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The impact of health technology on the delivery of paediatric care: a narrative review

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ABSTRACT

Background: The use of technology in paediatrics is increasing, and new health technology will change the way in which paediatric care is delivered in the future. This review is part of the Royal College of Paediatrics and Child Health Paediatrics 2040 project, which is developing a credible vision for the future of paediatrics in the UK.

Aims: To summarise the impact of health technology on the delivery of paediatric care over the last ten years. To learn from existing technology use and make recommendations for future implementation.

Methods: A search strategy was developed and two databases (Cochrane Library and PubMed) were systematically searched in August 2019 for relevant publications in English. Searches were limited to papers published between January 2009 and August 2019 (with further rapid review of papers published between September 2019 and November 2020). We included papers that studied young people up to the age of 24 or on those providing care for this population. A thematic synthesis of the data from the included studies was undertaken using seven domains of paediatric care.

Results: 128 studies were included, grouped by domain of care. Most included studies were defined as digital (n=55) or communication (n=37). Studies looked at the different types of health technology used within different domains of care, including secondary and tertiary care (n=39), public health and prevention (n=29), and community (n=20). Studies were assessed on delivery of care outcomes using

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positive, negative, mixed and no effect. The most common outcomes reported were adherence and satisfaction.

Discussion: This review highlights the growing importance of technology in delivering paediatric care. Six themes emerged: the importance of clear guidelines, continuity of care, confidentiality and privacy, digital poverty, using a personalised approach, and using technology to supplement rather than replace. In future, technology development should involve the end user throughout the design process.

Keywords

paediatrics; delivery of care; health technology; digital poverty; confidentiality; usage guidelines; continuity of care; technology to supplement; personalised approach and user design.

What is already known on this topic?

- Technology is an important part of paediatric practice but has been underutilised
- There is a lack of children and young person's engagement in the development of new technologies
- New health technology will change the way in which paediatric care is delivered in the future.

What this study adds

- There is a need to reinforce the principle that all relevant stakeholders involved in paediatric care, including children and young people themselves, should be involved in technology design and innovation.
- This review highlights the importance of tailoring technological interventions to suit the needs of children and young people as a separate population from adults.
- It also supports the need for clear technology usage guidelines for both healthcare providers and patients. These should include clear information on privacy and confidentiality regarding data storage and use.

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INTRODUCTION

The Royal College of Paediatrics and Child Health (RCPCH) Paediatrics 2040 project is developing a credible vision for the future of paediatrics in the UK.[1] This review forms part of the innovation stream, exploring how existing technology is used and how positive changes can be implemented in the future.

Economic, political, and social changes mean that the role of paediatricians - and the shape of paediatrics - is very different today to what it was two decades ago. It is likely that two decades from now, in 2040, the delivery of paediatrics in the UK will be very different.

New health technology will change the way in which paediatric care is delivered in the future. As COVID-19 has demonstrated, when we are forced to make changes, we can usually find a way to do so.[2] It is important to look at the technology that is already having a positive impact on the delivery of care in child health, so we can look at where technology use should be expanded in the future.

Our reference group of UK paediatrics and experts (n=18) identified eleven technology types of relevance to paediatrics. These are digital (relating to web-based interventions or those that used a combination of internet and other technologies), communication (relating to telehealth, helplines, and messaging interventions), apps, diagnostics (both software and hardware), Artificial Intelligence/machine learning, genomics, virtual and augmented reality/gamification, sensors, wearables, big data (relating to creating databases and keeping electronic-records) and assistive technology.

This narrative review aimed to summarise the impact of health technology on the delivery of paediatric care over the last ten years, to learn from existing technology use and to make recommendations for future implementation.

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METHODS

This review follows the approach used in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses[3] statement with the exception of full critical appraisal.

A search strategy was developed by all authors in August 2019 and two databases (Cochrane Library and PubMed) were systematically searched in August 2019 for relevant publications in English. Searches were limited to papers published between January 2009 and August 2019. Due to the potential impact of the #COVID19 pandemic on innovation an additional search was conducted in December 2020, to identify new papers published between September 2019 – November 2020. The same search strategy was applied to the same two databases (Cochrane Library and PubMed).

Eligibility Criteria

The populations of interest were healthcare providers involved with paediatric care and children and young people (CYP) aged zero to 24 years of age, as well as their parents or guardians.

Only studies in EU15+ countries plus Norway, Canada, and Australia were initially included in the review. The United States of America was later added to the scope of this review as the authors felt it would provide additional insight into the use of health technology in paediatric care.

The intervention of interest was the type of health technology being used. The technology types were based on the NHS Topol Review[4] and consultation with clinicians involved in the Paediatrics 2040 project. If technology was not a key part of the intervention, the paper was excluded.

The outcome of interest was delivery of care and studies focusing solely on health outcomes were excluded. Delivery of care was defined using a King's Fund definition[5] and incorporating terms from a systematic review.[6] The definitions of each delivery of care outcome can be seen in **Table 1**.

Included studies were sorted by domain of care before data were extracted, allowing clinicians to search by area of interest. The definitions of each domain of care can be found in **Table 2**.

Search strategy

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Technology/Innovation
"health technology" OR "health innovation" OR "internet" OR "WebMD" OR "genomics" OR "artificial intelligence" OR "digitali$ation" OR "digital integration" OR "wearables" OR "robotics" OR "digital health" OR "digital medicine" OR "big data" OR "data governance" OR "cyber security" OR "sequencing technology" OR "telemedicine" OR "app" OR "smart$phone app" OR "biosensors" OR "remote diagnosis" OR "monitoring" OR "image interpretation" OR "automat$" OR "wearable technology" OR "biometrics" OR "e$health" OR "telehealth" OR "machine learning" OR "m$health" OR "mobile" OR "mobile$phone" OR "speech recognition" OR "online service$" OR "video appointment$" OR "medical device"
Impact
"impact$" OR "effect$" OR "advance$" OR "measur$" OR "improv$"
Delivery of care
"delivery" OR "delivery of care" OR "quality" OR "quality of care" OR "quality of diagnosis" OR "diagnosis" OR "prescription$" OR "referral" OR "admission rate$" OR "readmission$" OR "cost$" OR "price" OR "management" OR "cost$effectiveness" OR "patient safety" OR "equit$" OR "ethic$" OR "efficacy"
Paediatric care
"p$ediatric health" OR "p$ediatrician" OR "child health" OR "p$ediatric care" OR "GP" OR "community p$ediatric$" OR "p$ediatric nurse" OR "CAMHS" OR "p$ediatric health$service" OR "p$ediatric health$care" OR "health$care provider$" OR "community care" OR "community health$care" OR "school$based" OR "social$worker$" OR "counsel$or" OR "emergency p$ediatric care" OR "adolescent health" OR "teenage health" OR "young adult" OR "general p$ediatric$" OR "p$ediatric cardiology"

Author contributions

The primary search (January 2009 – August 2019) was conducted by SB in August 2019. Studies were screened against the eligibility criteria by SB. Included studies were checked independently by AF. SB subsequently led the data extraction for all included studies.

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The secondary search (September 2019 – November 2020) was conducted by AF in December 2020. Abstracts were screened against the eligibility criteria by DR and checked independently by AF. After exclusions, included studies were reviewed against our identified themes by AF.

SB led the writing of the results and discussion sections. Regular meetings were held between SB, AF and DR from January 2020 - August 2020 to discuss results and emerging findings. All authors provided advice on research methods and scope and all authors commented in detail on the final manuscript prior to submission.

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RESULTS

Summary of Searches

Searching published literature from January 2009 – August 2019 identified 6275 records and an additional 18 were identified through other reviews and reference lists. A summary of the search and screening process can be found in Figure 1. Reasons for full-text exclusion included studies on adult populations, conference abstracts and studies that had insufficient data on the delivery of care. After exclusions, 128 studies were included in the final analysis.

Data were extracted according to the technology's impact on the delivery of care. The findings are presented as positive, negative, mixed, or no effect as determined by author reporting in each study. These have been sorted by domain of care and the results are presented in **Tables 3-9**.

Approximately 70% of the included studies were published during or after 2014. In terms of type, there were 65% randomised control trials (RCTs) and one systematic review. Almost half (62/128) of the studies were conducted in, or included, participants from the USA. The most common domain of care studied was secondary and tertiary care with 39 studies and the most common technology type was digital innovation with 55 studies.

The secondary search (published literature from September 2019 – November 2020) identified 436 records. Abstracts were screened and after exclusions, 12 studies were included in the final analysis.[7-18] These 12 studies were not retrospectively included in our full data extraction work and are therefore not referenced in our results section. Instead, the papers were reviewed against our pre-determined themes (see discussion).

