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Digitalization of home-based records for maternal, newborn, and child health: a scoping review

Marije Geldof^{1*}, Nina Gerlach² and Anayda Portela³

Abstract

Background At least 163 countries use a form of home-based record, a document to record health information kept at home. These are predominantly paper-based, although some countries are digitalizing home-based records for improved access and use. This scoping review aimed to identify efforts already undertaken for the digitalization of home-based records for maternal, newborn, and child health (MNCH) and lessons learned moving forward, by mapping the available peer-reviewed and grey literature.

Methods The scoping review was guided by Arskey and O'Malley's framework. A literature search of references published from 2000 until 2021 was conducted in Medline, Embase, CINAHL, EBM reviews, Google Scholar, IEEE Xplore as well as a grey literature search. Title and abstract and full texts were screened in Covidence. A final data extraction sheet was generated in Excel.

Results The scoping review includes 107 references that cover 120 unique digital interventions. Most of the included references are peer-reviewed articles in English language published after 2015. Of the 120 unique digital interventions, 80 (66.7%) are used in 31 different countries and 40 (33.3%) are globally available pregnancy applications. Out of the 80 digitalization efforts from countries, most are concentrated in high-income countries ($n=68$, 85%). Maternal health ($n=73$; 61%) and child health ($n=60$; 50%) are the main health domains covered; the main users are pregnant women ($n=57$; 48%) and parents/caregivers ($n=43$; 36%).

Conclusions Most digital home-based records for MNCH are centered in high-income countries and revolve around pregnancy applications or portals for home access to health records covering MNCH. Lessons learned indicate that the success of digital home-based records correlates with the usability of the intervention, digital literacy, language skills, ownership of required digital devices, and reliable electricity and internet access. The digitalization of home-based records needs to be considered together with digitizing patient health records.

Keywords Maternal newborn and child health, Home-based records, Digital health/eHealth, Immunizations/Vaccines, Health informatics

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Background

A home-based record is a document used to record an individual's history of health services received, and in some countries, also to share health education messages. Those who interact with the home-based record are typically the individual or their parent/caregiver, health workers, and those managing and monitoring public health programmes. Home-based records can have different formats. For maternal, newborn and child health (MNCH) programmes, formats include immunization records, antenatal care records, child health booklets, or maternal and child health booklets [1]. The use of home-based records has been recommended for MNCH by the World Health Organization to compliment facility-based records to improve care-seeking behavior, men's involvement, maternal and child self-care, family care practices, infant and child feeding, and communication between health workers and women/parents [2].

At least 163 countries use some form of home-based records, with the highest prevalence of home-based records (90%) in the European Region [2–4]. However, these records vary greatly in terms of their design and information captured. They are adapted for use in local contexts, by considering health priorities, available services, and languages. Furthermore, the content, design, and durability of home-based records are crucial for their sustainability, effectiveness and implementation [5]. The great majority of these home-based records are paper-based, although many countries have plans for digitalizing them for improved access to key health information and use, as well as for higher rates of recording of health information [4]. In some middle- and high-income countries, electronic home-based records are already used to promote information sharing between providers, to improve the integration of care, and to reduce the risk of data loss [6]. However, in many countries electronic health management information systems remain in their infancy and paper home-based record will remain important as these systems mature [7].

To learn from the literature and experiences prior to planning new activities, global partners supporting the implementation and monitoring of home-based records have identified the digitalization of home-based records as an important area for future work and proposed to conduct a scoping review. A scoping review aims to map key concepts underpinning a research area and to identify the main sources and types of evidence available [8].

This objective of the scoping review was to understand the efforts already undertaken in terms of the digitalization of home-based records for MNCH and to compile the lessons learned for moving forward by mapping

peer-reviewed and grey literature. The following review question guided the exercise towards this objective:

- What efforts have already been undertaken for the digitalization of home-based records for MNCH?

Moreover, the following six sub-questions were to be answered:

1. In which geographical contexts have efforts to digitalize home-based records already been undertaken?
2. What are the experiences in the public versus the private sectors for these efforts?
3. What studies or evaluations affiliated with these digital interventions are known?
4. What are the challenges and lessons learned from these efforts to digitalize and implement?
5. What literature is available from health areas other than MNCH regarding digitalization of home-based records?
6. What terminology is most commonly used in relation to digitalization of home-based records?

To our knowledge, this is the first scoping review on this topic.

Methods

This scoping review was conducted based on the framework outlined by Arksey and O'Malley [8] that includes the following five steps: 1) development of the research question; 2) development of a search strategy to identify relevant materials; 3) application of inclusion and exclusion criteria for the selection of relevant materials; 4) data extraction from the included materials and 5) synthesizing the findings. The objectives, eligibility criteria, and methodology of the conduct of this scoping review were previously documented in a protocol [9]. The results of the scoping review are reported in line with the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist [10] (see [Supplementary file](#)).

Data sources

The scoping review drew on a variety of different materials, including published and grey literature to ensure diversity in the retrieved materials. These were retrieved through four mechanisms: an electronic database search, a grey literature search, expert recommendations, and reference searching.

