Mobile child development tracking applications for parents described in the scientific literature: a scoping review

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Abstract

Using mobile applications to monitor child development is a facilitator towards access to pediatric care in Brazil. **Objective:** This study aims to review the main mobile apps that parents can use to track children's development. **Method:** A scoping review was conducted in the Scielo, PubMed, Embase, and Lilacs databases. The descriptors included: "developmental milestones" OR "child development" OR "developmental tracker" AND "application" OR "app". **Results:** The initial search found n=445 studies but only 12 met the eligibility criteria. Among these studies, n=9 apps were found and described in terms of their features and functions. However, only one is available for use in Brazil. **Conclusion:** Mobile m-Health applications are limited in Brazil but they have the potential to overcome continental geographical barriers for access to healthcare

Key-words: m-Health, Telehealth, Developmental Milestones, Child Development

Resumen

Aplicaciones móviles de seguimiento del desarrollo infantil para padres descritas en la literatura científica: una revisión de alcance.

El uso de aplicaciones móviles para monitorear el desarrollo infantil constituye un facilitador viable para el acceso a la atención pediátrica en Brasil. **Objetivo:** El presente estudio tiene como objetivo revisar las principales aplicaciones móviles para padres orientadas al seguimiento del desarrollo infantil retratadas en la literatura. **Método:** Se realizó una revisión de alcance en las bases de datos Scielo, PubMed, Embase y Lilacs. Tú descriptores usado eran: "hitos del desarrollo" O "desarrollo infantil" O "rastreador del desarrollo" Y "aplicación" O "app". **Resultados:** Una búsqueda inicial encontró n=445 estudios, de los cuales solo 12 cumplieron con los criterios de elegibilidad. A partir de estos estudios, se encontraron n=9 aplicaciones y se describieron en términos de sus características y funciones. De éstos, sólo uno está disponible para su uso en el contexto nacional. **Conclusión**: Las aplicaciones móviles de m-Salud, aunque ausentes en Brasil, pueden convertirse en una herramienta con potencial para superar las barreras geográficas continentales en favor del acceso a la atención de salud.

Palabras clave: m-Salud, Telesalud, Hitos del desarrollo, Desarrollo infantil.

Resumo

Aplicativos móveis de rastreio do desenvolvimento infantil para pais descritos na literatura científica

O uso de aplicativos móveis para o monitoramento do desenvolvimento infantil se constitui como facilitador viável em direção ao acesso ao atendimento em pediatria no Brasil. **Objetivo**: O presente estudo objetivo revisar os principais aplicativos móveis para pais destinados ao rastreio do desenvolvimento infantil retratados na literatura. **Método**: Foi conduzida uma revisão de escopo realizada nas bases de dados Scielo, PubMed, Embase e Lilacs. Os descritores utilizados foram: "developmental milestones" OR "child development" OR "developmental tracker" AND "application" OR "app". **Resultados:** Foram encontrados em busca inicial n=445 estudos, dos quais apenas 12 corresponderam aos critérios de elegibilidade. Destes estudos, foram encontrados e descritos n=9 aplicativos em termos de seus recursos e funções. Destes, apenas um encontra-se disponível para uso no contexto nacional. **Conclusão** Aplicativos móveis de m-Health, embora carentes no Brasil, podem se tornar ferramenta com o potencial de superar as barreiras geográficas continentais em prol do acesso à assistência em saúde.

Palabras-chave: m-Health, Telessaúde, Marcos do Desenvolvimento, Desenvolvimento Infantil.

INTRODUCTION

The early years of life are a crucial period for acquiring skills related to developmental domains. Healthy development has an essential foundation for academic success, health, general well-being, and other achievements [2]. Delays in achieving developmental milestones may indicate risks and suggest the presence of disorders, including neurodevelopmental [3], genetic, and neuropsychiatric disorders [4]. The estimated prevalence of children with developmental delays varies between 16 and 18% in the international literature but it is estimated that less than one-third of them are detected by health professionals [5,6]. In Brazil, the challenges in tracking developmental milestones are even more prominent. These limitations are characterized by the lack of training of professionals in primary health care, difficulties in accessing information, and the shortage of pediatric professionals in public health services [7]. As a result, Brazil has been implementing public policies aimed at early childhood and greater recognition of the importance of regular monitoring of child development [8].

As part of the Primary Care programs within the Unified Health System, development monitoring is carried out using the "Child Health Handbook", which was updated in 2024, along with the "Manual for Monitoring Child Development" [9]. In 2006, the American Academy of Pediatrics published a report that encouraged and provided guidelines for the developmental monitoring of infants up to 3 years of age. The report had 15 recommendations, including the need to improve the effectiveness of developmental monitoring at home [10]. To address this issue, some countries have been investing in telecommunications infrastructure in low- and middle-income countries, given that mobile technologies are the main point of access to the internet in these areas [11].

The use of telehealth in pediatrics plays an important role between families and access to safe and quality information, transforming the way people communicate and care for others, even from a distance [12,13]. Some countries have created applications to track child development to reduce disparities in access to information and ensure early access to necessary interventions and referrals [14,15]. In this context, mobile health (also referred to as m-Health) meets this demand by making information available through information and communication technologies (ICTs), more specifically mobile applications. m-Health has proven to be an effective and viable method of intervention via mobile devices, including in the context of medical education, clinical decision-making systems for diagnosing and managing diseases, data collection methods, medical records, and distributions of test and examination results, among others [16,17]. It also proves to be an important intervention tool for the general population, with the potential to promote health campaigns.

