

# Health Apps for Children: Deploying Digital Health in a Safe, High Quality and High Efficacy Way in the Pediatric Field

## Short title: Health Apps for Children

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### ABSTRACT

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Research shows children and young people (CYP) engage with digital software applications (apps) from as young as one year old. CYP often see the value of wearables and enjoy the educational experience of being proactively involved in their health education and management. Parents, carers and teachers are heavy influencers of digital health use, but adults themselves lack policies around digital health education, often focusing on risks, and are less familiar with child-led digital health education. Health applications (apps) can create a space for children to learn about health conditions, healthy lifestyles and preventative health measures: Providing personalized knowledge as their bodies and needs develop. CYP are growing up in a world where many health services are likely to have a so-called ‘digital front door’, with some health management strategies or results likely to be delivered on-line or virtually. Due to stretched resources, CYP may need to be able to self-manage mild health conditions and could be better prepared to transition to adult services where they are likely to need to manage their digital health records and safe sharing of their personal health information.

CYP have the ability to be the ‘Trojan horse’, introducing apps, wearables and digital health solutions to parents, carers or wider family members without digital literacy or experience. Pediatric apps and related health tech or wearables need to keep a child safe, connected, educated, empowered and healthy. Children should ideally access health apps that are safe, appropriate for their age and support management of their health preventatively and proactively. Some health apps for adults have been seen to simply extend their included age range to include children without the appropriate research or considering safety or health differences between children and adults. Children have specific health, cognitive, developmental and physiological needs which need to be reflected in the health apps and digital health solutions recommended by health care professionals.

This paper examines the considerations needed for designing, recommending, and using pediatric health apps.

## KEYWORDS

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**Pediatric, digital health, apps, children**

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### 1. Introduction

Ideally all parents should be engaging in face-to-face, individualized, healthy and positive learning at all times with their children, but in reality many parents use screens (including TV, computers, tablets and smartphones) to entertain their children, with one study showing 65% of parents giving the child a device to 'stay calm' and 29% giving a child a device at bedtime<sup>1</sup> (despite health recommendations to reduce screen time at bedtime to improve sleep quality). If children are using devices, there is an opportunity to provide apps which educate, prevent or support health and well-being. Without health care professionals recommending or prescribing pediatric health apps, and in the absence of robust guidance for parents, children are at risk of accessing incorrect, unsafe or inappropriate apps.

Research shows most preschoolers spend a significant amount of their day on screens. One study of children under 5 years demonstrated 96.6% of the research group using digital tools, with most of them starting to use devices under the age of one.<sup>1</sup> Children as young as 15 months can learn from apps but do best when they have parental guidance and assistance.<sup>2</sup>

Research of older children shows that they can view health app use as an adult-only arena, but find they are easily able to access health apps, with one third reporting that they have used adult apps despite having to navigate what content might be irrelevant for their age.<sup>3</sup> Health apps create a space for learning about health, provide teaching about health education, healthy lifestyles and preventative health. Research has shown teenagers engaging with health education material online and via social media with older teenagers often requesting apps with content around love, relationships and sexual health.<sup>4</sup> Children are aware that apps need to accommodate for their growth and change both physically and mentally. Secondary school or high school children engaged in app research appear to use apps in a thoughtful, sensible and engaging way, often skipping content they believe is relevant only for adults.<sup>3</sup> Teachers, parents and carers can help by supporting access to health apps: using safe 'app libraries' within schools would be a way of recommending trusted health apps, and supporting proactive education around digital health use.<sup>4</sup>

Pediatric apps and related health technologies (such as wearables or implanted devices) need to keep a child safe, connected, educated, empowered and healthy<sup>5,6</sup> and acknowledge that children have specific needs that are different to adults.<sup>7</sup> Table 1 shows potential considerations for developing, recommending, assessing and using apps meant for children, that may be different to that expected for adult apps. Children should access health apps that are appropriate for their age that support the holistic management of their health preventatively and proactively as well as supporting their skills to navigate health systems effectively.<sup>4-6</sup>

### 2. Methodology

Using accessible UK, Australian, Canadian and US-based health guidance, policies, research or best practice regarding health apps, this paper considers the specific considerations for developing or using safe, effective pediatric apps.

