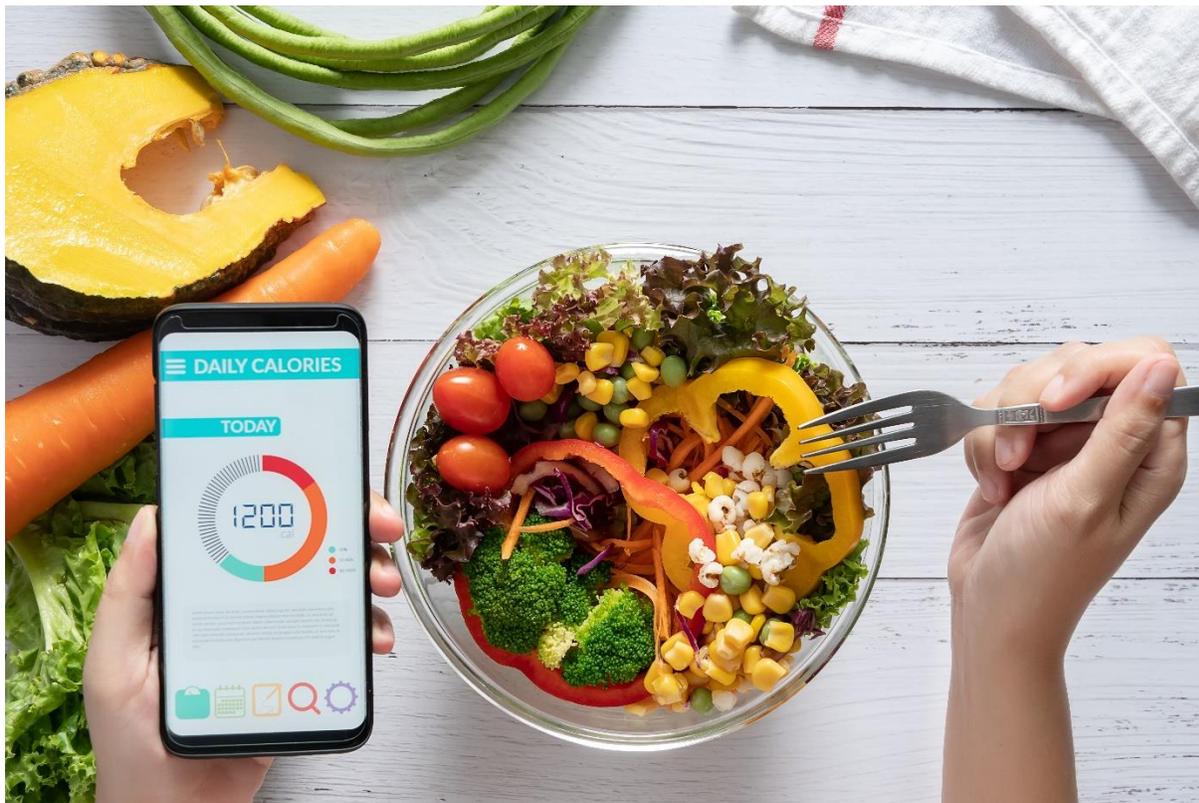


EVIDENCE BRIEF

Effectiveness of eHealth Interventions to Promote Breastfeeding and Healthy Eating for Children



April, 2021

Key Messages

- eHealth and virtual public health service delivery has become increasingly commonplace during the COVID-19 pandemic. As a result, there is a need to determine best practices for evidence-based eHealth interventions. We conducted an umbrella review of eHealth interventions for healthy eating, focused on children, and breastfeeding.
- eHealth interventions ranged from internet, computer, or mobile interventions, and included websites, programs, applications, email, videos, CD-ROMs, games, telehealth, short message service (SMS), and social media, or a combination of multiple communication tools.

- Due to heterogeneity of eHealth interventions, duration of intervention and follow-up, comparison groups, and outcomes measured, the effectiveness of these interventions remains unclear.
- The effect of eHealth interventions on breastfeeding and other diet outcomes in children is small and inconsistent. There is evidence that eHealth interventions involving web-based technologies and targeted client communication with mobile devices improved breastfeeding outcomes. Nutrition (non-breastfeeding) eHealth interventions through the internet, computers, and mobile devices, seemed to be most promising for improving fruit and vegetable intake, however many reviews found mixed results.
- In light of the adoption of virtual service delivery for healthy eating and breastfeeding supports by public health units, evaluation of these services and opportunities for practice-based research would be a valuable contribution to the current gaps in evidence in this area.

Issue and Research Question

Poor nutrition, especially in early childhood, is a leading risk factor in the development of non-communicable diseases, such as cardiovascular disease, cancer, stroke, and diabetes.¹ In 2016, research identified that 12% of all deaths in Canada could be traced back to a poor diet.² Breastfeeding is the unequalled method of feeding infants in the first six months of life and provides short- and long-term positive outcomes.^{3,4} However, despite decades of international breastfeeding promotion, education and interventions,⁵ rates of exclusive breastfeeding and breastfeeding duration in Canada remain low.^{6,7}

Novel approaches to improve nutrition in children and breastfeeding are critical,⁸ and digital technologies are increasingly recognized for their potential role in strengthening the public health system.² Although in-clinic individual counselling is a universally accepted and evidence-based approach to deliver lifestyle and nutrition interventions,⁸ the rise of digital health interventions and virtual service delivery, particularly during the COVID-19 pandemic, has made public health practitioners question if this a promising avenue for public health interventions post-pandemic. On-demand nutrition information has previously been available for consumers and health professionals through online and telephone platforms via EatRight Ontario, however, this service was discontinued in 2018 when funding ceased.⁹ Infant and child feeding inquiries were among the most popular topics inquired on to EatRight Ontario by consumers.⁹

‘Digital health interventions’ is an umbrella term frequently used to describe a range of digital technologies used to address various health related needs. Digital health technologies include things such as computer and mobile applications, telehealth, and electronic medical records systems.² The term digital health stems from eHealth, which is broadly defined as “the use of information communications technology in support of health and health-related fields.”^{2 (p. 9)} Mobile health, or mHealth, is an element of eHealth which focuses solely on mobile technology and is defined as “the use of mobile wireless technologies for public health.”^{2 (p. 9)} The term eHealth will be used to encompass all types of digital health interventions in this review.

