Parents' use of mobile applications in the first year of parenthood: a narrative review of the literature

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Abstract: Parent's use of apps to support their parenting is on the rise. The purpose of this narrative review of the literature is to explore the characteristics of research on parents' app use in the first year of parenthood, types of apps available to parents, and the factors that encourage or discourage parents' app use. A narrative review of the literature and thematic analysis of the full-text English language articles between January 2000 and December 2019 relating to parents' use of apps in the first year of parenthood was conducted to provide a comprehensive overview of the existing literature using seven academic databases: CINAHL Plus with Full Text, MEDLINE, SocINDEX with Full Text, PsychINFO, Academic Search Complete, Web of Science, and Google Scholar. Forty-one articles were included based on prespecified eligibility criteria. The majority (n=30) discussed a parenting app or mHealth intervention that included an app. Most studies (n=15) recruited women as participants and were conducted in Australia (n=10). Thematic analysis of the eligible articles (n=41) revealed four themes: (I) increased app use related to shifts in parenting trends; (II) types of apps available to parents; (III) apps to overcome the digital divide; and (IV) factors encouraging or discouraging app use. Although numerous literature reviews have been conducted to explore parents' use of online resources, none of the reviews specifically focus on mobile apps developed to support parents in the first year of parenthood. This research advocates that health professionals and researchers should find alternatives to standardized means of delivering and developing parenting social support to fulfill contemporary parents' needs.

Keywords: Mobile applications (apps); parenting apps; mHealth; digital health; narrative review of the literature

Introduction

The birth of a first child can be an overwhelming and stressful experience for many parents due to adaptation to the new role, infant care responsibilities, and changes in spousal and social relationships. Social support refers to the provision of resources that helps an individual deal with stressful situations. The common forms of social support are informational and emotional support. Informational support is defined as the provision of advice, guidance, suggestions, or other useful information, in response to someone's needs (1,2). Emotional support refers to the offering of empathy, compassion, and genuine concern to support individuals' emotional needs such as connecting with someone, talking about stressors and concerns, and seeking reassurance (1,3). A combination of informational and emotional support improves parents' wellbeing and assists with their parenting concerns (1-3).

Mobile applications (apps) have the potential to provide informational and emotional support to parents

24 hours a day, 7 days a week. Parents have consistently used apps to connect to other parents and professionals such as nurses, pediatricians, breastfeeding experts, and sleep training consultants. Parents use app features such as social networking, online forums, live chat, texts, and video calls to seek informational and emotional support on parenting matters (4,5). Apps provide an anonymous venue to discuss and seek advice on sensitive issues, such as the resumption of sexual activities after childbirth, which some parents might not be comfortable sharing in person with family and friends. The anonymity allows parents to share their experiences, feelings, concerns, and intimate details regarding their childbirth experience more liberally without feeling judged (6).

Researchers around the world have introduced several apps to support parents in the first year of an infant's life (7,8), however, parents continue to face difficulty finding apps that are credible and meet their expectations of usability and functionality. As a result, parents use non-secure and non-credible apps mostly developed by commercial entities that may lead to harmful parenting practices (9-11). There is a need to better understand parents' app use preferences and factors that encourage or discourage their apps' use. Therefore, the purpose of this narrative review of the literature is to provide a comprehensive overview of the multidisciplinary research on parents' use of apps in the first year of parenthood and highlight significant areas of research. This review aims to address the following research questions:

(I) What are the characteristics of literature on parents' app use in the first year of parenthood?
(II) What types of apps are available to parents to support their parenting in the first year?
(III) What are the factors that encourage or discourage parents' app use?

Methodology

The study combines a narrative review method and thematic analysis of the eligible articles to capture the novelty of the topic, as well as the breadth and diversity of the available research. This technique is suitable when addressing a broad area of research and the purpose is to describe the literature to expand the understanding of the topic (12,13). The thematic analysis enables researchers to identify patterns and to describe various facets of the data (14).

Search strategy

Academic databases were searched for articles related to the topic using prespecified eligibility criteria. Articles were screened based on a reading of the abstracts. In cases where an abstract was not available, articles were scanned briefly and if relevant to the review topic, an analysis of the full text was conducted. The literature lacks research articles on the use of parenting apps among healthy parents of healthy infants. Therefore, in an effort to present a comprehensive review of the literature, conference presentations, master's/doctoral theses, and relevant documents such as reports and viewpoints were also included in the search.

The following search terms were combined with the Boolean search operators AND, OR and NO: "Mobile Application" OR App OR Smartphone OR mHealth AND Parent OR Parenting OR Parenthood OR Parental OR Mother OR Mom OR Mum OR Motherhood OR Maternal OR Father OR Dad OR Daddy OR Fatherhood OR Paternal OR Infant OR Child OR Baby NOT Pregnancy OR Toddler OR Preschool OR Adolescent. The search from multiple disciplines such as nursing, medicine, psychology, and sociology was conducted using the following academic databases: CINAHL Plus with Full Text, MEDLINE, SocINDEX with Full Text, PsychINFO, Academic Search Complete, Web of Science, and Google Scholar.

Eligibility criteria

Inclusion criteria

Articles were included if they were full-text English language articles between January 2000 and December 2019 relating to parents' use of apps in the first year of infants' lives including reviews of parenting apps and apps that were developed to support parents.