**Age range**

Research shows that for children under 5 years of age, their parents are often the best targets for improvements in child health, education and support.<sup>8</sup> Between 4–14 years, children have specific developmental needs and require forms of protection around what digital content they access. Adult apps are unlikely to be suitable and therefore should not be allowed to drop their targeted range unless pediatric focused research can demonstrate effectiveness, value and safety. Over 14 years of age, children start to have access to social media and may also start to transition to adult health services.

**Table 1.** Specific considerations for developing safe and effective pediatric apps

<i>Construction</i>	<i>Benefit</i>	<i>Concerns</i>	<i>Mitigation</i>	<i>Resources</i>
<b>Apps spanning greater than 5-year age range<sup>5,9</sup> (RCPCH p2040 document; children's design guide document)</b>	<p>App can grow with the child.</p> <p>Wide reach if apps can address greater than 5-year age range.</p> <p>(App may need to consider differences in design for different ages, how health presents or is managed in different age groups).</p>	<p>Apps spanning greater than 5 years need to be able to justify why their app suits a wider audience, is able to address different developmental needs, and considered how health presentations differ in presentation and management over different age groups</p>	<p>Explanation about how age groups are addressed.</p> <p>Consideration of age appropriate sections within the app.</p>	<p>Children's design guide: <a href="https://childrensdesignguide.org/dsd-cards-developmental-stages-of-5-6-7-9-10-12-y-o/">https://childrensdesignguide.org/dsd-cards-developmental-stages-of-5-6-7-9-10-12-y-o/</a></p> <p>NICE guidance NG204 <a href="https://www.nice.org.uk/guidance/ng204/chapter/Recommendations#communication-and-information/Recommendations#communication-and-information">https://www.nice.org.uk/guidance/ng204/chapter/Recommendations#communication-and-information/Recommendations#communication-and-information</a>.</p>
<b>Who is the app aimed at? The child, the parent or carer, the health care professional (HCP) or a mix.<sup>10</sup></b>	<p>Research shows children benefit from health app use mostly when over the age of 5 and when a parent or carer helps them navigate app use. Apps designed for both the parent/carer and the child or young person (CYP) can encourage family support around the child's health.</p> <p>Children's apps could provide health education to wider family members.</p> <p>Potential benefits of HCP having access to data.</p>	<p>Risk of poor clarity regarding which part of the app is targeting which individual. Can child access the parent/carer or HCP section? If so, is that appropriate?</p>	<p>Clear sections for parent or child. Clear explanation about who app is aimed at.</p>	<p>J Edwards, J Waite-Jones, T Schwartz, V Swallow. Digital Technologies for Children and Parents Sharing Self-Management in Childhood Chronic or Long-Term Conditions: A Scoping Review Dec 2021. <i>Children</i> 2021, 8(12), 1203; <a href="https://doi.org/10.3390/children8121203">https://doi.org/10.3390/children8121203</a></p>