Based on the preliminary search strategy included in the protocol, flexibility was adopted to refine and narrow it down. In September 2021, a librarian conducted an

electronic database search in Medline, Embase, CINAHL, EBM reviews, Google Scholar, IEEE Xplore. Preprints were searched through ArXiv and a grey literature search conducted, as outlined in the [Supplementary file](#). Experts in the field were contacted to provide relevant materials that might be missed through the database search. The bibliographies of included references and of systematic reviews that were identified through the search were also reviewed. An overview of the results by database is available the [Supplementary file](#).

Search terms

Relevant search terms were defined in the methods guide, however the final terms were determined through an iterative process. Search terms were tested and refined based on the relevance of materials found with particular search terms. For example, using search terms like ‘vaccination’ and ‘immunization’ on their own resulted in a lot of irrelevant materials. Therefore, the search was narrowed by combining terms such as ‘vaccination’ or ‘immunization’ with terms such as ‘card’, ‘record’ or ‘passport’. A list with the final search terms used in the different databases can be found in the [Supplementary file](#). The terms aimed to encompass a wide range of terms used to refer to ‘home-based records’ in various countries. A filter was applied to search for relevant terms in the titles and abstracts.

Inclusion and exclusion criteria

The references resulting from the search strategy were considered for inclusion based on predetermined criteria. In order to ensure that the criteria were sensitive in capturing relevant materials, they were tested on a sample of studies identified during preliminary searches. The inclusion and exclusion criteria used can be found in [Table 1](#).

Due the focus of this scoping review on digital interventions that included an individual’s access to a health record, there were several MNCH-related digital interventions that were removed, because they did not fulfill all inclusion and exclusion criteria. For example, there are several pregnancy applications providing information, but without health record access. Similarly, portals or applications meant to provide vaccine information and promote uptake, but without access to the vaccination record, were not included. Digital interventions entailing one-directional text messages, such as appointment reminders, or a physical token, such as a near-field communication token, with a digital copy of a health record that cannot be accessed by the patients themselves, were also excluded.

Reference screening and selection

All references identified through the search strategy were uploaded into Covidence [11], where duplicates were

Table 1 Inclusion and exclusion criteria to assess eligibility of studies

	Inclusion criteria	Exclusion criteria
Home-based records and digitalization	Materials addressing both home-based records and digitalization were considered for inclusion. The digitalization of a home-based record is understood as an individual/patient or the parent/caregiver having electronic access to elements of their health record. This could also include access to health messages.	Interventions that only health workers can access and clients/patients can not. Interventions where people hold a physical token with a digital copy of the record, but are unable to access it themselves (i.e. smart card or Near-field communication token). Interventions that only provide one-directional text messages or information to an individual/patient without health record access.
Health area	Interventions focusing on maternal, newborn and/or child health, including pregnancy and postnatal care, immunization, nutrition, and early child development.	Digital interventions that covered a subset of the MNCH population, such as patients with a particular disease (e.g. gestational diabetes or pediatric cancer). Digital interventions addressing other health areas. Materials exclusively focused on COVID-19 vaccinations. The COVID-19 pandemic has led to advances in the digitalization of vaccination certificates and was beyond the scope of this review.
Language	Any language.	There were no language restrictions.
Timeframe	References published since 2000, as digitalization is a relatively new field and all key materials should likely be published after that.	References published before 2000.
Type of material	Any relevant peer-reviewed article or grey literature (e.g. books, book chapters, journal articles, conference papers, reports, and websites).	Systematic reviews (relevant reference lists would be manually searched).

removed. The screening was done by authors MG and NG independently, after a common understanding was established based on test screening of a few references. MG completed the screening of all references at title and abstract and full-text stage, and NG independently screened a random sample of 20% for quality assurance at both stages. Disagreements were resolved through discussion with AP. Materials not in English were assessed with the help of Google Translate or using language skills from the review team. A reference identified in German was reviewed by NG. This scoping review encompassed literature focusing on MNCH. Literature that addressed digital home-based records in other health areas were noted but considered beyond the scope of this review.

Data extraction

A data extraction form was developed in Covidence through an iterative process, tested against five included references to ensure all necessary data was captured appropriately and best met the objectives of the scoping review. The final version of the data extraction form can be found in the [Supplementary file](#). Data extraction was done in Covidence. MG extracted information from all references, and NG reviewed a 50% sample. Any discrepancies were resolved through discussion among MG and NG and, if consensus was not reached, managed by AP. The extracted information was imported from Covidence to a Microsoft Excel (Excel version 16.64, <https://office.microsoft.com/excel>, 2022, Redmond, United States of America (USA)) spreadsheet and was finalized in Excel.

The first columns in the data extraction sheet related to the included references, for example publication type,

timeline, language. Other information that was extracted referred to the digital interventions identified through the references, for example geographical area, health domain, implementers, funders and scale of implementation (see [Supplementary file](#)).

Moreover, a free text column captured any reflections in the included manuscripts related to factors influencing the implementation of the digital interventions, which were then grouped together in similar categories. The result section is divided accordingly and first presents findings related to the included references, while the latter section refers to the digital interventions identified.