Compared to conventional clinic-based educational approaches, the effectiveness of eHealth interventions to improve diet and lifestyle has not been well established, particularly for children.⁸ Over the last few years, there has been a growing interest and demand in the use of modern technologies, such as internet and mobile applications, for healthcare and public health interventions (e.g., Apple Health, MyFitnessPal, Nike Run Club, Health Canada COVID alert app, breastfeeding support, and

healthy eating programs).⁸ These technologies provide an opportunity to increase the reach of interventions as well as reduce costs, resources, and efforts required to produce or deliver programming.^{2,8} High adoption rates of technology among all age groups also provides an opportunity for a greater influence among peers and social networks.¹⁰ Additionally, technology allows for educational opportunities during an individual's free time, enabling more autonomy and privacy during the learning process.^{1,11}

The emergence of the COVID-19 pandemic has facilitated a rapid shift towards virtual work, sparking the need for public health to re-examine the ways to engage with communities and target populations. For many, virtual work will likely become commonplace, even well after the pandemic is over. As a result, there is a need to explore the literature to determine best practices for evidence-based eHealth interventions.

The primary aim of this evidence brief is to examine the effectiveness of eHealth interventions on dietary outcomes (including breastfeeding), compared to status-quo interventions (e.g., conventional in-person programming or non-digital supports) in children. In addition, evidence on features of eHealth interventions that are most effective at promoting breastfeeding and healthy eating will be described.

Methods

A literature search was conducted November 2020 by PHO Library Services for articles published between 2015 and the search date. The search involved 8 databases: Ovid MEDLINE, PsycINFO, Global Health, CINAHL, SocINDEX, AgeLine, Child Development and Adolescent Studies, and Scopus. The following search terms were included, but were not limited to: digital interventions, telehealth, telemedicine, videoconferencing, social media, apps, health promotion, public health, preventive health services, breastfeeding initiation, breastfeeding duration, exclusive breastfeeding, diet, food, eating, and nutrition. References from the included articles were hand searched for additional relevant studies. A forward search of relevant review protocols was completed in December 2020 to identify published results. The full search strategy is available upon request from Public Health Ontario.

Articles were eligible for inclusion if they: were systematic reviews, assessed eHealth interventions on dietary outcomes as the primary outcomes (including breastfeeding), quantified effects of eHealth interventions, were human studies, were aimed at pregnant or postpartum individuals, children under 18 years, or reported separate results for children, and were published in English. A variety of eHealth interventions as a proxy for face-to-face practitioner interventions were included such as telehealth, applications (apps) and short message services (SMS) on mobile devices, internet, social media, computer programs, and video games.¹² Reviews were excluded if they focused on in-person/face-to-face interventions, or mixed in-person or print with eHealth intervention outcomes, assessed adults and children together, focused on adult populations only, reported only on intervention design rather than effects, or were scoping reviews. Primary outcomes were effect on breastfeeding (initiation, duration, exclusivity) and food and nutrition behaviours, knowledge, and attitudes. Secondary outcomes were effects by behavioural change theory/technique.

Three reviewers independently screened titles and abstracts with 20% of results double screened to ensure high inter-rater agreement. Full text articles were retrieved, and reviewed by two reviewers, confirmed by a third. Consensus on included studies was achieved through discussion. Relevant findings were extracted from each article for breastfeeding and diet outcomes separately by two reviewers.

Quality appraisal was completed on all included articles, with a subsample of reviews completed by two independent reviewers to test inter-rater reliability. The AMSTAR II was used to assess the quality of systematic reviews. No discrepancies in quality appraisal between the reviewers were identified. More information on quality appraisal is available upon request.

Main Findings

The search identified 1,178 articles, from which 101 were selected for full-text review and 17 articles met the inclusion criteria. The search identified nine reviews examining eHealth interventions to improve breastfeeding outcomes in pregnant and postpartum women. After full-text review and quality appraisal, three of the reviews were excluded for inappropriate interventions; one was a mass media education intervention in low- and middle-income countries,¹³ and two used telephone voice calls only.^{14,15} Of the remaining 92 articles reviewed for nutrition interventions and outcomes, 18 were excluded due to study design, seven for non-digital or mixed digital and non-digital interventions, 33 for lacking any or detailed nutrition outcomes, and one for interventions included in another review. Twenty-three reviews were relevant to the research question but were adult focused and thus were excluded. Search results are presented in a PRISMA diagram in Appendix A.

Six studies were included that examined the effect of eHealth interventions on breastfeeding outcomes,¹⁶⁻²¹ and 11 reviews examined impacts of eHealth interventions on dietary outcomes in children and youth.^{12,22-31} Four reviews included meta-analyses.^{12,17,22,24} One review was high quality,¹⁶ eight reviews were of moderate quality,^{12,17,22,25-28,31} one was of low quality,²⁹ and seven were critically low quality.^{18-20,23,24,30 21}

Interventions ranged from internet, computer, or mobile interventions, and included websites, programs, applications, email, videos, CD-ROMs, games, short message service (SMS), telehealth, and social media.

