Mobile apps for oral healthcare: recommendations for navigating uncharted terrain

Clement Seeballuck,*[1] Alex Blair,[2] Joseph Donnelly[3] and Ashley Towers[4]

Key points

Mobile apps are a rapidly advancing technological sector, with potential to transform patient care.	The ability to appraise the quality and safety of mobile apps is crucial if they are to be used as part of oral healthcare interventions.	Clinicians should be aware of the potential uses and dangers of mobile apps.

Abstract

The past two years have prompted significant changes with regards to how healthcare is both taught and delivered. There has been a shift towards remote healthcare interventions where appropriate. As we return towards pre-pandemic practice, we must recognise that the healthcare environment has permanently changed. It is vital that safeguards and 'pandemic proofing' are built into healthcare provision.

The prevalence of personal digital devices continues to increase, along with internet coverage. This technological revolution has also brought with it a plethora of free or cheap online platforms that allow individuals with limited IT skills to make mobile applications (apps). These factors create a perfect environment for considering mobile apps as viable, widespread healthcare interventions. There is also great potential for these to contribute to tackling inequality, reducing barriers and enhancing healthcare access. However, their use must be carefully considered.

This article discusses the myriad of considerations pertaining to both developing and recommending mobile apps for healthcare. Examples of contemporaneous examples will be used, in conjunction with an app developed by the authors to demonstrate the process of creating bespoke resources.

Introduction

Mobile applications (apps) supporting a healthy lifestyle are not novel concepts. Searching 'diet' in any app store yields a myriad of results. Commercial apps such as MyFitnessPal[1] are gaining popularity[2] and claim to assist with weight loss[3] or healthy living. A narrative literature review, however, determined that more evidence-based research is required to confidently declare the efficacy of mobile apps for this[4] and a recent systematic review[5] found no strong evidence of the efficacy for behaviour change.

[1]Clinical Lecturer in Paediatric Dentistry, School of Dentistry, University of Dundee, Dundee, Scotland, UK; [2]Undergraduate Dental Student School of Dentistry, University of Dundee, Dundee, Scotland, UK; [3]Deputy Data Protection Officer, NHS Tayside, Dundee, Scotland, UK; [4]University Teacher in Dental Skills Simulation and Informatics, School of Clinical Dentistry, University of Sheffield, Sheffield, UK.
*Correspondence to: Clement Seeballuck
Email address: c.seeballuck@dundee.ac.uk

Clearly, there is merit in research regarding the potential benefits of mobile apps.

Historically, creating an app required competence in software development. Modern, 'no-code' platforms are addressing this barrier, creating opportunities for motivated clinicians to develop oral-health-focused mobile apps.[6]

The conditions imposed by the pandemic prompted significant changes regarding how healthcare is delivered. There has been a shift towards remote healthcare interventions where appropriate.[7] With global lockdowns, most non-essential treatment ceased and services were significantly impacted when restarted.[8] This helped catalyse adoption of remote healthcare interventions as there were no real alternatives that complied with social distancing for the heavily burdened health services. Returning towards pre-pandemic practice, we must recognise that the healthcare environment has permanently changed. Although we hope never to return to restricted healthcare, it is vital that safeguards and 'pandemic proofing' are built into healthcare provision, mitigating against further lockdowns.

Smartphones are now ubiquitous in the UK. In 2020, 84% people in the UK aged 16 and over used smartphones for personal use, rising to 98% in the 16–24 age group[9] and using them for an average of 3 hours 59 minutes a day.[10]

These factors warrant exploration of the need and value of digital tools to implement wide-scale educational and clinical interventions. This paper discusses the potential of mobile apps in oral health interventions and training. We will discuss from the perspective of responsibilities towards the patient, the profession, to data security and as developers of apps available through public access platforms. Details and lessons learned will be shared drawing on experiences developing a mobile app at Dundee Dental School.

Responsibilities to the patient

Patients trust our clinical decisions and advice.[11] We must therefore be confident in the effectiveness of treatments we advocate, including digital interventions. It is crucial to demarcate between healthcare interventions and 'lifestyle' applications. As clinicians, we are duty-bound to provide evidence-based, safe treatment. Recommending mobile apps is no different.