Exclusion criteria

Articles were excluded if they were: duplicates (n=50); published in a language other than English (n=7); exclusively for children or parents of children above the age of 1 year (n=110); targeting sick/preterm infants or their parents (n=83); exclusively for pregnant parents (n=13); targeting apps for health professionals or used by health professionals and researchers to collect data (n=38), and not relevant to the topic (n=455). A total
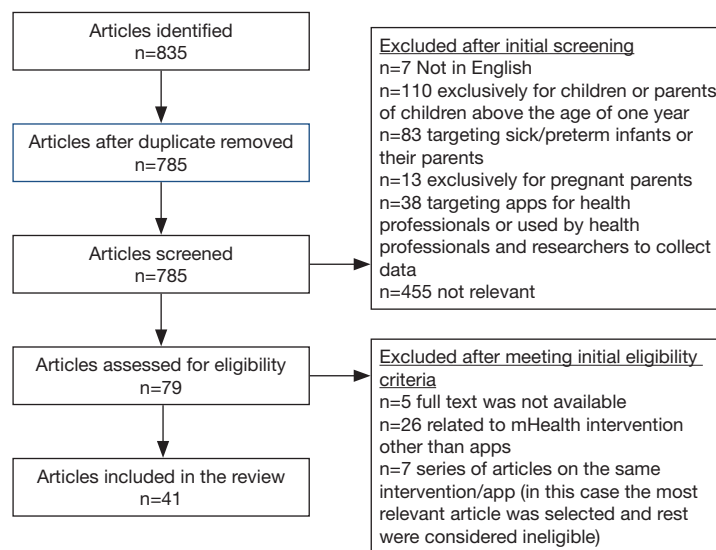
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┌─────────────────────────┐
│   Articles identified   │
│        n=835            │
└─────────────────────────┘
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             ▼
┌─────────────────────────┐          ┌──────────────────────────────────┐
│ Articles after duplicate│          │ Excluded after initial screening │
│     removed             │          │ n=7 Not in English               │
│        n=785            │          │ n=110 exclusively for children   │
└─────────────────────────┘          │ or parents of children above the │
             │                       │ age of one year                  │
             ▼                       │ n=83 targeting sick/preterm      │
┌─────────────────────────┐          │ infants or their parents         │
│   Articles screened     │───────▶  │ n=13 exclusively for pregnant    │
│        n=785            │          │ parents                          │
└─────────────────────────┘          │ n=38 targeting apps for health   │
             │                       │ professionals or used by health  │
             ▼                       │ professionals and researchers to │
┌─────────────────────────┐          │ collect data                     │
│ Articles assessed for   │          │ n=455 not relevant               │
│     eligibility         │          └──────────────────────────────────┘
│        n=79            │
└─────────────────────────┘          ┌──────────────────────────────────┐
             │                       │ Excluded after meeting initial   │
             │            ───────▶   │ eligibility criteria             │
             ▼                       │ n=5 full text was not available  │
┌─────────────────────────┐          │ n=26 related to mHealth          │
│ Articles included in    │          │ intervention other than apps     │
│   the review            │          │ n=7 series of articles on the    │
│        n=41            │          │ same intervention/app (in this   │
└─────────────────────────┘          │ case the most relevant article   │
                                     │ was selected and rest were       │
                                     │ considered ineligible)           │
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Figure 1 Article selection flowchart.

of 79 articles met the initial eligibility criteria and were reviewed by the primary author. Articles were further excluded if the full text was not available (n=5); were related to mHealth intervention other than apps (n=26), and series of articles on the same intervention/app (n=7) (in this case the most relevant article was selected and rest were considered ineligible). See *Figure 1* for the article selection flowchart.

Results

Characteristics of included studies

Of the 835 articles identified in the initial search, a total of 41 met the eligibility criteria and included published research papers (n=29), conference presentations (n=5), unpublished master's thesis (n=2), and documents such as viewpoint articles and reports (n=5). A majority of the articles were related to an app or mHealth intervention that accompanied an app (n=30), including a focus on informational and emotional support needs around infant care (n=25), self-care (n=4), and couple relationships (n=1). The remaining 11 articles described parents' use of apps (n=5) and parenting app reviews/critiques (n=6). See *Table 1* for the studies included in this literature review.

The majority of studies targeted women (including pregnant women and mothers) exclusively (n=13) or in combination with health professionals (n=2). Very few studies focused exclusively on male participants (n=2) or in combination with health professionals (n=1). Some researchers studied couples and families or parents of children under the age of 5 years (n=5) while a few studied parents and health professionals (n=2), as well as app development team members and app users (n=1). Most studies were conducted in Australia (n=10), followed by the United States of America (n=5) and the United Kingdom (n=3) and one each in Canada, Denmark, Jordon, Uganda, Thailand, China, and Taiwan. In the remaining (n=16) articles country was not mentioned.

Articles varied in their nature as some articles focused on social support needs about parenting, whereas others described the app development, deployment, and dissemination processes. Similarly, a wide variety of theoretical models were used (n=10), of which only social cognitive theory (15) was mentioned twice. Other theories included: unified theory of acceptance and use of technology (16); technology acceptance model for mobile service (17); behavior change wheel (18); capability, opportunity, and motivation model of behavior change (18); theory of planned behavior (19); fun theory (20); theory of change (21); national extension relationship and marriage education model (22); family life course development theory (23); black feminist theory (24); analyzing children's creative thinking framework (25); taxonomy of play (26); and health belief model (27).

Table 1 Summary of studies included in the review

Citation	Purpose	App/intervention description	Key findings*
Anggraini et al., 2015	Discuss the development and testing of the Pregnancy and Infant Encyclopedia app	The Pregnancy and Infant Encyclopedia app aims at providing nutritional information during pregnancy and infancy. The information is divided into seven sections. The app also allows users to select specific food preferences such as vegetarian	The app testing using black-box testing, showed all seven sections work well and the output of recommendation is per expectations
Asiodu et al., 2015	Describe the use of social media and parenting apps among African American mothers during the perinatal period	N/A	Mothers used social media apps to access information, social support, and advice. Most study participants reported using at least one app. Ninety-one percent viewed an app or a website on a daily or weekly basis. Mothers frequently downloaded several free apps based on their popularity but only used one or two apps. The most frequently used apps were BabyCenter, BabyGaga, and I'm Expecting. Participants rarely questioned the authenticity of the app content and when in doubt they referred to social media for confirmation
Balaam et al., 2015	Design, develop and deploy the FeedFinder app to support women in finding, reviewing, and sharing places for public breastfeeding	The FeedFinder app is used to search places where other women have previously breastfed to support public breastfeeding. The app provides reviews and ratings about such places in five categories: comfy(ness), clean(liness), privacy, baby facilities, and average money spent. Women can also add new places where they have breastfed and leave reviews for other mothers	Thematic analysis revealed two themes: pressures on unfamiliar ground and exposing a new self. FeedFinder app was primarily used in the UK but a growing, number of venues and reviews have been added in the USA, Western Europe, and Australia. FeedFinder has over 3,000 users, 1,900 breastfeeding locations, and 1,810 reviews. Peak times for app usage were 9 am, 4 pm and 9 pm. The most reviewed venue categories were departmental stores (n=119), coffee shops (n=95), cafes (n=87) and pubs (n=60)
Balu et al., 2018	Describe the development of the DadTime app	The DadTime app helps fathers improve their engagement with and attendance at the Just Beginning parenting education program. The app features include reminders for upcoming sessions, personalization with the name of the child, instructions to help fathers plan their attendance at the sessions, and a relationship tree feature that represents the growth in the father-child relationship over time	Fathers preferred to control the time of the reminders and felt anxious about the upcoming sessions. Based on the feedback, the study team identified three key times to send reminders: the day before the session; the day after the session, and the weekend after the session. Fathers reacted positively to the icons and emojis that were used in the app's basic design to simplify the content and reduce the reading load
Friedman et al., 2018	Engage participants in the development of a WIC (Women, Infants, and Children) Nutrition Education app prototype appropriate for English- and Spanish-speaking women	The WIC Nutrition Education app focuses on three areas: breastfeeding, physical activity, and family healthy eating. Breastfeeding support includes a live assistant interface, breastfeeding timer, and a growth chart. The physical activity section provides an activity tracker and progress sharing to social media. The healthy eating segment features meal planning, a recipe database, a calendar, and a shopping list builder	Participants liked the app as it was multifunctional, self-explanatory, easy to use, and from a trusted source. The reasons for using apps were accessing information, soliciting support, and tracking progress for the targeted behaviors. Compared to Spanish-speaking mothers, English-speaking women preferred entertaining, customizable, child-friendly, and social networking features in the app

