Process evaluations of early childhood obesity prevention interventions delivered via telephone or text messages: a systematic review

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Abstract

Background: Increasingly, public health interventions are delivered via telephone and/or text messages. Recent systematic reviews of early childhood obesity prevention interventions have not adequately reported on the way interventions are delivered and the experiences/perceptions of stakeholders. We aimed to summarise the literature in early childhood obesity prevention interventions delivered via telephone or text messages for evidence of application of process evaluation primarily to evaluate stakeholders’ acceptability of interventions.

Methods: A systematic search of major electronic databases was carried out using the Population, Intervention, Comparison, Outcomes framework. Studies were included if interventions were delivered via telephone/text messages; aimed at changing caregivers’ behaviours to prevent early childhood obesity; with one or more outcomes related to early obesity risk factors such as breastfeeding, solid feeding, tummy time, sleep and settling, physical activity and screen time; published from inception to May 2020. All eligible studies were independently assessed by two reviewers using the Cochrane Collaboration tool for assessing risk of bias. Qualitative studies were assessed using the Consolidated Criteria for Reporting Qualitative Research and Standards for Reporting Qualitative Research tools.

Results: Twenty-four studies were eligible, and the overall risk of bias was low. Eight studies (33%) had evidence of process evaluation that examined participants’ perceptions of interventions. Participants appreciated the convenience of receiving interventions via telephone or text messages. 63% of all studies in this review showed improvement in one or more behaviours related to childhood obesity prevention. Participants were likely to modify behaviours if they received information from a credible source such as from health professionals.

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Conclusion: There is limited reporting of stakeholders’ experiences in early obesity prevention studies delivered by telephone or text messages. Only one-third of studies examined participants’ acceptability and the potential for delivery of childhood obesity prevention interventions conveniently using this mode of delivery. Interventions delivered remotely via telephone or text messages have the potential to reach equal or a greater number of participants than those delivered via face-to-face methods. Future research should build in process evaluation alongside effectiveness measurements to provide important insight into intervention reach, acceptability and to inform scale up.

Trial registration: PROSPERO registration: CRD42019108658

Keywords: Childhood obesity prevention, Telephone, Text messages, SMS, Apps, Antenatal/postnatal women, Caregivers, Systematic review, Early childhood, Process evaluation

Background
The high prevalence of obesity is recognised world-wide, with an increasing interest in the prevention of obesity in the early years, from pre-birth up to and including 5 years of children’s age. Early childhood obesity prevention has gained momentum during the last decade, with a focus on children’s primary caregivers, mothers in most instances, as key agents to whom interventions are delivered [1–4]. Early prevention studies have utilised existing platforms such as mothers’/parents’ groups [3], child health clinics [4] and post-birth follow-up home visits by nurses [2] to deliver key messages to caregivers.

There has been an exponential growth of mobile phone ownership and its use globally, both in developed and developing countries alike [5, 6]. In Australia alone, an estimated 92% over the age of 18 used a mobile phone in 2012, additionally over half of those aged 25–34 were mobile-only phone users [7]. Public health and health promotion researchers have harnessed the increased dependability on mobile phones to deliver interventions via telephone and/or text messages [8, 9]. Crucially, this mode of delivery was welcomed for its cost-effectiveness [10], ability to reach wider population [11] and its acceptability to those receiving the interventions [12].

Population-wide increases in communication via telephone and/or text messages has led to growth in the number of interventions delivered using these modes in clinical care, public health and health promotion. Earlier examples have included text messages to patients to send medical appointment reminders [13], text messages for routine chronic disease management [14, 15], and telephone calls for mental health management [16]. There has also been extensive use of telephone calls and/or text messages by public health and health promotion researchers to communicate health promotion messages and public health interventions [17, 18]. Similarly, there has been a growth in the number of studies using mobile phones to communicate key messages to new caregivers and women with young children [1, 19, 20].

To date, findings of systematic reviews of telephone and text message support have suggested improved outcomes among several groups: in pregnant women and new mothers who received telephone support for smoking, breastfeeding, birthweight and postpartum depression [21]; in adults who received telephone-delivered interventions for physical activity and dietary outcomes [22]; in pregnant women who received telephone support for depression and breastfeeding during pregnancy and post-birth [23]; and in adolescents who received text message interventions for physical activity and sedentary behaviours [24]. Interventions for childhood obesity prevention or behaviour change delivered via telephone or text messages and their effectiveness have been established and reported, however process evaluation among study participants as well as stakeholders is often less well reported [25, 26].

In this systematic review, we aimed to examine early childhood obesity prevention interventions delivered via telephone or text messages (solely or supplementary to traditional modes), for evidence of process evaluation. Our objective was to explore the acceptability of the interventions to stakeholders, primarily to participants, intervention deliverers, health managers and policymakers.

Methods
This systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) standardised reporting guidelines and checklist [27].

Protocol and registration
A protocol was developed prior to the review process and was registered with the International Prospective Register for Systematic Reviews (PROSPERO). It can be accessed via (https://www.crd.york.ac.uk/prospero/ registration number: CRD42019108658).
Eligibility, study inclusion and exclusion criteria
Eligible studies were identified using the Population, Intervention, Comparison, Outcomes (PICO) framework [28]. Patient Problem (or Population) – pregnant women or caregivers who received childhood obesity prevention interventions for children from birth up to and including 5 years of age. Intervention – interventions aimed at changing caregivers’ behaviours to prevent early childhood obesity; delivered via telephone (including via telephone applications (apps)) or text messages primarily or supplementary to face-to-face or online methods. Comparator or control – caregivers who received usual care or maintenance care (for example, control group in randomised controlled trials (RCT), non-equivalent control group in quasi-experimental design). Outcome – one or more early obesity prevention or behaviour change outcomes such as body mass index (BMI), breastfeeding, solid feeding, “tummy time” (allowing babies time lying prone on their abdomen while they are awake), sleep and settling, physical activity, screen time and participant well-being.

The review encompassed intervention studies including randomised and cluster-randomised controlled trials, case control studies, quasi-experimental studies without comparators and descriptive studies with evidence of program outcome(s). The review included studies that delivered interventions via telephone (including apps) or text messages (solely or supplementary to traditional modes). We focussed specifically on those studies undertaking process evaluation to explore participant and health professional experiences. Studies were excluded if they did not have at least one childhood obesity related or behaviour change outcome, and if studies only reported outcomes of children older than 5 years of age.

Information sources
The following databases were searched from their inception to 15 May 2020, to identify eligible trials: MEDLINE (OVID; 1966), Scopus (Elsevier 1980), Web of Science (Clarivate Analytics post-2016, Thomson Reuters pre-2016); CINAHL Complete (EBSCOhost; 1994), the Cochrane Library databases, Database of Systematic Reviews, and the US National Library of Medicine’s ClinicalTrials.gov. We also searched the reference lists of several relevant systematic and narrative reviews, grey literature including doctoral theses and conference proceedings, relevant government websites, Google Scholar and Google Search.