Within the field of oral healthcare, there are several high-quality apps targeting specific treatment objectives. The Scottish Dental Clinical Effectiveness Programme[12] have released Dental Prescribing and Dental Companion apps, both targeting dental professionals. Similarly, the International Association of Dental Traumatology[13] released ToothSOS,[14] which can be used by patients to help them understand traumatic dental injuries and provides dental professionals with guidelines. Although addressing quite different oral health issues, these apps have several features in common: they have accountability, linked to appropriately reputable organisations and focus on contemporaneous, evidence-based treatment.

Permitting advertising in mobile apps must be approached with caution. Patients could extrapolate that we endorse third-party products or services promoted within the app. There is often little control over the content of these promotions and when designing/recommending a healthcare app, it is crucial to avoid integrating any such features. The Office of Communications' 'Pilot online harms survey' reported 9% of the population experienced 'harmful of misleading advertising'.[15] To retain our professional integrity, patients must not be unintentionally influenced.

Responsibilities to data security

App users must be assured that their data are protected. If data are recorded, they must be compliant with UK General Data Protection Regulations.[16] Health data are considered a 'special category' and have additional requirements.[17] Storing patient-identifiable information should be considered analogous to medical databases with regards to governance and security. The Information Commissioner's Office (ICO)[18] has detailed guides regarding data protection. Anyone collecting such data should familiarise themselves with these.

Data capture and subsequent use are particularly important with apps targeted at children. Currently, over 60% of children aged ten have smartphones in the UK.[10] However, over one-third of children have encountered something 'worrying or nasty' online.[10] Children and young people have grown up with online social networking and are comfortable sharing aspects of their lives in this way but they may have limited awareness of how information is being collected and shared.

Networking capabilities of apps also present significant risks; one-third of 12–15-year-olds have been contacted by a stranger who wanted to be their friend.[15] A simple solution is to avoid user interconnectivity. Network features should only be included if necessary and subject to increased regulation. Additional safety features for data privacy can be considered, such as end-to-end encryption, where messages can only be decrypted by the recipient.[19] However, this too can have hidden dangers. The No Place to Hide campaign[20] for example is raising awareness that safeguards should be put in place to ensure that private messages can still be detected if containing dangerous content.

Capturing location data inherently presents a risk due to the potential misuse if breached. Location data should therefore be turned off by default unless there is a compelling reason to leave it on. If turned on during an interaction, it should return to 'off' at the end. To support enhanced protection, the ICO have created the age-appropriate design code (or children's code).[21]

'Nudge techniques' are design features encouraging users to follow the designer's preferred paths, for example, making a large 'yes' button more prominent than a small print 'no' option, or exploiting unconscious psychological processes via associations between certain colours or imagery and positive outcomes. While an app may opt to use these techniques, they should not encourage users to activate settings to provide more of their data or turn off privacy protections.

Data protection issues can be mitigated by simply not externally collecting data. However, relevant data capture may be crucial for the intended healthcare purpose. Let us consider a toothbrushing diary. We may want to review saved data and discuss these with the patient. In these circumstances, the data storage default should be the personal device of the patient. However, as locally stored data will not be part of the medical record, it will be crucial that all relevant information is documented to maintain comprehensive notes. If a device is lost, so too will all locally stored data.

Responsibility to equality

Mobile apps intended for use as healthcare interventions should be designed to be inclusive and intuitive, tackling inequality rather than propagating. While it may appear that everyone has a smartphone, this is not the case. The Digital Poverty Alliance

co-founded by The Institution of Engineering and Technology states 22% of the population lack essential digital skills for life. One in five children do not have access to a suitable device for learning and low income is a contributing factor.[22] Furthermore, 6% of homes – around one and a half million – had no internet access in March 2021.[15] It cannot be assumed every patient will have equal access to apps we are recommending and any service provision dependent on these may become exclusionary. Where a patient has access to a device, it cannot be assumed that it is the latest and most powerful handset. Recommended apps should function with minimal system and storage requirements across the major operating systems. Patients must be aware of any potential data charges inherent in use.