Maternity and neonatal

There were five studies included, three using diagnostic software[19-21] and two using communication technology[22, 23]. Delivery of care outcomes studied included healthcare utilisation, usability, adherence to clinical protocol and satisfaction. The diagnostic software studies both focussed on fetal electrocardiography (ECG) and reported mixed results, with no effect observed on healthcare utilisation. The communication studies reported positive outcomes on usability and satisfaction. Further detail on the studies can be found in **Table 3.**

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Emergency care

There were five studies included, three focused on communication[24-26], one on virtual and augmented reality/gamification[27] and one was a digital technology type[28]. The most common delivery of care outcomes studied were feasibility and satisfaction. The studies reported mostly positive outcomes, with mixed results for acceptability. The studies were heterogeneous regarding the disease or disorder studied, and included assault, substance use and life support. Further detail on the studies can be found in **Table 4.**

Primary care

There were 11 studies included, three focused on communication,[29-31] three on digital interventions[32-34], two on diagnostic software[35, 36], two used apps[37, 38] and one on use of sensors[39]. The most common delivery of care outcomes studied were usability and healthcare utilisation. Usability outcomes were varied, and often reported as negative or mixed from the perspective of the healthcare provider. The sensor study reported mostly negative findings for all outcomes. Further detail on the studies can be found in **Table 5.**

Child and adolescent mental health services (CAMHS)

Nineteen studies were included that focused on child and adolescent mental health, nine of which were digital interventions[40-48], eight of which were communication[49-56], and two were apps[57, 58]. One study was a systematic review looking at the use of mental health mobile apps for children and adolescents below the age of 18[57].

The most common delivery of care outcomes measured were satisfaction and adherence. Both outcomes were reported to be mostly positive across these studies, with feasibility showing more variability. Healthcare providers reported on lack of time and training as barriers to implementation of mental health apps[57], and others reported overly flexible online training leading to a lack of accountability, stating that some face-to-face or live interaction would be beneficial to address this[41]. The desire for some face-to-face interactions was also reported by patients[42]. Further detail on the studies can be found in **Table 6.**

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Community care

There were twenty included studies that focused on community care, ten of which used digital interventions[59-68], six were communication[69-74] and one each on big data[75], diagnostics[76], a sensor[77] and an app[78].

Once again, the most common outcomes measured were adherence and satisfaction. There was variability in the adherence outcomes with healthcare providers reporting some difficulty in sticking to protocol on a 24-hour helpline[70], as well as differences in adherence between older and younger age groups, with adherence reported as lower among younger children[67]. Common areas of interest for the studies were asthma and sexual and reproductive health. Further detail on the studies can be found in **Table 7.**

Public health and prevention

There were 29 studies included in this domain of care. Twenty-one of the studies were digital innovations[79-99], four used communication technologies[100-103], two used apps[104, 105], one used assistive technology[106] and one used wearables[107].

More than half of the studies included reported mostly positive findings. The most common outcomes measured were feasibility, adherence, and satisfaction. Interventions that reported mostly positive outcomes for adherence and satisfaction were reported as being easy to use and understand[80, 84, 86, 87, 91]. Studies that reported negative outcomes were perceived as 'boring'[93] as well as time-consuming[96, 99]. Further detail on the studies can be found in **Table 8.**

Secondary and Tertiary care

There were 39 studies that focused on secondary and tertiary care. Eleven of these studies used digital innovations[108-118], eleven used communication technologies[119-129], six used app interventions[130-135], five used sensors[136-140], two used diagnostics[141, 142], two used genomics[143, 144], one AI/Machine learning[145] and one virtual reality[146].

The most common outcomes measured were adherence, satisfaction, and healthcare utilisation. Differences in adherence as well as satisfaction between adult and child populations were observed

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in this domain. Four of the five sensor studies used continuous glucose monitoring (CGM) for people with diabetes[136-139] and each of these studies included both adult and younger populations, as well as caregivers/parents. Each of these studies reported differences in adherence, which was often lower or less likely in children and adolescents[136], as well as differences in reasons for satisfaction between adult and child patients[137-139].

Healthcare utilisation was mostly reported as positive, and the technologies used were shown to improve diagnoses[141, 144, 145], participation in laboratory testing[122], and medication uptake[116]. Further detail on the studies can be found in **Table 9.**

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DISCUSSION

Our review has identified a range of technologies that have been trialled in children and young people. These span a wide range of domains or care and the included studies focused on different aspects of the technology in their analysis. However, the studies often have small sample sizes and small statistical power. Adherence and satisfaction were the most common outcomes studied, largely by measuring compliance and attrition rates and using exit surveys. Studies included in the public health and prevention domain produced the most positive findings, especially when interventions were tailored to meet the needs of CYP. Primary, secondary and tertiary care studies frequently reported feedback from participants that they would have preferred some face-to-face interaction with clinicians.

This review focused on the delivery of care which is an important component of implementing health interventions. However, health outcomes are another essential aspect of successfully implementing innovations and are beyond the scope of this review.

Emerging themes

Clear guidelines

An emerging theme from many of the studies was the need for clear guidelines or protocols when introducing new technologies in health settings. This includes ensuring protocols are context or country specific as health policies will differ depending on location[20].

Many care providers expressed the need to have more training on using innovations, whether face-to-face or online[41, 57, 70, 78, 106]. Studies included in the primary care domain also highlighted the need for training, and authors reported lower compliance with interventions[36] as well as reluctance to use innovations on younger age groups[29]. Not all healthcare providers will be “digitally literate”, and so when implementing new innovations training and clear guidelines are necessary.

Continuity of care

Both patients and providers reported concerns for continuity of care. This was apparent in many of the communication studies which often included triage. Patients wished to receive consistent care

and from the same clinician[29, 30] or community[66], and to not have to repeat themselves if they were referred to another professional.

Some interventions improved the number of detected cases of a specified condition, however clinicians expressed concerns over post-diagnosis follow-up for harder to reach populations if specialists were not available[32]. This demonstrates the importance of clear protocols to give guidance about next steps following a diagnosis.

Confidentiality

Many studies reported the importance of having privacy and confidentiality. This was especially the case for studies focusing on mental and sexual health[38, 49, 57, 135], and assuring confidentiality was even shown to improve result notification of positive results for sexually transmitted infections[25].

Providers also reported concerns regarding sharing data, especially in relation to younger populations in a primary care setting[31] and parents of paediatric patients were significantly more restrictive in genomic data sharing decisions than adult participants[143].

Digital poverty

Most studies reimbursed participants or covered the costs of mobile phone usage and had requirements of access to a stable internet connection and/or a smartphone for enrolment[33, 53, 68, 69, 74, 95, 102, 121]. It is important to consider the context of the environment when introducing an innovation and whether it is feasible for the respective populations to access the necessary technology. This will help ensure that underserved populations are not further isolated.

Personalised approach and user design

Studies that took a more personalised approach or included their target population in the development of the intervention often reported positive findings. This included being able to personally tailor messages and meeting with providers to schedule appropriate timings for phone calls, which received positive feedback from participants[38, 69, 71, 83, 127, 131]. This was also

observed in studies that adapted innovations to suit the language[76] or cultural needs[87] of their target population.

A common theme in exit survey feedback was to make interventions more tailored[63, 116, 123, 140, 147]. This included specifically targeting younger populations as separate from older adolescents and/or adults[34, 67, 136-138, 146]. The same theme emerged in separate survey work conducted through RCPCH with both paediatricians and with children and young people calling for more tailored healthcare and an increase in stratified medicine[1].

Technology to supplement rather than replace

Participants (both care providers and care recipients) often stated a preference for interventions that used a blended approach. Patients reported they found it more comfortable and easier to engage with a clinician at in-person appointments[125]. Another study reported enjoyment from use of telemedicine but preference for using it as a supplement or form of follow-up instead of completely replacing the original service[30]. Including face-to-face interactions was suggested by authors to improve acceptability of innovations, as discussion with a clinician may ensure credibility of the feedback[28].

Providers found that using technology prior to meeting with patients allowed for more specific discussions[135]. Authors suggested that using, in this case, an app before meeting patients may be particularly useful in a primary care setting where time with patients is often limited. A blended approach was preferred when providing teaching or training for clinicians, to improve adherence to the intervention and provide familiarity with other participants when engaging in peer learning[27, 41]. This theme reinforces the importance of implementing a personalised approach to delivering paediatric care, as participants will have individual preferences about how they receive it[2].