In pediatrics, mobile devices offer caregivers greater opportunities to closely observe and monitor their children's development, allowing them to be the first to notice problems. Thus, involving parents as partners in monitoring child development can promote screening efforts [10]. Despite their advantages, a recently published review found that, among n=149 mobile applications found in the 'App Store' and 'Google Play' platforms for parents aimed at child development, only 6.7% demonstrated technical accuracy regarding the information on feeding, sleep, diaper monitoring, and developmental milestones [18]. These data highlight the need for regulation of mobile health applications and the importance of choosing applications developed by health professionals and researchers with systematic designs. One way to verify the available options is through a review of scientific articles describing existing applications.

In this context, the present study aimed to evaluate the key mobile applications for tracking and mapping child development for parents and caregivers focusing on their characteristics, functions, contents, and available resources through a scoping review of the scientific literature.

METHODOLGY

Study search and selection procedures

A scoping review was conducted based on the PRISMA Extension for Scoping Reviews (PRISMA- ScR) [19]. The searches were performed by a psychologist pursuing a master's degree in pediatrics (VG) in August 2024. The databases searched are: Scielo, PubMed, Embase, and Lilacs using the keywords in English: ("developmental milestones" OR "child development" OR "developmental tracker") AND ("application" OR "app"), with search filters for abstracts and titles. The results were processed using Rayyan software [20]. Duplicate studies were detected and excluded by the software, and two reviewers (EM and LFL) performed an initial blinded eligibility analysis of the studies based on the title and abstract. The eligibility criteria were based on studies published in scientific journals that described mobile applications for tracking child development for

parents and caregivers, available in English or Portuguese. Studies considered ambiguous in terms of eligibility were classified as “maybe” by the reviewers through the platform. A final analysis of the studies was conducted jointly with the two reviewers (EM, LFL) and a third reviewer (VG) to resolve any potential conflicts of choices and evalute ambiguous articles through a full group reading. After the final decision, the information from the selected studies was organized in a table format. Finally, the results were integrated and analyzed (VG) in a narrative format focused on the following data:

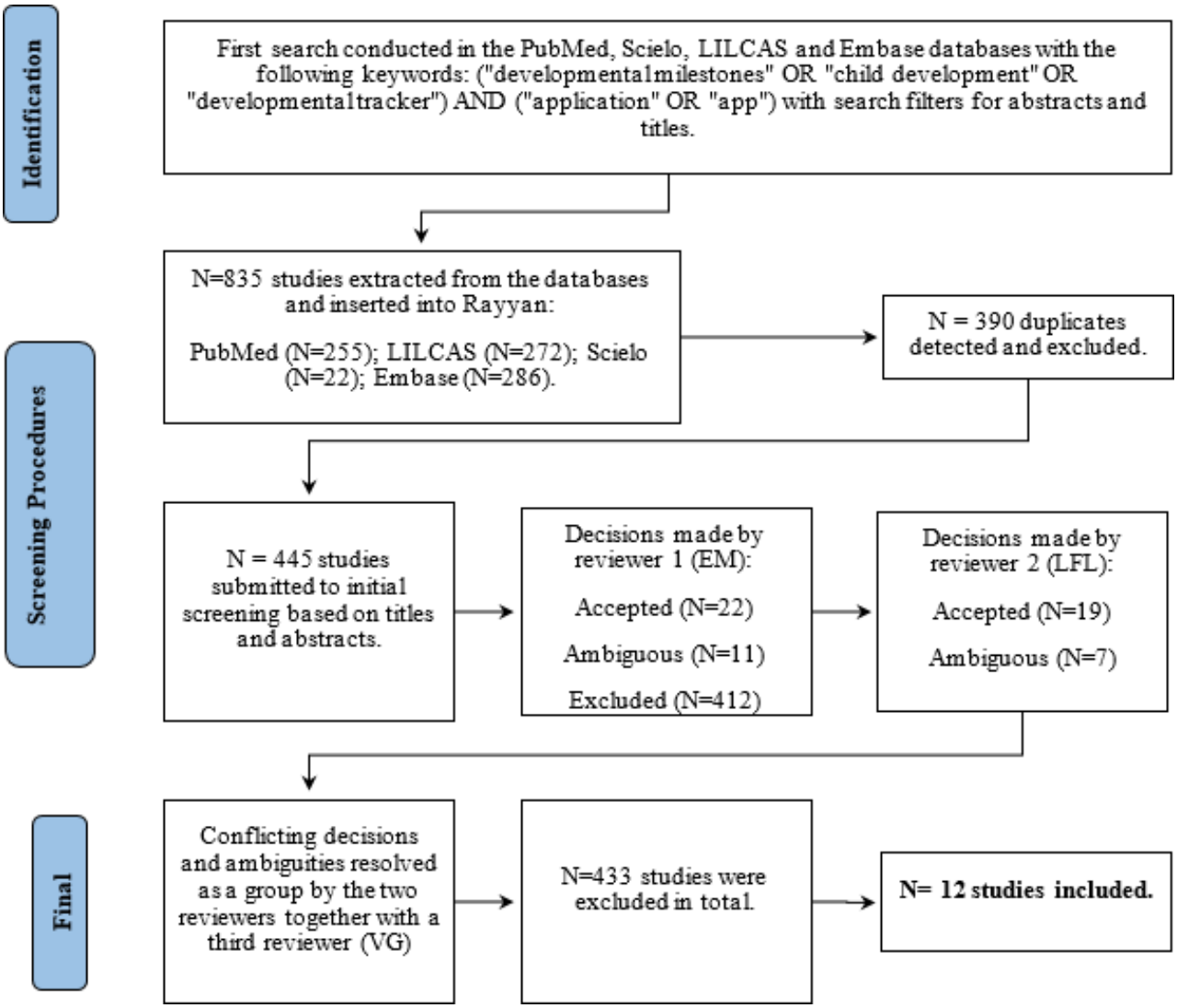
1) countries involved;
2) objectives of the studies;
3) names of the applications used or developed;
4) objectives of the apps;
5) characteristics, resources and functions of the application;
6) current status of the apps; and
7) accessibility information in Brazil.