The principle of inclusivity also applies to the cost of the app itself. Recommended apps should be available free of charge via the first party app stores for the major platforms: Google Play for Android devices and the Apple App Store for iOS devices. If the app is to be provided free of charge and advertising is discouraged, the costs of developing and maintaining the app must be found elsewhere, such as research grants – no easy task! The cost of development and maintenance must be carefully considered. Funding bodies may also have terms and conditions incompatible with other organisations.

There are further areas where an app should not contribute to inequalities: can it be used by individuals in multiple languages? Is the information presented in a format that factors-in patients with additional needs? Is the format age-appropriate? If we are seeking to provide a treatment to our patients, it must be useable by all, or have suitable alternatives that are equally effective. Brush DJ[23] is an excellent example of an inclusive mobile app that aims to deliver supplemental oral hygiene instruction to make brushing teeth fun.

Responsibilities as developers of software

When producing a novel healthcare app, there are considerations specific to the production process:

- Financial resources available
- Technical expertise
- Viable, simpler alternatives delivering the same outcome
- Viable existing alternative apps
- Evaluation process.

Furthermore, if the product is intended to be used to provide electronic information for health or social care purposes, it should be developed with reference to the Digital Technology Assessment Criteria for health and social care.[24] This comprehensive document provides evaluation criteria in line with relevant best practice to healthcare organisations when procuring technology suppliers and provides developers of such systems with a guide to the minimum standards that should be adopted.

To demonstrate the mobile app development process, Defeat the Decay[25,26] was created with limited resources. This app uses gaming principles[27,28] to provide information for children on preventing dental caries through recognition of how to modify some of the core elements required for the caries process. The app also provides patients with exposure to the 'feel' and sound of high-speed rotary instruments (Figures 1, 2 and 3).

While an in-depth understanding of computer programming permits more complicated apps to be developed, it is no longer necessary for certain categories of app if their scope is managed. Modern app frameworks automate many of the low-level technical details, removing many of the barriers which previously prevented motivated individuals with an idea to start. Graphical development environments allow the novice developer to create apps using a menu-driven interface. However, if the desired features of the app go beyond what the framework provides, it may require expertise to extend its capabilities.

Modular online frameworks may restrict what the developed app can be used for, claim copyright of derived works, demand a share of revenue, or place other requirements on you and your app. Before producing an app for public use, you must be aware of all the technical and legal aspects of the frameworks you use. It is crucial that you are aware of any pathways regarding data collection introduced by the app framework.

In the development of Defeat the Decay, app builders, including Unreal Engine[29] and Corona SDK,[30] were considered before ultimately choosing Unity (Fig. 4).[31]

These frameworks can be adopted to develop a working prototype as proof of concept. Creating a prototype is well established as an important step in the design process, allowing information gathering, user feedback and validating that there is a true (rather than perceived) need for the app.[32] These app builders are unlikely to provide a
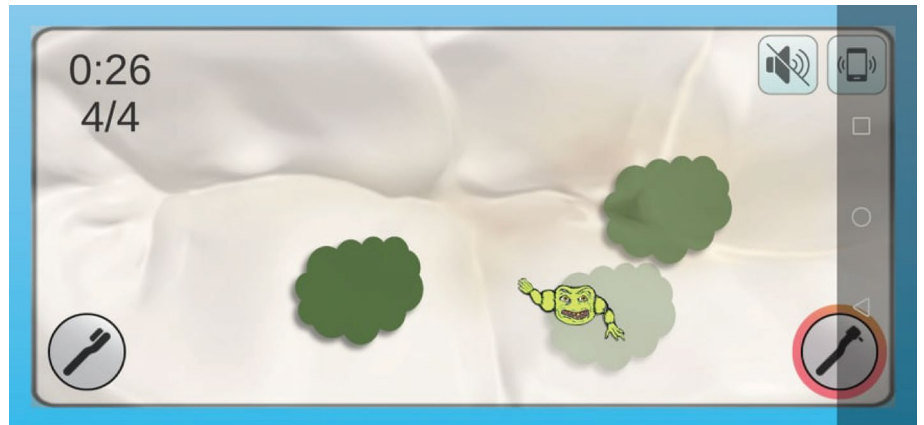