Additional papers

Of the 12 papers identified in our secondary search, four studies complemented our identified themes. These were technology to supplement rather than replace[7, 8, 12], personalised approach[13] and user design, and confidentiality[8].

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Strengths and limitations

The broad scope of our research aim was useful in fulfilling the objectives of the review and as a contribution to forming recommendations for the RCPCH Paediatrics 2040 project. Future studies should consider a narrower scope, such as one particular technology type or domain of care.

The studies included were not double screened or critically appraised due to time constraints. Sorting studies into particular domains of care was challenging due to the different systems in each country and the delivery of care outcomes often overlapped.

Delivery of care outcome measures were presented as positive, negative, mixed, or no effect as determined by the author reporting in each study due to the difference in populations included, meaning a certain level of adherence may be considered positive for some populations and negative for others. This is inevitably subject to the bias of the authors in portraying their intervention in a particular way.

Health outcomes were not analysed, therefore it is important to consider that although delivery may have been effective, the health outcomes may not have been, and both need to be considered when implementing innovations.

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CONCLUSION

There is a lack of research conducted on children and young people in relation to technology and health. This review highlights the importance of tailoring technological interventions to suit the needs of children and young people as a separate population from adults, as well as the importance of ensuring adequate training is given to care providers to implement new innovations.

Recommendations

The following recommendations were formed from our findings:

- Technology used in paediatric settings should be designed or adapted for use specifically with children and young people.
- All relevant stakeholders involved in paediatric care, including children and young people themselves, should be involved in technology design and innovation.
- Clear technology usage guidelines should be established for both healthcare providers and patients. These should include clear information on privacy and confidentiality regarding data storage and use.
- All innovations and technology should be assessed for accessibility to ensure they will not further isolate underserved populations.

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Figure 1. Adapted PRISMA flow chart of summary of search process and results.

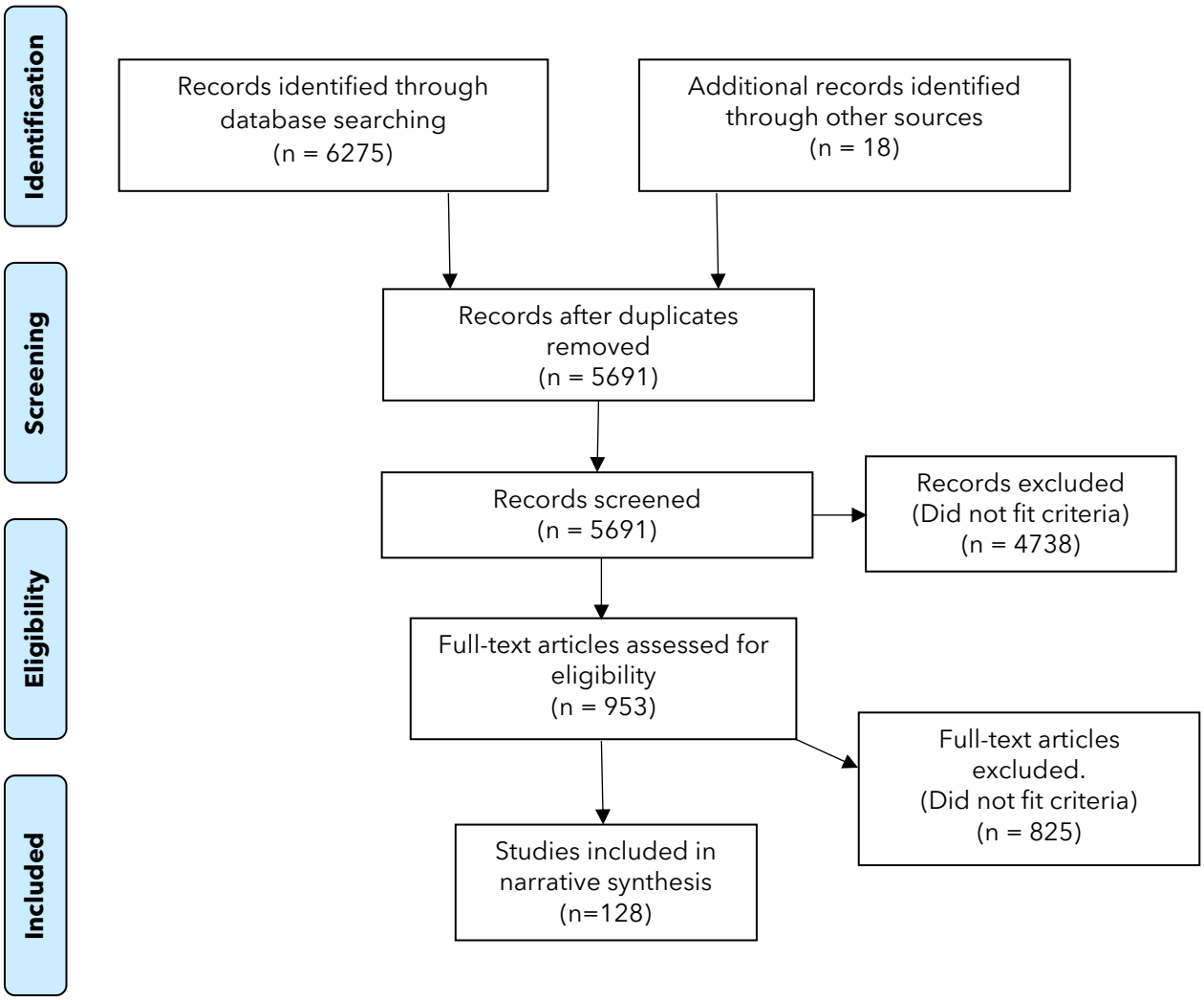

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Table 1. Definitions of delivery of care outcomes.

Delivery of care outcome	Definition
Acceptability	Was the intervention acceptable for participants to use? Was it viewed as credible and valid?
Adherence	Did participants adhere to the intervention and/or to protocol? This outcome includes whether participants completed the intervention as required by authors, and compliance and engagement rates.
Feasibility	Was the intervention feasible for participants to use in the required setting? This includes logistical aspects of the intervention, such as whether it could be implemented, costs, access to internet, as well as time and scheduling.
Healthcare utilisation	Did the intervention influence service use, such as the number of admissions, appointments, and referrals? This is outcome also refers to prescriptions, medicinal uptake/adherence.
Satisfaction	Were the participants satisfied with the intervention? Did they find it to be enjoyable, and would they use it again or recommend it to others?
Usability	Were participants able to use the intervention? Was it understandable in its functionality and/or easy to navigate?

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Table 2. Definitions of domains of care.

Domain of care	Definition
Maternity/Neonatal	Relating to maternal and fetal health, or care delivered by neonatal care specialists.
Primary care	Participants were recruited from primary care clinics, with care delivered by a primary care practitioner.
Emergency Care	Participants were recruited from emergency departments, or care delivered by emergency care specialists.
CAMHS	Participants with a diagnosis of a mental health disorder. Care is delivered by a mental health professional such as a psychiatrist or mental health nurse.
Community	Participants recruited from community clinics, or outreach interventions to communities. Care delivered by clinicians.
Public health and prevention	Participants recruited from non-clinical environments, with interventions often delivered online or in schools. Care is delivered by non-clinicians.
Secondary and Tertiary	Participants have been recruited from a specialist clinic or hospital and often have a diagnosed condition.