Search
Preliminary literature searches were carried out in 2018 to assess the feasibility of the review. The full electronic search strategy is provided in Table 1. A comprehensive literature search was conducted by one author (ME) in May 2019 and repeated in May 2020.

Study selection
Titles and abstracts of references were independently screened by two reviewers (ME and SE) in Covidence systematic review software (www.covidence.org). Disagreements were resolved by discussion with a third reviewer (SM), where necessary. Following the retrieval of full texts, the same two reviewers independently screened them against the specified inclusion/exclusion criteria defined above. Papers relating to the same trial were grouped into one study.

Data collection process
Records from all databases and hand searches were imported or recorded into a reference management software package (Endnote version X9) and then exported from Endnote to Covidence. Duplicate records were removed. Any additional articles identified from reference lists of included trials were included to supplement the analysis.

Data extraction
Data were extracted using a data extraction table that represented the categories of intended data items which were tested and piloted for feedback from all authors. After agreement was reached, ME extracted all data that were reviewed by at least one other author (Table 2). For those studies without reported outcomes, we contacted authors of the trials to obtain the required data.

Process evaluation
We analysed all eligible studies (and associated published literature) that described process evaluation or assessed program satisfaction through quantitative and/or qualitative surveys. Although process evaluation includes several components, we focussed on stakeholders’ perceptions of interventions that are fundamental to their subsequent implementation and effectiveness. Some process evaluation measures that we explored included continued participation (retention), ease and convenience of delivering interventions (feasibility), acceptability of interventions by participants, adherence to advice provided, and experiences of participants, intervention deliverers and researchers.

Planned methods of analysis
Comprehensive analysis of all eligible studies (and related published literature) was undertaken to identify studies that conducted process evaluation. We gathered and analysed data informed by the Template for Intervention Description and Replication (TIDieR) [49]. The data included name, theoretical framework, what
Table 1 Searches on MEDLINE, SCOPUS, WEB OF SCIENCE and CINAHL from inception to May 2020

| For MEDLINE (OVID; 1966) | Number of records Search updated 15/5/2020 | Number of records Search conducted 23/5/2019 |
|--------------------------|---------------------------------------------|---------------------------------------------|
| 1 exp infant/             | 1,128,327                                   | 1,096,984                                   |
| 2 child, preschool/ or exp. infant, newborn/ | 1,346,166                                   | 1,306,248                                   |
| 3 child*.tw.             | 1,362,646                                   | 1,297,657                                   |
| 4 p*ediatr*.tw.          | 345,746                                     | 321,730                                     |
| 5 newborn*.tw.           | 159,763                                     | 154,057                                     |
| 6 toddler*.tw.           | 10,743                                      | 9884                                        |
| 7 preschool*.tw.         | 28,089                                      | 26,452                                      |
| 8 babies.tw.             | 36,506                                      | 35,004                                      |
| 9 baby.tw.               | 37,467                                      | 35,675                                      |
| 10 neonat*.tw.           | 260,610                                     | 248,563                                     |
| 11 infant*.tw.           | 432,073                                     | 414,324                                     |
| 12 or/1–11               | **2,646,778**                               | **2,540,388**                               |
| 13 pediatric obesity/    | 8130                                        | 6686                                        |
| 14 p*ediatric obesity.tw.| 1327                                        | 1226                                        |
| 15 obesity/              | 177,751                                     | 169,076                                     |
| 16 obes*.tw.             | 292,628                                     | 272,156                                     |
| 17 overweight/           | 24,244                                      | 22,316                                      |
| 18 over?weight.tw.       | 67,592                                      | 62,394                                      |
| 19 over?fe*.tw.          | 2025                                        | 1912                                        |
| 20 weight gain/ or weight loss/ | 64,821                                    | 61,683                                      |
| 21 (weight adj4 (loss or gain or excess or increase or decrease)).tw. | 171,307                                    | 161,199                                     |
| 22 BMI.tw.               | 139,870                                     | 127,847                                     |
| 23 Body mass index.tw.   | 178,809                                     | 164,850                                     |
| 24 body mass index/      | 124,645                                     | 117,367                                     |
| 25 or/13–24              | **642,516**                                 | **600,221**                                 |
| 26 exp health promotion/ | 75,732                                      | 72,135                                      |
| 27 exp health education/ | 241,031                                     | 232,601                                     |
| 28 (health* adj4 (behavio?r or promot* or educat* or eat* or food*)).tw. | 171,123                                    | 157,573                                     |
| 29 behavio?r therapy.tw. | 6652                                        | 6336                                        |
| 30 early intervent*.tw.  | 18,692                                      | 17,152                                      |
| 31 early child*.tw.      | 26,789                                      | 24,884                                      |
| 32 motivat*.tw.          | 129,595                                     | 119,624                                     |
| 33 exp child health services/ | 24,033                                   | 23,215                                      |
| 34 social support*.tw.  | 38,032                                      | 35,119                                      |
| 35 counsel*.tw.          | 106,490                                     | 99,853                                      |
| 36 (parent* adj3 group*).tw. | 7327                                        | 6943                                        |
| 37 mother* group*.tw.    | 340                                         | 325                                         |
| 38 breastfeeding/        | 37,064                                      | 35,511                                      |
| 39 breast?feed*.tw.      | 25,812                                      | 23,688                                      |
| 40 breast?fed*.tw.       | 6694                                        | 6203                                        |
| 41 (infant* or child*) adj4 (feed* or food* or meal* or diet*).tw. | 35,522                                      | 33,342                                      |
| 42 (feeding adj4 (practice* or behavio?r* or style*)).tw. | 18,344                                      | 17,186                                      |
Table 1  Searches on MEDLINE, SCOPUS, WEB OF SCIENCE and CINAHL from inception to May 2020 (Continued)