RESULTS

Study selection

The study flowchart is shown in **Figure 1.** Out of the n=445 studies submitted for analysis, n=433 were excluded, and n=12 were accepted for inclusion [21-32] after the final phase of analysis based on the full reading of the studies by the reviewers.

Figure 1 - Study search and screening flowchart



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Overview of studies

The characteristics of the selected studies are shown in **Table 1**. These studies were published in English, between 2019 and 2023. In general, the studies aimed to: describe the procedures for developing the applications [21,25-28,30,32]; verify adherence and acceptability by caregivers [24,27,31,32], assess the variables that relate to and mediate the user experience [22,24,28], and the effects of the applications on parental behavior and child care [22,28,32]. Furthermore, two studies aimed to test the convergent validity of the statistical and normative parameters developed and obtained by the applications regarding developmental milestones [23,29] compared to conventional measures and sources. They include: normative parameters from the US Centers for Disease Control and Prevention (CDC) [33], 'Ages and Stages Questionnaire' [34], 'Mullen Scales of Early Learning' [35], Denver II Developmental Screening Test [36], Motor Development Study conducted by the World Health Organization (WHO) [37], Study on the Well-Being of Young Children [38], and the National Growth Survey of the Ministry of Health, Labour and Welfare of Japan [39].

Table 1. General description of studies.

N	First author and year	Objective	Application	Countries	Sample	Summary of findings
1	LaMonica (2022)	Descriptive study that aims to describe the process of developing and improving the ' Thrive ' application by Five' in terms of content, functions and features, with special attention to cultural adaptation for use in Afghanistan.	Thrive by Five	Indonesia, Afghanistan, Namibia, Kenya, Kyrgyzstan, Uzbekistan, Democratic Republic of the Congo, Cameroon and Ethiopia,	N=174 parents; n=58 expert judges.	The step-by-step development of the application is described, and was achieved in partnership with researchers from nine countries in Southeast Asia, Central Asia and Africa.
2	Ben-Sasson (2023)	percentile data from traditional child development tracking measures with data obtained by parents using the BabyTRACKS app regarding their child's development.	BabyTRACKS	Israel	Data from n=1951 children registered in the application; n=57 parents answered the ASQ-3; n=13 parents answered the MSEL.	The percentile parameters obtained by the application were shown to be comparable to parameters from the CDC and traditional developmental screening measures , including ASQ-3 and MSEL.
3	LaMonica (2024)	Investigate the impacts of the application and its content in terms of parental attitude, knowledge and behavior in relation to their children's child development, as well as family dynamics and relationships in different cultures and contexts.	Thrive by Five	Indonesia, Afghanistan, Namibia, Kyrgyzstan, Uzbekistan, Cameroon and Malaysia.	n=65 to 158 parents completed the form; n=49 to 52 parents participated in workshops; n=7 to 10 expert judges, depending on the country.	The results of the study were shared with partners involved in the project, and will be published in a separate publication.

4	Park (2022)	Describe the development procedures, content analysis and implementation of a mobile application that supports the development of premature babies.	Todak-Todak	South Korea	n=8 judges; parents babies.	expert 10 of	The application demonstrated high and satisfactory rates in terms of content (accuracy, comprehension, objectivity) and design (consistency, suitability to the design, precision in communication) according to the evaluation of user parents and expert judges.

Caption: No applicable (N/A); Ages and Stages Questionnaire – third editing (ASQ-3); Mullen Scales of Early Learning (MSEL); Centers for Disease Control and Prevention (CDC).

N	First author and year	Objective	Application	Countries	Sample	Summary of findings
5	Matsubara (2022)	Clarifying developmental milestones for Japanese infants with real-time data from a caregiver-driven app.	Papatto Ikuji	Japan	Data from n = 16,627 Japanese infants.	The distribution of the age at which the data were achieved was normal and overlapped with standard developmental tracking measures, with the exception of the item "smiling responsively ", which was shown to be delayed according to the application's databases.
6	Kitsao-Wekulo (2021)	Describe the creation of a mobile application for use by primary caregivers, evaluate its feasibility and the initial impact of the use of this application by caregivers in monitoring the development of their children.	Early childhood development app.	Kenya	N = 108 caregivers of children aged 7 to 24 months.	The app's uptake in the first 3 months was over 90%, showing that it is viable for use among caregivers. After this period, the response rate decreased to 76%. Most caregivers were able to track their children's achievement of developmental milestones.
7	Sunarsih (2023)	Implement and evaluate the adoption of the PROSA-HI application by parents and caregivers, which aims to monitor child development.	PROSE-HI	Indonesia	N = 291 mothers using the application.	The user acceptance test of the PROSA-HI application indicated an average of 89%, which suggests that, in the users' perception, it is suitable for implementation.
8	Ben-Sasson (2020)	To investigate how variables associated with the technology usage profile relate to the experience and satisfaction of using the application, designed to track child development milestones.	BabyTRACKS	Israel	N = 260 mothers using the app and their 260 babies with a mean age in months of 17.60 (SD = 13.70).	Most users (63.8%) said they would use the app in the future. Those who were more involved with technology and the internet and who demonstrated greater proactivity in solving technological problems had better experiences with the