If a digital intervention covered more than one health domain (maternal health, newborn health, child health, immunization), all health domains were marked in the data extraction sheet. Subcategories for each health domain were also coded (for example, antenatal care, postnatal care, immunization, nutrition, growth and development). If a digital intervention did not mention explicit reference to a particular health domain, for example because it was created for the general population and included MNCH, maternal, newborn, and/or child health were all indicated in the data extraction sheet.

Results

The different searching techniques retrieved a total of 630 records that were uploaded in Covidence. Figure 1 describes the reference selection process. After 11 duplicates were excluded, 617 records were screened on title and abstract. A further 324 records, including an additional 28 duplicates, were excluded. The full texts of 295 records were screened, with 107 references meeting the

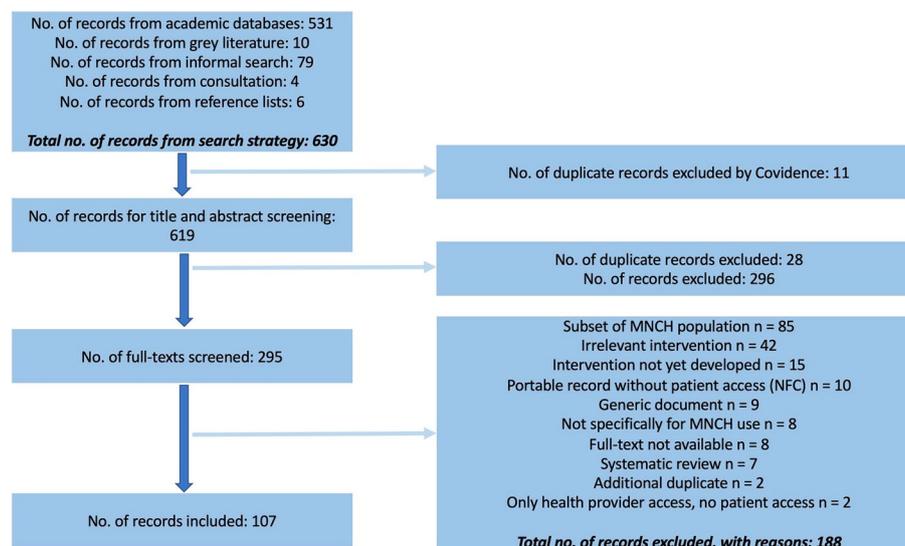


Fig. 1 Flow chart of the reference selection process

criteria for inclusion. Reasons for exclusion at full-text stage can be reviewed in Figure 1.

Some references covered more than one digital intervention. Conversely, several references focused on the same digital intervention. The 107 included references covered 120 unique digital interventions. A list of all included references can be found in the [Supplementary file](#).

The findings are divided in two parts: the first section presents the characteristics of the 107 included references, such as publication type, timeline and language. The second part describes the characteristics of the 120 unique digital interventions, including geographical distribution, health domains and targeted users, implementers, funders, scale of implementation, terminology for digital interventions, associated studies, aim of the digital interventions, and reflections on the impact of digital interventions. The latter section responds to the main review question: *What efforts have already been undertaken for the digitalization of home-based records for MNCH?* A summary table with the characteristics is provided in the [Supplementary file](#).

Characteristics of included references

Publication type, timeline, language

Of the 107 references, the majority were peer-reviewed articles ($n=76$; 71%) or other types of academic publications ($n=17$; 16%; i.e. conference papers and posters, and master theses). Only a small number of the included publications were other type of publications ($n=14$; 13%; i.e. NGO reports, government documents). The majority ($n=76$; 71%) of included references were published since 2015 (Figure 2).

All included materials were in English language, apart from one German reference. The geographic scope of the 107 references was characterized by an Anglophone dominance.

Characteristics of the digital interventions

Geographical distribution

Out of the 120 digital interventions, 80 (66.6%) were used in 31 countries, compared to 40 (33.3%) pregnancy applications that could be used globally. The majority of interventions ($n=38$; 31.7%) focused on English-speaking countries: USA ($n=28$), Canada ($n=4$), United Kingdom ($n=3$), Australia ($n=2$), and Ireland ($n=1$), as indicated in Table 2.

Based on the income levels by the World Bank [12], out of the 80 digitalization efforts from countries, most were concentrated in high-income countries ($n=68$, 85%). A significantly smaller proportion were from upper-middle income countries ($n=9$; 11%) and few from lower-middle income countries ($n=3$; 4%). None of the digital interventions was implemented in low-income countries.

Health domains and targeted users

Maternal health ($n=73$; 61%) was the main health domain covered across the 120 unique digital interventions, due to a large number of pregnancy applications that were identified, followed by child health ($n=60$; 50%) and newborn health ($n=40$; 33%) (Figure 3). Several of the digital interventions covered more than one health domain (for example, newborn and child health). Few ($n=3$; 2.5%) digital home-based records covered immunization for the general population (i.e. CANImmunize in Canada).