| Search                                                                 | Number of records Search updated 15/5/2020 | Number of records Search conducted 23/5/2019 |
|------------------------------------------------------------------------|---------------------------------------------|---------------------------------------------|
| 43 solid*.tw.                                                           | 352,781                                     | 328,752                                     |
| 44 (introduc* adj3 solid*).tw.                                         | 1389                                        | 1292                                        |
| 45 diet*.tw.                                                           | 552,787                                     | 522,485                                     |
| 46 nutr*.tw.                                                           | 397,898                                     | 370,735                                     |
| 47 (diet* adj4 (intake or modification* or habit*)).tw.                | 66,999                                      | 62,921                                      |
| 48 vegetable*.tw.                                                     | 54,058                                      | 50,178                                      |
| 49 fruit*.tw.                                                          | 104,890                                     | 96,805                                      |
| 50 eating habit*.tw.                                                  | 5276                                        | 4862                                        |
| 51 play*.tw.                                                           | 1,176,268                                   | 1,102,335                                   |
| 52 exp exercise/                                                       | 191,577                                     | 178,510                                     |
| 53 physical activit*.tw.                                              | 108,536                                     | 99,211                                      |
| 54 ((screen* or device* or computer* or television* or TV) adj4 time).tw.| 18,403                                      | 16,937                                      |
| 55 sedentar*.tw.                                                      | 31,004                                      | 28,619                                      |
| 56 supine* position.tw.                                               | 10,881                                      | 10,400                                      |
| 57 or/26–56                                                           | 3,247,052                                   | 3,048,762                                   |
| 58 pregnant women/                                                    | 8099                                        | 7443                                        |
| 59 (pregnan* adj4 (wom?n or mother*)).tw.                             | 140,528                                     | 131,818                                     |
| 60 ((ante?natal or pre?natal or post?natal or post?partum or post?birth) adj4 wom?n).tw. | 17,970                                      | 16,561                                      |
| 61 (expec* adj3 mother*).tw.                                          | 1969                                        | 1833                                        |
| 62 mothers/                                                           | 42,794                                      | 39,792                                      |
| 63 mother*.tw.                                                        | 216,584                                     | 205,204                                     |
| 64 or/58–63                                                           | 347,003                                     | 327,952                                     |
| 65 12 and 25 and 57 and 64                                             | 8097                                        | 7401                                        |
| 66 cell phone/ or text messaging/                                     | 10,432                                      | 9442                                        |
| 67 (mobile* or telephone* or phone* or smart?phone* or cell?phone* or hand?held).tw. | 189,480                                     | 175,681                                     |
| 68 (text* adj2 messag*).tw.                                           | 4048                                        | 3474                                        |
| 69 SMS.tw.                                                            | 5750                                        | 5204                                        |
| 70 (mobile* adj3 app*).tw.                                            | 7110                                        | 5779                                        |
| 71 or/66–70                                                           | 197,231                                     | 182,657                                     |
| 72 65 and 71                                                           | 220                                         | 202                                         |

SCOPUS (Elsevier 1980)

search terms as in MEDLINE

WEB OF SCIENCE (Clarivate Analytics post-2016, Thomson Reuters pre-2016)

search terms as in MEDLINE

CINAHL Complete (EBSCOhost; 1994)

search terms as in MEDLINE

Free text terms searched

* truncation
# wildcard
? wildcard
adj adjacent
.tw textword field includes title and abstract
exp exploded term
Table 2: Studies included in this review

| Trial name: First author publication year (year study commenced), Country, (Reference #) | Age of child at commencement (intervention duration) in months | Measured study outcomes | Study design | Main medium of intervention delivery | Supplementary medium of intervention delivery | Intervention delivery provider | Intervention setting | No. of sessions | Parity | Retention % | Measurement time points | Care giver age (years) | Qualifications of mother |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INFANT: Campbell 2008 (2008), Australia [3] | 3 (15) | BMI; TV viewing, PA and non-core drink & fruit, veg, dietary intake | Cluster-randomised controlled trial | Group sessions | Text messages + mail-outs | Dietitians | Parent groups | 6 calls (number of text messages not specified) | Primiparous | 89 | 3 months, 9 months, 20 months | 32.3 | 54.2% tertiary qualified |
| Carlsen 2013 (2010), Denmark [9] | At birth (6) | BMI; exclusive breastfeeding & any breastfeeding | Randomised trial | Telephone | None | Certified lactation consultant | Participant choice | 9 | Primiparous & 67% | 1 month, 3 months, 6 months | 31.3 | Not reported |
| PRIMROSE: Doring 2014 (2014), Sweden [30] | 9 (48) | BMI and waist circumference; eating habits, physical activity | Cluster-randomised trial | Face-to-face Group sessions + telephone | Child Health Centre nurses | Child Health Centres | First-time mothers, 100% primiparous | 9 total - 7 face-to-face; 2 telephone | Primiparous (34.1%) | 92 | 0 mo (baseline), 1 month, 3 months, 6 months, 4 months | 32.8 | 26.1% tertiary qualified |
| Franco-Antonio 2018 (2018), Spain [31] | At birth (6) | Breastfeeding; breastfeeding self-efficacy | Multi-centre parallel group RCT | Combination Face-to-face + telephone | Midwife or trained nurse | Community | 4 | Not reported | 86 | 2-3 months, 4-5 months | 31 | 61% tertiary qualified |
| MumlubConnect Gallegos 2014 (2010), Australia [32] | 25 (2) | Breastfeeding rates and breastfeeding self-efficacy | Non-concurrent prospective comparison trial | Text messages | Telephone + social media | Breastfeeding counsellor | Participant choice | 8 | Not reported | 86 | 2-3 months, 4-5 months | 31 | 61% tertiary qualified |
| Gibby 2019 (2019), Hawaii & Puerto Rico [33] | Near birth (4) | Weight changes; feeding practices | Randomised controlled trial | Text messages | None | Third-party web-based text messaging platform | Participant choice | 18 | Primiparous (40.2%) | 0-1mo and 4-6mo | 27 | 53.5% tertiary qualified |
| Steps to Growing Up Healthy: Gains 2014 (2014), USA [34] | 35 (12) | BMI | Randomised trial | Combination Face-to-face + telephone + home visits | Medical team (clinician, paediatric resident, nurse and medical assistant); phone calls and home visits by community health worker (CHW) | Paediatric primary care clinic | Not reported | 90 | 35mo and 47mo | 35.4 | Not reported |
| Healthy Habits, Happy Homes: Hayes 2013 (2011), USA [35] | 48 (6) | Behavioural outcomes: eating meals together as family, sleep duration, TV viewing time, presence of TV in child’s sleeping room | Randomised trial | Combination Home visits + telephone + text messages + educational materials | Health educator | Mainly at home | 48 total - 4 home visits; 4 telephone calls; 40 text messages | Not reported | 92 | 48mo and 54mo | Not reported | 49% tertiary qualified |
| Hannan 2012 (2012), USA [36] | At birth (2) | Weight gain | Randomised clinical trial | Telephone | Paediatric nurse practitioners | Participant choice | 6 | Primiparous 100% | 0 and 2 months | 24.1 | 69.1% high school qualified or more |
| Harris-Luna 2018 (2018), USA [37] | At birth (5) | Exclusive Breastfeeding and Breastfeeding duration | Pragmatic design | Telephone | Certified promotoras | Participant choice | 8 | Not reported | 100 | 0 to 12 weeks | 26.36 | Not reported |
| M528 Hmone | During pregnancy | Exclusive breastfeeding | 2-group | Text | Text messages were | Participant | 117 text | Primiparous | 79 | 1,2,3,4,5 & 6 | 60% 25–96% high | |
| Trial name: First author publication year (year study commenced), Country, (Reference #) | Age of child at commencement (intervention duration) in months | Measured study outcomes | Study design | Main medium of intervention delivery | Supplementary medium of intervention delivery | Intervention delivery provider | Intervention setting | No. of sessions | Parity | Retention % | Measurement time points | Care giver age (years) | Qualifications of mother |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 (2013), Myanmar [38] | 28 weeks’ gestation (9) | rate | parallel-arm randomised controlled trial | messages | sent by CommConnect, Teleivet | choice | messages | 57% | months | 34 | 34 age group | school qualified |
| Healthy Babies: Horodynski 2011 (2011), USA [39] | 1 (11) | Infant growth pattern, maternal knowledge and self-efficacy; feeding practices | Randomised experimental short-term longitudinal controlled trial | Home visits | Telephone | Paraprofessional instructor | Mainly at home | 9 | Not reported | unclear | 1 month (baseline), 6 months and 12 months | Not reported | 75% high school qualified |
| Jang 2014 (2014), China [40] | 3rd trimester of pregnancy (15) | Duration and rate of EBF, timing of intro of solid foods; other feeding practices (eg. cup feeding, bottle feeding, food reward) | Quasi-experimental design | Text messages | None | FrontlineSMS used for sending messages | Participant choice | 66 | Primiparous | 82 | Breastfeeding at 4, 12mo; Intro of solid foods at 4, 6mo; infant feeding behaviours at 12mo | 25–29 age group | 100% high school qualified |
| The Baby Milk Trial: Lohdharma 2015 (2011), UK [41] | At birth (6) | Change in weight; change in BMI; skinfold thickness | Explanatory, parallel, individually randomised controlled trial | Combination: Faceto-face + telephone + leaflets + stickers | None | Research nurses | Health check clinics | 5 | Primiparous | 87 | Baseline, 6 months and 12 months | 31.9 | 59.3% tertiary qualified |
| Growing Healthy: Laws 2018 (2015), Australia [42] | At birth (9) | Breastfeeding duration; Intro to solids; formula preparation (where applicable) | Quasi-experimental design | Combination: App + website + push notifications + social media | None | App and website developed by research team | Participant choice | 72 | Push notifications + text messages | 57.5% | Baseline (3mo), 6 months and 9 months | 30.4 | 78.9% tertiary qualified |
| Smart Moms: Neemani 2018 (2014), USA [43] | 55 (6) | Child SSB consumption and BMI | Two-group randomised controlled trial | Combination: Group session + Website + text messages | None | Principal investigator | Community group session | 73 total - 1 group + 72 text messages | Not reported | 82 | Baseline (564 mo), 3 months and 6 months post-intervention | 36.6 | 81.5% tertiary qualified |
| Patel 2018 (2010), India [44] | 3rd trimester of pregnancy (9) | Exclusive Breastfeeding; bottle feeding | Two-arm hospital-based pilot study | Combination: Telephone + text messages | None | Auxiliary nurse midwives | Participant choice | 288 total - 36 calls + 252 text messages | Not reported | 92 | 24 h after birth, weeks 6, 10, 14 and at 6 months | <=24 age group | 29.5% high school qualified |
| WC: Pugh 2010 (2003), USA [45] | At birth (6) | Breastfeeding | Two-group randomised controlled trial | Hospital and home visits | Telephone | Nurse + Peer counsellor | Mainly at home | 17 | Primiparous | 71 | 6 weeks, 12 weeks and 24 weeks postpartum | 23.1 | 11.3% tertiary qualified |
| Tahir 2013 (2010), Malaysia [46] | At birth (6) | Breastfeeding practice | Single blinded randomised controlled trial | Telephone | None | Certified lactation counsellors (Nurses trained in lactation counselling) | Participant choice | 12 | Primiparous | 89 | 1 month, 4 months, 6 months | 28.6 | 27.7% tertiary qualified |
Table 2: Studies included in this review (Continued)