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						app compared to users who were not.
9	Hsu (2020)	To develop a mobile application based on the MCAT (computer-based multidimensional adaptive test) combined with the Multidimensional Screening in Child Development (MuSiC) for parents and health professionals, in order to contribute to the early identification of delays. The aim was to compare the efficiency and accuracy of the MCAT and the NAT (non-adaptive test) in five domains: cognitive, linguistic, social, fine and gross motor.	Not informed	Taiwan	N = respondents about children aged 1 to 3 years.	The MCAT (computer-assisted multidimensional adaptive test) produced significantly more accurate measurements and was significantly more efficient than the NAT (non-adaptive test). Although the MCAT had significantly fewer items than the NAT, its accuracy was not compromised. Its use in an online format via a mobile phone facilitates screening for developmental delays in children.
N	First author and year	Objective	Application	Countries	Sample	Summary of findings
10	Baralt (2020)	To describe the development and investigate the effectiveness of an application designed to promote mother-child communication with low-income Hispanic mothers, with special emphasis on promoting the use of the native Spanish language in Hispanic families living in the US, and promoting the stimulation of linguistic functions.	Call me baby	USA	Mothers of n=21 children.	Mother-child verbal interactions increased with the use of the app. In a later phase of the research, a sociolinguistic pride component was added, and this time, a statistically significant increase in mother-child verbal interactions was identified. Mothers also reported feeling more proud to use Spanish with their children.
11	Ibrahim (2023)	Assess the needs and requirements for a new mobile application covering components of the child welfare clinic service. Subsequently, develop the application prototype and validate it.	Sehhat Tefy	Egypt	N= 500 caregivers of children up to 5 years of age.	Based on the results, data about the caregiver, their child, and desired resources from the parent survey were included in the app. The app's quality rating was considered satisfactory by expert judges, and the app was downloaded 1,445 times over a 4-month period.
12	Jones (2019)	To develop a mobile application that promotes education on the prevention of unintentional injuries, and child health data, including stages of child development. The	Grow up Safely	England	Focus groups with N= 15 mothers.	Participants in two focus groups found the app informative and considered using it. Participants in the “young mothers” focus group found the information provided to be “common sense” but

			aim was also to explore the usability of the application and refine its content.		found the language too complex. All participants reported that further development of push notifications and recommendation from a trusted source would increase their engagement with the app.	

Characterization of applications

Information regarding the features, resources, and functions of the applications can be found in **Table 2.** In total, the following applications were used or developed: 'Thrive by Five' [21,22], 'BabyTRACKS' [23,24], 'Todak-Todak' [27], 'Papatto Ikuji' [29], 'PROSA-II' [31], 'Háblame Bebé' [28], 'Sehhat Tefy' [25], and 'Grow up Safely' [26]. The study by Kitsao-Wekulo developed an unnamed application, referred to in our table as 'Early Childhood Development Application' [32].

Table 2. Characterization of applications.

N	Application name	Promoting institution	Application Objectives	Features, resources and functions.	Situation	Access (Brazil).
1	Thrive by Five	Minderoo Foundation	Promote knowledge of healthy and typical child development for parents, suggest activities to support this development, and contribute to universal access to knowledge in other countries and contexts.	Real-time recording of developmental milestones achieved and progress monitoring; photographic record of milestones achieved in the form of a memory album; organization of routine activities through an activity planner ; suggestions of stimulating activities to be carried out in favor of optimal child development (e.g .: vocabulary stimulation).	In activity.	Google Play.
2	BabyTRACKS	Not informed	Contribute to understanding the milestones of child development, allowing for the instant recording of the milestone achieved in a given period.	Real-time recording of milestones achieved by domain in a daily format (Language, Social, Cognitive, Fine Motor, Gross Motor); provision of statistical and normative parameters regarding the period of the milestone achieved in percentiles obtained through the registration of 3600 children registered in the same application; receipt of reports regarding the developmental progress of their children.	Discontinued .	Unavailable.