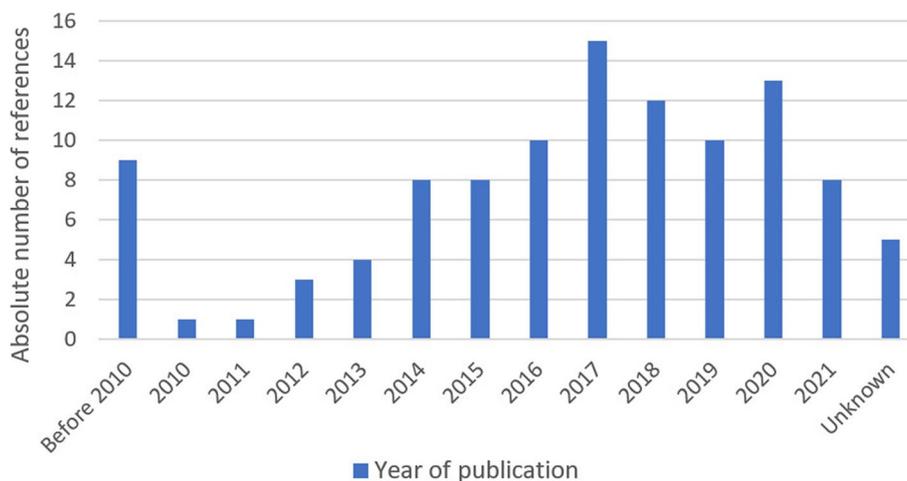


Fig. 2 Year of publication of included references ($n=107$)

Table 2 Number of included references and digital interventions by country and income level

Country	Income level (based on the World Bank's classification for fiscal year 2023)	Number of digital interventions (n=120)	Number of publications (n=107, some references discussed interventions from more than one country)
AMRO			
Argentina	Upper-middle income	2	3
Canada	High income	4	12
United States of America	High income	28 ^a	47
EMRO			
Jordan	Upper-middle income	2	5
EURO			
Austria	High income	2 ^a	3
Azerbaijan	Upper-middle income	1 ^b	1
Bulgaria	Upper-middle income	2 ^a	2
Czech Republic	High income	1	2
Denmark	High income	3 ^b	3
Estonia	High income	1 ^b	2
Finland	High income	2 ^b	4
France	High income	3	4
Germany	High income	1	1
Greece	High income	1 ^b	2
Iceland	High income	1	2
Ireland	High income	1	2
Israel	High income	1 ^a	1
Italy	High income	2	3
Malta	High income	1	2
Netherlands	High income	4	4
Poland	High income	2	2
Portugal	High income	1 ^a	2
Republic of Moldova	Upper-middle income	1	1
Romania	High income	1 ^a	2
United Kingdom	High income	3	12
SEARO			
India	Lower-middle income	2	2
Indonesia	Lower-middle income	1	2
Thailand	Upper-middle income	1	1
WPRO			
Australia	High income	2	6
Singapore	High income	1 ^a	1
Taiwan	High income	2	2
Global	NA	40	4

^a One digital intervention is not yet implemented

^b Transitioning to a portal

For slightly more than two-third ($n=82$; 68%) of digital home-based records, the health domains could be further specified. Out of these 82 records, the majority recorded data on pregnancy ($n=56$; 68%), immunization ($n=23$, 28%) and growth and development ($n=17$; 21%). Information about postnatal care was captured in

two digital home-based records and another two captured data on nutrition. A total of 17 (21%) digital interventions covered more than one subcategory of health domains.

Overall, the main user groups targeted by the 120 digital interventions were pregnant women ($n=57$;

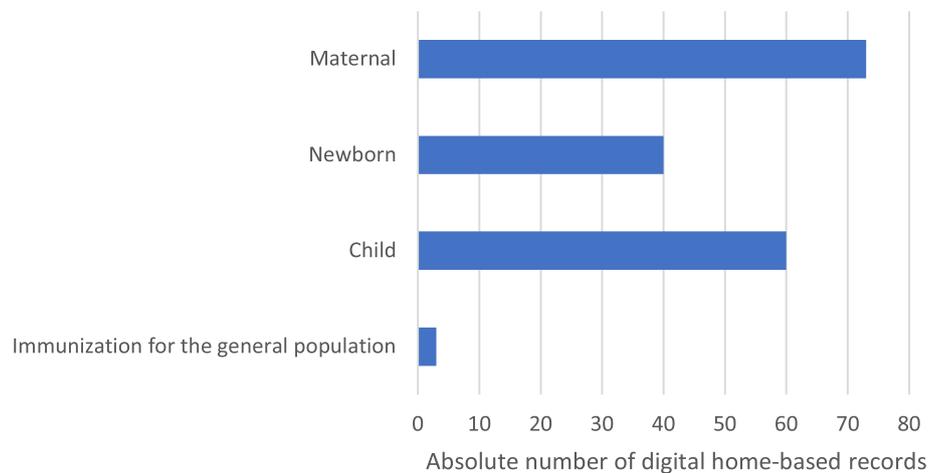


Fig. 3 Health domains of the digital interventions ($n=120$)