Fig. 1 Defeat the Decay, a mobile app with the objectives of 'preventing and managing' carious lesions. Here, the 'drill' has been selected to remove decay. This emulates the sound and feel through the phone speaker and vibration function

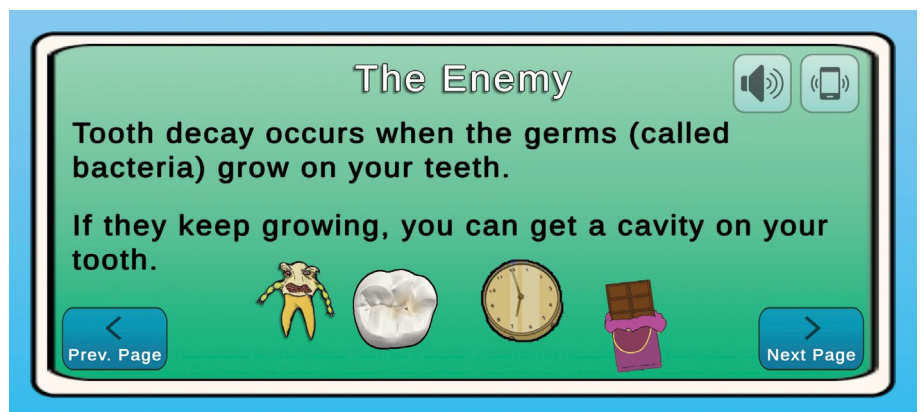**Fig. 2** Users can 'brush away' the food substrate before carious lesions form

Fig. 3 Simple information about the carious lesion process and prevention is conveyed to the user between levels

user experience and refined user interface of sufficient quality to attract and retain users long-term. However, the information gathered can guide the development of the final product.

Releasing an app is not a singular event. Over time, frameworks develop and operating systems receive upgrades. If these changes are ignored, the app may stop working. A patient relying on an app to assist their health care needs cannot have it abruptly lose functionality due to poor maintenance. Upgrades and changes should never prevent a user from accessing any existing data entries.

Furthermore, security patches released by the vendor of the app builder should be incorporated as soon as possible. Failure
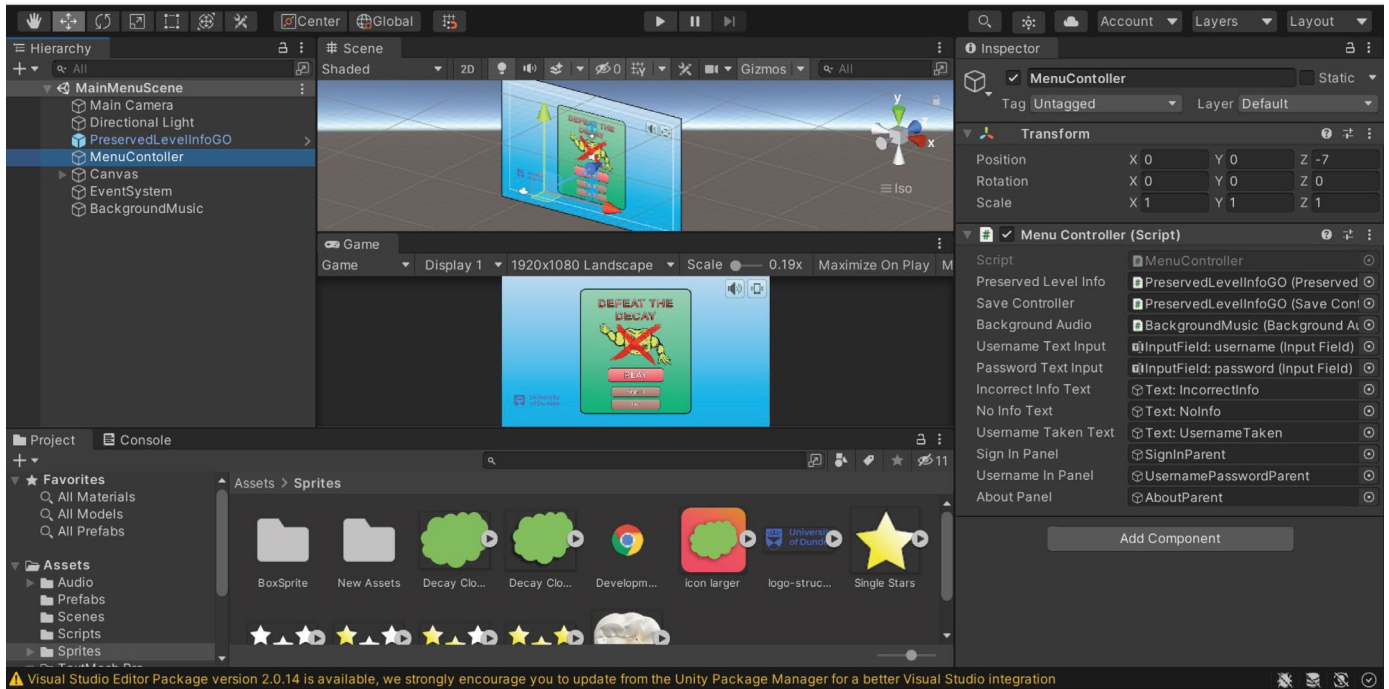
Fig. 4 Unity was chosen as the app builder due to the intuitive user interface