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3	Todak-Todak	Not informed	Developmental support care app that provides necessary information after discharge and promotes developmental activities for premature babies.	Diary for recording information about the baby's development, including data on feeding, hygiene, potty training, emotional bonding, growth and developmental milestones (motor, cognitive, linguistic and socio-emotional according to age); personalized guidance on care, such as breastfeeding, hygiene; suggestions for activities and playful games that promote motor, cognitive, sensory and language development by age; provision of a community space for interaction between parents in order to enable the sharing of doubts and concerns regarding the child's developmental and health aspects.	Not clear.	Unavailable.
4	Papatto Ikuji	First Ascent Inc (Japanese Corporation)	Application that provides support for parents in monitoring the child development of children up to 6 years of age.	Real-time recording of up to 60 child development and care milestones; provision of statistical information on child performance with normative data; monitoring of developmental progress; sharing of information between other caregivers (e.g. family members, other users) allowing greater interaction, also enabling the registration of more than one caregiver about the same child in order to promote greater efficiency in recording, support and collaboration in child care.	In activity.	Unavailable.
5	Early Childhood Development App	Not informed	Application developed for research purposes with the aim of promoting an intervention with parents and caregivers in Kenya, aimed at monthly tracking of their children's development and management through the detection of delays.	Instant messaging platform with information on child health and development for caregivers; questions sent monthly about their child's development by domain (communicative, fine and gross motor, personal-social, problem-solving); receiving feedback regarding the milestone reached or delayed depending on the caregiver's response; suggestions of activities to be carried out in order to stimulate child development; notification sent to trained health professionals, who are called upon when the expected milestone according to age is not met to assist the family regarding the actions to be taken.	Not clear.	Unavailable.
6	PROSE-HI	Not informed	Application that allows monitoring of child growth and development up to 72 months of age.	Recording and accessing the history of child development milestones and previously performed exams; detecting and warning of potential delays; tips and suggestions for development stimulation activities; providing informative materials and videos about typical development.	Not clear.	Unavailable.

7	Call me baby	Not informed	Application designed to promote bilingualism and child development, with an emphasis on language for Hispanic mothers.	Real-time recording of developmental milestones according to CDC guidelines; Provision of educational and didactic materials regarding language stimulation, the benefits of bilingualism ; illustrative videos with suggestions for language stimulation activities; gamification techniques to encourage the use and engagement of the application; bilingual registration portal for recording words spoken by the baby in the native language.	In activity.	Unavailable.
8	Sehhat Tefy	Not informed	The app aims to monitor children's health by caregivers, as well as serving as a database for epidemiological surveillance. It measures important growth indicators, such as stunting, overweight, obesity and underweight, and nutritional indicators, such as breastfeeding.	Assessment and recording of physical growth; child development milestones based on CDC guidelines; vaccination records and schedules including symptoms; record of the child's nutritional history; monitoring and assessment of risks in the home (e.g. , risk of drowning, falls, etc.); recording and monitoring of the emergence of teeth; report containing the normative parameters of all information obtained; conduct, actions and activities indicated upon detection of developmental delays or health risks.	Not clear.	Unavailable.
9	Grow up Safely	Not informed	Application designed to increase parental awareness about the risks of injuries in children, as well as about child development, allowing parents and caregivers to be better prepared when caring for their young children.	Providing tips for preventing unintentional childhood injuries; Providing structured information according to developmental stage; Information about child development and awareness of hazards at each stage; Safe play tips to support child development; Links to first aid websites.	Not clear.	Unavailable.

The application developed by Hsu and colleagues lacks a clear name, as well as its specific attributes and features[30]. Due to insufficient data to characterize it, the application was not included. Regarding the access and continuity of the applications, a secondary search was conducted and it was not possible to confirm the continuity of most of the applications found [25-27,31,32]. The application ' BabyTracks' has been discontinued according to the ' Crunchbase' database, while the applications 'Thrive by Five' [21,22], 'Papatto Ikuji' [29]and 'Háblame Bebé' [28]remain active. However, only 'Thrive by Five'[21,22] is available in the national context via Google Play.

The apps offered information about typical child development for parents, as well as resources for tracking, recording, and monitoring child developmental progress [21-32]. Additional resources found in the apps included: illustrative materials on typical development [26,31]; suggestions for interventions to be done at home or for conduct and initiatives to seek professionals for child care and development[21,22,25-28,31,32]; personalized care guidelines according to the child[27]and care activities in a planner[21,22]; a community space for users and caregivers to exchange messages[27,29]; and recording of exam history and additional health information[25,27,31]. One app also allowed the recording of photos and videos at the time of the milestone acquisition[21,22]. However, only 3 apps provided statistical parameters of the child's performance in the milestone achieved[23-25,29], based on standardized clinical measures [34-36] and official health organizations, including the CDC [33].

DISCUSSION

The use of mobile applications in telehealth and m-Health has grown exponentially and has contributed significantly to increasing access to health information and services for patients [16,17,40]. In pediatrics, mobile applications for parents have

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proven to be a useful, accessible, and convenient tool. They contributed to the efficient and structured recording of children's health data and provided effective parental guidance toward tracking potential delays and health problems [41]. Despite the growing number of applications, evidence indicates that most of them present an alarming lack of quality and technical accuracy of content [18].

This study aimed to review the main mobile applications in scientific articles that track and map child development for parents. The objective was to review the applications based on their characteristics, functions, content, and available resources through a scoping review of the international scientific literature. A total of 9 mobile applications for parents were found and described in 12 international studies published between 2019 and 2023. The studies were conducted in North America, Asia, Africa, and Europe and the names are: 'Thrive by Five' [21,22], 'BabyTRACKS' [23,24], 'Todak-Todak' [27], 'Papatto Ikuji' [29], 'PROSA-II' [31], 'Háblame Bebé' [28], 'Sehhat Tefy' [25], 'Grow up Safely' [26], and an 'Early Childhood Development App' [32].

