

Problematic smartphone use: Digital approaches to an emerging public health problem

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Abstract

Problematic smartphone use is an emerging public health problem since the launch of the first smartphone 10 years ago. In this article, pathways to problematic use of smartphones, approaches to deal with this issue and their limitations are discussed. This includes problematic use of smartphones by people who self-identify that they or their family members use mobile devices in a problematic way. Extreme problematic use (e.g. relating to online gambling or heavy gaming) that severely disrupts people's lives is a form of digital addiction is excluded from this discussion. Smartphone use can be problematic for some people due to the availability of constant connection, the addictiveness of applications (apps) combined with personal psychological factors. This is facilitated by characteristics of the technology, including easy access, the possibility of escaping daily life, being able to remain anonymous online, and the frequency of alerts and messages. While various non-technical interventions, such as digital detoxes, and digital interventions, including apps to limit use, have been developed to help people control their smartphone use, none of these has proven to work yet. An overview of currently available apps for problematic smartphone use is provided. Further work is needed on various aspects of problematic smartphone use, including the understanding of how smartphone use impacts on people's lives, strengthening the definition of problematic smartphone use, and validation of its measurement, and more rigorous development and assessment of tools. We hope that these efforts will help people to use their smartphones in a healthy and effective way.

Keywords

Problematic smartphone use, digital interventions, addiction, Internet

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Problematic smartphone use as a public health problem

It is only 10 years since Apple launched the first iPhone, but problematic smartphone use has become a new challenge to population health. Problematic use of the mobile phone can be defined as 'an inability to regulate one's use of the mobile phone, which eventually involves negative consequences in daily life (e.g. financial problems)'.¹ The estimated prevalence is up to 38%, depending on the setting (e.g. UK, USA, China), definition and scales used to quantify a person's behaviour.^{1–4} Findings from a UK survey showed that almost half of respondents spend more time online and on social media than originally intended each day. UK adults are online on average for a day per week (25 h), 40% go online more than 10 times a day and 10% more than 50 times a day.⁵ Four in 10 UK adults find that they spend too much time online, 60% consider

themselves 'hooked' to the Internet and about one-third find it difficult to disconnect.⁵ Younger people are the most frequent users of smartphones and the Internet and therefore more likely to be affected by problematic use.

The constant availability of connected personal devices like smartphones combined with the addictiveness of popular applications (apps) can become

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problematic when people use them in unproductive or even harmful ways.⁶ The specific issues arising from overuse of smartphones and the Internet are not fully understood, but include: (a) psychological effects such as poor memory, concentration and decision-making, anxiety, procrastination and sleep disturbance; (b) social effects such as negative impact on relationships and loss of sense of community; (c) physical effects such as harm from accidents, repetitive strain injury (RSI) and posture.⁷ One in eight respondents in the UK survey felt nervous or anxious when being offline. Smartphone use also impacted on sleep as about half had missed out on sleep; checked their phone as the last thing before going to bed; made sure their phone was within reach when going to bed; and checked their phone first thing after waking up. Furthermore, one in eight respondents admitted to being late for work sometimes because of procrastinating by spending time online, and almost half neglected housework.⁵ Specifically social media use has been associated with eating concerns, sleep disturbance and depression.⁸ One study found that heavier Facebook users agreed more frequently that others were happier and had better lives.⁹

About one-third of respondents in the same survey had missed out on spending time with friends and family, and one-fifth admitted being late for a meeting with them. When talking face-to-face, half found that connected devices interrupted conversations. Almost one in five felt ignored by a friend or family member daily, because that person was using their phone.⁵ In addition, physical effects included those caused by using a smartphone whilst undertaking another activity such as walking or driving. One in four respondents in the UK survey had bumped into someone at least once a week because they were looking at their phone.⁵ Furthermore, a report from the UK Institute for Advanced Motorists in 2012 warned that distraction from mobile phones had been a contributory factor in 1690 road accidents of which 110 were fatal incidents between 2006–2010.¹⁰ Based on this report, the THINK campaign from the UK Department for Transport tells people that they are twice more likely to crash when texting than when drunk driving. From March 2017, using a mobile phone while driving is heavily fined with a £200 fine and six penalty points in the UK. The campaign says that ‘the problem is many of us are addicted to our mobile phones’ and advises people to ‘make the glove compartment the phone compartment’.¹¹ In terms of physical body damage, there are case reports and studies of ergonomic ill-effects, e.g. overuse resulting in pain and musculoskeletal disorders in the upper part of the body (hands, wrists, arms, neck etc.).^{12–14}