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Table 3. Maternity and neonatal included studies

Authors	Title	Year	Study Design	Setting	Population	Disease/topic	Technology Type	Delivery of care outcome	Positive, negative, mixed, no effect
Valverde, M. et al.	Effectiveness of pulse oximetry versus fetal electrocardiography for the intrapartum evaluation of nonreassuring fetal heart rate	2011	RCT	Spain	Pregnant women (n=180)	Child Development	Diagnostics	Healthcare utilisation (diagnosis)	**Mixed**
Homko, C. J. et al.	Impact of a telemedicine system with automated reminders on outcomes in women with gestational diabetes mellitus	2012	RCT	USA	Women with Gestational Diabetes Mellitus (n=80)	Child Development	Communication	Usability	**Positive**
McCrossan, B. A. et al.	A fetal telecardiology service: patient preference and socio-economic factors	2012	Descriptive Study	Northern Ireland	Pregnant women (n=66)	Child Development	Communication	Satisfaction	**Positive**
Belfort, M. A. et al.	A Randomized Trial of Intrapartum Fetal ECG ST-Segment Analysis	2015	RCT	USA	Women with a singleton fetus at more than 36 weeks (n=11,108)	Child Development	Diagnostics	Healthcare utilisation	**No effect**
								Adherence (use of protocol)	**Negative**
Vijgen, S. M. C. et al.	Cost-effectiveness of cardiotocography plus ST-analysis of the fetal electrocardiogram compared to cardiotocography only in the prevention of cerebral palsy	2011	Cost-effectiveness analysis	the Netherlands	Laboring women (n=5,667)	Child Development	Diagnostics	Feasibility (costs)	**Positive**
								Healthcare utilisation	**No effect**

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Table 4. Emergency care included studies

Authors	Title	Year	Study Design	Setting	Population	Disease/topic	Technology Type	Delivery of care outcome	Positive, negative, mixed, no effect
Blackstone, M. M. et al.	Feasibility of an interactive voice response tool for adolescent assault victims	2009	Observational study	USA	12 - 19 year olds, victims of assault injury (95 consented to IVR process)	Violence	Communication	Feasibility	**Mixed**
								Satisfaction	**Positive**
								Healthcare utilisation (data Collection)	**Positive**
Reed, J. L. et al.	Improving sexually transmitted infection results notification via mobile phone technology	2014	RCT	USA	Young people aged 14 - 21 (n=584) who had tested postively for a STI	Sexual Health	Communication	Health care utilisation (result notification)	**Positive**
Lehmann, R.et al.	Improving Pediatric Basic Life Support Performance Through Blended Learning With Web-Based Virtual Patients: randomized Controlled Trial	2015	RCT	Germany	57 medical students	Life Support	Virtual & Augmented Reality / Gamification	Adherence (use of clinical protocol)	**Positive**
								Healthcare utilisation (quality of care)	**Positive**

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Newton, A. S. et al.	A randomised controlled pilot trial evaluating feasibility and acceptability of a computer-based tool to identify and reduce harmful and hazardous drinking among adolescents with alcohol-related presentations in Canadian pediatric emergency departments	2017	RCT	Canada	Adolescents ages 12-17 years (n=44)	Substance Use	Digital	Feasibility	**Positive**
								Acceptability	**Mixed**
Suffoletto, B. et al.	Which behavior change techniques help young adults reduce binge drinking? A pilot randomized clinical trial of 5 text message interventions	2019	RCT	USA	Young adults aged 18 to 25 (n=149)	Substance Use	Communication	Acceptability	**No effect**
								Satisfaction	**Positive**

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Table 5. Primary care included studies

Authors	Title	Year	Study Design	Setting	Population	Technology Type	Disease/topic	Delivery of care outcome	Positive, negative, mixed, no effect
Carroll, A. E., et al.	Targeted screening for pediatric conditions with the CHICA system	2011	RCT	USA	Children 0-11 years (n=2239)	Diagnostics	TB / anaemia	Adherence (use of clinical protocol)	**Positive**
Eisen, J. C., et al.	Pilot study of implementation of an internet-based depression prevention intervention (CATCH-IT) for adolescents in 12 US primary care practices: clinical and management/organizational behavioral perspectives	2013	RCT	USA	63 healthcare providers, 83 adolescents	Digital	Depression	Usability	**Mixed**
Douglas McLaughlin, MD, John R. Hayes, PhD, and Kelly Kelleher, MD	Office-Based Interventions for Recognizing Abnormal Pediatric Blood Pressures	2010	RCT	USA	40 physicians	Diagnostics	Blood Pressure	Usability	**Mixed**
								Healthcare utilisation (diagnosis)	**Positive**
Reid, S. C., et al.	A mobile phone application for the assessment and management of youth mental health problems in primary care: health service outcomes from a randomised controlled trial of mobiletype	2013	RCT	Australia	Young people aged 14 - 24 (n=114) and GPs	App	Mental Health	Healthcare utilisation (data collection)	**Positive**
								Usability	**Positive**

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Hamilton-Shield, J., et al.	Changing eating behaviours to treat childhood obesity in the community using Mandolean: the Community Mandolean randomised controlled trial (ComMando) - A pilot study	2014	RCT	England	61 families with an obese child aged between 5 and 11 years took part in the trial	Sensor	Weight management	Adherence (use of clinical protocol)	**Negative**
								Healthcare utilisation (appointments)	**Negative**
								Usability	**Negative**
								Feasibility	**Negative**
Tan, L., Hu, W. and Brooker, R.	Patient-initiated camera phone images in general practice: a qualitative study of illustrated narratives	2014	Descriptive Study	Australia	Nine GPs, their clinical interests included adolescent health, palliative care etc	Communication	Non-specific	Healthcare utilisation (diagnosis)	**Mixed**
Campbell, J. L., et al.	The clinical effectiveness and cost-effectiveness of telephone triage for managing same-day consultation requests in general practice: a cluster randomised controlled trial comparing general practitioner-led and nurse-led management systems with usual care (the ESTEEM trial)	2015	RCT	England	Patients aged aged ≥ 16 years or < 12 years (participants under 24 = 5672) (total participants = 20,990)	Communication	Non-specific	Feasibility	**Mixed**
								Healthcare utilisation (admissions)	**Positive**

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Van Voorhees, B. W., et al.	Development of a technology-based behavioral vaccine to prevent adolescent depression: a health system integration model	2015	RCT	USA	Adolescents aged 13 - 24 (n=329)	Digital	Depression	Usability	**Positive**
								Adherence	**Positive**
Webb, M. J., Wadley, G. and Sanci, L. A.	Improving Patient-Centered Care for Young People in General Practice With a Codesigned Screening App: Mixed Methods Study	2017	Observational study	Australia	Young people aged 14-25 years (n=115)	App	Public Health	Usability	**Positive**
								Acceptability	**Positive**
Ray, K. N., et al.	Family Perspectives on Telemedicine for Pediatric Subspecialty Care	2017	Observational study	USA	Parent/caregivers of children, adolescent patients aged 14-17 years and young adult patients aged 18-21 years (n=21)	Communication	Non-specific	Acceptability	**Positive**
Pittaway, S., et al.	Comparative, clinical feasibility study of three tools for delivery of cognitive behavioural therapy for mild to moderate depression and anxiety provided on a self-help basis	2009	Observational study	England	Adults above the age of 18, 18 to 24 group (n=15)	Digital	Depression and anxiety	Adherence	**Negative**
								Healthcare utilisation	**No effect**

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Table 6. CAMHS included studies

Authors	Title	Year	Study Design	Setting	Population	Disease/topic	Technology Type	Delivery of care outcome	Positive, negative, mixed, no effect
BOYDELL, K. M., VOLPE, T., and PIGNATIELLO, A.	A qualitative study of young people's perspectives on receiving psychiatric services via televideo	2010	Descriptive Study	Canada	Children aged 7 - 18 years (n=30)	Mental health	Communication	Satisfaction	**Mixed**
FUKKINK, R. G., & HERMANNS, J.	Children's experiences with chat support and telephone support (ADDITION)	2009	Observational study	Netherlands	Children aged 8 - 18 years (n=223)	Mental health	Communication	Satisfaction	**Positive**
LOGSDON, M. C., et al.	Adapting and testing telephone-based depression care management intervention for adolescent mothers	2010	Observational study	USA	Adolescent mothers aged 13-18 years (n=22)	Post-partum depression	Communication	Feasibility	**Negative**
								Acceptability	**Positive**
MITCHELL, S. A., et al.	Professional opinions of the use of telemedicine in child and adolescent psychiatry	2009	Descriptive Study	Scotland	24 professionals with experience in CAMHS	Mental health	Communication	Feasibility	**Mixed**
								Acceptability	**Positive**
								Satisfaction	**Positive**
		2009		England		OCD	Communication	Acceptability	**Positive**

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TURNER C., & HEYMAN, I.	A Pilot Study of telephone cognitive behavioural therapy for obsessive-compulsive disorder in young people		Observational study		Teenagers aged 13 - 17 referred for treatment for childhood OCD (n=10)			Feasibility	**Positive**
Vander Stoep, A. and Myers, K.	Methodology for conducting the children's attention-deficit hyperactivity disorder telemental health treatment study in multiple underserved communities	2013	RCT	USA	Children aged 5.5 - 12.9 years old (n=223)	ADHD	Communication	Adherence	**Positive**
WOOD, J., S, et al.	E-CYMHS: An expansion of a child and youth telepsychiatry model in Queensland.	2012	Descriptive Study	Australia	Healthcare providers, parents and children	Mental health	Communication	Satisfaction	**Positive**
Grist, R., Porter, J. and Stallard, P.	Mental Health Mobile Apps for Preadolescents and Adolescents: A Systematic Review	2017	Systematic Review	North America, Northern Europe, Australia	Children and adolescents younger than 18 years	Mental health	App	Feasibility	**Mixed**
								Acceptability	**Mixed**
								Adherence	**Mixed**
Schlosser, D. A., et al.	Efficacy of PRIME, a mobile app intervention designed to improve motivation in young people with schizophrenia	2018	RCT	Online recruitment, USA, Canada, Australia	Young people with schizophrenia, mean age 24 (n=43)	Schizophrenia	App	Adherence	**Positive**
								Satisfaction	**Positive**
MYERS, K. M., et al.	Child and adolescent telepsychiatry: variations in utilization, referral patterns and practice trends	2010	Observational study	USA	Children <7 - <12 years old (n=701)	Mental Health	Communication	Healthcare utilisation	**Positive**