Out of the 9 apps found, 78% were developed primarily to promote awareness and assess child development [21-25,27,29-32]. One app was developed to reduce accidental child injuries [26], and another was developed to promote bilingualism in children of Hispanic mothers [28]. Despite this, the majority of the apps (n=8; 89%) offered features for recording, tracking, and monitoring child development milestones [21-25,27- 29,31,32]. The ' Grow up Safely' [26 app] only offered informative and structured data on child development milestones by age, aligned with typically expected standards., while 'PROSA-HI' did it through informative materials and videos [31]. Both applications demonstrated satisfactory levels of acceptability and adherence by their users and focus groups [26,31], as did the ' Todak-Todak' application, which received positive feedback from parents and expert judges in its content, comprehension, accuracy, design, and communication [27]. In the case of the ' BabyTRACKS ' application, 63.8% of users stated that they would use it in the future. Those with experience using the internet were the most proactive in resolving any technological setbacks. The ' [24]Thrive ' application developed by Five' offers the option of including photographic records of milestones in real time in the form of a memory album [21,22.] The main objective of to promote knowledge of child development for parents from different contexts, cultures, and countries. Some other apps also allowed the recording of data on physical growth, vaccinations, previous exams, hygiene, potty training, nutritional history, teething, and emotional bonding. Some of them are: 'Sehhat Tefy' [25], 'PROSA-HI' [31], 'Todak-Todak' [27]. In addition, some provided statistical parameters for the achievement of the milestone of the children compared to normative data, including 'BabyTRACKS', 'Papatto Ikuji', and 'Sehhat Tefy' [23-25,29]. The first, in one of its studies, demonstrated results comparable to current [23]CDC normative data and the 'Ages and Stages Questionnaire' [34] and ' Mullen Scales of Early Learning' [35]. Similarly, a study investigating the Japanese app [29]found that 95% of the data obtained by the app (19 of 20) matched the normal statistical parameters in percentiles obtained by the Denver II technical measures and references [36], and the WHO motor development reference studies [37], the well-being of young children [38]and the Japanese Ministry of Health growth studies [39]. The apps also provided real-time child development progress. The 'Grow up Safely' also offered age-specific accident prevention information [26] like 'Sehhat Tefy' [25], which also provided an option for assessing and monitoring home accident risks. In the case of the early childhood development app for intervention purposes, monthly messages were sent to mothers asking whether specific milestones had been met. If a certain milestone was missed, feedback and activities to be carried out to mitigate the delay were sent, and, depending on the delay, health professionals suggested activities to assist parents. A 90% user uptake was observed in the first month, followed by a decline to 76% after 3 months of intervention [32]. A similar approach was used in the 'Sehhat Tefy' app, which provided suggestions for actions and behaviors upon detection of developmental delays or health risks [25]. Some applications also provided recommendations and tips for activities and games to be done to stimulate specific areas of child development, regardless of whether delays were identified. In the ' [21,22,26-28,30-32]Háblame Bebé' application, such suggestions were in the form of illustrative videos to teach how to develop language through play[28]. The benefits of bilingualism for child development were also informed. Some applications such as 'Todak- Todak', also provided personalized care guidelines according to the child's profile [27], and the ' Thrive ' application by Five' offered organization options and suggestions for routine activities in the form of a planner [21,22]. In addition, two apps offered a social networking feature to provide a community space between parents and caregivers facilitating the exchange and sharing of information and tips on child development such as 'Todak-Todak' [27]and 'Papatto Ikuji' [29]. In the case of ' Papatto Ikuji', it offered a direct sharing feature between more than one caregiver or family member of the child that allowed more than one user to record the milestone reached by the same child, contributing to more efficient tracking [29]. Out of nine apps, only 'Thrive by Five' [21,22], 'Papatto Ikuji' [29]and 'Háblame Bebé'

[28]remain active based on our secondary search, with only the ' Thrive by Five'available in Brazil on the Google Play platform.

This study summarizes the features and functions commonly offered by mobile apps for parents to track and monitor children˜s developmental milestones. These findings guide future research interested in developing similar tools. Furthermore, these findings highlight the scarcity of mobile apps available in Brazil for caregivers to monitor child developmental milestones. In the context of pediatric care in Brazil, there are several barriers related to the lack of adequate primary care service structure, specialized workforce, geographic inequalities in access, and lack of availability of appointments and services to child care. One of the most important obstacles is the lack of centrality of family and community-based actions [42,43]. Telehealth in Brazil has the potential to overcome continental geographic barriers in favor of access to health care [44]. In the context of m-Health applications, their accessibility and low cost are some advantages of their use such as access to health information and educational content, preliminary screening of symptoms, promotion of behavioral changes in favor of preventing health problems, in addition to guidance regarding the moment to seek targeted assistance from specialists [45]. In this sense, the apps can reduce the frequent administrative overload of health centers, optimization of health data recording, and early screening of warning signs, among other advantages [46].

Considering the limitations of the present study, it is necessary to reflect on the possible existance of applications related to the subject without any record in the researched literature. In addition, the search criteria were limited to journals in English and Portuguese. There are several applications available in Brazil aimed at tracking and stimulating child development milestones, which were not found by our search and keywords such as 'Kinedu', 'Baby Connect', 'BabyCenter', and 'TEDI', available on the iOS ([47]*Apple*), *Android* and *Google Store* platforms. The TEDI app(Screening and Stimulation of Child Development) was developed from a recently published cross-cultural validation and translation study from the Survey of Wellbeing of Young Children (SWYC) [48], also integrating information from the Child's Record [47]. Overall, validation and consistency of the instrument have acceptable results, available electronically for use in the country.