Table 1 (*continued*)

Table 1 (*continued*)

Citation	Purpose	App/intervention description	Key findings*
Bonafide et al., 2017	Critique the use of smartphone-integrated infant physiologic apps in preventing SIDS	N/A	Apps used to prevent SIDS at home are integrated with sensors built into socks, onesies, buttons, leg bands, and diaper clips. The apps can monitor infants' physiological parameters and generate alarms for apnea, tachycardia, bradycardia, and desaturation. There are no medical indications for the use of these monitors in healthy infants and the companies only claim to alert the parents in an event of an abnormal physiological parameter. Despite the lack of supporting evidence, the sales of these products are on the rise and the market is expanding. These monitors may generate false-positive alarms due to motion artifacts and true-positive alarms for events that are not clinically important in healthy infants which may result in a risk of overdiagnosis and potential harm
Bond et al., 2019	Explore user behavior patterns of the maternal mental health app	The Moment Health app aims at screening mothers for prenatal and postnatal depression and associated anxieties. Key features include a mood tracker, a symptoms checker, a locator to find desired resources nearby, a guide to practical and accessible coping strategies, an online community, and notifications to prompt users to log moods	Happiness was the dominant mood during day times (peaked at 1 pm; anger peaked in the evening (5 pm and 6 pm); anxiety (peaked at 1 am) and sadness (peaked at 4 am) were prominent during night times. Users who have four or five scales completions were likely to adopt the app and consistently complete mental health scales. The majority of users (95%) were transient users and not adopters
Burgess et al., 2018	Evaluate the efficacy of the Cool Runnings app	The Cool Runnings app aims at improving knowledge about the risks of hot beverage scalds and burns, and first aid in mothers of young children. Control and intervention groups had different versions of the app. The intervention group was provided with nine messages, gamification, and engagement with the content whereas, the control group received three messages, no gamification, and no content engagement. The intervention group was encouraged to earn points by viewing content, completing pop quizzes, and uploading photos as part of weekly challenges. The winners were awarded additional bonus points. Tangible rewards included Aus $25 and Aus $50 movie or shopping vouchers and the intangible rewards included leaderboard position and winner badges	The intervention group achieved significant improvement in overall knowledge than control group participants (P<0.001). There were significant correlations between gamification techniques and knowledge change (P<0.001). Odds of knowledge improvement between baseline and 6-month follow-up was higher in participants with low-moderate app activity compared with no app activity (OR: 8.59, 95% CI: 2.9–25.02) and much higher in participants with high app activity (OR: 18.26, 95% CI: 7.1–46.8)
Chaudhry, 2016	Describe the features of the Baby Feed app	The Baby Feed app aims at tracking most aspects of an infant's life, such as diaper, feeding, medications, growth, etc. App features include reminders, real-time updates, and statistics of infant activity	N/A

Table 1 (*continued*)

Table 1 (*continued*)

Citation	Purpose	App/intervention description	Key findings*
Danbjørg et al., 2014	Describe the design, development, and testing of the Me & My Baby app	The app aims at supporting the needs of the postnatal parents discharged early from the hospital. App features include asynchronous communication with healthcare professionals via text, images, and videos; evidenced-based content with a search function; and customized messages every 12 hours from the time of birth	Three categories emerged from the data analysis: new working routines (for nurses); the functionality of the app: and new ways to communicate. Overall, parents reported feeling reassured and found it natural to communicate online. However, nurses found it hard to adjust to the new work processes and felt stressed due to the lack of experience with apps
Davis et al., 2017	Critique existing parenting apps	N/A	Out of 203, 48 apps met the eligibility criteria and were reviewed. The price ranged from free to $4.99. The apps were created between 2009 and 2016 and last updated between 2010 and 2016. 23.4% of the apps did not list a source for the information and 12.8% contained commercial ads. Thirty/43 apps received an Understandability PEMAT (Patient Education Materials Assessment Tool) score between 76% and 100%, and 19/43 apps received an Actionability PEMAT score between 76% and 100%. The functionality of the apps was limited, with none of them providing a customized experience
Deave et al., 2019	Assess the effectiveness of the Baby Buddy app, in improving maternal self-efficacy	The Baby Buddy app aims at increasing parental self-efficacy with a particular focus on expectant mothers under 25 years old. App features include the creation of the app avatar, goal setting, media download, ask me a question and what does that mean	The app did not elicit a statistically significant change in self-efficacy scores or mental well-being from baseline to 3 months post-birth. The scores also did not statistically significantly differ between active vs. passive and high vs. low app users. However, app usage did lead to higher levels of self-reported breastfeeding
Dhumal et al., 2016	Develop an app to monitor and identify critical conditions	The app provides real-time monitoring of the baby's heart rate and temperature using a sensor embedded in a hand glove. The app alerts the users in critical situations and provides detailed analysis	N/A
Fonseca et al., 2014	Discuss and evaluate a system to prevent sudden death in infants	The app aims at remotely monitoring the baby using a sensor and wireless connectivity feature. The system continuously collects data from the sensors (heart rate, breathing, cradle temperature, baby's position, and crying) and notifies the users of an unexpected event based on the pre-defined threshold values	The experiment demonstrated that the system is reliable in detecting unexpected events and can be used for SIDS prevention

Table 1 (*continued*)