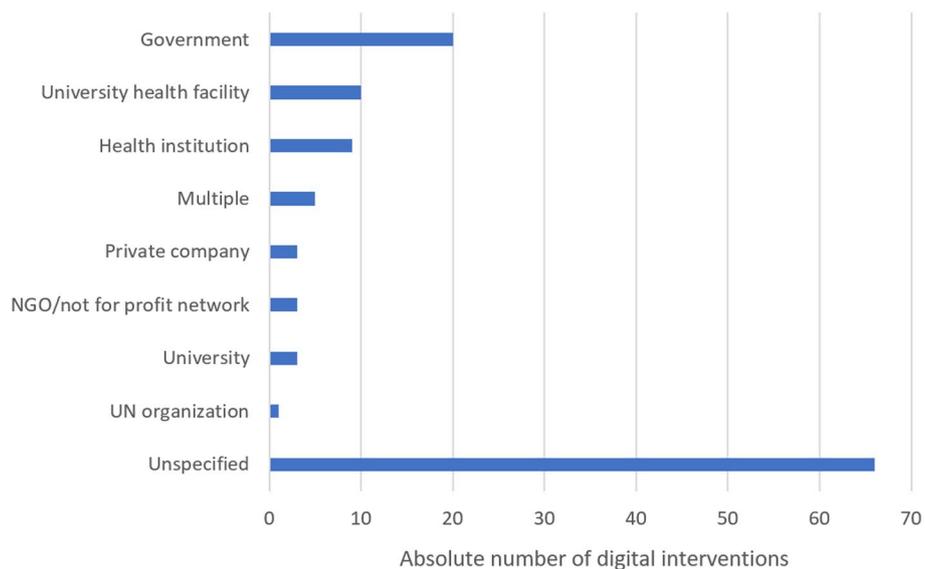


Fig. 4 Implementers of the included digital interventions ($n=120$)

48%) and parents/caregivers ($n=43$; 36%). In some cases ($n=20$; 17%), digital interventions were designed for the general population, or the patient population at a specific hospital, which implicitly encompasses MNCH user groups such as parents and pregnant women.

Implementers, funders, and scale of implementation

Figure 4 illustrates the distribution of implementers of the digital interventions, predominantly by government ($n=20$; 17%), university health facilities ($n=10$; 8%) and health institutions ($n=9$; 7%). For more than half of the interventions, the implementer was not clear, not specified in the report or difficult to discern (i.e. for pregnancy apps) ($n=66$, 55%). Out of the 120 digital interventions,

the majority ($n=110$; 92%) were associated with a study, while the remaining 10 (8%) were not.

In many cases the funding source for the digital intervention was also not clearly stated. However, for some national digital interventions, such as eRedbook in the UK, it was implicit that funding came from the national government. A third of the 120 digital interventions were implemented at global level ($n=40$; 33%), which includes pregnancy monitoring apps. Of the remaining 80 references, 16 (13%) digital interventions were implemented at national level, e.g. the eRedbook in the UK or CANImmunize in Canada. Many of the other interventions were either implemented at individual health facilities ($n=13$; 11%) or were at the pilot stage ($n=13$; 11%) (Figure 5).

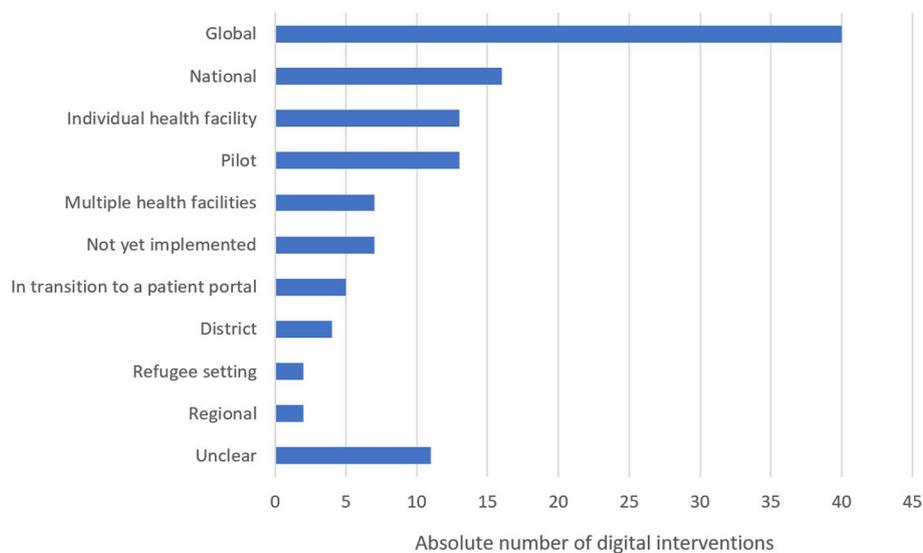


Fig. 5 Scale of the digital interventions ($n=120$)

Terminology for digitalization interventions

The most common terminology for the 120 digital health interventions was ‘patient portal’ ($n=26$; 22%). Other terminology included ‘Personal Health Record’ (PHR) ($n=17$; 14%), including ‘personal child health record’ and ‘mobile Personal Health Record’, which typically provide patient access to the patient information captured in an electronic health record (EHR), often through a patient portal. Definitions for patient portal, PHR, and vaccination app are provided in Table 3.