| Study | Design | Medium of Intervention Delivery | Setting | No. of Sessions | Parity | Retention % | Measurment Time Points | Qualifications of Mother |
|-------|--------|---------------------------------|---------|----------------|--------|-------------|------------------------|-------------------------|
| Baby’s first bites: van der Veek 2019 (2019), Netherlands [47] | Four-arm randomised controlled trial | Combination: Print materials + telephone | Participant choice | 5 | 100% | Baseline, 18, 24 and 36 months | 41.6% high school qualified |
| Mothers & Others: Wasser 2017 (2013), USA [48] | 2-group randomised controlled trial | Combination: Home visits + Newsletters + text messages | Mainly at home | Total 130-8 home visits + 122 text messages | Not reported | unclear | Not reported | Not reported |
| Healthy Beginnings: Wen 2007 (2007), Australia [2] | Randomised controlled trial | Home visits | Specially trained community nurse | 8 plus proactive telephone | Primiparous | 75% | Baseline, 6 months; 12 months; 24 months | 80.4% high school qualified |
| CHAT: Wen 2017 (2017), Australia [1] | 3-arm parallel randomised controlled trial | Email Child and family health nurse (telephone); automated SMS | Participant choice | 6 calls or 48 text messages | Primiparous | 54% | Baseline (on recruitment); 6 months; 12 months | 68% Tertiary qualified |
| Linked trial for HB: Wen 2019 (2019), Australia [19] | Parallel randomised controlled trial | Email Child and Family Health Nurse/ midwife | Participant choice | 3 calls plus 48 text messages | Ongoing | ongoing | Baseline at 24 months and 36 months of child’s age | Ongoing |
interventions were delivered, who delivered the interventions, how (mode of delivery), where the interventions were delivered (intervention setting), number of times and over what period the interventions were delivered or dose (number of sessions and frequency of intervention delivery), and intervention adherence or fidelity (retention). Additionally, we gathered data relevant to this review such as design, objectives, outcomes, parity or birth order. For synthesis of process evaluation data, a convergent segregated approach [50, 51] was used to firstly enable synthesis of quantitative and qualitative evidence within studies, followed by narrative synthesis to determine the experiences / perceptions of participants and health professionals (where available) who received or delivered the interventions [50, 52]. For ongoing studies, we tried to contact the study investigator where possible to obtain further information.

Risk of bias in individual studies
All eligible studies were independently assessed by two reviewers (ME and SE) using the Cochrane Collaboration tool for assessing risk of bias [53]. Disagreements were resolved through discussion with a third reviewer, when necessary. Studies that met the eligibility criteria were assessed for all five domains, namely, randomization process, deviations from intended interventions, missing outcome data, measurement of outcome, and selection of the reported result [53]. Risk was reported as 'high' or 'low' or 'some concerns', as recommended in the Cochrane Risk of Bias (RoB 2) revised tool [54].

Assessment of qualitative studies
While risk of bias assessment enables confidence that estimates of effect are near true values for outcomes, it does not assess the qualitative inquiry [53]. Therefore, eligible qualitative studies that demonstrated evidence of process evaluation, satisfaction or feasibility measures were assessed for rigour to investigate the extent to which study authors conducted their research to the highest possible standards. Studies were assessed against the Consolidated Criteria for Reporting Qualitative Research (COREQ) [55] and the Standards for Reporting Qualitative Research (SRQR) checklists [56]. COREQ and SRQR include 32-item and 21-item checklists, respectively, that draw together important aspects of qualitative research to assess the reporting of relevant information. There are three broad domains in COREQ: research team and reflexivity (personal characteristics, relationship with participants); study design (theoretical framework, participant selection, setting, data collection); and analysis and findings (data analysis, reporting). In SRQR, the first two items are the article’s title and abstract; the remaining 19 items relate to congruity between authors: problem formulation and research question; research design and methods of data collection and analysis; results, interpretation, discussion, and integration; and other information.