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Citation	Purpose	App/intervention description	Key findings*
Galinsky et al., 2017	Describe the translation of developmental science into practice using MITM and the Vroom examples	Vroom is available via a web and a free app. The app sends a daily customized notification of a Vroom tip to turn everyday moments into learning moments for both children and their parents. Each tip is short and at a third to fifth grade reading level in both English and Spanish language and explains the science behind the tip. MITM resource consist of a DVD collection of 42 videos; a free downloadable tip sheet; a book, and learning modules for community leaders (in English and Spanish), intended to promote engaged learning and executive functioning skills	There are more than 100,000 app downloads in more than 100 countries in just over a year after its launch
Gessesse, 2019	Discuss the development of the Infant Growth Calculator app	The Infant Growth Calculator app calculates the growth rate (height, weight, and head circumference) of the infant and compares the result with the world health organization's growth rate standard percentile. The app feature includes personalized results in the form of text and a graph	The app can be improved in the future by adding the following functionalities: increasing age range from birth to 2 years; including an option to store users' data; an option to use it for multiple children; and including BMI calculation
Hearn et al., 2014	Summarize the findings and report the implementation of the Healthy You, Healthy Baby website and app in the first year since its inauguration	The Healthy You, Healthy Baby website and app use a self-assessment tool to track and generate customized suggestions to improve maternal lifestyle behaviors and weight during pregnancy and the first 18 months of motherhood	A total of 2,378 users signed up over the first year with a user growth of 47% (62 new users per week increasing to 91 new users per week). App self-assessments were completed at a rate of 167 per week, with the highest usage in the first two trimesters of pregnancy and in the first 3 months after birth. Overall, the website hits (including both new and repeated) were higher than the app signups. However, 25% of website traffic came directly from the app
Houle et al., 2017	Discuss the features of the CANImmunize app and its use among pharmacists	The CANImmunize app aims at securely recording immunization for multiple people and generating customized reminders. It provides evidence-based information on communicable diseases and immunizations especially teaching immunization to kids using child-friendly interactive features	The app was launched in 2014 and it has been downloaded more than 175,000 times across Canada
Jabraylov et al., 2018	Develop and evaluate the IQI scale and app	The app features the IQI instrument that assesses overall health-related quality of life in infants (birth to 1 year)	The IQI app was shown to be relevant, easy-to-use, and well-understood in parents of infants 0–1-year-old
Kapinos et al., 2019	Explore the use of the Telelactation app among rural mothers	The Telelactation app provides 24/7 breastfeeding assistance from experts via free unlimited video call visits	The Telelactation app users were mostly working mothers (68%); women with no prior breastfeeding experience (39%); or not exclusively breastfeeding before hospital discharge (52%). Seventy percent of video calls occurred during the infant's first month of life and 41% occurred outside of business hours. Fifty percent of the participants did not use the app because of no breastfeeding problems (26%), not comfortable with video calls (11%), stopped breastfeeding (8%), and busy (7%)

Table 1 (*continued*)

Table 1 (*continued*)

Citation	Purpose	App/intervention description	Key findings*
Kernot et al., 2014	Pilot and assess the usability of the Mums Step It Up Facebook app	The Mums Step It Up Facebook app encourages mothers to take 10,000 steps a day measured by a pedometer. The app features include daily tips, rewards, ability to monitor activity and see progress	The app was successful in increasing activity in mothers by an average of 177 minutes per week (P=0.01). Walking was the most popular physical activity. The major concerns of the app's usability were related to technical issues
Khader et al., 2019	Determine the role of the ClmA in improving the vaccination uptake and documentation among refugees	The ClmA aims at improving the vaccination uptake and documentations among refugees. The app features include vaccination promotion messages; automated reminders; and vaccination records and schedules for each child using color-coded labels	N/A
Kuo et al., 2012	Design and evaluate the Newborn Baby Care Support app	The Newborn Baby Care Support app offers a baby health record system and baby care consultation system. The app features include diary-keeping, FAQs, reminders, nurse consultation, growth trend analysis, and periodic health reports generation	Participants reported the app was easy to navigate (94%) easy to learn (100%), secure (66%) and could answer their questions (84%) Usability evaluation showed the ease of learning was most valued (4.14), followed by usefulness (4.07), acceptance (4.05), ease of use (3.98), satisfaction (3.86), and trust (3.74)
Larkin et al., 2019	Develop and evaluate the efficacy of the intervention to improve the quality of infant-parent interactions	The intervention included an animated video, a face-to-face hypothetical scenario discussion, and the installation of the BabyMind app and demonstration of its functions. The app features include daily information alert and journal function with cues to upload a note, photo, or video documenting baby's thinking or feeling	The intervention was effective in facilitating mind-mindedness at the 6-month evaluation. Mothers in the intervention group produced significantly more appropriate mind-related comments than control group mothers
Laws et al., 2018	Explore the feasibility of the Growing Healthy program (website and app)	The Growing Healthy program contains a free app and a website sharing evidence-based articles and videos on infant feeding. The program features include three notifications/week directing parents to age-and feeding-specific content within the app; a weekly email including the three messages for the week with links to the website; invitation to join a Facebook group where one feeding message/week was posted by a moderator, and participants were encouraged to discuss practical experiences around infant feeding	Eighty-six percent of the participants opted to access the program via the app. App usage declined over time from 92% using the app at least once on enrollment to 38.2% at study completion when infants were 8 to 9 months of age. Participants showed higher engagement with the program if they were first-time mothers, recruited by a healthcare professional, registered during the early postnatal or antenatal period, and used both the app and the website
Lee and Walsh, 2015	Describe the development and usability testing of the mDad app	The mDad app supports new fathers' engagement with their children. It used push notifications to direct users to personalized parenting education messages within the app. The app prompts users to document their child's development by creating logs and uploading pictures/videos	The overall content was perceived as interesting, useful, and relevant. The participants also appreciated the content for being both educational and humorous and its friendly, non-pedantic tone. Participants liked the brief specific messages and reported the timing of the messages (Tuesdays and Fridays) as highly favorable as it allowed them to plan activities for the weekend. They found sharing the app with another parent/ caregiver and virtual tracking of their child's development was highly engaging. The app was easy to navigate and customization was reported as its major strength

Table 1 (*continued*)

Table 1 (*continued*)