Breastfeeding Digital Health Interventions

Six reviews on eHealth interventions to improve breastfeeding outcomes were included in this review. One study was high quality,¹⁶ one was moderate¹⁷ and four were critically low quality.¹⁸⁻²¹ The study settings included both high income countries (United States (US), France, Spain, Finland, Canada, Ireland, Australia, United Kingdom (UK), and Sweden) as well as low- and middle-income countries (Kenya, Ecuador, Iran, Taiwan, China, Nigeria, Bangladesh, Thailand, and the Philippines). The breastfeeding outcomes that were examined were exclusive breastfeeding (four weeks, three months, up to six months), breastfeeding initiation, intention, attitudes, knowledge, support, education, self-efficacy, coping, confidence, and promotion/encouragement. Although many studies demonstrated improved breastfeeding knowledge and education there were fewer studies that measured key breastfeeding outcomes (initiation, exclusivity, and duration) and showed effective results.

INTERVENTION CHARACTERISTICS

There were multiple modalities used to deliver eHealth interventions, also often referred to as information and communication technology (ICT)^{18,20} including mobile devices (e.g., SMS, videoconferencing, apps), web-based/internet-based platforms (e.g., social media, online social networks or discussion boards), computer-based (e.g., compact disc read-only memory (CD-ROMs), visual interactive computer agent via computer kiosk), or a combination of multiple communication tools. eHealth interventions involving telehealth or telemedicine (henceforth referred to as telehealth)

were also included. Telehealth is defined as “various types of health care when patient and provider are geographically separated – it can involve videoconferencing, telephone calls, electronic data transmission, and other ways of communicating over the Internet.”^{32 (p. 1)} eHealth interventions were defined as either synchronous - information was shared and received in real time (e.g., videoconferencing), often more personalized, or asynchronous - information exchanged offline as in automated text messages or pre-recorded voice messages.²⁰ Interventions for breastfeeding support were provided by nurses, lactation consultants and other health professionals. Many eHealth interventions for breastfeeding education digitized existing knowledge into static learning modules with multimedia to aid explanation. The most commonly used systems were direct client communication with web-based technologies, mobile apps, and SMS as the most used platforms.¹⁸ There were a few mobile phone apps that helped mothers track breastfeeding and pumping logs to provide personalized feeding and pumping volume control.¹⁹ Only one review reported whether each study had specified a theoretical framework or behaviour change theory to guide their intervention logic.¹⁹ Most eHealth breastfeeding interventions were designed to support pregnant individuals and those in the postnatal period.

IMPACT OF EHEALTH INTERVENTIONS BY MODALITY

MOBILE

There was conflicting evidence about the use of mobile apps on breastfeeding outcomes. One high quality Cochrane review found targeted client communication via mobile devices (TCCMD) increased rates of exclusive breastfeeding at three months (risk ratio (RR) 1.30, 95% Confidence Interval (CI) 1.06 to 1.59) compared to standard of care in settings where exclusive breastfeeding is less prevalent, based on one study. In countries where breastfeeding rates were high (low- and middle-income countries) there was little to no effect. Compared to non-digital targeted client communication (TCC), such as pamphlets, there was no significant effect of TCCMD (RR 0.92, 95% CI 0.79 to 1.07).¹⁶ Almohanna, Win & Meedya reported participants receiving interactive guides to resolve breastfeeding problems delivered via mobile apps had longer breastfeeding durations compared to usual care.¹⁹ However, in another review asynchronous support text messages sent in the pre- and postnatal period did not have a significant impact on breastfeeding status (odds ratio (OR) 1.26, 95% CI 0.54–2.66).²⁰ Monitoring and breastfeeding tracking apps were least effective in improving breastfeeding outcomes.¹⁹ Participants in these studies had high prenatal breastfeeding intention rates, which is consistent with Canadian women.⁷

INTERNET

Four reviews included internet-based interventions, which mainly reported improved breastfeeding outcomes.¹⁷⁻²⁰ In the meta-analysis, internet-based interventions improved exclusive breastfeeding initiation (RR 1.76, 95% CI 1.54-2.01, N=2 studies) but did not have any significant effect on exclusive breastfeeding duration at six weeks (RR 1.01 95% 0.88-1.17, N=2 studies).¹⁷ Although Lau et al., included 16 studies with a total of 5,505 perinatal women the pooled results only had seven studies for breastfeeding initiation, two studies for exclusivity at four weeks and three studies for exclusivity at six months and, due to heterogeneity, the meta-analyses were conducted in small subgroups. In 11 web-based breastfeeding interventions using a combination of education and focused support, eight demonstrated improvements in breastfeeding knowledge and exclusive breastfeeding at six weeks.¹⁹ Two reviews included studies examining an internet-based breastfeeding diary intervention, designed to record breastfeeding data and used data monitoring strategies to promote breastfeeding which showed significant improvements on breastfeeding duration and exclusivity at three months.^{18,19} However, some

of these studies that showed significantly improved rates only included the period during the hospital stay and measured exclusive breastfeeding at discharge. One intervention used lactation consultants to monitor and facilitate an online discussion board to encourage mothers to maintain breastfeeding which showed improved rates of exclusive breastfeeding and duration.¹⁹ Similarly, there was some evidence of higher rates of exclusive breastfeeding in an intervention group using an online interactive system of breastfeeding monitoring; 84% exclusive breastfeeding at three months compared to 66% in the control group.²⁰ Overall, internet-based interventions had positive effects on short-term breastfeeding outcomes, however no studies reported significant effects for longer durations of any or exclusive breastfeeding.