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PRETORIUS, N., et al.	Cognitive-behavioural therapy for adolescents with bulimic symptomatology: The acceptability and effectiveness of internetbased delivery.	2009	Observational study	UK	Adolescents aged 13 - 20 years (n=101)	Eating disorders	Digital	Adherence	**Positive**
								Healthcare utilisation	**No effect**
								Acceptability	**Positive**
								Satisfaction	**Mixed**
De Bruin, E. J., van Steensel, F. J. and Meijer, A. M.	Cost-Effectiveness of Group and Internet Cognitive Behavioral Therapy for Insomnia in Adolescents: results from a Randomized Controlled Trial	2016	RCT	the Netherlands	12 - 19 year olds with insomnia	Insomnia	Digital	Feasibility	**Positive**
McGill, B. C., Sansom-Daly, U. M., Wakefield, C. E., Ellis, S. J., Robertson, E. G. and Cohn, R. J.	Therapeutic Alliance and Group Cohesion in an Online Support Program for Adolescent and Young Adult Cancer Survivors: lessons from "recapture Life"	2017	RCT	Australia	Adolescents and young adults aged 15-25 years less than 12 months off treatment for cancer (n=39)	Cancer	Digital	Acceptability	**Positive**
								Satisfaction	**Positive**
Vigerland, S., et al.	Internet-delivered cognitive behavioural therapy for children	2016	RCT	Sweden	Children aged 8 - 12 years with	Anxiety	Digital	Adherence	**Mixed**

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	with anxiety disorders: a randomised controlled trial				anxiety disorders (n=93), and parents (n=182)			Satisfaction	**Mixed**
Clarke, G., et al.	Randomized effectiveness trial of an Internet, pure self-help, cognitive behavioral intervention for depressive symptoms in young adults	2009	RCT	USA	18-24 year olds (n=160)	Depression	Digital	Healthcare utilisation	**No effect**
McMillen, J. C., Hawley, K. M. and Proctor, E. K.	Mental Health Clinicians' Participation in Web-Based Training for an Evidence Supported Intervention: signs of Encouragement and Trouble Ahead	2016	RCT	USA	Mental Health clinicians who have worked with children who have been traumatised (n=163)	Trauma	Digital	Feasibility	**Mixed**
								Adherence	**Mixed**
Lenhard, F., et al.	Therapist-Guided, Internet-Delivered Cognitive-Behavioral Therapy for Adolescents With Obsessive-Compulsive Disorder: a Randomized Controlled Trial	2017	RCT	Sweden	Adolescents aged 12-17 years with OCD (n=67)	Obssessive Compulsive Disorder (OCD)	Digital	Adherence	**Positive**
								Satisfaction	**Positive**
Backman et al.	Internet-delivered psychoeducation for older adolescents and young adults with autism spectrum disorder (SCOPE): an open feasibility study	2018	Observational study	Sweden	Adolescents and young adults aged 16-25 years with a diagnosed autism spectrum disorder	Autism Spectrum Disorder (ASD)	Digital	Adherence	**Positive**
								Acceptability	**Positive**
								Satisfaction	**Positive**

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Dear, B. F., et al.	Treating anxiety and depression in young adults: a randomised controlled trial comparing clinician-guided versus self-guided Internet-delivered cognitive behavioural therapy	2018	RCT	Australia	Young adults aged 18-24 with self-reported depression and anxiety (n=217)	Depression and anxiety	Digital	Adherence	**No effect**
								Satisfaction	**No effect**

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Table 7. Community care included studies

Authors	Title	Year	Study Design	Setting	Population	Disease/topic	Technology Type	Delivery of care outcome	Positive, negative, mixed, no effect
Belzer, M. E., et al.	Acceptability and Feasibility of a Cell Phone Support Intervention for Youth Living with HIV with Nonadherence to Antiretroviral Therapy	2015	RCT	USA	Youth living with HIV aged 15 - 24 years (n=37)	Sexual Health	Communication	Feasibility	**Positive**
								Adherence	**Mixed**
								Satisfaction	**Positive**
Butler, C. W., et al.	Managing medical advice seeking in calls to Child Health Line	2009	Descriptive Study	Australia	12 nurses	Child development	Communication	Adherence (use of clinical protocol)	**Mixed**
Epstein, J. N., et al.	Impact of a Web-Portal Intervention on Community ADHD Care and Outcomes	2016	RCT	USA	Children with ADHD, mean age: 7.8 years (n=577) and healthcare providers (n=213)	ADHD	Digital	Healthcare utilisation	**Positive**
Free, C., et al.	Can text messages increase safer sex behaviours in young people? Intervention development and pilot randomised controlled trial	2016	RCT	UK	Young people aged 16 - 24 diagnosed with chlamydia or reporting unprotected sex (n=200)	Sexual Health	Communication	Feasibility	**Positive**
								Adherence	**Positive**
								Acceptability	**Positive**
								Satisfaction	**Positive**

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Grad, R., et al.	Peak flow measurements in children with asthma: what happens at school?	2009	Observational study	USA	6-12 year olds (n=323)	Asthma	Digital	Adherence (& to protocol)	**Mixed**
Morris, R. R., Schueller, S. M. and Picard, R. W.	Efficacy of a Web-based, crowdsourced peer-to-peer cognitive reappraisal platform for depression: randomized controlled trial	2015	RCT	USA	Participants aged 18 - 35 years, mean age: 23.7 (n=166)	Depression	Digital	Adherence	**Positive**
								Satisfaction	**Positive**
Mortimer, N. J., et al.	A web-based personally controlled health management system increases sexually transmitted infection screening rates in young people: a randomized controlled trial	2015	RCT	Australia	Participants aged 18 - 29 years, mean age: 21 (n=747)	Sexual Health	Digital	Healthcare utilisation	**Positive**
Mustanski, B., et al.	Feasibility, acceptability, and initial efficacy of an online sexual health promotion program for LGBT youth: the Queer Sex Ed intervention	2015	Observational study	USA	Participants ages 16 - 20 years (n=202)	Sexual Health	Digital	Acceptability	**Positive**
								Satisfaction	**Positive**
Nelson, E. L., et al.	Telemedicine and adherence to national guidelines for ADHD evaluation: a case study	2012	Descriptive Study	USA	Children mean age 9.3 (n=22)	ADHD	Communication	Adherence (use of clinical protocol)	**Positive**
Nicholas, A., et al.	The Sexunzipped trial: young people's views of participating in an online randomized controlled trial	2013	RCT	UK (all nations)	Young people aged 16 - 20 years old (n=22)	Sexual Health	Digital	Feasibility	**Positive**
								Acceptability	**Positive**
								Satisfaction	**Positive**

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Perry, T. T., et al.	Results of an asthma education program delivered via telemedicine in rural schools	2018	RCT	USA	Children aged 7-14 years with asthma (n=363)	Asthma	Communication	Adherence	**Mixed**
								Healthcare utilisation (medicinal uptake)	**Positive**
Portwood, S. G. and Nelson, E. B.	Data sharing to inform school-based asthma services	2013	Observational study	USA	10,560 students from pre K (4/5) - High school	Asthma	Big Data	Healthcare utilisation (Data collection, quality of care)	**Positive**
Räsänen, P., et al.	An online guided ACT intervention for enhancing the psychological wellbeing of university students: a randomized controlled clinical trial	2016	RCT	Finland	Students aged 19 - 32 years, mean age 24.29 (n=68)	Mental Health	Digital	Adherence	**Positive**
								Satisfaction	**Positive**
Shaw, H., Rohde, P. and Stice, E.	Participant feedback from peer-led, clinician-led, and internet-delivered eating disorder prevention interventions	2016	RCT	USA	Young women experiencing body dissatisfaction, mean age 22.2 years (n=680)	Eating disorders	Digital	Satisfaction	**Mixed**
Tait, R. J., et al.	Six-month outcomes of a Web-based intervention for users of amphetamine-type stimulants: randomized controlled trial	2015	RCT	Australia	Participants aged abpve 18 years, mean age: 22.4 (n=160)	Substance Use	Digital	Adherence	**Negative**
								Satisfaction	**Positive**

