, “MOtalks,” and motivational quotes. The 7-day point-prevalence abstinence rate in the intention-to-treat population of one cohort was 58% at 6 weeks and 52% at 12 weeks; more frequent and diverse engagement with app features was associated with a greater likelihood of sustained abstinence. Each additional login was associated with a 5% increase in the odds of abstinence at 12 weeks (odds ratio [OR] 1.05, 95% confidence interval [CI] 1.01–1.08), and participants earning more than 5,000 points had substantially higher odds of quitting at 6 weeks (OR 3.12, 95% CI 1.25–7.75) and 12 weeks (OR 4.65, 95% CI 1.83–11.76) compared with those earning fewer points.⁴

TControl is an application that monitors smokers attempting to quit, interprets their status, and delivers advice and psychological support messages, alongside a bidirectional text-messaging channel between patients and clinicians and a peer-chat feature. The app demonstrated stable, high performance during startup and message delivery, with age and gender showing no statistically significant effect on users' ability to use it. TControl was estimated to have the potential to reduce costs to the Catalan public health system by up to €400 million over 10 years.⁷

In one data-collection protocol, participants accessed a therapy application via Telegram and completed a form covering age, gender, education, and occupation before choosing a module for smoking cessation, cannabis cessation, or physical activity. Depending on the module selected, participants answered relevant screening questions, were encouraged to create self-recordings, and received motivational messages to support progress.

Behavioural Change Techniques and Psychological Support

Pharmacological therapy

Pharmacotherapy offers a range of options that reduce cravings, lessen nicotine withdrawal symptoms, and improve the likelihood of successful cessation. Nicotine replacement therapy (NRT), bupropion, and varenicline are the principal agents in this field. In addition to bupropion

and varenicline, the US Food and Drug Administration (FDA) has approved five NRT formulations—patches, lozenges, gum, inhalers, and nasal sprays—as important components of cessation therapy. Recent randomised controlled trials have demonstrated the efficacy of NRT over placebo. Bupropion and varenicline act on nicotine receptors in the brain and can reduce the discomfort of quitting; because of potential side effects and drug interactions, they are typically combined with counselling or support-group participation as part of a structured quit plan, under medical supervision. Pharmacotherapy therefore forms one component—rather than the sole basis—of a successful cessation strategy.⁸

Behavioural counselling

Behavioural therapy is a non-pharmacological approach using rewards, motivational interviewing, and cognitive-behavioural strategies to encourage and reinforce behaviour change. Grounded in behavioural and cognitive psychology, these techniques are often used together, employing goal-setting (e.g., setting a quit date), self-monitoring (e.g., identifying the times and situations associated with smoking), rewards, and skills training to help smokers resist urges after quitting, thereby improving self-control over smoking behaviour.⁸

Combination treatment

Combination therapy integrates behavioural and pharmacological approaches, typically comprising brief physician- or nurse-delivered interventions that combine medication with cessation advice; this is the most widely used approach among smokers seeking help to quit. Although more than 60% of smokers report wanting to quit, clinicians often encounter limited patient motivation to act on this intention. Incorporating psychotherapeutic techniques to manage side effects can improve overall outcomes, treatment retention, and the effectiveness of cessation programmes.⁸

Personalization and User-Centred Design

NicOff uses the Modified Fagerström Test for Nicotine Dependence to tailor treatment to individual users, with care pathways developed according to whether dependence is rated as high, moderate, or mild (Table 1).

Table 1: Personalized care pathway by level of nicotine dependence

Highly Dependent	Moderately Dependent	Minimally Dependent
● Brief counselling ● Behavioral interventions ● Lifestyle modification ● Yoga therapy ● Nicotine replacement therapy (NRT)	● Brief counselling ● Behavioral interventions ● Lifestyle modification ● Yoga therapy ● Nicotine replacement therapy (NRT)	● Brief counselling ● Behavioral interventions ● Lifestyle modification ● Yoga therapy ● Nicotine replacement therapy (NRT)

Personalization and user-centred design can enhance self-efficacy, engagement, adherence, and long-term behavioural change in tobacco-cessation apps. Advanced applications may increasingly draw on artificial intelligence and user-generated data to continuously refine recommendations and remain responsive to users' evolving needs.

App-Based Monitoring and Self-Management

The application can track a user's tobacco-use patterns and progress over time. Daily tobacco-use tracking records the number of cigarettes, cigars, bidis, or smokeless tobacco products consumed. Craving monitoring logs the frequency, intensity, and duration of cravings, while trigger identification records situations—such as stress, alcohol, caffeine, social settings, or post-meal periods—associated with tobacco use.

Quit-day tracking records the number of days since cessation, and relapse monitoring logs slips or relapses and helps identify contributing causes. Withdrawal-symptom tracking monitors irritability, anxiety, restlessness, difficulty concentrating, and sleep disturbance. A progress dashboard displays milestones achieved, money saved, and cigarettes avoided, while notifications and reminders support counselling sessions, motivational messaging, and medication or NRT adherence.

Self-control strategies

The app's features can be used to actively manage cravings and withdrawal symptoms.

A. Craving management: brief attention-diversion techniques (approximately 5 minutes); deep-breathing exercises; mindfulness and relaxation techniques; drinking water; and physical activity, summarised as “delay, deep breath, drink water, and do something else.”