COMPUTER

Two reviews reported on studies that investigated the use of CD-ROM-based programs for breastfeeding mothers.^{17,18} In the meta-analysis, eHealth interventions using e-prompts, CD-ROM and other web-based modalities grouped together moderately improved exclusive breastfeeding initiation (RR 1.11 95% CI 1.03-1.19, N=4 studies).¹⁷ However, the CD-ROM study on its own did not significantly improve breastfeeding knowledge or rates after a one month follow up.¹⁸ There was insufficient data for a meta-analysis, but an interactive computer agent intervention resulted in improved breastfeeding attitudes and knowledge for antenatal women during their hospital stay which was reported by both reviews.^{17,18} Despite some significant effects in the meta-analysis, technology has evolved past the common use of non-portable devices or CD-ROMs.

TELEHEALTH

Four reviews described studies examining multiple eHealth interventions which provided access to a certified lactation consultant through telehealth support (also referred to as telelactation support), text message, email, online discussion boards and videoconferencing or using a webcam to address concerns or questions about breastfeeding.^{17,18,20,21} One review identified six studies that examined telehealth interventions on breastfeeding exclusivity and duration and found the majority of studies (N=5) reported improved exclusive breastfeeding and longer breastfeeding duration.²¹ However, Lau et al., reported visual consultation did not improve exclusive breastfeeding initiation or duration at six weeks, although this was based on one primary study.¹⁷ Tang included three studies that facilitated communication between lactation consultants and mothers with limited access to maternal care through telehealth. However, the studies were small and heterogeneous therefore were unable to report any effect on breastfeeding outcomes.¹⁸ Finally, Ferros dos Santos and colleagues included five videoconferencing interventions however most of the studies examined feasibility, acceptability, and experiences of clients and providers, which were generally positive, but no breastfeeding outcomes that corresponded to the telehealth interventions.²⁰

Nutrition eHealth Interventions

Fruit and vegetable intake was the most commonly assessed outcome, followed by intake of fat and sugar-sweetened beverages. Other dietary outcomes included intake of fast food, junk food, eating behaviours, nutrition knowledge, and healthy eating self-efficacy, however these outcomes were rarely evaluated. Most reviews simply presented the overall impact of eHealth interventions on diet, as sub-analyses by outcome were usually not possible due to insufficient evidence.

The reviews included children between the ages of seven and 19 years. One review focused on parents of children aged one to early adolescents.³¹ Two reviews reported findings for children and adults.^{12,23} Rodriguez et al. provided separate overall results by age group, but results by digital platform were

analyzed across all ages collectively. Chau included adolescents and young adults (up to age 25 years); although results were not presented separately for adolescents, this review was retained as it was the only review that focused solely on social media. Sociodemographics of the participants varied within and between reviews by sex, income, ethnicity, and weight status.

INTERVENTION CHARACTERISTICS

Only two reviews looked at a single digital modality: Mack²⁷ assessed gaming interventions, and Chau²³ assessed social media interventions. All other reviews included at least two eHealth intervention types. Definitions of eHealth interventions were rarely clear in reviews and thus may be inconsistent across reviews. Internet- and computer-based interventions were most commonly reported on; mobile interventions were less common. Findings are presented as overall impacts of eHealth interventions collectively, unless results were available separately by intervention type. Most reviews included studies where the eHealth intervention was one component of a larger intervention,^{22-26,28-31} with Darling³⁰ and Hsu²⁶ stating that some interventions reviewed also included face-to-face components.

All interventions focused on improving food and nutrition behaviours or knowledge. One review explicitly stated a focus on attributes of food literacy.³⁰ Champion et al.²² and Tallon et al.²⁹ focused on school-based eHealth interventions. Interventions recruited participants and/or were delivered in a variety of settings, with schools being the most common.^{12,22,25,26,29,30} Other settings included the community,^{12,26} camps,³⁰ clinics,^{12,26} and supermarkets.¹²

The dose and duration of eHealth interventions ranged from a single exposure to multiple sessions over one or two years, or a certain amount of content to be completed over a defined time period. Most outcomes were evaluated immediately after the interventions, with few reviews reporting on effects at medium (e.g., two month) or long (e.g., two year) follow-ups.^{22,23,26,27,29} Study comparison groups ranged from no intervention, non-nutrition digital interventions (e.g., website on physical activity), non-digital nutrition interventions (e.g., print healthy eating information; usual nutrition education), and in-person interventions, and were often mixed within reviews.

Six reviews discussed the use of theories or frameworks to inform the interventions. The majority of studies in these reviews used some theory or framework (ranged from 58% to 100% of studies within reviews). The most commonly mentioned theories included: social cognitive theory,^{12,23,25,26} and transtheoretical model (stages of change).^{12,22,23,25,26} Other theories mentioned included: theory of planned behaviour;^{22,25,26} theory of reasoned action;^{22,25} social learning theory,^{25,26} and self-determination theory.²⁶ Hsu et al. also reported on studies that used of transcontextual model of motivation, attitude, social influence, and self-efficacy model, and a public health promotion model in social media interventions.²⁶

A variety of behaviour change techniques (BCT) were incorporated into digital interventions evaluated in the reviews. Rodriguez et al. identified 20 unique BCT used across 19 studies; a mean of four BCT (range: 1-7) were used. Instruction or education was reported as being used by the majority of interventions in three.^{12,26,28,31} Other common BCT incorporated into interventions included personalized feedback,^{12,22,26,31} goal-setting,^{12,22,26,28,31} tailoring interventions to individuals,¹² and self-monitoring.^{22,24,28,31} Social support,²⁶ rewards and incentives,²⁶ and parental/family involvement,²² were mentioned in single reviews.