<i>Construction</i>	<i>Benefit</i>	<i>Concerns</i>	<i>Mitigation</i>	<i>Resources</i>
<b>Duration and timing of screen time: consideration of impact on mental health<sup>11</sup> sleep<sup>12,13</sup> physical activity<sup>14</sup> and development<sup>15</sup></b>	Access to app versus screen time. Healthy screen time	<ol style="list-style-type: none"> <li>1. Access to devices at bedtime need additional consideration due to concerns around sleep disruption</li> <li>2. Notifications causing anxiety</li> <li>3. Tech addiction</li> <li>4. Impact on social skill development</li> </ol>	<ol style="list-style-type: none"> <li>1. Screen time or light emission may need altering at the end of the day</li> <li>2. Notifications appropriate to age group. Easily changed.</li> <li>3. Time limit or recommendations interacting with app need to be safe. Opportunities to engage with others via the app.</li> </ol>	<p>New WHO guidelines on physical activity, sedentary behavior and sleep for children under 5 years of age. April 2019 News release Geneva.</p> <p>Canadian Pediatric Society Digital Health Task Force<sup>15</sup></p>
<b>Security and ability to share information, e.g. on social media<sup>16</sup></b>  <b>Who has access to the child's data and can the child or family share health data?</b>	Child connecting with others offers wider support network and access to further resources.	Sharing health data on social media is unsafe. Social media sites have poorly controlled age restrictions.	Clear age-appropriate information. Consent Assent Parental/carer controls.	B Cawthorne. Age restrictions on social media services. UK Safer Internet Centre. April 2018.
<b>Connection to others (parents/safe adults/local community/charities/school/health care professionals/medical records)<sup>17,18</sup></b>	Connection allows children to access a wider support network.	<p>Vulnerability</p> <p>Developing a sick role.</p>	Clear age-appropriate information. Consent Assent Parental/carer controls.	

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<b>Education (age appropriate info)</b> <sup>5,8,19</sup>  <b>(Committee on the Science of Children Birth to Age 8: 2015)</b>	Health apps can provide access to health education.	Poor understanding.  Age appropriate content needs to cover all developmental ages and stages.	Age appropriate content that addresses different learning styles.  Clear messaging about what to do if child needs additional help To access education.	Age-appropriate pedagogies for the early years of schooling.  Foundation paper summary. Dept. of Education and Training, Queensland Government.
<b>Equalities (digital environment/digital access/digital literacy)</b> <sup>20</sup> <b>(Gann, NHS Digital, 2019)</b>	Digital health has the potential to reduce inequalities if done well.  Children without access at home need to be able to access via school (e.g. digitally healthy schools) or libraries or clubs.	Children without ready access to digital environments.	Health care professionals prescribing bear responsibility for establishing patients' digital access and digital environment prior to prescribing.	National Institute for Health and Care Excellence. NICE and health inequalities.
<b>App changes and updates (Who will be alerted? When and why?)</b> <sup>11</sup>	Alerts to switch to another app. Parents or children can then switch to another app if needed, or are alerted to improved updates, additional functionality.	App functionalities may be lost if updates not well communicated.  Users may stop using the app if functionality changes. If an app ceases to exist, users who were previously relying on the app or managing their health through the app may stop managing their condition and may not download an alternative app if the knowledge of an alternative is not easily available.	Choice regarding whom is alerted and when may help.	Bespoke Digital Health Libraries. <a href="http://orchahealth.com">orchahealth.com</a>

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<b>Empowering children (self-management/transitioning to adult services)<sup>21</sup></b>	<p>Young children need to feel empowered to manage their health.</p> <p>They are a group where small changes can make a lifetime of changes.</p> <p>Access and transition to adult services can be supported.</p>	<p>Over-monitoring.</p> <p>Creation of health anxieties.</p> <p>Sick role Dependency</p>	<p>Young people need to navigate the physical, cognitive and emotional change in the move to independent adulthood. (Reference Helen &amp; Douglas House 2014: Transition and beyond toolkit. Oxford: Helen &amp; Douglas House).</p> <p>Collaboration between children and adult services helps support young people. (Reference Helen &amp; Douglas House 2014: Transition and beyond toolkit. Oxford: Helen &amp; Douglas House).</p>	<p>Young Minds (2020) Transferring from CAMHS to adult mental health services.</p> <p>Southampton Children's Hospital Ready Steady Go resources for health professionals.</p> <p>Queen's Nursing Institute (2017) Transition from children to adult community services: learning resource. London: QNI.</p> <p>Campbell F, Biggs K, Aldiss SK, O'Neill PM, Clowes M, McDonagh J, While A and Gibson F (2016) Transition of care for adolescents from pediatric services to adult health services, Cochrane Database.</p> <p>Chambers L and Kelly K (2015) Stepping Up: Developing a good transition.</p>
<b>Researched information (app researched for specific age group or cohort)<sup>5-7</sup></b>	<p>Research of the app provides usability, accessibility data as well as best timing of app use, optimum user experience.</p>	<p>Research cannot capture all benefits and concerns. Expert opinion is sometimes used to fill gaps.</p>	<p>Research for targeted age group accessing the app.</p>	<p>National Institute for Health and Care Excellence Research Recommendations Process and Methods Guide July 2015.</p>
<b>Provide correct, up-to-date information, targeted to needs and age of the child<sup>5,22</sup> (NHS England National Information Board, Nov 2016)</b>	<p>Apps can provide fast updates and respond to changes (for example new healthcare options provided in pandemic).</p>	<p>App not updated does not provide most accurate information.</p>	<p>Updates provided within certain time frame.</p>	<p>UK government Department for Education 'Development Matters' document. Updated July 2021.</p>