Results
Study selection
We identified 1028 records after the systematic conduct of electronic and hand searches. After duplicate removal, title and abstract screening, 106 references were selected for full-text review. Twenty-four studies were finally included in this review (Fig. 1). A list of included studies is provided in Table 2.

Characteristics of studies
Key study characteristics are presented below and described in detail in Table 3.

Study design and participation rates
The majority of identified studies (19 out of 24) were published in the last decade, of which one-half were published within the last 4 years. Sixty-three percent of studies were conducted in the USA or Australia. The majority (80%) were RCTs, of which 18 were individual RCTs and two were cluster RCTs; two had a quasi-experimental design and the remaining two studies were pragmatic. Key study characteristics are represented in Table 3. Retention rates ranged from 71 to 100%, and 16 studies (67%) indicated participant retention rates of greater than 80%.

Setting and medium of intervention delivery
More than half (54%) of the studies (13 of 24) delivered interventions exclusively and flexibly via telephone and/ or text messages where participants or deliverers did not need to go to a predetermined location to receive or deliver interventions. The remainder were face-to-face sessions, group sessions or home visits supplemented by telephone or text messages.

Target population
Interventions were delivered to caregivers who were predominantly women. Intervention delivery commenced as early as when women were pregnant (25%), as well as when the children were <3 months of age (42%), 4–12 months of age (16%) and >12 months of age (17%). In studies where the mean age of participants was reported (n = 20), the majority (60%) were aged 30 years or under. Parity was reported by 14 studies (58%); five of these studies delivered interventions to first-time mothers only.
Intervention characteristics
Almost one-half of the studies (46%) delivered interventions for a period of 6 months or less, 29% delivered interventions for a period of 7–12 months, 17% delivered interventions for a period of 13–24 months, while 8% delivered interventions for longer than 24 months. Interventions were delivered via nurses or midwives (38%), health educators (17%), dietitians (8%), or automated text messages, apps or online (21%).

Intervention components
Interventions were delivered for breastfeeding, food and drink intake, “tummy time” (allowing babies time lying prone on their abdomen while they are awake), play time / physical activity, sleep, screen time, goal-setting and maternal well-being. The number of outcomes measured typically varied between one and four, with most studies reporting fewer than four outcomes.

Risk of bias within studies
We included all types of studies in this review, hence in the domain ‘randomisation process’ four studies were judged as having ‘some concerns’ as they did not randomise participants or lacked adequate information on the randomisation process. For the domain ‘deviation from intended outcomes’, seven studies were judged as having ‘some concerns’ as they did not provide adequate information on the blinding of participants and intervention deliverers. Nineteen studies had high participant retention rates (> 70%) and were judged as low risk; five had low participant retention which were assessed as high risk in the ‘missing outcomes data’ domain. Information on ‘measurement of outcome’ was provided clearly by 16 studies, the remaining 8 studies that lacked adequate information or were ongoing were judged as having ‘some concerns’. Eleven studies in this review stated that more than one outcome and/or outcomes were measured at various time points; therefore, in the
### Table 3 Study characteristics

| Characteristic                                      | Category                                                                 | Studies |
|-----------------------------------------------------|---------------------------------------------------------------------------|---------|
| **STUDY**                                           |                                                                           |         |
| Year study commenced (N = 24)                       | 2003 to 2011                                                              | 5 21    |
|                                                     | 2012 to 2016                                                              | 7 29    |
|                                                     | 2017 to 2019                                                              | 12 50   |
| Country of studies (N = 24)                         | Australia                                                                 | 6 25    |
|                                                     | China                                                                     | 1 4     |
|                                                     | Denmark                                                                   | 1 4     |
|                                                     | India                                                                     | 1 4     |
|                                                     | Malaysia                                                                  | 1 4     |
|                                                     | Myanmar                                                                   | 1 4     |
|                                                     | Netherlands                                                               | 1 4     |
|                                                     | Spain                                                                     | 1 4     |
|                                                     | Sweden                                                                    | 1 4     |
|                                                     | UK                                                                        | 1 4     |
|                                                     | USA                                                                       | 9 38    |
| Study design (N = 24)                               | RCT                                                                       | 18 75   |
|                                                     | Cluster RCT                                                               | 2 8     |
|                                                     | Non-concurrent, prospective comparison trial                             | 1 4     |
|                                                     | Pragmatic design                                                          | 1 4     |
|                                                     | Quasi-experimental design                                                | 2 8     |
| Participant retention rate (N = 24)                 | > 90%                                                                     | 6 25    |
|                                                     | 80–90%                                                                    | 9 38    |
|                                                     | < 80%                                                                     | 4 17    |
|                                                     | Not specified/unclear/ongoing                                             | 5 21    |
| **MEDIUM**                                          |                                                                           |         |
| Intervention setting (N = 24)                       | Community settings (Child health centres, parent groups, health check clinics, primary care) | 6 25    |
|                                                     | Home                                                                      | 5 21    |
|                                                     | Participant choice                                                        | 13 54   |
| Mode of intervention delivery (N = 24)              | Face-to-face (group or home visits or community settings) + Supplementary telephone | 7 29    |
|                                                     | Face-to-face (group or home visits or community settings) + Supplementary text messages | 3 12    |
|                                                     | Face-to-face (group or home visits or community settings) + Supplementary telephone and text messages | 1 4     |
|                                                     | Telephone                                                                 | 5 21    |
|                                                     | Telephone (incl. apps) + Text messages                                   | 5 21    |
|                                                     | Text messages                                                             | 3 12    |
| **POPULATION**                                      |                                                                           |         |
| Age of child at intervention commencement (N = 24)  | Prior to child’s birth (during pregnancy)                                | 6 25    |
|                                                     | 0–3 months                                                                | 10 42   |
|                                                     | 4–6 months                                                                | 3 12    |
|                                                     | 7–9 months                                                                | 1 4     |
|                                                     | > 12 months                                                               | 4 17    |
| Characteristic                              | Category                      | Studies  |
|--------------------------------------------|-------------------------------|----------|
|                                            |                               | n   |
|                                            |                               | %  |
| Mean age of mother (N = 20)               | 21–30 years                   | 12  |
|                                            | 31–40 years                   | 8   |
| Parity of mothers (N = 14)                | Primiparous 100%              | 5   |
|                                            | Primiparous 50–99%            | 6   |
|                                            | Primiparous < 50%             | 3   |
| Qualifications of mother (N = 18)         | Tertiary (> 50%)              | 9   |
|                                            | Tertiary (< 50%)              | 2   |
|                                            | High school (> 50%)           | 5   |
|                                            | High school (< 50%)           | 2   |
| Intervention duration (N = 24)            | ≤ 6 months                    | 11  |
|                                            | 7–12 months                   | 7   |
|                                            | 13–24 months                  | 4   |
|                                            | > 24 months                   | 2   |
| Intervention deliverers (N = 24)          | Automated                     | 5   |
|                                            | Counsellor                    | 1   |
|                                            | Dietitians                    | 2   |
|                                            | Health Educator/Instructor    | 4   |
|                                            | Lactation consultant          | 1   |
|                                            | Medical Team                  | 1   |
|                                            | Nurse + Peer Counsellor       | 1   |
|                                            | Nurses / Midwives              | 9   |
| Number of intervention sessions           | Face-to-face ± telephone      | 16  |
|                                            | 1 to 9                        | 1   |
|                                            | 10 to 19                      | 2   |
|                                            | > 20                          | 1   |
|                                            | Text messages                 | 1   |
|                                            | 1 to 9                        | 1   |
|                                            | 10 to 19                      | 1   |
|                                            | 20 to 49                      | 3   |
|                                            | > 50                          | 6   |
| OUTCOMES                                   | Number of outcomes measured (N = 24) | 6  |
|                                            | Two                           | 4   |
|                                            | Three                         | 3   |
|                                            | Four or more                  | 9   |
|                                            | BMIz                          | 13  |
|                                            | Weight gain                   | 3   |
|                                            | Breastfeeding                 | 16  |
|                                            | Solid feeding / food habits   | 15  |
|                                            | Tummy time                    | 3   |
|                                            | Play time / Physical activity | 5   |
|                                            | Sleep duration / sleep quality| 4   |
|                                            | TV viewing / Screen time      | 7   |
domain ‘reporting of the selected results’, studies without published evidence of outcomes at the various time points were judged as having ‘some concerns’. Risk of bias is represented in Fig. 2. Full details of our assessment of bias are in Table 4. Five studies had low risk of bias in all five domains.