IMPACT OF EHEALTH INTERVENTIONS BY MODALITY

Many reviews highlighted the promise of eHealth interventions to improve diets, however, the wealth of evidence on its impacts on dietary outcomes in children remains inconclusive. Tallon et al.²⁹ and Wickham and Carbone³⁰ both reported that all studies reported at least one positive result in favour of the intervention, however, the findings were mixed when collated across studies. Do Amaral e Melo et al.²⁵, Zarnowieski et al.³¹ and Rose et al.²⁸ also reported a mix of positive, null, and negative impacts of digital interventions across studies reviewed. Rodriguez et al. reported that eHealth interventions were effective in improving fruit and vegetable intake in adolescents (effect size=0.26, SE=0.06, 95% CI 0.14, 0.38, p<0.001) but not children (effect size=0.11, SE=0.11, 95%CI and p-value not reported); no other dietary outcomes were assessed.¹² In studies that evaluated maintenance of eHealth intervention effects, positive results seen from immediate impacts of interventions were generally not sustained over time.^{12,22,25,28,29}

INTERNET

Seven reviews included internet-based interventions,^{12,22,26,28,30,31} which may or may not include websites, social media, or email, for example. Internet-based interventions made up approximately half to most (88%)^{30,31} or all (100%)^{22,26,28} of interventions evaluated in these reviews.

Meta-analyses by Rodriguez et al.¹² and Champion et al.²² found small significant impacts of internet-based interventions. Rodriguez et al. reported an effect size of 0.19 (SE=0.05, 95%CI 0.09, 0.29, p<0.001) on fruit and vegetable intake across ten internet-based interventions for adults, adolescents, and children (assessed together).¹² Champion et al.²² reported a standard mean difference of 0.11 (95%CI 0.03, 0.19, p=0.007) of eHealth interventions (14 internet; two CD-rom) delivered in schools on mean servings of fruit and vegetable per day of 11-18 year olds, however this effect was not sustained at two to 36 week follow-ups. Positive impacts of eHealth interventions (where the majority were internet-based) on fruit and vegetable intake were also reported by Zarnowiecki et al.³¹ and Hsu et al.²⁶ however, results were inconsistent across all studies in these reviews.

Hsu et al. also reported mixed results for other outcomes (intake of sugar-sweetened beverages, junk food, fast food, breakfast intake, and calcium intake) which were usually evaluated in only a few studies.²⁶ Champion et al. found no effect on fat or sugar-sweetened beverage intake in 11 to 18 year olds from meta-analyses with three studies each.²² Websites (n=7) and apps (n=1) geared towards using parents as agents of change for children's nutrition were found to have positive impacts on parents' and children's knowledge, attitudes, and feeding practices, but had mixed findings on dietary intake.³¹ Wickham and Carbone reported mixed findings of eHealth interventions used for adolescent food literacy programming (88% were internet-based) on nutrition knowledge, attitudes (e.g., self-efficacy), skills (e.g., planning), and intake (including fruit and vegetable intake).³⁰ Finally, Rose et al. found that only three of ten website interventions had significant improvements in diet, while the remaining seven reported null or inconclusive findings.²⁸

COMPUTER

Only one review evaluated the impact of computer-based interventions separate from other modalities.¹² Rodriguez et al. found that computer-based interventions produced the largest effect size (ES=0.44, p<0.001, 95%CI not reported) on fruit and vegetable intake from six interventions on adults, adolescents, and children (assessed together). Tallon et al. included 12 computer-based interventions (programs, games, websites, email) and one mobile phone intervention and found mixed results for nutrition knowledge and dietary changes for 12 to 18 year olds.²⁹ Rodriguez and Rocha evaluated the

impact of computer-based interventions from three studies and found a moderate effect size on fruit and vegetable intake, however no study in the meta-analysis included children or adolescents.¹²

Findings on internet-based eHealth interventions indicated above^{25,29} may be relevant in this section (and vice versa) as Do Amaral e Melo et al.,²⁵ and Tallon et al.²⁹ reported aggregate findings of eHealth interventions which included some computer-based interventions.

MOBILE

From three interventions included in a meta-analysis, Rodriguez et al. found that SMS interventions had a moderate impact on fruit and vegetable intake (ES=0.41, SE, 0.1, 95%CI (0.21, 0.63), $p < 0.01$) for adults, adolescents, and children (all ages assessed together).¹² Darling and Sato evaluated mobile interventions (three SMS interventions; four interventions designed for smartphones or handheld devices) that included self-monitoring of behaviours.²⁴ This critically low quality review found a very small effect on fruit and vegetable and sugar-sweetened beverage intake (assessed together) ($d = 0.10$, 95%CI: 0.002-0.024) in overweight and obese children.²⁴ Darling and Sato concluded that the true effect of mobile interventions with self-monitoring was difficult to determine as few studies were randomized controlled trials.²⁴ Rose included only one study that evaluated SMS on diet and found that there was no impact on fruit and vegetable intake compared to a control condition.²⁸ Other reviews included one or two mobile interventions in their overall assessments,^{25,31} but results specific to mobile interventions could not be extracted.