The Secretariat of Information and Digital Health – SEIDIGI – in Brazil [49] created by Decree 11,358 on January 1, 2023, is responsible for formulating public policies to guide the management of digital health. It has interacted with the Ministry of Health seeking to incorporate technologies into the Unified Health System, including those related to child development. This is an opportune time to include applications that facilitate access by family members and health professionals.

Given the above, we conclude that further research is needed on applications on this topic. We need results that allow conclusions about the effectiveness of child development tracking tools for parents and caregivers, especially in our country, due to its continental dimensions, poor geographic distribution of health professionals, and socioeconomic-cultural variability.

REFERENCES

1. Bellman M, Byrne O, Sege R. Developmental assessment of children. BMJ. 2013 Jan 15;346(Jan15 2): e8687-e8687.

2. Denburg A. A Sensitive Period: Bioethics, Human Rights, and Child Development. Health Hum Rights . 2015;17(1):19.

3. American Psychiatric Association . Diagnostic and statistical manual of mental disorders revised - DSM-5-TR. Artmed Publisher ; 2022.

4. Belsky J. Differential Susceptibility to Environmental Influences. International Journal of Child Care and Education Policy. 2013 Nov 20;7(2):15-31.

5. Committee on children with disabilities of the American Academy of Pediatrics. Developmental surveillance and screening of infants and young children. Pediatrics. 2001;108:192 -6.

6. Brothers KB, Glascoe FP, Robertshaw NS. PEDS: Developmental Milestones--An Accurate Brief Tool for Surveillance and Screening. Clin Pediatr (Phila). 2008 Apr 1;47(3):271-9.

7. Marcelino da Silva JA, Ogata MN, Teixeira Machado ML. Training of health workers in primary care: impacts and perspectives. Electronic Journal of Nursing. 2009 Sep 8;9(2).

8. Ministry of Human Rights and Citizenship. Early Childhood. https://www.gov.br/mdh/pt-br/navegue-por-temas/crianca-e-adolescente/acoes-e-programas-de-gestoes-anteriores/primeira-infancia#:~:text=As%20áreas%20prioritárias%20para%20as,como%20a%20proteção%20contra%20toda. 2022.

9. Starfield B. Primary Care: balancing health needs, services and technology. Brasília; 2002.

DOI: 10.32443/2175-2990(2024)473

10. Council on Children With Disabilities. Identifying infants and young children with developmental disorders in the medical home: An algorithm for developmental surveillance and screening. Pediatrics. 2006;118(1):405–20.

11. International Telecommunication Union. Measuring digital development Facts and figures 2020. https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2020.pdf. 2020.

12. Hjorth L, Ohashi K, Sinanan J, Horst H, Pink S, Kato F, et al. Digital media practices in households: kinship through data. Amsterdam: Amsterdam University Press; 2020.

13. McConnochie KM. Potential of Telemedicine in Pediatric Primary Care. Pediatr Rev. 2006 Sep 1;27(9):e 58–65.

14. Almas AN, Degnan KA, Nelson CA, Zeanah CH, Fox NA. IQ at age 12 following a history of institutional care: Findings from the Bucharest Early Intervention Project. Dev Psychol. 2016 Nov;52(11):1858–66.

15. Doyle O, Harmon CP, Heckman JJ, Tremblay RE. Investing in early human development: Timing and economic efficiency. Eco Hum Biol. 2009 Mar;7(1):1–6.

16. Steinhubl SR, Muse ED, Topol EJ. The emerging field of mobile health. Sci Transl Med. 2015 Apr 15;7(283).

17. Free C, Phillips G, Felix L, Galli L, Patel V, Edwards P. The effectiveness of M-health technologies for improving health and health services: a systematic review protocol. BMC Res Notes. 2010 Dec 6;3(1):250.

18. DeWitt A, Kientz J, Liljenquist K. Quality of Mobile Apps for Child Development Support: Search in App Stores and Content Analysis. JMIR Pediatr Parent. 2022 Nov 8;5(4):e 38793.

19. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA- ScR): Checklist and Explanation. Ann Intern Med 2018 Oct 2;169(7):467–73.

20. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Syst Rev. 2016 Dec 5;5(1):210.

21. LaMonica HM, Crouse JJ, Song YJC, Alam M, Ekambareshwar M, Loblay V, et al. Developing a Parenting App to Support Young Children's Socioemotional and Cognitive Development in Culturally Diverse Low- and Middle-Income Countries: Protocol for a Co-design Study. JMIR Res Protoc . 2022 Oct 1;11(10).

22. LaMonica HM, Song YJC, Loblay V, Ekambareshwar M, Naderbagi A, Zahed IUM, et al. Promoting social, emotional, and cognitive development in early childhood: A protocol for early evaluation of a culturally adapted digital tool for supporting optimal childrearing practices. DigitHealth. 2024 Jan 1;10.

23. Ben-Sasson A, Jacobs K, Ben-Sasson E. Early childhood monitoring application: Correspondence between crowd-based developmental percentiles and clinical tools. Health Informatics J. 2023 Jan 1;29(1).