Vargas, P. A., et al.	Using information technology to reduce asthma disparities in underserved populations: a pilot study	2010	Observational study	USA	Parents/caregivers of children with asthma (n=48)	Asthma	Diagnostics	Feasibility	**Mixed**
								Usability	**Positive**
								Satisfaction	**Positive**
Wiecha, J. M., et al.	Evaluation of a web-based asthma self-management system: a randomised controlled pilot trial	2015	RCT	USA	Children with asthma aged 9 to 17 years (n=58), thirteen physicians and 1 nurse-practitioner	Asthma	Digital	Feasibility	**Mixed**
								Adherence	**Positive**
								Acceptability	**Positive**
								Healthcare utilisation	**No effect**
								Satisfaction	**Positive**
Trent, M., Thompson, C. and Tomaszewski, K.	Text Messaging Support for Urban Adolescents and Young Adults Using Injectable Contraception: outcomes of the DepoText Pilot Trial	2015	RCT	USA	Adolescents aged 13 - 21 years (n=100)	Sexual Health	Communication	Feasibility	**Positive**
								Adherence	**Positive**

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Boreland, F., et al.	Effectiveness of introducing point of care capillary testing and linking screening with routine appointments for increasing blood lead screening rates of young children: a before-after study	2015	Observational study	Australia	7 - 59 month old children who had a blood lead test between 1/1/2005 and 31/12/2012 (n~10,100)	Toxic substances	Sensor	Healthcare utilisation (screening)	**Positive**
Blanson Henkemans, O. A., et al.	Design and evaluation of the StartingTogether App for home visits in preventive child health care	2018	Observational study	the Netherlands	PHC nurses in Amsterdam (n=34), and parents (n = 166)	Non-specific	App	Usability	**Positive**
								Satisfaction	**Positive**

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Table 8. Public health and prevention included studies

Authors	Title	Year	Study Design	Setting	Population	Disease/topic	Technology Type	Delivery of care outcome	Positive, negative, mixed, no effect
Slootmaker S.M, et al.	Accelerometers and Internet for physical activity promotion in youth? Feasibility and effectiveness of a minimal intervention	2010	RCT	The Netherlands	Adolescents aged 13 - 17 years (n=87)	Public Health	Wearables	Feasibility	**Mixed**
								Adherence	**Mixed**
								Satisfaction	**Mixed**
Epton, T., et al.	A theory-based online health behaviour intervention for new university students (U@Uni): results from a randomised controlled trial	2014	RCT	England	Undergraduate students, mean age 18.9 (n=1,445)	Health behaviours	Digital	Adherence	**Negative**
								Feasibility	**Negative**
Hebden, L., et al.	A mobile health intervention for weight management among young adults: a pilot randomised controlled trial	2014	RCT	Australia	Students and staff aged 18 - 35 years, mean ages 23.1 and 22.6 in control and intervention arms respectively (n=51)	Weight management	Digital	Adherence	**Negative**
								Satisfaction	**Positive**
Shegog, R., et al.	It's Your Game-Tech: Toward Sexual Health in the Digital Age	2014	Observational study	USA	School students aged 12 - 14 years (n=33)	Sexual Health	Digital	Usability	**Positive**

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Skov-Ettrup, L. S. et al.	Comparing tailored and untailored text messages for smoking cessation: a randomized controlled trial among adolescent and young adult smokers	2014	RCT	Denmark	Young adult smokers aged 15 - 25 years (n=2030)	Substance Use	Communication	Satisfaction	**Positive**
Tubeuf, S., et al.	Cost effectiveness of a web-based decision aid for parents deciding about MMR vaccination: a three-arm cluster randomised controlled trial in primary care	2014	Cost-effectiveness analysis	England	First-time parents with a child aged 3-12mths (n=220)	Vaccinations	Digital	Healthcare utilisation	**Positive**
								Feasibility (costs)	**Positive**
van Beelen, M. E., et al.	Effectiveness of web-based tailored advice on parents' child safety behaviors: randomized controlled trial	2014	RCT	the Netherlands	Parents with a child aged between 5 and 8 months (n=1409)	Accident prevention	Digital	Satisfaction	**Positive**
								Usability	**Positive**
Bauermeister, J. A., et al.	Acceptability and preliminary efficacy of a tailored online HIV/STI testing intervention for young men who have sex with men: the Get Connected! program	2015	RCT	USA	Young men who have sex with men (YMSM) between the ages of 15 and 24 (n=130)	Sexual Health	Digital	Feasibility	**Positive**
								Acceptability	**Positive**
Champion, K. E., et al.	A cross-validation trial of an Internet-based prevention program for alcohol and cannabis: Preliminary results from a cluster randomised controlled trial	2016	RCT	Australia	Year 8 students (n=1320) from 13 different schools	Substance Use	Digital	Adherence	**Positive**
								Satisfaction	**Positive**

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Goodman, S., et al.	A randomized, controlled trial evaluating the efficacy of an online intervention targeting vitamin D intake, knowledge and status among young adults	2016	RCT	Canada	Young adults aged 18 - 25 years (n=90)	Bone health	Digital	Adherence	**Negative**
								Usability	**Mixed**
								Satisfaction	**Mixed**
Hutchesson, M. J., et al.	Self-monitoring of dietary intake by young women: online food records completed on computer or smartphone are as accurate as paper-based food records but more acceptable	2015	RCT	Australia	Young women aged 18-30 years, mean age 23.4 (n=22)	Weight management	Digital	Acceptability	**Positive**
								Usability	**Positive**
Markham, C. M., et al.	Internet-Based Delivery of Evidence-Based Health Promotion Programs Among American Indian and Alaska Native Youth: A Case Study	2016	RCT (secondary analysis)	USA	Self-identified American Indian and Alaskan Native (AI/AN) youth aged 12-14 years (n=40-191)	Public Health	Digital	Feasibility	**Mixed**
								Acceptability	**Positive**
								Usability	**Mixed**
								Satisfaction	**Positive**
West, D. S., et al.	A Technology-Mediated Behavioral Weight Gain Prevention Intervention for College Students: controlled, Quasi-Experimental Study	2016	Observational study	USA	Undergraduate students, mean age 21.6 (n=58)	Weight management	Digital	Adherence	**Positive**
								Satisfaction	**Positive**

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van Rosmalen-Nooijens, K., et al.	Young People, Adult Worries: randomized Controlled Trial and Feasibility Study of the Internet-Based Self-Support Method "Feel the ViBe" for Adolescents and Young Adults Exposed to Family Violence	2017	RCT	the Netherlands	Adolescents and young adults (AYAs) aged 12-25 years exposed to family violence (FV) (n=40)	Violence	Digital	Feasibility	**Positive**
								Acceptability	**Positive**
Baker, S., et al.	A randomized controlled trial evaluating a low-intensity interactive online parenting intervention, Triple P Online Brief, with parents of children with early onset conduct problems	2017	RCT	Australia	Parents with a child aged between 2 and 9 years (n=200)	Behaviour	Digital	Adherence	**Positive**
								Usability	**Positive**
								Satisfaction	**Positive**
Fucito, L. M., et al.	Using Sleep Interventions to Engage and Treat Heavy-Drinking College Students: a Randomized Pilot Study	2017	RCT	USA	Undergraduate students, mean age 20 years (n=42)	Substance Use	Digital	Adherence	**Positive**
								Usability	**Positive**
								Satisfaction	**Positive**
Haug, S., et al.	Efficacy of a web- and text messaging-based intervention to reduce problem drinking in adolescents: results of a cluster-randomized controlled trial	2017	RCT	Switzerland	Students aged 16-19 years (n=1041)	Substance Use	Communication	Feasibility	**Positive**
								Adherence	**Positive**
								Satisfaction	**Positive**