GAMING

One review studied the impacts of 21 digital gaming interventions on nutrition outcomes.²⁷ Mack et al. stated that the majority of studies reported improvements in nutrition knowledge, eating habits (including fruits and vegetables, fat, and sugar), and attitudes (e.g., intentions, self-efficacy).²⁷ Reported effect sizes were small to large across a subsample of six studies. Rose et al. reported on one game-based intervention which found positive impacts on fruit and vegetable intake, however the impacts on other dietary outcomes were unclear.²⁸ Rodriguez et al. assessed gamified interventions on CD-roms, mobile apps, and video games but reported that there was no statistically significant effect on fruit and vegetable intake for adults, adolescents, and children (assessed together).¹² Wickham and Carbone included eight randomized controlled trials with gaming elements (plus two non-controlled intervention studies) and reported mixed findings across all reviews, as mentioned earlier.³⁰ Do Amaral e Melo et al. included four computer games, but did not report results separately.²⁵

SOCIAL MEDIA

Only one critically low review reported that eight out of 16 studies found at least one positive impact of social media interventions on dietary outcomes,²³ however it is unclear whether results were consistent across studies. Intakes of fruits and vegetables were most commonly reported, followed by sugar-sweetened beverage intakes. The authors note that social media interventions were highly heterogeneous, often with various behavioural change techniques and/or as a component of a multi-component intervention thus the impact of social media itself is difficult to determine.²³

IMPACTS OF EHEALTH INTERVENTIONS BY BCT

Rodriguez et al. concluded that eHealth interventions that incorporated seven or eight BCTs had larger effects (ES=0.42, SE=0.1, 95%CI 0.21, 0.62, $p < 0.001$) than eHealth interventions that used fewer techniques on improving fruit and vegetable intake in adults, adolescents, and children.¹² However,

Rodriguez et al. did not find any difference in the effectiveness of eHealth interventions on fruit and vegetable intake by the five common BCTs: instruction, feedback, goal setting, identify barriers, and explain consequences of behaviour. Interventions that were tailored (ES=0.27 (SE=0.05, 95%CI 0.16, 0.37, p<0.001) and non-tailored (ES=0.22 (SE=0.11, 95%CI 0.00, 0.44 p=0.05)) were both effective; no significant difference in effectiveness was found between tailored and non-tailored eHealth interventions.¹² Rose et al. reported that significant improvements in at least one diet outcome were found more often in eHealth interventions that included goal setting; eHealth interventions that included self-monitoring techniques were said to be more effective if they also included goal setting.²⁸

Do Amaral e Melo et al. stated in their discussion that all studies that used the social cognitive theory showed immediate significant positive outcomes, but could not conclude that the impacts were due to the use of this theory.²⁵ Similarly, Champion et al. stated that better outcomes were found when interventions were guided by the transtheoretical model and provided personalized feedback to students, although this was not analyzed in the review.²²

Discussion and Conclusions

A substantial body of evidence exists on nutrition and breastfeeding eHealth interventions as evidenced by 17 systematic reviews. There was significant heterogeneity between reviews and across studies included in the reviews in terms of the types of eHealth interventions included, intervention duration, follow-up evaluations, comparison groups, and dietary outcomes. As a result, the evidence is unclear and inconsistent. There were also important differences between the types of eHealth Interventions targeting breastfeeding-related outcomes as opposed to general nutrition-related outcomes for children and adolescents. Specifically, eHealth interventions to support breastfeeding were more aligned to current telehealth services that could provide real-time, synchronistic, problem-solving services. Non-breastfeeding nutrition eHealth interventions were mainly non-telehealth, featuring a variety of modalities used by children (only one study targeted parents). These included internet websites, online communication, mobile apps, computer programs and games or a combination thereof (although details on interventions were poorly described across reviews).

For breastfeeding outcomes, eHealth interventions with interactive, tailored, and personalized feedback led to more positive breastfeeding outcomes. There was some evidence that increased connectivity, and two-way communication provided by lactation consultants may provide enhanced breastfeeding knowledge and engagement which may therefore improve breastfeeding duration. There was little evidence to support virtual breastfeeding interventions through videoconferencing. Most digital interventions included in this review did not provide practical breastfeeding skills that affect some key breastfeeding problems such as the perception of milk supply and physical comfort.¹⁸ New technologies or eHealth interventions could use cross-platform interventions with multiple elements (an education component via an app with a practical support communication channel, via FaceTime, Skype, or Zoom).

For other dietary outcomes, most reviews made conclusions based on the relative number of studies with positive and/or statistically significant results in favour of the intervention. Few reviews meta-analyzed studies to estimate effect sizes. Nutrition eHealth interventions for seemed to be most promising for improving fruit and vegetable intake, however many reviews found mixed results. For example, the moderate quality review by Rodriguez Rocha which focused solely on vegetable and fruit intake found a small impact in adolescents but not children.¹² There is limited evidence on the impact of nutrition eHealth interventions on other dietary outcomes, including nutrient intake, food and nutrition knowledge, attitudes, and skills.