Parents’ use of smartphones is closely linked to their children’s use.^{15,16} Many children start using mobile devices even before the age of one year.¹⁷ There is little evidence-based guidance on teaching children to use these devices in a healthy way, and the effects of interactive media technology on children’s cognition and behaviour are largely unknown.¹⁸ This could result in growing public health problems related to overuse of devices including inactivity, lack of sleep, poor relationships with family and friends, depression, anxiety, cyberbullying and poor performance at school.^{19–21}

Several non-technological and technological approaches to dealing with problematic smartphone use have been proposed, which have similarities with approaches used for moderating food or alcohol intake. For example, digital diets where people spend a couple of days without their phone, are a popular short-term approach to break their habit of smartphone overuse.⁵ There are also several apps that can help people with tracking smartphone use and setting goals for moderating use, both for themselves and for their family members. However, none of these have been assessed and there is therefore a lack of evidence on what works effectively to help people manage their Internet and smartphone use.²²

In this article, we describe pathways to problematic use of smartphones, approaches to dealing with this issue, and the challenges faced. This article focuses on problematic use of smartphones by people who self-identify that they or their family members use mobile devices in a problematic way. Extreme problematic use such as that related to online gambling or heavy gaming, which severely disrupts people’s lives is a form of digital addiction that falls outside the scope of this article.^{23,24}

Explaining problematic use of smartphones

Problematic smartphone use is facilitated by characteristics of the technology, including easy access, the possibility of escaping daily life, being able to remain anonymous online, and the frequency of alerts and messages. Popular apps, like the Facebook app, are designed in ways that increase the amount of time people spend on them.²⁵ For example, apps make use of ‘intermittent variable rewards’; this means that designers link a user’s action to receiving a variable reward, which maximises addictiveness. The power of intermittent reinforcement can also be seen in, for example, slot machines where pulling a lever may result in one of a range of prizes, or nothing. Smartphone apps provide these intermittent variable rewards by, for example, notifications, messages, ‘likes’ on social media, and ‘matches’ on dating apps.

‘nomophobia’, the fear of being unreachable,²⁶ and the ‘fear of missing out on something important’ (FOMSI)²⁷ makes it hard for people to turn off their device, to stop notifications or to unsubscribe. Furthermore, people can be sensitive with regard to social approval and reciprocity, which means that they feel obliged to tag others, share achievements and respond quickly to messages when delivery notifications show the sender that they have read them.⁶

Different groups of people based on demographics and psychological characteristics (e.g. age, gender, socio-economic status, introvert/extrovert) have different triggers that make them use their smartphone in a problematic way and which influence attitudes towards use.²⁸ These groups have specific problematic use profiles, because smartphones meet their needs in different ways. Individual characteristics such as high levels of extraversion and low levels of self-esteem have been shown to be predictors of problematic use, and can be linked to behavioural addiction.²⁹ Some work has been done to understand the psychological pathways which lead to problematic phone use.^{30,31} Billieux outlined different routes to problematic smartphone use based on traits such as impulsivity, ability to regulate self-control and emotions, self-esteem, neuroticism and distorted thinking.¹ People with poor self-control and/or maladaptive emotion control are susceptible to impulsive decisions that result in using their smartphone in an inappropriate situation (such as driving) because they like to seek risks or cannot inhibit their emotions for another reason. Those with a low level of self-esteem and high level of neuroticism are more likely to have a constant need of reassurance from other people through their smartphone. Extravert people have a higher desire to communicate with others and are prone to use their smartphone phones excessively to maintain and form relationships. Finally, some people overuse smartphones because they enable engagement with games, gambling or social networks.¹

Therapeutic approaches to problematic use of smartphones

Whilst classic mobile phones were mostly used for written or oral communication between two people, smartphones and Internet connectivity allow people to engage with a wide range of activities with multiple people. Addiction models that are applied to excessive behaviours (such as unrestrained gambling or buying products) and substance use (such as alcohol and drugs) can also be applied to problematic smartphone use.¹ For example, using cognitive behaviour therapy (CBT) models to understand and modify cognitions and behaviour associated with problematic use. This

article will focus on technology-based approaches for problematic smartphone use.