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<b>Child's voice represented and captured?</b> <sup>23</sup> (Note: this may overlap with coproduction)	Improved child engagement.	Not adequately representing the patient and public voice.	Coproduction.  Patient and public involvement (PPI).	Royal College of Pediatrics and Child Health 'Children and young people voice'. RCPCH &Us programme including 'Resources for working with children, young people and families.'
<b>Alerts and reminders (reminders versus increased anxiety and health/tech addiction).</b> <sup>11</sup> <b>Research suggests push notifications link to smartphone addiction</b>	Improved health management.  Enhanced communication of health or treatment needs.  Adherence to management plan.	Tech addiction "Push notifications for incoming messages were strongly linked to smartphone addiction." Reference 1  Alerts to others needs to be balanced against child empowerment and self-management. Alerts can cause the user to dwell more about their health conditions than is useful Alerts can cause anxiety Alerts can negatively affect task performance if the receiver is doing a task at the time they receive the text. <sup>7</sup>	Guidance on the app to advise best timings.  Learning and education around pros and cons of push notifications/alerts.  Choice regarding notifications.	Seul-Kee Kim, So-Yeong Kim, and Hang-Bong Kang. An Analysis of the Effects of Smartphone Push Notifications on Task Performance with regard to Smartphone Overuse Using ERP. <i>Comput Intell Neurosci.</i> 2016; 2016: 5718580  Published online 2016 Jun 5. doi: 10.1155/2016/5718580
<b>Accessibility (e.g. hearing, eyesight, language)</b> <sup>5,24,25</sup>	Accessibility for developmental ages, reading ages, different languages, adaptability for eyesight and hearing differences.  Accessibility on different devices (e.g. Apple, Android, web).	Exacerbation of inequalities.	Different languages, can size of text be altered, are videos accompanied by text to read. Coproduction, codesign and research into accessibility of different ages or developmental stage.	National Deaf Children's Society. <a href="https://www.ndcs.org.uk/">https://www.ndcs.org.uk/</a>  Royal Society for Blind Children. <a href="https://www.rsb.org.uk/">https://www.rsb.org.uk/</a>  Mencap (UK) <a href="https://www.mencap.org.uk/">https://www.mencap.org.uk/</a>  Cardmedic (UK) <a href="https://www.cardmedic.com/">https://www.cardmedic.com/</a>