Outcomes / effectiveness of studies

There were 24 eligible studies in this review, with details of outcomes of studies provided in Table 5. Sixteen studies measured anthropometric outcomes of which less than a quarter reported statistically significant age appropriate lower BMI z-score (BMIZ) in the intervention group in comparison to the control group. Thirteen studies measured age appropriate BMIZ [1–3, 19, 29, 30, 33–35, 40, 42, 43, 47] and three measured age appropriate weight gain in children as an outcome [36, 41, 48]. Sixteen studies measured duration of breastfeeding [1, 2, 19, 29, 31–33, 37–40, 42, 44–46, 48]; 15 studies reported on solids feeding or food habits of the children [1–3, 19, 30, 33, 34, 38–43, 47, 48]; 3 studies reported on the practice of tummy time [1, 2, 19]; 5 studies reported on play time / physical activity in children [1, 2, 19, 34, 58]; 4 studies reported on sleep duration / sleep quality [1, 2, 19, 35]; and 7 studies reported on children’s screen time/ television (TV) viewing time [1–3, 19, 34, 35, 48] (Table 5).

**Table 3** Study characteristics (Continued)

| Characteristic | Category                                      | Studies |
|---------------|-----------------------------------------------|---------|
| Goal setting  | for mothers                                    | 4       |
| Mother’s      | well-being                                     | 2       |
| Measurement   | time points (child’s age)                      |         |
| 0–3 months    |                                               | 24      |
| 4–6 months    |                                               | 16      |
| 7–9 months    |                                               | 3       |
| 10–12 months  |                                               | 5       |
| 12–24 months  |                                               | 4       |
| > 24 months   |                                               | 9       |

**PROCESS EVALUATION / SATISFACTION**

| Process evaluation / satisfaction (N = 24) | Studies |
|-------------------------------------------|---------|
| Mention of process evaluation             | 8       |
| Mention of Satisfaction measure           | 3       |
| Evaluation post-intervention              |         |
| Quantitative survey                       | 1       |
| Qualitative interviews                    | 5       |
| Evaluation during intervention            |         |
| Quantitative survey                       | 8       |
| Qualitative interviews                    | 4       |

Abbreviations: RCT randomised controlled trial; UK United Kingdom; USA United States of America
*Numbers rounded so total may not add up to 100

**Fig. 2** Risk of bias assessment of eligible studies (N = 24)
Over two-fifths (44%; 7 of 16) demonstrated an increase in breastfeeding duration, 47% (7 of 15) reported improved food habits in children. Changes in feeding habits included: reduction in non-core drink consumption at 9 months of children’s age [57], and reduction in juice consumption and sugary drinks at 4 years of children’s age [43, 58, 59] in the intervention group in comparison to the control. There were higher odds of appropriate timing of introduction of solids in the intervention group in comparison to the control group (at 6–7 months of children’s age) [60–62]. 67% (2 of 3) reported increased practice of “tummy time”, 20% (1 of 5) reported an increase in children’s duration of outdoor activities, 50% (2 of 4) reported an increase in sleep duration of children, and 43% (3 of 7) reported a decrease in TV viewing or screen time.

We also looked for commonalities between effectiveness of interventions and mode of delivery. Of the studies that showed improvements in behaviours related to childhood obesity, 53% (8 of 15) were delivered solely via telephone or text messages.

**Process evaluation**

Eight studies (33%) had evidence of process evaluation or satisfaction measures [1, 3, 32, 33, 38, 40–42]. All eight studies quantitatively measured participant satisfaction at the time interventions were delivered. Qualitative interviews with trial participants were conducted by three studies during the intervention phase [63–65] and by five studies post-intervention [32, 33, 66–68], with only one study measuring perceptions of participants and recruiters during the recruitment phase [69]. Details of this analysis are shown in supplementary file 1. Our assessment of the qualitative studies against the COREQ criteria showed that all studies except one (that included a self-assessment against COREQ) had