The term ‘Electronic/Digital Health Record’ was commonly used in relation to the digital interventions ($n=19$; 16%), even though it is not strictly an example of a digitalized home-based record, as it typically only provides access to healthcare providers and not to patients. However, it is directly intertwined with PHRs that are typically built as an extension of existing EHRs that healthcare providers already use to access the patient health records, by giving the patient also access to their health record that is already available in the EHR.

Aim of the digitalization interventions

The aims of the digital interventions in the included references can be summarized as follows:

1. Individual patients and parents/caregivers given online access to their or their child’s health records or clinical notes.
2. Individual patients and parents/caregivers actively engaging in their own healthcare or their child’s healthcare, including communications with health workers.

3. Individual patients and parents/caregivers tracking and managing immunizations.
4. Supporting women to monitor their pregnancy.
5. Providing a digital versions of paper-based home-based records (e.g. parent-held record books, child health records/books).

Factors influencing the implementation of the digital interventions

The included references have a broad scope in terms of the impact of the digital interventions and possible barriers to implementation they discuss, which can be grouped under the following categories: 1) Usability and functionality; 2) User characteristics influencing the implementation of the digital intervention; 3) Confidentiality, security and credibility; 4) Further impact of the digital interventions (Table 4).

Usability and functionalities

Design and usability factors influence the successful uptake of digital home-based records. For example, the design simplicity, content, and user-friendly user interfaces are determinants of how likely a system will be used. One study identified how difficulties in navigation and the complexity of the medical language reduced user motivation [27]. Another publication outlined how pregnant women preferred the paper-based version as the digital system was unfamiliar and difficult to navigate [28]. Moreover, proper orientation on digital interventions, what it is, what services are offered and how to use it are important enablers.

Table 3 Definitions for patient portal, PHR and immunization/ vaccination app

Patient portal	Personal Health Record (PHR)	Immunization/vaccination app
<p>Healthcare-related online application that allows patients to interact and communicate with their healthcare providers, as well as give them instant access to their health information from anywhere with an internet connection.</p>	<p>A health record where health data and information related to the care of a patient are managed by the patient. This stands in contrast to the more widely used EHR, which is operated by healthcare providers. <i>Personal child health record (PCHR)</i>: a form of PHR that records a child's growth, development, and history of health services received. <i>Mobile personal health record (mPHR)</i>: an application through which patients can access, manage, and share their PHR from a mobile device.</p>	<p>A mobile application that provides access to a patient's digital immunization record and upcoming immunization schedules.</p>

Table 4 Further impact of digital interventions discussed across the included references

Empower users and give patients a more active role in their own healthcare [13–15]
Improve data quality by allowing patients to correct mistakes or outdated information [16]
Increase participation in immunization and knowledge of vaccination history [13, 17]
Provide time and cost savings for the health system [17–19]
With electronic records patients have less concerns about record loss [20]
Digital interventions for maternal health can have a positive impact on breastfeeding exclusivity and duration, but not on the decision to breastfeed [21]
Pregnant women with poor pregnancy histories and parents of younger children or those with chronic issues are more likely to use patient portals [22]
Some patients worry that a portal can undermine in-person relationships with health workers, however, in practice parents use patient portals and phone calls to communicate [23].
Patient-generated images can enhance communications between patients and caregivers [24]
The availability of epidemiological data in an electronic format makes analysis easier [25]
An electronic immunization record system has the advantage of obtaining data at a lower cost than through population-based surveys [26]

The different digital interventions cover a range of functionalities ranging from appointment reminders to discussion forums to electronic prescriptions. One of the more popular features is access to diagnostic results, although there are calls for updates to be quicker [27, 29, 30]. Provider-patient communications can be improved through electronic systems [31]. Moreover, users need to be encouraged to report concerns or errors [32]. Frequent power interruptions can pose a challenge for digitalization and for operations and maintenance in resource-constrained settings [25].

User characteristics influencing the implementation of the digital interventions

There are a number of user characteristics that determine the potential for successful use of digital home-based records. These indicate that in the end the successful adoption of a system depends on a combination of people's skills and resources, technology, and processes [31, 33–37], namely 1) digital literacy skills; 2) ownership of digital devices, 3) reliable electricity and internet access, and 4) language skills in the operational language of the digital intervention.

The presence or absence of these factors greatly varies with socioeconomic status with a risk that digitalization of home-based records can lead to further reinforcement of racial, ethnic, economic, and educational disparities [38]. For example, interventions that are only available for iPhone and not Android pose limitations for people of lower economic status [39]. Moreover, digital interventions should be sensitive to the diverse needs of the populations and bridge the rural/urban divide [40].

Confidentiality, security, and credibility

Confidentiality, security, and credibility of data are essential for the management of PHRs, including digital home-based records. Parents frequently express concerns about

who has access to their own or their children's health data [13, 20, 27, 41–43]. Yet, the benefits of being able to view medical records, get laboratory results, or send messages often outweigh confidentiality concerns.