24. Ben-Sasson A, Ben-Sasson E, Jacobs K, Malinovitch R. The relationship between users' technology approaches and experiences in a child development mobile application. Health Technol (Berl). 2020 Sep 1;10(5):1079–94.

25. Ibrahim NM, Ez-Elarab HS, Momen M, Mossad IM, Eletriby SS. A novel wide-scale well-baby clinic mobile application: an Egyptian pilot study. BMC Health Serv Res 2023 Dec 1;23(1).

26. Jones F, Whitehouse A, Dopson A, Palaghias N, Aldiss S, Gibson F, et al. Reducing unintentional injuries in under fives : Development and testing of a mobile phone app. Child Care Health Dev 2020 Mar 1;46(2):203–12.

27. Park JH, Cho H. Development of a mobile application focusing on developmental support care for Korean infants born prematurely: A methodological study. Child Health Nursing Research. 2022;28:112 –23.

28. Baralt M, Darcy Mahoney A, Brito N. Háblame Bebé : A phone application intervention to support Hispanic children's early language environments and bilingualism. Child Lang Teach Ther. 2020 Feb 1;36(1):33–57.

29. Matsubara K, Hattori T, Narumi S. Achievement of Developmental Milestones Recorded in Real Time: A Mobile App-Based Study. Journal of Pediatrics. 2022 Jun 1;245:201 - 207.e9.

30. Hsu CF, Chien TW, Chow JC, Yeh YT, Chou W. An app for identifying children at risk for developmental problems using multidimensional computerized adaptive testing: Development and usability study. JMIR Pediatr Parent. 2020 Jan 1;3(1).

31. Sunarsih T, Astuti EP, Purnamaningsih N, Suwarno , Syah ME, Shanti EFA, et al. Innovation of M-Health-Based Prose -Hi Application for Early Detection of Child Growth and Development.

Jurnal Profession Doctor : Newspaper Kedokteran dan Kesehatan. 2023 Dec 11;17(2):214-22.

32. Kitsao-Wekulo P, Langat NK, Nampijja M, Mwaniki E, Okelo K, Kimani-Murage E. Development and feasibility testing of a mobile phone application to track children's developmental progression. PLoS One. 2021 Jul 1;16(7 July).

33. US Centers for Disease Control and Prevention. CDC's Developmental Milestones. https://www.cdc.gov/ncbddd/actearly/milestones/index.html. 2024.

34. Squires J, Bricker DD, Twombly E. Ages and stages questionnaires. Baltimore, MD: Paul H. Brookes; 2009.

35. Mullen EM. Mullen scales of early learning. Circle Pines, MN: AGS; 1995. 58-64 p.

36. Sabatés AL. Denver II: developmental screening test: training manual. 1st ed. São Paulo: Hogrefe; 2017.

37. de Onis M. WHO Motor Development Study: Windows of achievement for six gross motor development milestones. Acta Paediatr. 2006 Apr 2;95(S450):86-95.

38. Sheldrick RC, Schlichting LE, Berger B, Clyne A, Ni P, Perrin EC, et al. Establishing New Norms for Developmental Milestones. Pediatrics. 2019 Dec 1;144(6).

39. Japan Agency for Children and Families. Child Physical Growth Survey. https://www.e-stat.go.jp/statistics/00450272. 2023.

40. Croke L. Mobile health apps are transforming patient care. AORN J. 2020 Jun 28;111(6).

41. Zuckerman B, Ng CY, Daglilar JO, Wang CJ. Connected Pediatric Primary Care for At-Risk Children. Pediatrician Clin North Am. 2020 Aug;67(4):665-73.

42. Silva GS, Fernandes D de RF, Alves CRL. Evaluation of child health care in Primary Care in Brazil: systematic review of methods and results. Cien Saude Colet. 2020 Aug;25(8):3185-200.

43. Jaime PC, Frias PG de, Monteiro HO da C, Almeida PVB, Malta DC. Healthcare and unhealthy eating among children aged under two years: data from the National Health Survey, Brazil, 2013. Brazilian Journal of Maternal and Child Health. 2016 Jun;16(2):149-57.

44. Santos A de F dos, Souza C de, Alves HJ, Santos SF dos. Telehealth: an instrument for care support and continuing education. Belo Horizonte: Editora UFMG; 2006.

45. Nichiata LYI, Passaro T. mHealth and public health: the digital presence of the Brazilian Unified Health System through mobile device applications. Electronic Journal of Communication, Information & Innovation in Health. 2023 Sep 29;17(3).

46. Sharma S, Kumari B, Ali A, Yadav RK, Sharma AK, Sharma KK, et al. Mobile technology: A tool for healthcare and a boon in pandemic. J Family Med Prim Care . 2022 Jan;11(1):37-43.

47. Moreira RS, Moreira JM, Escarce AG, Guimarães MAP, Ferreira R de C, Oliveira RM dos S, et al. TEDI a Brazilian electronic tool for assessing child development. Brazilian Journal of Evaluation. 2022;11(3 spe):e111422.

48. Perrin EC, Sheldrick C, Visco Z, Mattern K. The Survey of Well-being of Young Children (SWYC) User's Manual (1.01). Boston; 2016.

49. BRAZIL. Interministerial Secretariat for Information and Digital Health. Available at: https://www.gov.br/saude/pt-br/composicao/seidigi Last accessed on October 17, 2024.

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