| Study first author publication year (Reference #) | Domain 1: Randomization process | Domain 2: Deviations from intended interventions | Domain 3: Missing outcome data | Domain 4: Measurement of outcome | Domain 5: Selection of the reported result |
|-----------------------------------------------|--------------------------------|-----------------------------------------------|-------------------------------|---------------------------------|-------------------------------------------|
| Campbell 2008 [3]                            | Low                            | Low                                           | Low                           | Low                             | Low                                      |
| Carlsen 2013 [29]                            | Low                            | Low                                           | Low                           | Low                             | Low                                      |
| Döring 2014 [30]                             | Low                            | Low                                           | High                          | Some concerns                   | High                                     |
| Franco-Antonio 2018 [31]                     | Low                            | Low                                           | Low                           | Low                             | Low                                      |
| Gallegos 2014 [32]                           | High                           | Some concerns                                 | Low                           | Low                             | Low                                      |
| Gibby 2013 [33]                              | Some concerns                  | High                                          | High                          | Low                             | Some concerns                            |
| Gorin 2014 [34]                              | Low                            | Some concerns                                 | Some concerns                 | High                            | Some concerns                            |
| Haines 2013 [35]                             | Low                            | Some concerns                                 | Low                           | Low                             | Some concerns                            |
| Hannan 2013 [36]                             | Some concerns                  | Some concerns                                 | Low                           | Low                             | Some concerns                            |
| Harris-Luna 2018 [37]                        | High                           | High                                          | Low                           | Some concerns                   | Low                                      |
| Hmone 2017 [38]                              | Low                            | Low                                           | High                          | Some concerns                   | Some concerns                            |
| Horodyński 2011 [39]                        | Low                            | Some concerns                                 | High                          | Some concerns                   | Some concerns                            |
| Jiang 2014 [40]                              | High                           | Some concerns                                 | Low                           | Some concerns                   | Some concerns                            |
| Lakshman 2015 [41]                           | Low                            | Low                                           | Low                           | Low                             | Low                                      |
| Laws 2018 [42]                               | High                           | Low                                           | High                          | Some concerns                   | Low                                      |
| Nezami 2018 [43]                             | Some concerns                  | Low                                           | Low                           | Low                             | Low                                      |
| Patel 2018 [44]                              | Low                            | Some concerns                                 | Low                           | Low                             | Some concerns                            |
| Pugh 2003 [45]                               | Low                            | Low                                           | Low                           | Low                             | Low                                      |
| Tahir 2010 [46]                              | Some concerns                  | Low                                           | Low                           | Low                             | Some concerns                            |
| vanderVeen 2019 [47]                         | Low                            | Low                                           | Low                           | Low                             | Some concerns                            |
| Wassell 2017 [48]                            | Low                            | Some concerns                                 | Some concerns                 | High                            |                                           |
| Wen 2007 [2]                                 | Low                            | Low                                           | Low                           | Low                             | Low                                      |
| Wen 2017 [1]                                 | Low                            | Low                                           | Low                           | Low                             | Low                                      |
| Wen 2019 [19]                                | Low                            | Low                                           | Some concerns                 | Some concerns                   | Some concerns                            |
| Trial name: First author publication year (year study commenced), Country (Reference #) | Outcomes measured (in comparison to control) | BMIz | Breastfeeding changes | Solid feeding / feeding habit changes | Tummy time | Play time and/or physical activity | Sleep duration/ sleep quality | Screen time changes | Goal setting | Mother’s well-being |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INFANT: Campbell 2008 (2008), Australia [3, 57] | No significant change | N/A | ↑ non-core drink at 9 months ↓ sweet and snack at 20 months | N/A | N/A | N/A | ↓ TV viewing time at 20 months | N/A | N/A |
| Carlsen 2013 (2010), Denmark [29] | No significant change | ↑ exclusive and partial breastfeeding rates at 6 months | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| PRIMROSE: Doring 2014 (2014), Sweden [30, 58] | No significant change | N/A | ↑ vegetables, fruits and fish; ↓ sugary drinks, french fries at 4 years of age | N/A | No significant change | N/A | N/A | N/A | N/A |
| Franco-Antonio 2018 (2018), Spain [31] | N/A | ↑Exclusive Breast Feeding (EBF) duration and any BF at 6 months | N/A | N/A | N/A | N/A | N/A | No change | N/A |
| MumBubConnect: Gallegos 2014 (2010), Australia [32] | N/A | ↑ in EBF rates | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Gibby 2019 (2019), Hawai‘i and Puerto Rico [33] | No significant change | N/A | No significant change | N/A | N/A | N/A | N/A | N/A | N/A |
| Steps to Growing Up Healthy: Gorin 2014 (2014), USA [34, 59] | ↓BMI percentile | N/A | ↓ juice consumption, whole milk consumption at end of the intervention | N/A | No significant change | N/A | No significant change | N/A | No change | N/A |
| Healthy Habits, Happy Homes: Haines 2013 (2011), USA [35] | ↓ BMI | N/A | N/A | N/A | ↑sleep duration | N/A | TV viewing on weekend days | N/A | N/A |
| Hannan 2012 (2012), USA [36] | Healthier weight gain | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Harris-Luna 2018 (2018), USA [37] | N/A | ↑EBF | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| MS28: Hmone 2017 (2015), Myanmar [38] | N/A | ↑ EBF rate at 6 months | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Healthy Babies: Horodynski 2011 (2011), USA [39] | N/A | Not published | Not published | N/A | N/A | N/A | N/A | N/A | N/A |
| Jiang 2014 (2014), China [40] | No significant change | ↑ EBF rate at 6 months | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| The Baby Milk Trial: Lakshman 2015 (2011), UK [41] | ↓ weight gain at 6 months and at 12 months | N/A | No significant change | N/A | N/A | N/A | N/A | N/A | N/A |
insufficient information (supplementary file 2). Hence, we assessed the studies against the SRQR criteria: six studies reported sufficient information (supplementary file 3).

Four of the eight studies were conducted in Australia, two were collaborative studies with Australia conducted in China and Myanmar, one study was in the UK and one in Hawai’i/Puerto Rico. Six studies measured BMIz or weight change of which one study noted a decrease in weight gain in comparison to the control. Three studies noted increased breastfeeding rates and three studies observed improved feeding habits in comparison to the control. Two studies that targeted screen time in children found a reduction in screen time in comparison to the control. One study that targeted a range of behaviours observed an earlier start of tummy time by participants in comparison to the control (Table 5).

Participants’ perceptions/satisfaction with the program during the intervention phase of the study were evaluated by three studies through in-depth interviews [65], qualitative interviews [64] and semi-structured qualitative interviews with a purposive sample of participants during