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<b>Further support needed. E.g. emotional or mental or physical health (Is it clear who the child should speak to/reach out to for additional support?)<sup>26</sup></b>	Safety nets and enhanced support networks can be created around the child.	Child doesn't know how to move from the app to engaging an adult/supporter/parent or carer.	The app could encourage the child to speak to a parent, trusted family member or teacher if they need further support.	Royal College of Pediatrics and Child Health child protection resources <a href="https://childprotection.rcpch.ac.uk/resources/">https://childprotection.rcpch.ac.uk/resources/</a>
<b>Safeguarding<sup>27</sup></b>	Safeguarding concerns can be addressed.	Safeguarding concerns not addressed.	Clear information about how safeguarding issues can be addressed.	Safeguarding (RCPCH) <a href="https://childprotection.rcpch.ac.uk/resources/intercollegiate-roles-and-responsibilities/">https://childprotection.rcpch.ac.uk/resources/intercollegiate-roles-and-responsibilities/</a>
<b>App mindful of space saving to allow for other app download<sup>28</sup></b>	The less 'space'/ fewer bytes an app uses up on a device or phone the more likely the app and other apps are to be used.	Apps using large amounts of data are less accessible. Optional downloading of sections.	To allow sections of the app to be downloadable or linked	T Allingham, N van Hout. How to free up space on iPhone and Android. Save the Student: Mobile Phones 2022.  <a href="http://savethestudent.org">savethestudent.org</a>
<b>Coproduction and codesign<sup>5,29</sup></b>	Improved accessibility, usability, adherence, management, and timing of app use.	Product not suitable for target users.	Ensure coproduction, co-development and co-design at all phases of app development.	<a href="https://www.coproductioncollective.co.uk/">https://www.coproductioncollective.co.uk/</a>



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<b>Well-being and mental health considerations alongside physical health<sup>26</sup></b>	Enhanced and holistic health and well-being approach.	Reduced social and emotional interactions when interacting with app.	Time recommendations listed on an app. Potentially specifying the minimal time required to maximally benefit from the app, within respected national guidance or pediatric health institutions screen time recommendations.	mentalhealth.org.uk  www.mind.org.uk
<b>Reduce poly-app prescription<sup>30</sup></b>	Number of health apps the child recommended should be kept to the most effective minimum to prevent over-use of device.	In the same way that polypharmacy <sup>25</sup> is avoided to reduce side effects and improve adherence, health app use should be kept manageable and sensible.	Prescribed health apps should take into account previous apps the child to family are already using.	P Rochon, M Petrovic, A Cherubini et al. Polypharmacy, inappropriate prescribing, and deprescribing in older people: through a sex and gender lens. The Lancet, Healthy Longevity Vol. 2, Issue 5 E290-E300 May 2021
<b>Does the design of the app support play and/or creativity?</b>	Play and creativity are important developmental areas that can be supported through design of digital health tech and apps.	Aiming for play and creativity not to reduce health message or impact	Integrating play and games or gaming where appropriate.	S A Mummah, T N Robinson, S Sutton. IDEAS (Integrate, Design, Assess and Share): A Framework and Toolkit of Strategies for the Development of More Effective Digital Interventions to Change Health Behaviour. J Med Internet Res. 2016 Dec; 18(12): e317. Published online 2016 Dec 16. doi: 10.2196/jmir.5927 PMID: PMC5203679  S Livingstone & K Pothong (2022) Imaginative play in digital environments. Information, Communication & Society, 25:4, 485-501, DOI:10.1080/1369118X.2022.2046128

***Safety***

There are potential risks associated with the use of health apps. Children may be exposed to inappropriate content, receive incorrect information, or unknowingly share personal information with third parties. Over-dependency on technology, obsessive tech use or tech addiction can negatively impact children's lives. Pediatric health apps need to be designed specifically for children and their use is best supervised by adults. Parents, teachers and perhaps libraries need to play a role in educating children about safe online behavior and safe app usage to ensure their safety and privacy. Health professionals can play a role in guiding parents and children on the appropriate use of health apps and the potential risks involved.

***Adaptations to pediatric app assessments***

The Organization Reviewing Care and Health Apps (ORCHA) in the UK and the USA updated their assessments of pediatric apps in 2022, which meant ORCHA reviewers now look at the following additional features within pediatric apps:

- Age range
- Physical ability/disability
- Cognitive/learning abilities
- Language
- Flagging exclusion of certain population groups
- Clinical scenarios where caution required
- Pros, cons, risks and risk mitigation
- Use of app alerts and AI that could cause harm.
- Appropriate evidence and research.