Citation	Purpose	App/intervention description	Key findings*
López et al., 2013	Design, implement and evaluate a prototype for an app with a sensor to prevent SIDS	The app is designed to monitor the baby's position and temperature and alerts the caretaker for the potential risks for SIDS. A bear-shaped patch is attached to infants' pajamas. The patch contains a sensor, an on and off button, and an LED light (to indicate that the object is on). In case of a trigger, the alarm rings with two options: stop alert or call emergency	The result of the wizard of Oz technique indicated that the caregiver was able to monitor the baby remotely. The testing on a real baby revealed that it was comfortable, the baby was unable to take the object off and turn it off, and the baby's movement did not turn the sensor off
Lucier-Greer et al., 2018	Evaluate Love Every Day app as a means to promote couple resilience	The Love Every Day app aims at improving spousal relationship quality. The app sends a question each morning to both spouses with a request to respond within 24 hours. If no responses or just one response is received, the next prompt is delivered. Once both partners have responded, the answers are revealed, unlocking bonus activity, intended to facilitate warm interactions (e.g., hug your partner for 7 seconds)	The majority of couples engaged with the app consistently and 58% of the participants answered all questions. Participants reported significantly higher levels of relationship quality, greater partner cohesion, better relationship satisfaction, more relationship confidence, and less relationship distress. Participants indicated a high degree of satisfaction (4.8/5) with the app. The most liked app features were anticipating or revealing their partner's responses (34%) and prompts to communicate with their partner (23%). The unliked features were 24-hour timeout for answering questions (11%) and multiple prompts (7%)
Lupton, 2016	Discuss the use of digital media among Australian pregnant women and mothers	N/A	Focus group discussion analysis revealed nine characteristics of digital media including apps: (I) immediate, (II) regular, (III) detailed, (IV) entertaining, (V) customized, (VI) practical, (VII) professional, (VIII) reassuring, and (IX) unbiased. Overall, participants reported apps provided advice and reassurance quickly and anonymously. Mothers preferred multi-functional and interactive apps with regular customized notifications, videos, and an option to add infant data. First-time mothers particularly appreciated baby monitoring apps, tracking apps, and information apps. Facebook was commonly used for social networking, accessing customized and local information, and connecting with other mothers
Lupton and Pedersen, 2016	Investigate the use of pregnancy and parenting apps among Australian women	N/A	Out of those women who reported using a parenting app, 59% had only used one app while 39% had used 2 to 4 apps and only 2% had used 5 or more apps. Parenting app use was less common than pregnancy apps. The most common use of parenting apps was for obtaining information and tracking/monitoring children. Twelve percent of mothers found parenting apps unhelpful due to boredom (33%), time constraints (29%), inaccurate information (14%), irrelevant information (14%), and anxiety-provoking content (14%). Sixty-eight percent of women never checked the information source in a parenting app. Twenty-seven percent of mothers were not at all concerned about the potential use of personal information by the app developers

Table 1 (*continued*)

Table 1 (*continued*)

Citation	Purpose	App/intervention description	Key findings*
Marsh et al., 2018	Investigate the extent to which apps for children aged 0–5 foster play and creativity	N/A	Children used tablets for a mean of 1 hour and 19 minutes on a weekday, and 1 hour and 28 minutes on a typical weekend day. The children were more likely to use tablets with a parent or guardian (57%) than use them on their own (35%). The most favorite apps were YouTube, Internet of Toys (apps with physical toys), augmented reality apps, communication, and social media apps were used to foster play and communication with family and friends. On average, children used six apps regularly. Key features of apps that limit play and creativity were poor design, lack of repetition, no clear aim or too many aims, not age-appropriate, very few scaffolding techniques, excessive advertisements, and pop-ups for in-app purchases
Nansen, 2015	Seek to understand the everyday contexts of children using media	N/A	Three themes emerged from this ethnographic study: accidental, assisted, and automated. Accidental use was mostly occurring via screens lighting up through touch prompts and habituation through gestural interaction, especially swiping. Assisted media use included keeping the child engaged during family vacations, showing digital content, and communicating with families abroad. Automated media use was related to the ways digital databases and apps facilitated infant exploration and navigation. These included photo galleries, YouTube, children's Internet television services which are visually organized and easily scrollable
Pérez, 2014	Develop VacApp to records vaccinations, prescriptions, and personal health records n an area with low Internet connectivity	The VacApp records vaccinations and medical history. It keeps all information in the phone memory and once the connection is established (cellular or Wifi) the sync function automatically backs up the data to the cloud for future retrieval. App features include add/delete/modify entries, create notifications, and view past entries	N/A
Scott et al., 2015	Examine 10 free maternal and child apps for their trustworthiness and technical performance	N/A	Four/10 apps developed with the involvement of health professionals and provided information from evidence-based medical content. Four/10 apps were fully functional, 2/10 were fully usable and 3/10 adequately implemented security. None of the apps were fully functional, usable, or secure
Taki et al., 2015	Provide information on available infant feeding websites and apps	N/A	Ninety-one percent of the apps were rated poor quality due to navigability, design, readability, accessibility, and breadth of coverage. Seventy-eight percent of the apps received the highest comprehensibility score. There are currently no apps available that address a variety of infant feeding topics

Table 1 (*continued*)

Table 1 (*continued*)

Citation	Purpose	App/intervention description	Key findings*
Vanosdol et al., 2019	Explore the usability and acceptability of the NeMo system among target users and volunteer community health workers	The NeMo system consists of a wearable sensing band and a low-cost smartphone preloaded with the custom NeMo app. The app uses audiovisual cues in the local language enabling mothers to assess the seven neonatal danger signs. The app analyzes the quantitative and qualitative assessment data and displays representative images of any danger signs detected and, if indicated, produces a red phone icon to prompt the mother to call a community health worker for further assessment and help	Fifty-nine percent of women using the app version I were able to navigate the app easily. After modification made in verbal instructions and question framing, 90% of women using the app version II were able to use the phone and app with no difficulty. The participants scored the NeMo system 4.3/5 for its ease of use score and 3.5/5 for its learnability
Virani et al., 2019	Provide a list of quality apps for parents of infants	N/A	Of 4,300 free apps, 16 apps were included in the review. Thirteen apps were also available on the iOS platform. All apps had a privacy policy, and half of the apps contained advertisements. Twelve apps were updated within the last year and received 4.5 or above ratings from users. Eleven apps received MARS scores between 4.2 and 4.4/5, with four apps received the highest MARS score of 4.5/5, and one app received the lowest MARS rating of 4/5. Most apps were rated high on functionality and ease of use (mean score =4.6), followed by visual appeal (mean score =4.2); and information (mean score =4.2). Babybrains, an evidence-based app, had the lowest number of downloads (one thousand) whereas, a commercial app, BabyCenter, had the highest number of downloads (ten million). None of the apps addressing fathers' needs were qualified for the review
Wang et al., 2018	Evaluate the usability and usefulness of the MoomMae app	The MoomMae app supports breastfeeding women. It has three main features: feeding records, pumping records, and feeding rooms. The feeding record function allows women to add feeding records and view weekly or monthly summaries and history. The pumping record feature permits mothers to add pumping records and view daily statistics. The feeding room function provides mothers information (descriptions, facilities, routes, and photos) of nearby or popular feeding rooms	Seventy-six percent of the mothers used the app 4 to 7 days/week. The most frequently used functions were breastfeeding record (57%) and pumping record (38%). Post-use interview analysis revealed mostly negative comments on usability including difficulty with navigation, lack of intuitive and personalized features; and loading time issues; and mostly positive comments on usefulness including confidence building, feeding/pumping volume control, time management, and ease of breastfeeding in public
White et al., 2016[a]	Develop the Milk Man app to support men as breastfeeding partners	The Milk Man app addresses the key issues affecting men as supportive breastfeeding partners. App features include push notifications to alert users to discussion topics; social connectivity via a guided conversation; an information library, and gamification including leaderboards, badges, and reward points to encourage participation in conversations and accessing information	Most participants were positive about the idea of apps for new fathers. There was a mixed response to the idea of a discussion forum for men to connect. The average MARS score for the app was 4.3 out of 5. The think-aloud method identified 6 areas of functionality and usability to be addressed, including the addition of a tutorial, increased size of text and icons, and greater personalization