B. Behavioural self-regulation: selecting a quit date; setting daily and weekly goals; avoiding known triggers; identifying alternative activities; listing personal reasons for quitting; and applying coping strategies in high-risk situations.

C. Motivation: daily inspirational messages; achievement badges and milestones; visual reminders of the health benefits of quitting; calculation of money saved; and tracking of tobacco-free days.

Advantages

- Available 24/7
- Promotes patient participation and autonomy
- Provides continuous monitoring
- Helps identify personal triggers
- Offers immediate feedback during cravings
- Improves motivation and adherence
- Helps prevent relapse
- Can complement professional counselling

User Engagement and Adherence

Digital cessation interventions can help smokers quit, but user engagement is generally low; because engagement is positively correlated with quitting success, low engagement may limit the effectiveness of digital therapies. This suggests that engagement is itself a major determinant of intervention effectiveness, making it a research priority to identify intervention content and design features—such as interactivity and customisation—that encourage sustained participation.² The evidence-based Smoke Free app (www.smokefreeapp.com), which gains around 3,000 new downloads daily, provides a useful test bed for such research; one experimental study examined whether an artificial intelligence (AI)-powered supportive chatbot within the app increased user engagement and quitting success at one-month follow-up compared with a version without the chatbot.⁹

User engagement and adherence are key determinants of the success of mobile cessation apps. Long-term engagement depends on the app being personalised, dynamic, easy to use, encouraging, and rewarding. Real-world effectiveness can be assessed through adherence metrics such as login frequency, feature utilisation, completion of quitting activities, and retention over time.

Effectiveness and Clinical Outcomes

Numerous cessation programmes have been developed with varying levels of effectiveness, spanning behavioural, pharmacological, and combination approaches. Giulietti et al. demonstrated the enhanced effectiveness of combining NRT formulations: in one trial included in their analysis, adding fast-acting NRT to a nicotine patch increased abstinence rates by 5% compared with patch monotherapy. Their analysis also showed that varenicline—a partial nicotinic-receptor agonist known to reduce cravings—was more effective when combined with behavioural therapy or NRT than when used alone.⁵

Safety, Privacy, and Ethical Issues

As NicOff handles personal, behavioural, and potentially sensitive health-related information, safety, privacy, and ethical considerations are essential to its development. Informed consent, data minimisation, and secure storage should be built into app development from the outset, with particular attention to confidentiality, responsible use of user data, algorithmic transparency, and prevention of unauthorised data sharing.

Challenges in the Development and Implementation of Cessation Apps

India's high mobile-phone density enables greater outreach, engagement, and real-time delivery of cessation and awareness interventions, particularly in underserved areas. Nonetheless, the widespread adoption of digital tobacco-control interventions in India remains limited, constrained by low digital literacy and inadequate infrastructure.¹⁰ Beyond individual-level cessation support, mobile technology has also been used to strengthen the public-health workforce itself—for instance, through smartphone-based training programmes for tobacco-control personnel in India—underscoring its broader utility across the cessation care continuum.¹¹

The development and implementation of tobacco-cessation apps face several challenges, including low user engagement, poor long-term adherence, limited personalisation, and variable user

motivation to quit. Ensuring data accuracy, privacy, security, and the ethical use of personal health information is essential. Technical barriers such as device compatibility, internet accessibility, usability, and integration with healthcare services may further limit adoption, and many apps lack robust clinical evidence or standardised evaluation frameworks, making their effectiveness difficult to establish.

Future Perspectives: AI and Digital Innovation

According to Mohr et al.'s "Model of Supportive Accountability," human support enhances adherence to digital health interventions by fostering a sense of accountability to a coach perceived as trustworthy, benevolent, and competent.¹² Artificial intelligence is increasingly being explored as a means of approximating this human support at scale, helping bridge the gap between expertly personalised support and scalable digital interventions.¹³ AI has the potential to transform tobacco-cessation apps from simple tracking tools into intelligent, personalised digital companions capable of providing timely support throughout the quitting journey; NicOff is envisaged to incorporate AI as one such supportive tool.

Research Gaps

Although mobile applications for tobacco cessation are becoming more widely available, several questions remain unanswered. Evidence of long-term efficacy and sustained user adherence is lacking, and existing studies show considerable heterogeneity in intervention components, study designs, and outcome measures. Personalisation based on nicotine dependence, smoking patterns, triggers, and individual preferences remains insufficient, and many apps lack theoretically grounded, empirically validated behavioural components. While artificial intelligence offers potential for real-time personalisation, relapse prediction, and adaptive support, further research is required to establish its therapeutic efficacy, reliability, transparency, and ethical implications. Additional gaps include inadequate coverage of diverse and low-resource populations, limited integration with healthcare providers, and unresolved privacy and data-security concerns.

Conclusion

By integrating evidence-based behavioural techniques, self-monitoring, individualised support, and sustained user engagement, the NicOff app offers a feasible and accessible approach to tobacco cessation. Artificial intelligence and adaptive technologies may further personalise interventions

and provide timely assistance for cravings, withdrawal symptoms, and relapse prevention. Future research should focus on evaluating the engagement, long-term efficacy, and practicality of AI-enabled mobile cessation interventions. With continued technological and clinical development, mobile applications have the potential to play a significant role in comprehensive, patient-centred tobacco-cessation programmes.

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Conflicts of Interest

There are no conflicts of interest.

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