Behavioural approaches such as abstinence (giving up) and moderating use (cutting down) as well as therapist-driven psychological approaches can be used. Smartphone use can be moderated in terms of the number of times a day a smartphone is used and how much time is spent (similarly to moderating calorie intake). Also, being conscious of emotions that make you want to check your phone and identifying which uses are not helpful, and focussing on moderating those can be helpful (similarly to focussing on nutrients that food provides).²³ An experiment with a group of management consultants found that taking regular predictable time off from devices resulted in increased efficiency and collaboration, heightened job satisfaction, and a better work-life balance.³² For people with an Internet addiction, detox centres have been established, mostly in Asia, but also in Western countries.³³ Many people who attempt a digital detox (period of time when someone refrains from using digital technologies) without professional help do not seem to succeed. Of the 15 m UK adults who had undertaken a ‘digital detox’, a quarter stayed offline for a day and only 5% for a month.⁵ However, we are unaware of any studies that have assessed the effects of a digital detox for problematic mobile phone use. It might be that, similarly to a very low-calorie diet which is an ineffective strategy for losing weight long-term,³⁴ a digital diet is an ineffective strategy for problematic use.

Several technical suggestions have been proposed to control use, such as: not always answering your phone by selectively turning off alerts; setting limits about not using a phone during certain situations or times; deleting old apps; unfollowing newsfeeds and friends that do not contribute usefully; and cleaning up email subscriptions.³⁵ The positive effects of regulating problematic smartphone use with digital interventions have not been widely studied. A recent systematic review of interventions for problematic Internet use screened 182 articles of which only three studies assessed digital interventions for problematic use. The included studies were pilots with small sample sizes. Two of the included studies assessed the efficacy of online interventions for Internet addiction and gaming addiction.²² Only one included study reported on the design and development of an app for smartphone addiction, of which the effectiveness had not been evaluated yet. The smartphone addiction app monitors use, provides use analytics, and provides prevention and treatment suggestions.²²

Despite this lack of empirical data, many apps have been developed to help people with regulating their smartphone use. Such interventions can make people aware of the situation, influence action, and give feedback and thereby use aspects of behaviour change

theories. For example, the transtheoretical (stages of change) model highlights the importance of different stages through which people go when changing behaviour, of which one important initial step is to be aware of the behaviour, and feedback is key to maintain the desired behaviour.³⁶ In addition, apps can be used to more accurately measure actual phone use compared to self-reported use. Self-reported use is not a valid measure as some of our phone interactions are habitual and people generally tend to underestimate their use. Also, people have very little awareness of the number of times they check their phone.^{37,38} It is difficult to correctly log time spent on use when people are switching between activities.³⁹

As this is an underexplored area we aimed to identify and characterise the digital approaches being used by apps currently available for regulating phone use. We searched the website alternativeto.net on 19 December 2016 and conducted an update search on 8 October 2017. We found 48 apps of which we excluded 27 desktop-based only apps and included 21 mobile apps for regulating smartphone use (Table 1). One of these apps was discontinued (no. 9, 'Keep Focus'). We added one app that was launched in October 2017; a newer version of the 'Breakfree' app (no. 3(a)) named 'SPACE' (no. 3(b)). These apps are focussed on personal use, use at work, and family use. Many apps monitor use and can block functions for a period or during certain times of the day. Only one app, 'Forest' (no. 7), uses a gaming technique to keep people engaged with the app; when productivity goals are achieved, the user will grow a tree that can turn into a forest over time.

Challenges with digital approaches to addressing problematic use of smartphones

Apart from the apparent irony in encouraging use of an app to reduce smartphone usage, there are several challenges for current apps for problematic smartphone use, or digital diet apps. Firstly, as documented above, apps lack scientific evidence for their safety, efficacy and effectiveness.²² Although there are measures such as the 20-item self-reported Problematic Use of Mobile Phones (PUMP) scale, and the Mobile Phone Problem Use Scale (MPPUS), which have been adapted from other digital addiction scales, these are not widely used or validated in all populations, and there need to be agreed approaches to assessing the scale of the problem and the size of any benefit. Also, when people use ineffective apps, it may also deter them from trying other approaches. Secondly, in the absence of empirical evidence of effectiveness it would be reassuring to have a sound theoretical basis underpinning the app intervention. However, the majority of the apps identified lack a psychological underpinning and are not tailored

to address the specific needs of different people. None of the current apps acknowledge that there are different types of problematic phone users. Equally, people's willingness and readiness to change needs to be considered. For example, some people might feel that their self-image is impacted as an app might identify them as an addict. Most apps work by blocking access to certain functions of the phone, rather than understanding and challenging the underlying motivators for use. The specific behaviours need to be uniquely targeted for behaviour change to take place. Apps need to involve users to engage people, incorporate their feedback, and have an effective rewarding system.⁴⁰ Engagement is particularly challenging as people become desensitised when they receive the same messages.⁴¹ Thirdly, some apps raise potential problems with data security and information governance, for example adherence to data protection principles. Some, for example, openly disclose the agenda of the app developers, which could lead to sharing of data to third parties.⁴² This can reduce user confidence in the products, and brings into question the ethics of the app. Fourthly, technical and design issues can limit the adoption, usability and effectiveness of an app. For example, an app which drains battery power may not be used for this reason.