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Halterman, J. S., et al.	Effect of the School-Based Telemedicine Enhanced Asthma Management (SB-TEAM) Program on Asthma Morbidity: A Randomized Clinical Trial	2018	RCT	USA	Children with asthma, mean age 7.8 years (n= 400)	Asthma	Communication	Healthcare utilisation, (ED visit, prescription of preventive medicine)	**Positive**
Hides, L., et al.	Efficacy and outcomes of a mobile app targeting alcohol use in young people	2018	RCT	Australia	16-25 year olds who drank alcohol at least monthly and had an iPhone (n=197)	Substance Use	App	Usability	**Positive**
								Satisfaction	**Positive**
Parisod, H., et al.	Feasibility of mobile health game "Fume" in supporting tobacco-related health literacy among early adolescents: a three-armed cluster randomized design	2018	RCT	Finland	Adolescents aged 10-13 years (n=151)	Substance Use	Digital	Adherence	**Positive**
								Acceptability	**Positive**
Vahabzadeh, A., et al.	Improved Socio-Emotional and Behavioral Functioning in Students with Autism Following School-Based Smartglasses Intervention: Multi-Stage Feasibility and Controlled Efficacy Study	2018	Observational study	USA	Children aged 6-8 years with autism spectrum disorder (n=4)	Neurodevelopmental disorders	Assistive technology	Feasibility	**Positive**
								Satisfaction	**Positive**

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Antonson, C., et al.	Upper secondary school students' compliance with two Internet-based self-help programmes: a randomised controlled trial	2018	RCT	Sweden	Adolescents aged 15-19 years (n=283)	Mental Health	Digital	Adherence	**Negative**
								Satisfaction	**Negative**
Direito, A., et al.	Apps for IMproving FITness and Increasing Physical Activity Among Young People: The AIMFIT Pragmatic Randomized Controlled Trial	2015	RCT	New Zealand	Adolescents aged 14 to 17 years (n=143)	Physical activity	App	Adherence	**Positive**
								Usability	**Positive**
								Satisfaction	**Mixed**
Wójcicki T. R., et al.	Promoting Physical Activity in Low-Active Adolescents via Facebook: A Pilot Randomized Controlled Trial to Test Feasibility	2014	RCT	USA	Children aged 13-15 years and their guardians (n=21)	Physical activity	Digital	Adherence	**Mixed**
								Satisfaction	**Positive**
CURRIE, S. L., MCGRATH, P. J., & DAY, V.	Development and usability of an online CBT program for symptoms of moderate depression, anxiety, and stress in post-secondary students.	2010	Descriptive Study	Canada	Psychology students aged 18 - 21 (n=10)	Mental Health	Digital	Usability	**Mixed**
								Acceptability	**Positive**
Lillevoll, K. R., et al.	Uptake and adherence of a self-directed internet-based	2014	RCT	Norway	Students aged 15 - 20 years (n=1337)	Depression	Digital	Feasibility	**Negative**

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	mental health intervention with tailored e-mail reminders in senior high schools in Norway							Adherence	**Negative**
Yardley, L., et al.	Evaluation of a Web-based intervention providing tailored advice for self-management of minor respiratory symptoms: exploratory randomized controlled trial	2010	RCT	UK	n=714 aged 18-79, 440 particpants under 25	Respiratory	Digital	Healthcare utilisation	**Positive**
								Acceptability	**Positive**
								Satisfaction	**Positive**
Wright, C. J. C., Leinberger, K. and Lim, M. S. C.	Challenges to translating new media interventions in community practice: a sexual health SMS program case study	2016	Descriptive Study	Australia	Young people aged 15 - 25 years (n=119)	Sexual Health	Communication	Feasibility	**Negative**
								Acceptability	**Mixed**
Burckhardt, R., et al.	A Web-Based Adolescent Positive Psychology Program in Schools: randomized Controlled Trial	2015	RCT	Australia	Students in grades 7 - 12 (n=572)	Mental Health	Digital	Feasibility	**Negative**
								Adherence	**Negative**

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Table 9. Secondary and tertiary care included studies

Authors	Title	Year	Study Design	Setting	Population	Disease/topic	Technology Type	Delivery of care outcome	Positive, negative, mixed, no effect
Beck, R.W., et al	Effectiveness of continuous glucose monitoring in a clinical care environment: evidence from the Juvenile Diabetes Research Foundation continuous glucose monitoring (JDRF-CGM) trial	2010	Observational study	USA	Diabetes patients age groups: >25 years (n=51), 15-24 (n=56), 8-14 (n=47)	Diabetes	Sensor	Adherence	**Mixed**
KOBAK, K. A., et al.	A web-based tutorial for parents of young children with Autism: Results from a pilot study	2011	Observational study	USA	23 parents with a child between 18mths and 6 yrs with an autism spectrum disorder.	Autism	Digital	Usability	**Positive**
								Satisfaction	**Positive**
Tansey, M., et al.	Satisfaction with continuous glucose monitoring in adults and youths with Type 1 diabetes	2011	Descriptive Study	USA	Adults (n=224), youths (n=208), parents of youths (n=192) with Type 1 Diabetes	Diabetes	Sensor	Satisfaction	**Mixed**
Oliver, J. M., et al.	Balancing the risks and benefits of genomic data sharing: genome research participants' perspectives	2012	RCT	USA	Adult (n=229) of which 75 were Parental consentees	Child development	Genomics	Feasibility (Data collection/consent)	**Mixed**

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Hanauer D,A, et al.	Computerized Automated Reminder Diabetes System (CARDS): E-Mail and SMS Cell Phone Text Messaging Reminders to Support Diabetes Management	2009	RCT	USA	Insulin-treated patients aged 12 - 25 years (n=40)	Diabetes	Communication	Adherence	**Mixed**
								Satisfaction	**Mixed**
Peyrot, M. and Rubin, R. R.	Treatment satisfaction in the sensor-augmented pump therapy for A1C reduction 3 (STAR 3) trial	2013	Descriptive Study	USA	Adult patients (n=334), paediatric patients aged 7-18 (n=144), paediatric caregivers (n=141)	Diabetes	Sensor	Satisfaction	**Positive**
Hommel, E., et al.	Impact of continuous glucose monitoring on quality of life, treatment satisfaction, and use of medical care resources: analyses from the SWITCH study	2014	RCT	Europe	81 adults and 72 children and adolescents with type 1 diabetes	Diabetes	Sensor	Satisfaction	**No effect**
Crosby, L.E., et al.	Development and evaluation of iManage: a self-management app co-designed by adolescents with sickle cell disease	2016	Observational study	USA	Adolescents and young adults with sickle cell disease aged 16 - 24 years (n=70)	Haematology	App	Feasibility	**Mixed**
								Usability	**Positive**
								Acceptability	**Positive**
								Satisfaction	**Positive**

Rajapreyar, P. et al	Tissue doppler imaging and focal, late-onset anthracycline-induced cardiovascular disease in long term survivors of childhood cancer: a research article	2016	Observational study	USA	Survivors of paediatric cancer and healthy volunteers, mean age 23.1/23.6 (n=33)	Cancer	Diagnostics	Healthcare utilisation (diagnosis)	**Positive**
Fortier, M. A., et al.	Pain buddy: A novel use of m-health in the management of children's cancer pain	2016	Observational study	USA	Children and adolescents between the ages of 8 and 18 years(n=12)	Cancer	Digital	Feasibility	**Mixed**
								Satisfaction	**Positive**
Lamping, F., et al.	Development of a diagnostic model for early differentiation of sepsis and SIRS in pediatric patients-a data-driven approach using machine-learning algorithms	2018	RCT (secondary analysis)	Germany	Patients under the age of 18 years admitted to the PICU (n=230)	Sepsis	AI / Machine learning	Healthcare utilisation (diagnosis)	**Positive**
Kunin-Batson, A., et al.	A randomized controlled pilot trial of a Web-based resource to improve cancer knowledge in adolescent and young adult survivors of childhood cancer	2016	RCT	USA	Cancer survivors aged 15-29 years, mean age 21.1 years (n=52)	Cancer	Digital	Adherence	**Negative**
								Usability	**Positive**
								Satisfaction	**Positive**
Looman, W. S., et al.	Effects of a Telehealth Care Coordination Intervention on Perceptions of Health Care by Caregivers of Children With Medical	2015	RCT	USA	Families with children with medical complexity aged 2 - 15 years (n=148)	Complex needs	Communication	Satisfaction	**Positive**

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	Complexity: a Randomized Controlled Trial								
Markowitz, J. T., et al.	Text messaging intervention for teens and young adults with diabetes	2014	RCT	USA	Patients aged 16-21 years (n=90)	Diabetes	Communication	Adherence	**Positive**
								Satisfaction	**Positive**
McKenzie, R. B., et al.	Text Messaging Improves Participation in Laboratory Testing in Adolescent Liver Transplant Patients	2015	Observational study	USA	Patients aged 12-21 years and greater than six months post-liver transplantation (n=33)	Hepatology	Communication	Adherence	**Positive**
								Healthcare utilisation	**Positive**
								Satisfaction	**Positive**
Peabody, J., et al.	Clinical Utility of a Comprehensive, Whole Genome CMA Testing Platform in Pediatrics: a Prospective Randomized Controlled Trial of Simulated Patients in Physician Practices	2016	RCT	USA	Paediatricians (n=232)	Child development	Genomics	Healthcare utilisation (Quality of care, diagnosis)	**Positive**
Stinson, J., et al.	The iPeer2Peer Program: a pilot randomized controlled trial in adolescents with Juvenile Idiopathic Arthritis	2016	RCT	Canada	Adolescents diagnosed with Juvenile Idiopathic Arthiritis (JIA) aged 12 - 18 years (n=30)	Rheumatology	Communication	Adherence	**Mixed**
								Satisfaction	**Positive**