Parental proxy access is often limited for adolescents and depends on the regulatory system within which the digital intervention operates. This possibly explains why adolescents were not as prevalent among the target users of the digital interventions in the included references. For example, in the USA, legal rights to access medical records by adolescents and parents varies between states and may differ depending on the record's content, especially for psychiatric or reproductive health issues [27]. Confidentiality is typically handled at the facility level, but this becomes more complex with the availability of electronic data and calls for further research to meaningfully and securely communicate appropriate information with teenagers and guardians [44].

Examples of frequently mentioned digital interventions

Several digital interventions were covered in different references. For example, 19 references referred to a patient portal in the USA, ten discussed a PHR in the United Kingdom (UK), nine references discussed an application in Canada, three an application in Jordan, and two discussed a different application in Jordan.

CANImmunize (Canada) [33, 39, 45–51] <https://www.canimmunize.ca>

The CANImmunize application was launched in 2014 as ImmunizeCA. It was funded by the Public Health Agency of Canada and developed by researchers at the Ottawa Hospital to help Canadians store, manage, and access immunization information. CANImmunize is a free bilingual (English and French) application that allows individuals to manage their own and their family's vaccination records. It does not require users to be connected

to WiFi and allows Canadian residents to easily access their records anytime, anywhere. The application permits multi-record vaccination tracking for parents or guardians to view digital records for themselves or their dependents. Information on vaccination in each jurisdiction is easy to understand and there are reminders for upcoming or overdue vaccinations.

MyChart (USA) [22, 29, 31, 44, 52–55] <https://www.mychart.com/>

MyChart is a patient portal with a secure website for patients to access personal health information. It is a real-time, patient-centered record with information available instantly wherever and whenever needed. MyChart patients are able to view records, clinical notes, laboratory, and imaging results. It also allows for messages, scheduling of appointments, and requests for medication refills. Patients have the option to sign up for patient portal access, but it is not required. Parents and legal guardians can obtain proxy access to their child's patient portal account in an unrestricted manner through to age 11, whereas for adolescents 12–17-years, the proxy access by parents and guardians is restricted.

eRedbook (UK) [34, 56–61] <https://www.eredbook.org.uk/>

The eRedbook is the UK's first digital PCHR that has been available nationwide since 2020. The online version of the familiar parent-held record book/'red book' facilitates a move from paper to electronic records, although parents will still be able to choose between paper or electronic. The eRedbook stores information about immunizations, health reviews, and screening tests; it tracks weight and height to give age-appropriate guidance. It was created and is maintained by parents and health professionals to involve parents in managing their child's health with an array of tools. The eRedbook can be accessed by parents with an internet connection through a computer, tablet or smartphone.

eMCH Handbook (Jordan) [28, 62, 63]

In April 2017, the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) released an electronic Maternal and Child Health Handbook (e-MCH Handbook) specifically for a refugee setting in Jordan. The application gives pregnant women and mothers on- and offline access to educational information and to both their own and their children's PHRs on a smartphone and is one of the first mobile health interventions in a refugee setting. The e-MCH Handbook also sends reminders for appointments and health education information. The e-MCH Handbook also functions as an efficient communication tool between patients and

UNRWA health centres compared to the paper-based MCH Handbook.

Children Immunization App (Jordan) [64, 65]

https://play.google.com/store/apps/details?id=com.letsnurture.vaccination&hl=en_US&gl=US

The Children Immunization App (CIImA) is a vaccination application for refugee settings that has been implemented in Zaatari Camp since 2019. The application is freely available in Google Playstore, in both English and Arabic (Android only). It documents the vaccination history of Syrian children and includes health education information and automated reminders for parents. There is a visual tool for parents with limited literacy.

Discussion

This section responds to the different questions the scoping review set out to answer, based on the results.

What efforts have already been undertaken for the digitalization of home-based records for MNCH?

The identified digital interventions were mostly applications to monitor pregnancies, revolved around general patient portals to give access to patient health records or specific MNCH-related interventions focused on either immunization or maternal and child health records (e.g. eRedbook in UK and CANImmunize in Canada).

In which geographical contexts have efforts to digitalize home-based records already been undertaken?

Overall, the scoping review demonstrated that the efforts for digitalization of home-based records for MNCH are centered in high-income countries, particularly the USA and other Anglophone countries. The findings indicate digital interventions exist in high- and middle-income countries, though there is a clear gap in the available literature on digitalization of home-based records in low-income countries.

Digital home-based records may be more prevalent in high-income countries, as digital devices, reliable electricity and internet access, digital literacy, and financial resources for internet access are more readily available than in low- and middle-income countries. Furthermore, the necessary financial resources and skills to undertake the digitalization of home-based records are often more readily available in high-income countries.

What are the experiences in the public versus the private sectors for these efforts?

The majority of digital interventions were implemented through initiatives of national governments,

by university or private health facilities. Other stakeholders like NGOs, telecommunication companies or private companies only appeared minimally in the included references. It is well possible that the digital interventions at particular health facilities were also used in other parts of the country or even in other countries, even if this was not directly evident in the particular publication. For a substantial number of digital interventions, particularly the pregnancy monitoring apps, it was unclear, who the implementer was.