Effects versus Usual Care

Observed positive effects of eHealth interventions on dietary outcomes were small to medium^{12,22,24} and comparable to effect sizes of traditional nutrition interventions for children.^{33,34} Fewer than one-third of effect sizes published in a review of various childhood nutrition interventions, such as nutrition education, food provision, and food environment and policy changes undertaken by families, schools, and childcare, were above 0.2ⁱ and statistically significant.³⁴ A meta-analysis of school-based nutrition education interventions showed small to medium effect sizes (between 0.14 and 0.40) on various outcomes including fruit and vegetable intake, sugar intake, energy intake, and nutrition knowledge.³³ Thus, it may be only reasonable to expect eHealth interventions to generate comparable effect sizes to conventional nutrition education interventions. eHealth interventions appeared to improve dietary outcomes immediately after the intervention but were not well maintained over time. The long-term success of both traditional³⁴⁻³⁶ and digital^{12,22,25,27,37} nutrition interventions is not well studied.

Digital Modality

It is unclear whether certain types of eHealth interventions are more effective than others as most studies did not compare individual types and many interventions were multi-component. Often multiple eHealth intervention types were assessed collectively in reviews making it impossible to distill impacts by digital modality as well as separate the effect resulting from digital aspects from other aspects of the intervention.^{23,29,30} Even when eHealth interventions were assessed independently, inconsistency between reviews impedes evaluating the strength of evidence. For example, a website may have been counted as an internet-based intervention in one review and a computer-based intervention in another; a mobile application may be counted as a mobile-based intervention or a gaming intervention.

Behaviour Change Theory

Consistent with this review, nutrition interventions are commonly informed by theory.³⁴ There is a large collection of behavioural theories and techniques that can be applied in nutrition interventions. For example, Abraham and Michie (2009) have a list of 26 behavioural change techniques reflecting the constructs of behavioural theory³⁸ that can be used to design interventions which can be used to categorize digital nutrition interventions designs.³⁹ Although the evidence was limited, the use of behavioural change theories and techniques appeared to be important in increasing the effectiveness of eHealth interventions, at least for diet.^{12,22,25} This is consistent with a review of characteristics of effective online nutrition interventions.³⁷ This may be in contrast to in-person interventions, as Murimi et al. also found that theory-based face-to-face nutrition interventions for children aged two to 19 years did not perform any better than those interventions that were not theory-based.⁴⁰ Black et al. also stated that the theoretical basis of family, school, and childcare nutrition interventions delivered in a conventional format was not associated with their effectiveness.³⁴ Murimi et al. suggested that other factors, such as face-to-face parent engagement, trained staff, objectives and activities aligned with specific target behaviours, age-appropriate activities (which included technology-based activities for children in secondary school), supportive environmental and policy changes, and an intervention duration of at least six months with frequent engagement (e.g., weekly) may have been more important than the use of a theory in the designs of childhood nutrition interventions.⁴⁰

ⁱ Effect sizes are interpreted as Small 0.1–0.2, moderate 0.3–0.5, large > or = 0.6. Higgins JPT, Green S, (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration; 2011. Available from: www.handbook.cochrane.org

Specific to eHealth nutrition interventions, Murimi et al. stated that personalized feedback, participant interaction with researchers, duration of at least three months, and objectives and activities aligned with specific target behaviours were factors of successful healthy eating interventions,³⁷ and was supported by results from the breastfeeding interventions. A meta-analysis of mobile apps aimed at improving diets in children under 18 years found that modelling and social support were significant predictors of intervention effect size on dietary outcomes (e.g., fruit and vegetable, nutrient intake); practicing behaviours was a significant predictor of intervention effect size for children but not adolescents.³⁹ The reviews included here describe a mixture of intervention designs with regards to behavioural change theories and techniques. Although best practices for digital intervention have not been established,³⁷ there are many promising options for program and policy makers to consider using to ensure the intervention is well-planned to match users' needs.

Limitations

Limitations in the evidence decrease the certainty with which conclusions can be made about intervention effectiveness across nutrition outcomes, such as breastfeeding,⁴¹ and fruit and vegetable intake.³⁵ Here, conclusions are limited by weaknesses in primary studies in the reviews. First, many reviews included studies with non-randomized controlled trials or quasi-experimental design, cross-sectional studies, and pre-post study designs. Reviews often collectively evaluated poorly described, heterogeneous interventions with various comparison group types and multiple outcomes which limited the ability to aggregate findings across reviews. In general, the included studies had very small sample sizes, often using convenience sampling and sometimes having as few as 10 participants in the intervention group.¹⁹ Effect sizes were rarely published which limits conclusion that could be made about how well digital nutrition interventions work. Although some studies reported significant differences between the intervention and control groups, the rates of breastfeeding duration and exclusivity particularly were still much lower than recommended. Non-comparable comparison groups, lack of intervention details (e.g., dosage), lack of tracking participant engagement, subjective outcome measurement and lack of follow-up were challenges also mentioned by Murimi et al. in their systematic review of digital nutrition interventions.³⁷

Further, the findings of this review are limited by the speed at which technology advances - the current evidence on digital interventions may not have yet sufficiently evaluated digital modalities that are popular today, such as video-conferencing or social media. Nonetheless, the feasibility and effectiveness of digital interventions is valuable to explore as they may have benefits in terms of population reach or cost-effectiveness.³⁷

Implications for Practice

Many questions remain with regard to best practices to implement eHealth interventions. The evidence reviewed did not yield information on digital accessibility, acceptability, and usability by participants, intervention logistics (e.g., how to get food and cooking equipment to participants in a remote cooking program), participant engagement, privacy and security, nor cost-effectiveness.²⁸ Further, the 'scale-up penalty' of adopting interventions must be considered as the effects seen in randomized controlled trials may not be yielded to the same extent in real-life implementation.⁴² Nutrition interventions, including eHealth interventions, should be carefully designed and implemented^{33,34} and contribute to a series of supporting interventions for healthy eating and healthy growth and development.^{34,40,43}