to issue an update that incorporates these changes leaves the app and users vulnerable to security threats to their devices and data. If the integrity and security of healthcare and personal data are not maintained, it could lead to legal or regulatory sanctions, or reputational damage to the developer and put those who recommended it at risk. It is therefore important to ensure that resources are available for maintenance.

The ongoing cost of marketing and promotion should also be considered. Without public awareness, a mobile app may become 'lost' in the mobile phone app store. Promotion may be directed at the end-user or the prescriber. If a mobile app is advocated by an organisation such as the NHS, this will make it easier; however, professional and public awareness will still be key. Depending on avenues of promotion, the process may be costly, time-consuming, or both. Mobile apps will only be effective if the intended recipients are aware of their existence.

Responsibilities to the profession

When designing or recommending apps, the General Dental Council's (GDC's) standards[33] must be upheld. There must be confidence that apps have been developed by a reputable organisation and designed for purpose. Apps should have clearly defined objectives

and evidence-based practice in mind. The efficacy of the app for achieving the desired goal should be evaluated and validated before recommending use as a healthcare intervention.

However, there is no reason, if done with care, that apps cannot actively support the GDC's standards and provide an improved experience for the patient. This can be achieved via quality assurance processes or by health boards to providing an approved library of apps. The Organisation for the Review of Health and Care Apps (ORCHA) is an organisation with core principles of systematically reviewing health apps and their systematic distribution.[34] ORCHA's Digital Health Library was launched in 2016 with an initial range of 100 apps. The library currently contains 6,000 reviews. ORCHA uses quality assurance processes to filter mobile apps. Having quality assurance can instil more confidence in a mobile app that we are recommending. The NHS Apps Library was initially set up as a beta site in 2017[35] but was decommissioned in December 2021.[36] NHSX, a relatively new initiative, aims to provide patients with digital tools and information for health, wellbeing and care.[37]

App repositories will become a significant component of individualised patient care. Having access to pre-validated apps which comply with the high NHS standards would be a powerful toolkit for the practitioner.

Conclusion

Mobile apps present an enticing healthcare tool: being able to widely disseminate an intervention for free. It will be important that we understand the potential and limitations inherent within the technology and develop the skills to be able to critically appraise apps in a similar fashion to any other treatment. Digital systems and mobile apps, if appropriately used, may also allow clinicians to prioritise clinical space for procedures that require physical intervention. Self-regulated and remote healthcare interventions may also reduce barriers to patient access. However, we must be mindful that a 'one size fits all' approach to patient care is not realistic and viable alternatives need to be available to ensure equality in our treatment.

Author contributions
Clement Seeballuck: lead and corresponding author. Contributed to the main body of text and general structure. Alex Blair: contributing author. Co-creator of the mobile app and contributed to app development. Joseph Donnelly: contributing author. Contributed regarding information governance and data protection. Ashley Towers: expert advisor. Contributed to the main body of text and editing.

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