Table 1 (*continued*)

Table 1 (*continued*)

Citation	Purpose	App/intervention description	Key findings*
White *et al.*, 2016[b]	Describe the development and dissemination strategies for Feed Safe app	The Feed Safe app educates breastfeeding women about the impact of alcohol consumption. One of the core features of the app is a timer showing women the time at which their breastmilk will be free of any alcohol	Over 1 year, the app was downloaded 28, 330 times. Facebook was the major source of all social media referrals, contributing 99.13% of social traffic. The app was used for an average of 732 times each day, with significant spikes on Christmas day (1,340 uses) and New Year's Eve (1,732 uses)
Zhao *et al.*, 2017	Assess the quality of Chinese infant feeding apps and explore Chinese mothers' perceptions of apps' quality and usability	N/A	Of 4,925 free apps, 26 apps were evaluated. All 26 apps were developed by commercial entities, and the majority of them were rated poorly. Twenty/26 apps promoted infant formula advertisements. The most common app functionality was a built-in social forum (19/26) and the least common functionality was the provision of a website link (2/26). Mothers preferred using apps due to the desire for an immediacy of information, multifunctionality of the apps, reminders, personalized notification, keyword search, and social networking features

*, please note the only content that was directly related to the topic was included in the key findings. The technical part of the articles (such as software specification in app development) was not included as it was beyond the authors' scope. Some of the key findings are paraphrased or directly quoted from the article as the original language was relevant to the point. [a], White BK, Martin A, White JA, *et al.*; [b], White B, White J, Giglia R, *et al.* N/A, not applicable; OR, odds ratio; MITM, Mind In The Making; BMI, body mass index; IQI, Infant Quality of life Instrument; CImA, Children Immunization App; mDad, Mobile Device Assisted Dad; NeMo, Neonatal Monitoring.

Thematic analysis of the eligible articles

The analysis revealed four overarching themes and 10 subthemes: (I) increased app use related to shifts in parenting trends; (II) types of apps available to parents; (III) apps to overcome the digital divide, and; (IV) factors encouraging or discouraging app use.

Theme #1. Increased app use related to shifts in parenting trends

The literature review findings revealed that the inability of the healthcare system to support parents; evolving parenting roles due to increased participation of women in higher education and paid work; geographical distances between parents and their families; and the ubiquitous availability of scientific parenting material have greatly increased parents' app use. Three subthemes emerged: (I) shorter postnatal hospital stays; (II) evolving parenting roles and responsibilities; and (III) increased geographical distance among families and the rise of scientific parenting.

Subtheme 1.1: shorter postnatal hospital stays

Circumstances have changed over the last two decades contributing to the rise of app use among parents. Parents turn to apps in a quest for finding answers for common parenting needs due to healthcare system changes that restrict postpartum hospital stays. Many first-time parents are not mentally ready to absorb all the information presented to them in the brief period immediately after giving birth and commonly leave the hospital with numerous questions about their self-care and the needs of their newborn (28-30). In a study, postpartum parents reported feeling most vulnerable in the middle of the night when they could not contact family, friends, or clinicians (31). While support services such as parenting helplines, public health nurses' visits, and community centers are available in most communities, many parents reported reluctance to contact clinicians post-discharge due to concerns they were interrupting nurses' busy schedules to address their simple questions (32). On the other hand, apps act as a convenient medium for parents to fulfill their informational, and emotional support needs around-the-clock. Researchers in Denmark designed an app in collaboration with postpartum nurses in an effort to address the issue of shorter hospital stays and found the app to be an efficient source of parenting information. The findings revealed that parents preferred the app over typical sources, such as pamphlets and consulting nurses via phone (31).

Subtheme 1.2: evolving parenting roles and responsibilities

In western societies, women are increasingly participating in higher education and paid employment. Stay-at-home fathers and dual-income families are increasing, giving rise to fathers' involvement in care and practical distribution of household responsibilities between working spouses. However, healthcare systems that are typically designed to support stay-at-home mothers often make fathers feel left out of the parenting process (33,34). Fathers and working parents often turn to apps for information due to the inability of the healthcare system to adequately support the changing trends and shifts in parental responsibilities. While apps such as mDad, DadTime, and Milk Man assist fathers in their parenting roles (34-36), tracking apps allow working parents to remotely monitor their infants' care synchronously with caregivers (33,37,38).

Subtheme 1.3: increased geographical distance among families and the rise of scientific parenting

Increased mobilization among parents to avail better career opportunities has led to an increase in geographical disconnection between new parents and their extended family support systems. Thus, parents are increasingly using communication and social media apps to connect with extended families and receive emotional and informational support (39,40). Further, increased availability and awareness of scientific information have given rise to scientific parenting, defined as parenting practices that are based on best evidence (41). Zhao *et al.* (42) reported mothers are veering away from simply providing physical care to their infants and turning to apps that scientifically support their child-rearing practices and decision-making in health-related matters.

Theme #2. Types of apps available to parents

Parents actively seek apps to adjust to their new role and there are several types of apps available to parents that can assist in meeting their social support needs. These needs can be categorized under the following two subthemes: (I) apps supporting infant care, and (II) apps focusing on self-care and couple relationships.

Subtheme 2.1: apps supporting infant care

First-time parents, in particular, have numerous concerns about the overall well-being of their infants. The following infant care needs have received researchers/app developers' attention: overall infant care; feeding/nutrition; growth and vaccination tracking; and sudden infant death syndrome (SIDS) prevention.