Discussion

In this article, we have provided an overview of the emerging public health concern of problematic use of smartphones which affects a considerable and growing number of people.¹⁻⁴ We have described approaches that can help people with moderating their use, and we particularly considered the possible role for digital interventions (apps) for problematic smartphone use. In general there is lack of empirical evidence in this area on the safety and effectiveness of any of these approaches.

Further work is therefore needed on various aspects of problematic smartphone use. Firstly, the definition and measurement of problematic smartphone use requires further validation, and this can establish the true scale of the problem in epidemiological terms, alongside work to measure the health and social impacts. Secondly, we need a more comprehensive understanding of the psychological basis of problematic smartphone use, exploring the associated cognitions and behaviours that precipitate and maintain it. This can then inform the interdisciplinary development of tailored interventions, ideally with contributions from the fields of health psychology and behaviour change, engineering and public health. Nudging and gaming techniques can be incorporated to engage users. Involvement of users is particularly important to

Table 1. Applications for problematic use of the Internet and smartphones.

No.	Name and URL reference	Aim	Features	Smartphone platform	Price
1	AppDetox https://play.google.com/store/apps/details?id=de.dfki.appdetox	Calm down mobile app usage and take a digital detox.	<ul style="list-style-type: none"> • Track use of apps and violations. • Set rules for app use and notifications. • Protect rules with pin. • Reminders. 	Android	Free
2	Blacklist https://masterbuilders.io/blacklist	Block websites for a certain amount of time.	<ul style="list-style-type: none"> • Block websites. • Set rules. 	iPhone, iPad	Freemium
3(a)	BreakFree http://www.breakfree-app.com/	Check addiction levels and unplug and disconnect from smartphone.	<ul style="list-style-type: none"> • Usage monitoring and statistics. • Non-intrusive notifications. • Phone management tools. • Parental control. 	iPhone, android	Freemium
3(b)	SPACE https://phonelifebalance.com/	Find a phone-life balance through behaviour change.	<ul style="list-style-type: none"> • Personalised to the user (based on what type of phone user you are, and what goals you want to set). • Positive messaging and experience to support behaviour change. • User-based tools to define level of interruption. • Social functionality to drive behaviour change based on reciprocity. 	Android, iPhone	Freemium
4	Checky http://checkyapp.com/	Helps become aware of phone usage, which can help to make changes.	<ul style="list-style-type: none"> • Find out exactly how much you are using your phone. • Compare your stats with friends. • Location tracking. 	iPhone, android	Free
5	ClockIn Portal https://www.clockinportal.com/	Track time of employees.	<ul style="list-style-type: none"> • Automatic tracking — auto populated details of tasks. • Clock in and out, track lunches. • Record time spent details. • Team members can easily enter the hours spent on completing project activities. 	Android	Freemium
6	Cold Turkey https://getcoldturkey.com/	Temporarily block popular social media sites, addicting websites and games so work can be done.	<ul style="list-style-type: none"> • Block websites, apps, and lock device completely. • Create whitelist of allowed activities. • Schedule blocks and allow breaks. • Track progress. 	Android	Freemium
7	Forest https://www.forestapp.cc/	Stay focused on work; plant a seed that will grow in a tree when 30 min of productivity is achieved.	<ul style="list-style-type: none"> • Make personal pattern of time management. • Share forest with friends. • Track history. • Customize allowed activity. 	Android, iPhone, Windows phone	Commercial
8	Moment https://inthemoment.io/	Track personal and family use of iPhone and iPad each day, automatically.	<ul style="list-style-type: none"> • Automatic tracking, including movements on a map. • Monitor and set limits for family screen time. • Screen-free family dinner time. • Set daily limits and reminders. • Background app. 	iPhone	Freemium

(continued)

Table 1. Continued.