What terminology is most commonly used in relation to digitalization of home-based records?

The most prevalent terminology for digital interventions across the included references were '(online) patient portal' (22%) and 'Personal Health Record' (14%). Both refer to a form of online access to a health record and this gives a clear indication that the most common access to home-based records for the included digital interventions is through an online patient portal. Online patient portals are typically not MNCH-specific, but rather for the general population, with specific access for parents and caregivers to their children's records. Because the search strategy was tailored towards MNCH, the online patient portals identified were usually part of a maternal or pediatric study.

What are the challenges and lessons learned from these efforts to digitalize and implement?

Given the broad diversity of digital interventions covered by the included references, there are a range of challenges and lessons learned from the references that can inform future digitalization of home-based records, particularly for underserved populations and remote geographical areas. There are many factors that influence the impact of any digital interventions and can pose barriers to implementation (see Table 5). Efforts should be made to ensure that already vulnerable populations are not further disadvantaged through the digitalization of home-based records.

Limitations

Despite the strength of scoping reviews in mapping available evidence, there are inherent limitations to its methodology that are important to note. The search strategy primarily targeted results that made explicit reference to MNCH-related search terms in the title or abstract, which means that any relevant digital interventions where MNCH search terms did not appear explicitly might have been missed. Moreover, some search terms were narrowed (e.g. 'vaccination record' instead of 'vaccination') in order to reduce the number of irrelevant results. While some relevant literature may have been

Table 5 Summary of the factors influencing the implementation of digital interventions

Usability factors	Design simplicity
	Attractiveness of user content
	User friendliness of user interfaces
	- Easy to navigate - Advanced medical language - User orientation about intervention
User characteristics	Digital literacy skills
	Ownership of digital devices
	Reliable electricity and internet access
	Language skills in the operational language of the digital intervention
Confidentiality, security and credibility	Confidentiality concerns
	Secure communication
	Parental proxy

missed, this limitation was balanced against the feasibility of reviewing such a large body of references with the potential for a low yield.

A particular challenge for this review was the wide range of terms used to refer to 'home-based records' in various countries, ranging from 'vaccination passport' to 'under-fives cards [66, 67]. The search strategy sought to encompass all these terms but may have missed relevant ones. As the search strategy was primarily based on English search terms, it resulted in predominantly Anglophone publications, even though no language filter was applied. A preliminary search revealed a number of examples of home-based records in local vernaculars in non-English speaking countries that were not easily picked up by the search strategy due to the lack of documentation in English, for example the electronic health-care service portal *Elektronikus Egészségügyi Szolgáltatási Tér* in Hungary.

Finally this search focused on MNCH literature. Additional insights and lessons learnt may be drawn from other health areas, which was considered beyond the scope of this review.

Despite these limitations, the authors are confident that the search strategy has nevertheless captured the majority of the available relevant literature, as reflected by the 107 references included for data extraction.

Conclusion

This scoping review mapped the available evidence from peer-reviewed and grey literature available on the digitalization of home-based records for MNCH. It demonstrated that digital home-based records exist, particularly in high-income countries, though increased efforts are needed to document and share promising experiences for other countries to learn from.

As the digitalization of home-based records cannot be considered separately from the digitalization of the health information system and electronic health records more generally, future efforts could establish a better link between digital home-based records and the development of electronic health records that allow patients to access their records. Likewise, future work could investigate non-MNCH specific literature to determine whether broader lessons of digital home-based records outside the MNCH domain are available.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s44247-023-00032-1>.

Additional file 1.

Acknowledgements

We acknowledge the contributions of: Caroline Sauvé, Centre Hospitalier de l'Université de Montréal, who helped to develop and execute the search strategy; Laura Nic Lochlainn, World Health Organization Department of Immunization, Vaccines, and Biologicals; Anne Detjen, UNICEF, and Keiko Osaki, Ibi Tomomi and Hirotugu Aiga from the Japan International Cooperation Agency for inputs on the methods guide. Finally, we thank Vanessa van Schoor from Integrity in Malawi for reviewing the final report.

Authors' contributions

Marije Geldof: main author who prepared the scoping review protocol and undertook the search, screening and data extraction and led the writing of the manuscript. Nina Gerlach: second author who served as a second reviewer for the screening and data extraction and did substantial editing of the manuscript. Anayda Portela: Oversaw the scoping review, mediated any disagreements between the two reviewers and provided inputs into the manuscript.

Funding

This manuscript was developed with funding from the World Health Organization Department of Maternal, Newborn, Child, and Adolescent Health and Ageing, through a grant received from the Japan International Cooperation Agency.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no conflicts of interests. Anayda Portela is a staff member of the World Health Organization. The authors alone are responsible for the views expressed in this manuscript and they do not necessarily represent the decisions, policy or views of the World Health Organization.

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Received: 19 December 2022 Accepted: 24 July 2023

Published online: 04 September 2023

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