Parents desired apps that provided informational support to fulfill basic infant care needs, such as bathing an infant and care for the umbilical cord, in the initial postpartum months. For example, the app Newborn Baby Care Support was created to allow parents to consult nurses 24/7 during the postpartum period (29). Similarly, Danbjørg and colleagues (31) developed the app called Me & My Baby that allowed parents to consult nurses via text, images, and videos and provided customized messages every 12 hours from the time of birth. Apps that provided support in dealing with other infant care such as infant cognitive and psychosocial development and parent-infant bonding were also valued by parents. Examples of such apps found were: mDad (34); DadTime (35); Vroom (43); and BabyMind (44).

Providing a healthy diet is an important aspect of infant care, and parents often report questions about breast/bottle feeding, the introduction of solids, and food allergies. Of all nutritional concerns reported by parents, by far breastfeeding received the most attention from researchers (30,45,46), possibly due to declining rates of breastfeeding (36). The most common issues related to breastfeeding mentioned in the literature were sore/cracked nipples and latching problems, as well as lack of support from partners/family and breastfeeding in public. A few apps were created to deal with common breastfeeding concerns. The Telelactation app delivers new parents 24/7 breastfeeding assistance from lactation consultants via video chat (47) while the MoomMae app provides feeding/pumping tracking and information on feeding rooms in public places (48). Recognizing the supportive role of a spouse in breastfeeding, White *et al.* (36) developed the cleverly titled Milk Man app that encourages fathers to act as a support for their breastfeeding partners. A few apps were developed to support parents' choices regarding healthy nutritious foods for infants such as the WIC Nutrition Education app (46), the Pregnancy and Infant Encyclopedia app (49), and the Growing Healthy app (50).

Tracking infants' basic activities, growth, and vaccinations were another reason parents use apps. The literature review revealed a few apps that assist parents in tracking infant development and vaccines. The Baby Feed app, for example, allows parents to record and track infants' basic activities such as feeding, urination/defecation, growth, and medications (37). The Infant Growth Calculator app enables parents to calculate the growth rate (height, weight, and head circumference) of infants and compares results with the World Health Organization growth rate standard percentiles (51). Using the CANImmunize app, parents can record immunizations for multiple family members and generate customized reminders for their next vaccination appointments (52).

SIDS prevention is another common concern of parents, and the focus of three articles found in this literature review (33,38,53). Apps that come with a sensing device (attachable to the infant's clothing or surroundings) assist parents in detecting abnormal infants' physiological parameters and take action in time. However, Bonafide *et al.* (54), presented a critique of SIDS prevention apps and indicated that there is no evidence these apps are useful in preventing SIDS; rather, these apps appear to create a sense of insecurity among parents, heightening fears that they are incapable to keep their infants safe.

Subtheme 2.2: apps focusing on self-care and couple relationships

Personal care and relational activities enhance parents' feelings of well-being and social support (1,3,6). Many parents seek informational support regarding self-care and couple relationships such as postpartum diet and exercise, resumption of sexual activities, and suggestions for maintaining a healthy spousal relationship. However, the literature review findings indicated that parents' self-care and spousal relationship needs received very little attention in the research (n=5) compared to infant care needs (n=25). Apps that were developed to support self-care included a social network-based physical activity app (20); a maternal mental health app (28); a maternal lifestyle and weight management app (55); and an app to increase maternal self-efficacy (56). Only one app, Love Every Day (57), was found to promote couple resilience.

Theme #3. Apps developed to overcome the digital divide

The term digital divide is commonly used to denote barriers in online information access. Inequalities based on age, income, education, availability of devices, and the Internet, as well as comfort level and skills required to use technology, prevent some people from using the Internet and apps, creating a divide between technology and non-technology users (58). Despite the prevalence of some degree of the digital divide, however, contemporary parents are increasingly using apps to fulfill their informational and emotional support needs (55,59). Given the increase in online health information, several health professionals and researchers have designed apps to improve access to health

services and information for parents who are difficult to reach through typical methods (pamphlets, consultations, and classes) due to geographical barriers, time constraints, and stigma (31,32,57). This literature review found several apps that were specifically developed for disadvantaged or vulnerable populations such as military and low-income fathers (34); mothers living in rural and remote areas (47); high-risk mothers (56); parents with low socioeconomic status (43,50,60,61); refugees (62); and areas of low internet connectivity (63).

Theme #4. Factors encouraging or discouraging parenting app use

The abundance of poor-quality parenting apps was mentioned as a major barrier in the effective utilization of apps. Serval researchers have performed parenting app reviews and mentioned most apps were of poor quality (64-66). For example, Virani *et al.* (67), reported out of 4,300 parenting apps reviewed, only 16 (0.4%) were relevant and of high quality. The majority of app reviews have suggested five areas to improve app quality to make them more appealing to parents, categorized under the following five subthemes: (I) functionality, (II) visual appeal, (III) interactive feature, (IV) content credibility, and (V) privacy and security (40,59,68).

Subtheme 4.1: functionality

Functionality refers to app performance, ease of use, and navigation. Apps that are difficult to navigate, freeze, or crash can frustrate users. Many users delete dysfunctional apps within a few minutes after installation due to navigation issues. The seamless functioning of apps is very important in utilization (20,46,50).

Subtheme 4.2: visual appeal

Often referred to as look and feel, visual appeal is an important aesthetic aspect that allows users to enjoy their experience. The app icon and logo provide the first impression of an app that communicates its quality even before users decide to download and test its functionality (66,67).

Subtheme 4.3: interactive feature

Interactive features of an app are crucial in engaging parents, improving control, and ensuring effortless ongoing access to desired parenting social support. Interactive features such as trackers (52,63), reminders (37,62), notifications (33,43), connecting with clinicians via video calling or texting (31,47), gamification (36,60), using geolocation to find nearby places for breastfeeding (45,48), and forums/social networking (20,42) were mentioned in the literature to create appealing evidence-based apps for parents.

Subtheme 4.4: content credibility

Credible content in an app is critical from researchers' and healthcare professionals' perspectives however, the analysis suggested otherwise. If an app is usable, engaging, and customizable, parents are willing to compromise on content credibility. Many evidence-based apps are content robust but lack appealing and usable features that discourage the use of such apps among parents. For example, Scott *et al.* (64) presented a parenting app review and found four apps with evidence-based content, out of which two did not fully meet the usability criteria. A few researchers shared concerns that lack of usable and appealing features such as seamless navigation, ease of use, and interactive features deter parents from using evidence-based apps thus put them at a risk of using content that may lead to harmful practices (32,42,67).