Decision makers should also be aware that a 'digital divide' still exists in some Ontario and Canadian communities where digital access may not be equitable across all populations.⁴⁴ Clients with low

socioeconomic status or individuals in rural or remote Ontario where cellular and internet service is limited may not be able to use eHealth services. Even if the majority of clients have mobile devices, they may not have data plans that some apps require. Moving forward with any eHealth interventions should also be accompanied by a Health Equity Impact Assessment.⁴⁵

In this digital revolution impelled by the COVID-19 pandemic, public health practitioners are seeking new ways to do their work. As this review described, the effect of eHealth interventions on breastfeeding and other diet outcomes is small and inconsistent. There is an argument to maintain established effective non-digital public health interventions. Nevertheless, digital adaptations or additions to these interventions based on behaviour change theory and techniques may be considered, but ongoing evaluation is necessary to make sure it works. Critical robust evaluation of adopted eHealth interventions during and after the COVID-19 is imperative to establishing practice-based research to advance public health research and practice.⁴⁶

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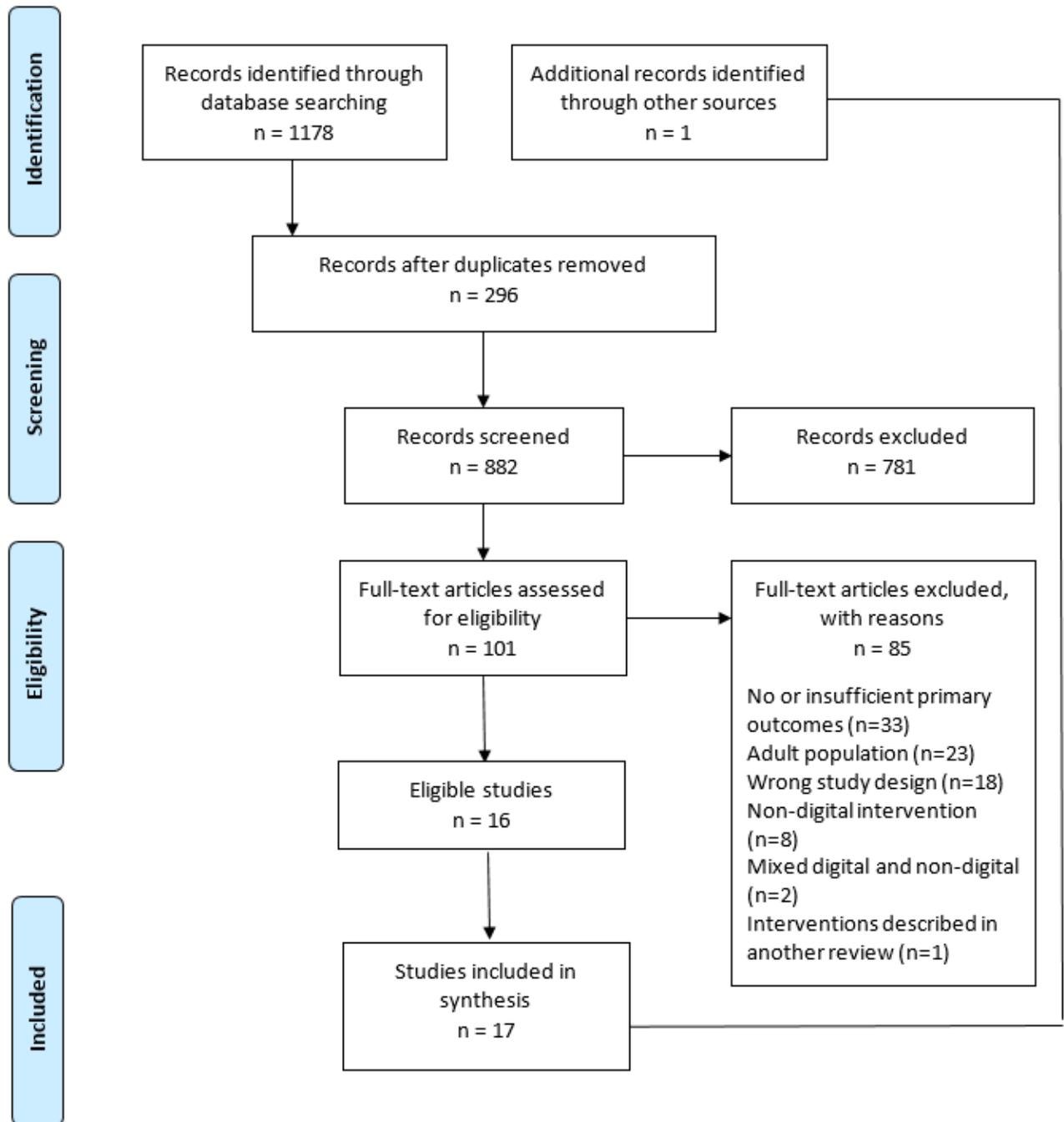
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Appendix A: PRISMA Diagram



Specifications and Limitations of Evidence Brief

The purpose of this Evidence Brief is to investigate a research question in a timely manner to help inform decision making. The Evidence Brief presents key findings, based on a systematic search of the best available evidence near the time of publication, as well as systematic screening and extraction of the data from that evidence. It does not report the same level of detail as a full systematic review. Every attempt has been made to incorporate the highest level of evidence on the topic. There may be relevant individual studies that are not included; however, it is important to consider at the time of use of this brief whether individual studies would alter the conclusions drawn from the document.

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