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Tan, J. E. and Caird, J.	Will electronic integrated text, visual and audio questionnaire be a better tool to evaluate the health status of paediatric hydrocephalus patients?	2016	Observational study	Ireland	Patients with hydrocephalus between the ages of 8 and 16 years (n=24)	Neurodevelop-mental disorders	Digital	Usability	**Positive**
								Satisfaction	**Positive**
Ammerlaan, J., et al.	Short term effectiveness and experiences of a peer guided web-based self-management intervention for young adults with juvenile idiopathic arthritis	2017	RCT	The Netherlands	Young adults aged 16-25 years with juvenile idiopathic arthiritis	Rheumatology	Digital	Healthcare utilisation (service use, medication)	**No effect**
								Adherence	**Positive**
								Satisfaction	**Positive**
Britto, M. T., et al.	A Randomized Trial of User-Controlled Text Messaging to Improve Asthma Outcomes: a Pilot Study	2017	RCT	USA	Children and young people aged 12-22 years with a diagnosis of persistent asthma (n=64)	Asthma	Communication	Feasibility	**Negative**
								Adherence	**Negative**
								Usability	**Positive**
								Satisfaction	**Positive**
Bunch, P. M., et al.	Skeletal development of the hand and wrist: digital bone age companion-a suitable alternative to the Greulich and Pyle atlas for bone age assessment?	2017	Observational study	USA	Two paediatric radiologists	Child development	Diagnostics	Healthcare utilisation (diagnosis)	**No effect**
								Usability	**Positive**
								Satisfaction	**Positive**

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Cai, R. A., et al.	Developing and Evaluating JIApp: Acceptability and Usability of a Smartphone App System to Improve Self-Management in Young People With Juvenile Idiopathic Arthritis	2017	Observational study	England	Young people aged 10 -23 years with juvenile idiopathic arthiritis (JIA) (n=29), and health care providers (HCPs) (n=21)	Rheumatology	App	Usability	**Positive**
								Acceptability	**Positive**
								Adherence	**Positive**
Di Bartolo, P., et al.	Young patients with type 1 diabetes poorly controlled and poorly compliant with self-monitoring of blood glucose: can technology help? Results of the i-NewTrend randomized clinical trial	2017	RCT	Italy	Young people aged 14-24 years with type 1 diabetes	Diabetes	Digital	Adherence	**Negative**
								Satisfaction	**Positive**
Mendoza, J. A., et al.	A Fitbit and Facebook mHealth intervention for promoting physical activity among adolescent and young adult childhood cancer survivors: a pilot study	2017	RCT	USA	Adolescents ages 14-18 years one year post cancer therapy (n=60)	Cancer	Digital	Feasibility	**Positive**
								Adherence	**Positive**
								Acceptability	**Positive**
								Satisfaction	**Positive**
Stewart, A. C., et al.	Adolescent and caregivers' experiences of electronic adherence assessment in paediatric problematic severe asthma	2018	Observational study	England	Adolescents aged 11-15 years referred to the tertiary service, (n=8)	Asthma	Sensor	Acceptability	**Mixed**

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Vriezinga, S., et al.	E-Healthcare for Celiac Disease-A Multicenter Randomized Controlled Trial	2018	RCT	The Netherlands	Patients below the age of 25 with celiac disease (n=304)	Auto-immune	Digital	Feasibility (costs, poc testing)	**Mixed**
								Satisfaction	**Mixed**
Scalzi, L. V., et al.	Improvement of medication adherence in adolescents and young adults with SLE using web-based education with and without a social media intervention, a pilot study	2018	RCT	USA	Adolescents and young adults between the age of 13 and 23 years (n=37)	Auto-immune	Digital	Feasibility	**Positive**
								Healthcare utilisation (medication)	**Positive**
Biddiss, E., et al.	Interactive media as a tool for reducing waiting anxiety at paediatric rehabilitation hospitals: a randomized controlled trial	2018	RCT	Canada	Young people with disabilities aged 5-19 years and parents attending clinics (n=313)	Child development	Virtual & Augmented Reality / Gamification	Satisfaction	**Positive**
Tarantino, N., et al.	Measuring antiretroviral adherence among young people living with HIV: observations from a real-time monitoring device versus self report	2019	RCT	USA	Adolescents aged 16-26 years with an HIV diagnosis (n=66)	Sexual Health	Digital	Healthcare utilisation (medication)	**Mixed**
								Adherence	**Mixed**
								Usability	**Negative**
		2018	RCT	USA			App	Feasibility	**Mixed**

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Jacobson, A. E., et al.	Mobile Application vs Paper Pictorial Blood Assessment Chart to Track Menses in Young Women: a Randomized Cross-over Design				Female adolescents aged 13-21 years (n=25)	Reproductive Health		Adherence	**Positive**
								Usability	**Positive**
								Satisfaction	**Positive**
Mulvaney, S. A., et al.	Mobile Momentary Assessment and Biobehavioral Feedback for Adolescents with Type 1 Diabetes: feasibility and Engagement Patterns	2018	RCT	USA	Adolescents aged 13-19 years with type 1 diabetes (n=44)	Diabetes	App	Adherence	**Mixed**
Chalmers, J. A., et al.	Psychosocial Assessment Using Telehealth in Adolescents and Young Adults With Cancer: A Partially Randomized Patient Preference Pilot Study	2018	RCT	Australia	Adolescents and young adults aged 15-25 years with a cancer diagnosis (n=19)	Cancer	Communication	Feasibility	**Positive**
								Acceptability	**Positive**
								Satisfaction	**Positive**
Stukus, D. R., et al.	Real-world evaluation of a mobile health application in children with asthma	2018	RCT	USA	Children aged 6mths - 21 years (mean age 6/7 years) presenting to ED with asthma exacerbations (n=200)	Asthma	App	Healthcare utilisation	**No effect**
Albanese-O'Neill, A., et al.	Transition Education for Young Adults With Type 1 Diabetes: Pilot Feasibility	2018	Observational study	USA	Young adults aged 18-25 years with type 1 diabetes (n=20)	Diabetes	Communication	Feasibility	**Positive**
								Adherence	**Positive**

	Study for a Group Telehealth Intervention							Satisfaction	**Positive**
Mimiaga, M. J., et al.	Positive Strategies to Enhance Problem-Solving Skills (STEPS): a pilot randomized, controlled trial of a multicomponent, technology-enhanced, customizable antiretroviral adherence intervention for HIV-infected adolescents and young adults	2019	RCT	USA	Youth aged 13-24 years with HIV (n=14)	Sexual Health	Communication	Adherence	**Positive**
								Acceptability	**Positive**
								Healthcare utilisation	**Positive**
								Satisfaction	**Positive**
Wendt, O., et al.	Effects of an iPad-based Speech-Generating Device Infused into Instruction with the Picture Exchange Communication System for Adolescents and Young Adults with Severe Autism Spectrum Disorder	2019	Observational study	USA	Adolescents and young adults between the ages of 14 and 23 (n=3)	Child development	Communication	Feasibility	**Mixed**
								Acceptability	**Positive**
								Satisfaction	**Positive**
Sousa P, et al.	Controlled trial of an Internet-based intervention for overweight teens (Next.Step): effectiveness analysis	2015	Observational study	Portugal	Obese adolescents aged 12 to 18 years (n=94)	Obesity	Digital	Adherence	**Negative**
Narring, F., et al.	Text-messaging to reduce missed appointment in a youth clinic: a randomised controlled trial	2013	RCT	Switzerland	Adolescents/young adults aged 12 - 24 years old (n=999)	Non-specific	Communication	Healthcare utilisation (appointments)	**No effect**

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REID, S., et al.	Using a mobile phone application in youth mental health: An evaluation study	2012	Observational study	Australia	47 adolescents aged 14 - 19 years and six paediatricians.	Mental health	App	Adherence	**Positive**
								Acceptability	**Positive**
								Satisfaction	**Positive**