Subtheme 4.5: privacy and security

App security mechanisms allow users to enjoy apps safely. However, many parenting apps, especially ones that provide customized information, collect and store personalized data on a daily basis. Users usually have no means and/or are unaware of the methods of deleting collected data and many apps do not use encrypted data sending features, making data prone to hacking (33,37). Scott *et al.* (64) examined ten free maternal and child apps and found only three apps employed a security mechanism to ensure users' security. While evidence-based apps take extra caution in ensuring users' security (29,52), researchers have found that parents continued to use commercial and/or poor-quality apps if they helped fulfill social support needs despite potential privacy and security issues (55,66,69).

Discussion

Through this literature review, the authors aim to explore characteristics of literature on parents' app use in the first year of parenthood, types of apps that provide informational and emotional support in the first year, and the factors that support and hinder parents' app use.

The findings indicated the majority of apps provided social support for infant care and only a handful of apps discussed self-care and couple relationships. Gilmer *et al.* (70), found similar results in a review of the literature on parenting education interventions. They indicated the majority of interventions focused on parenting an infant. However, the importance of self-care and couple

relationships cannot be denied in maintaining overall parental wellbeing. Hearn *et al.* (55) performed a gap analysis for parenting content and reported mothers felt the available parenting content was "child-focused" and they would prefer to have "parent-focused" content (p.3). Entsieh and Hallström (71) presented a literature review on the parental needs of first-time parents in early parenthood which also indicated that managing the spousal relationship was one of the important needs identified by parents.

Self-care and spousal relationships are some of the needs that were identified in this literature review that is lacking in the world of parenting apps and require researchers and app developers' attention. Many researchers who evaluated parenting programs also supported the similar notion that a lot of emphases was given on learning about labor, delivery, and infant care, and little attention was given to parents' emotional health, self-confidence, couple's relationships, and parenting skills (55,70,71). There is a need to shift the focus from developing apps to support infant care to apps that enhance parent's self-confidence, support their mental health, educate them about coping strategies, dealing with new challenges and budling resilience, help them learn parenting skills, facilitate self-care activities, and provide support in maintaining healthy family, and social relationships. In these tough times, when parents are feeling more isolated and experiencing mental health challenges due to the pandemic related social distancing measures, the need to develop apps that supports parents beyond infant care cannot be stressed enough.

Findings revealed that most researchers employed mothers as participants and a few involved fathers in research. Evolving circumstances have given rise to father's involvement and fathers are more involved in the child rearing activities than ever before. Further, the involvement of fathers in infant care has proven to be beneficial in the well-being of mothers and infants. Fathers also play an important role in a child's physical, mental and social development (34-36). Inclusion of fathers' perception in designing parenting resources is crucial therefore, researchers should also recruit fathers in parenting related research studies (72). A few researchers have also discussed the challenges of recruiting fathers such as work-related responsibilities and uncomfortableness with parenting programs which are mostly geared towards mothers (11,35,73). However, Lee and Walsh (34) suggested researchers should try different recruitment strategies and

recruit even a small sample of fathers in research to make them feel heard and to develop parenting resources that are more accessible and appealing to them.

The review findings suggest parents prefer appealing, usable, functional, and personalized apps with interactive features and for that experience, many parents do not hesitate to compromise on content credibility and security features. There could be many possible reasons for such findings. First, some researchers found many evidence-based apps are content robust and secure but lack parents' preferred features. Second, many evidence-based apps go through a stringent process of research and modifications before they are available to the public. Some evidence-based apps are only designed for one platform such as iOS or android which further limits their availability and visibility. For example, Virani *et al.* (67), found that while a literature search revealed a few evidence-based apps for fathers, these apps were not available on the Google app store. Third, evidence-based apps are low in number compared to poor quality apps which makes the process of finding a usable, appealing, secure, and credible app similar to finding a needle in a haystack (64,74,75). There is a need to develop credible and secure apps that are also usable and appealing to parents and available to the public on multiple platforms. A partnership between academia and the technology industry may result in such apps (76). Using user inclusive approaches such as participatory design to engage parents in the app development process can also result in apps that are not only are scientifically robust and secure but also appealing to parents.

Implication for practice

Parents often have busy schedules and generally select social support sources that require less time and are easily accessible. Danbjørg *et al.* (31) found parents preferred a postnatal app where they could send a picture, video, or text compared to consulting nurses over the phone. Considering shifting trends in accessing parenting social support, health professionals and researchers should recommend quality apps to parents (39,65,69). Deave *et al.* (56) reported parents were more likely to use an app if it was introduced or recommended by a health professional. Most parenting app reviews, however, presented quality issues with apps but did not guide health professionals or parents towards quality apps. Virani *et al.* (67) stressed the importance of providing

a list of quality apps that may ease the search process for parents and increase recommendations of apps by health professionals.

It is alarming to note that parents compromise on content credibility and security features due to the immediacy of the fulfillment of their needs and certain app features that make the app more usable or visually appealing. Parents tend to discard high-quality apps with evidence-based information due to poor visual appeal and lack of usable features (11). While evidence-based apps pay more attention to content credibility and security, they may lack appealing features that deter parents from utilizing these apps. Therefore, it is important to co-create apps with parents and incorporate their suggestions in app development. Vanosdol *et al.* (61) modified the NeMo app by incorporating users' feedback and indicated modification increased mothers' ability to accurately spot neonatal danger signs by at least 200%. Researchers should engage parents in the app development process to create appealing and usable evidence-based apps. The use of user inclusive approaches to design, such as participatory design, can be employed to engage users in the app development process.

Limitations

Narrative reviews are generally less systematic due to the flexibility of including different types of research and non-research articles; however, this flexibility allows researchers to incorporate a wide variety of literature and provide a comprehensive overview of the topic. Further, the authors did not perform a quality assessment of the included articles due to the heterogenicity of the theoretical perspectives and reported methods and results.

Conclusions

In this narrative review of the literature, the authors have discussed the types of apps available to parents providing informational and emotional support; evolving circumstances that have given rise to parents' app use; and app features that encourage or discourage parents' use of quality apps. Contemporary parents' increased use of apps demands health professionals to move from standardized approaches to providing parenting social support and adopting digital mediums to increase parents' access to evidence-based resources. Parenting app reviewers should focus on providing a list of quality apps that health professionals can recommend to parents. Researchers

should employ methods to co-create apps with parents to increase the uptake of evidence-based apps among parents.

Footnote

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