No.	Name and URL reference	Aim	Features	Smartphone platform	Price
9	Keep Focus DISCONTINUED	Fewer distractions; better focus; unlimited productivity.	<ul style="list-style-type: none"> Block apps, websites, calls, and Internet connection. Notifications when accessing a blocked feature. Open a productivity app when accessing a blocked app. Challenge phrase to be entered to change the settings. Schedule blocks and allow breaks. Link to official Keep Focus site. 		
10	Offtime http://offtime.co/	Monitor and customize connectivity; unplug and focus on your work, have quality time with people, or enjoy some peace of mind.	<ul style="list-style-type: none"> Block calls, texts, notifications, apps, the Internet. Calls and texts from VIP contacts remain unblocked. Custom auto-replies. List of missed phone activity. Profiles that fits needs. Schedule and auto-start profiles with calendar. Widgets for fast access. Phone and app usage analytics and compare to others. Set goals and reminders for excessive usage. 	Android, iPhone	Freemium
11	Procrastination Punisher https://play.google.com/store/apps/details?id=com.greatbytes.procrastination.punisher&hl=nl	Reduce procrastination.	<ul style="list-style-type: none"> Disable apps for certain time frames. Donate to charity for violations. Notifications. 	Android	Free
12	RescueTime https://www.rescuetime.com/	Understand exactly how time and attention is spend.	<ul style="list-style-type: none"> Auto tracking of software and sites use. Set goals and alerts. Compare productivity to the average RescueTime user. 	Android	Freemium
13	SaveMyTime — Time Tracker http://savemytime.co/en/	Handles analysis and provides information how time is spent and level of productivity.	<ul style="list-style-type: none"> Tracks online and offline activities Replaces standard lock screen and ask 'What have you been doing since you last checked your phone?', then it takes the input, analyses and gives insights how time is spend. 	Android	Free
14	Self Control for Study https://play.google.com/store/apps/details?id=com.specialj.selfcontrol&hl=nl	Reduce use of smart phones; for a specified period, apps are banned to help focus.	<ul style="list-style-type: none"> Block apps. Weekly and daily graphs. Call, messages, and specific apps that you set can always be executable. 	Android	Free
15	Time Doctor https://www.timedoctor.com/	Time management of remote staff.	<ul style="list-style-type: none"> Real time tracking of tasks with reports sent to other team members. Provides reports of websites visited and apps used. 	Android, iPhone	Freemium
16	Freedom https://freedom.to/	Free you from the distractions of the internet, allowing you time to code, write, or create.	<ul style="list-style-type: none"> Disables networking for up to eight hours at a time. At the end of your selected offline period, Freedom re-enables your network, restoring everything as normal. 	Android	Commercial

(continued)

Table 1. Continued.

No.	Name and URL reference	Aim	Features	Smartphone platform	Price
17	Focus me https://focusme.com/	Block all distractions on your devices to help to get your work done.	<ul style="list-style-type: none"> • Blacklist • Whitelist • Time tracker • Time limiter • Scheduler • Break reminder • Pomodoro timer • Forced mode • Password protection 	Android	Commercial
18.	Luna Launcher https://www.lunalauncher.com/	Parental control and a kid's home screen and prevent kid phone addiction.	<ul style="list-style-type: none"> • Features for parents. Time slots and geo fencing: block selected apps when your child is at school or family time. • Track time spent on apps, time usage per day. • Lock down the device when kids over-use. • Easily switch between parent mode and kid mode. • Apps for kid: age appropriate apps for your children. Features for kids Prevent smartphone addiction. • Easy for kids to navigate their content. • Limit to a list of selected apps and actions. • Actions are one click job. • Add favourite YouTube channels, play-lists and videos. • Easy for kids and toddlers to learn how to use smartphone. 	Android	Freemium
19.	Agendrix https://www.agendrix.com/	Optimize employee scheduling in a cost-effective manner.	<ul style="list-style-type: none"> • Submit approval requests for leave, shift transfers, and availability directly. 	Android, iPhone	Free
20.	Stay Focused: Stay Productive https://stay-focused-225d4.firebaseio.com/	Helps you focus by restricting the daily usage of blocked apps to the selected time.	<ul style="list-style-type: none"> • Block apps based on daily usage and stay focused. <ul style="list-style-type: none"> • Track daily time spent while using the app itself. • Quick play pause without changing existing settings. 	Android	Free
21.	ScreenTime https://screentimelabs.com/	Manage the time your kids spend on their tablets and smart phones.	<ul style="list-style-type: none"> • Time limits. Easily set time limits for your children's devices right from your phone or any browser. • School and bedtime. Set bedtime and school time restrictions for specific apps. • Pause and play. Use your phone or tablet to pause your child's device or give bonus time. • Homework and tasks. Create fun check lists of things you would like children to do or learn and motivate them with rewards. 	Android, iPhone	Freemium (basic services are free while for more advanced features must be paid for)

ensure that solutions are user-centred and engaging. Thirdly, interventions for problematic smartphone use need rigorous evaluation to measure their effectiveness. We hope that these efforts will help to develop useful tools for people to use their smartphone in a healthy and effective way.

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