***Current digital health landscape for pediatric and child health***

Pediatrics and child health is a rich area for patient engagement, since children are often happy and motivated to interact with devices. However, both the number and the quality of pediatric health apps have lagged behind apps available for adults (>18 years). In 2022, ORCHA had identified 181 pediatric apps (compared to 1,198 for adults) that reach the threshold for recommending to patients, which is around half of the apps assessed by ORCHA. Additionally, many children's hospitals have not adopted apps or digital solutions into practice, with a US study in June 2022 showing 25% don't use any and 25% of those that do are deploying only simple appointment scheduling apps.

**Suggested areas of future research**

1. The relationship between push notifications or alerts on health apps and childhood anxiety or childhood tech addiction
2. How CYP (children and young people) use of apps and wearables changes over time?
3. What is the best adaptation of apps and wearables for the younger population?
4. What features of health apps are appealing or unappealing to CYP?

5. Successful and unsuccessful health education (and/or behavior changes) in CYP delivered via health apps.
6. What factors/functions/tech interactions shape CYP engagement with health apps?
7. How many apps are enough?: Patients experience of being prescribed more than one app by healthcare professionals?
8. What is the impact of reduced parent child interactions when a child uses apps regularly?
9. How best to encourage parent/teacher/adult supervision of CYP app use?
10. Acquisition of developmental skills (such as language/vocabulary acquisition rates) and amount of time spent on specific apps.

### *The young person's perspective*

"I followed it [wearable and app] off my brothers because they go to the gym and all that, so I thought I might as well do something that contributes to my well-being".<sup>3</sup>

"I want personalized care", "I want to be in control of decisions to share my information"<sup>31</sup>

"We should learn everything and then choose which path to follow" Malala Yousafzai.

"Change is coming whether you like it or not" Greta Thunberg.

Children consulted on this paper: "An app is fun and an app is an opportunity to learn. When a child is on a long car journey and they borrow their mom's phone to play a game, if the children's game is fun it is an extra-long learning experience [and] for the child [it is] super fun." (Female, aged 12)

## 3. Conclusion

Children and their parents are downloading health apps even though ~85% of apps on app stores do not reach the quality thresholds that health or care professionals need, and many children are using apps that are designed with adults in mind. This paper considers protective features needing consideration when developing, designing, recommending and using apps in pediatrics, such as age-appropriate information, screen time, cost, accessibility, safety, emotional health, play, creativity, safeguarding needs, and growth with the child as they continue to change and transition to adult services.

App libraries within schools or community libraries could provide an opportunity to empower children to access trusted apps, self-manage mild conditions, understand preventative health, and improve their digital health literacy. Targeting children's health improves adult health, and relieves the pressure on healthcare services. Very small differences in health behaviors in childhood can make a large difference in adult health outcomes. Safe and effective children's health apps, together with adult support, have an opportunity to be simple health interventions that could make a lifetime of difference.



### **Glossary**

**Tech addiction:** “Addiction refers to a behavioral disorder in which a person uses content such as SNS, Internet browsing, and mobile games for an excessive amount of time without self-control, such that it interferes with daily life” (ref 1).

**Screen time:** Time spent using a device.

**Coproduction:** Citizens/the public/direct stakeholders are involved in creating policies or services.

**Polypharmacy:** Use of multiple medicines. (Poly-app use can be considered in a similar way)

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### **Conflict of interest statement**

T Holland Brown works as a pediatrician in the National Health Service (NHS). She founded the free Hear Glue Ear app (though has not benefitted financially from the app) and does paid pediatric consultancy work for ORCHA (Organization for the Review of Care and Health Apps).

K Prince has no conflicts to declare.

J Warner is Adjunct Professor, University of Redlands in Business and Entrepreneurship, and national science foundation I-Corps mentor. He has previously been the US president of ORCHA.



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