| Trial name: First author | Outcomes measured (in comparison to control) |
|-------------------------------------------------|---------------------------------------------|
| Growing Healthy: Laws 2018 (2015), Australia [42] | No significant change | No significant change | No significant change | N/A | N/A | N/A | N/A | N/A |
| Smart Moms: Nezami 2018 (2014), USA [43] | No significant change | N/A | ↓SSB/juice | N/A | N/A | N/A | N/A | ↓mother’s weight | N/A |
| Patel 2018 (2010), India [44] | N/A | No significant change | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| WIC: Pugh 2010 (2003), USA [45] | N/A | ↑any BF at 6 weeks and at 12 weeks | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Tahir 2013 (2010), Malaysia [46] | N/A | ↑EBF at 1 month, 4 months | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Baby’s first bites: van der Veek 2019 (2019), Netherlands [47] | Outcomes not published | Outcomes not published | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Mothers & Others: Wasser 2017 (2013), USA [48] | Outcomes not published | Outcomes not published | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Healthy Beginnings: Wen 2007 (2007), Australia [2, 60–62] | ↓BMI | ↑BF at 6 and 12 months | ↓Introduction to solids prior to 6 months | ↓age at which infants started tummy time and ↑daily practice of tummy time | No significant change | ↑mean nocturnal sleep duration | No significant change | N/A | N/A |
| CHAT: Wen 2017 (2017), Australia [1] | Outcomes not published | No significant change | ↑higher odds of appropriate timing of introducing solids (telephone support); ↓bottle at bedtime (telephone and SMS support) | Outcomes not published | Outcomes not published | Outcomes not published | Outcomes not published | Outcomes not published | Outcomes not published |
| Linked trial for HB: Wen 2019 (2019), Australia [19] | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing | Ongoing |
| Trial name: First author publication year (year study commenced), Country (Reference #) | ‘Process evaluation’ or satisfaction measurement | Evaluation components Quantitative evaluation (including during or post-intervention) | Qualitative evaluation (including during or post-intervention) | Participant perceptions where evaluated |
|---|---|---|---|---|
| INFANT: Campbell 2008 (2008), Australia [3, 66] | Process evaluation through response on a 4-point scale - quantitative | At each session, participants were asked to rate usefulness and relevance of the program on a 4-point scale from “not at all useful/relevant” to “very useful/relevant.” (i.e., “How useful was the session overall?” and “How relevant was this session to you and your family?”) | Participants were asked to complete forms after each session and indicate usefulness and relevance of the program and components of each of the sessions (during intervention) | Qualitative interviews were conducted 3–5 months after the completion of the program (post-intervention) | Preference for combination of delivery modes |
| Carlsen 2013 (2010), Denmark [29] | None specified | None specified | Participants were not asked to rate satisfaction | Participants were not interviewed | Not evaluated |
| PRIMROSE: Doring 2014 (2014), Sweden [30] | None specified | None specified | Participants were not asked to rate satisfaction | Participants were not interviewed | Not evaluated |
| Franco-Antonio 2018 (2018), Spain [31] | None specified | None specified | None specified | None specified | Not evaluated |
| MumBubConnect: Gallegos 2014 (2010), Australia [32] | Process evaluation | Frequency of text messages sent and responses received; number of telephone calls made by breastfeeding counsellor; Qualitative responses gathered via questionnaire to obtain women’s acceptability of service | Frequency of text messages sent and responses received; number of telephone calls made by breastfeeding counsellor (during intervention) | Qualitative responses gathered via post-intervention survey questionnaire to obtain women’s acceptability of service (post-intervention) | Considered themselves well supported through participation in program |
| Gibby 2019 (2019), Hawaii and Puerto Rico [33] | Satisfaction | Usefulness of text messages; how participants were influenced to change behaviours; and most and least liked messages; Satisfaction with the text messages delivered. Qualitative interviews at follow-up visits. | Most liked and least liked messages were rated by participants | At the follow-up visits, participants completed a qualitative interview regarding helpfulness of messages, ways in which receiving the messages influenced or changed feeding practices and overall feedback about receiving the messages. Responses to 6 open-ended questions (post-intervention) | More likely to make changes if the content delivered aligned with their pre-existing beliefs |
| Steps to Growing Up Healthy: Gorin 2014 (2014), USA [34] | Process evaluation stated in study protocol paper, no evidence of one being conducted | At the end of intervention period mothers asked to evaluate the program - helpfulness, components most useful, refer friend to program | Not evaluated | Not evaluated |
| Healthy Habits, Happy Homes: Haines 2013 (2011), USA [35] | None specified | None specified | Not evaluated | Not evaluated |
| Hannan 2012 (2012), USA [36] | None specified | None specified | Not evaluated | Not evaluated |
| Trial name: First author publication year (year study commenced), Country (Reference #) | ‘Process evaluation’ or satisfaction measurement | Evaluation components | Quantitative evaluation (including during or post-intervention) | Qualitative evaluation (including during or post-intervention) | Participant perceptions where evaluated |
|---|---|---|---|---|---|
| Harris-Luna 2018 (2018), USA [37] | None specified | None specified | | | Not evaluated |
| MS28: Hmone 2017 (2015), Myanmar [38, 65] | Process evaluation | The process evaluation used both quantitative phone-based surveys and qualitative in-depth interviews. | Informal assessment of user experience, acceptability, feedback from participants via text messages (during intervention) | In-depth semi-structured interviews with a sub-sample to explore user experience, perception and acceptance (during intervention) | Behaviour modification likely if information is from a credible source such as from health professionals |
| Healthy Babies: Horodynski 2011 (2011), USA [39] | Process evaluation stated in study protocol paper, no evidence of one being conducted | Proposal to conduct: Feasibility, fidelity, and educational effectiveness of interventions. Mothers’ satisfaction with the Healthy Babies intervention; Recruitment; retention; | Proposal to conduct only - not published | Proposal to conduct interviews - not published | Not evaluated |
| Jiang 2014 (2014), China [40, 64] | Process evaluation | A 3-phase process during planning and development | Baseline questionnaire survey to understand potential intervention approaches | Qualitative interviews with mothers midterm and at the end of the intervention | Behaviour modification likely if information is from a credible source such as from health professionals; Delivery of interventions via text messages facilitated sharing of messages with family and friends; Lack of personalisation of contents in text messages |
| The Baby Milk Trial: Lakshman 2015 (2011), UK [41, 68] | Process evaluation | Parents’ satisfaction with different aspects of the intervention will be assessed at 6mo via questionnaire | Questionnaire at 6 months to assess parents’ satisfaction with intervention | Semi-structured interviews with sub-sample of intervention and control group participants and facilitators to explore barriers and facilitators | All participants reported the trial participation as a positive experience; They shared various experiences of not getting external help, support, or information about formula-feeding; Most notably, the most positive outcome of the trial participation for the mothers, probably not captured in the trial’s quantitative outcome measures but a central finding in this qualitative study, was the personal and non-judgmental support they received for formula-feeding |
| Growing Healthy: Laws 2018 (2015), Australia [42, 67] | Process evaluation not specified. Acceptability measured | Assessment of App usage and App acceptability | Participant views | Qualitative follow-up interviews with parents | Behaviour modification likely if information is from a credible source such as from health professionals; More likely to make changes if the content delivered aligned with their pre-existing beliefs |
| Trial name: First author publication year (year study commenced), Country (Reference #) | 'Process evaluation' or satisfaction measurement | Evaluation components | Quantitative evaluation (including during or post-intervention) | Qualitative evaluation (including during or post-intervention) | Participant perceptions where evaluated |
|---|---|---|---|---|---|
| Smart Moms: Nezami 2018 (2014), USA [43] | None specified | None specified | None specified | None specified | Not evaluated |
| Patel 2018 (2010), India [44] | Process evaluation not specified | Process evaluation not specified | Not measured | None specified | Not evaluated |
| WIC: Pugh 2010 (2003), USA [45] | None specified | None specified | None specified | None specified | Not evaluated |
| Tahir 2013 (2010), Malaysia [46] | None specified | None specified | None specified | None specified | Not evaluated |
| Baby’s first bites: van der Veek 2019 (2019), Netherlands [47] | None specified | None specified | None specified | None specified | Not evaluated |
| Mothers & Others: Wasser 2017 (2013), USA [48] | None specified | None specified | None specified | None specified | Not evaluated |
| Healthy Beginnings: Wen 2007 (2007), Australia [2] | Process evaluation not specified | None specified | Questionnaires to participants only to evaluate infant feeding such as duration of breastfeeding, introduction of solids and healthy feeding practice | None specified | Not evaluated |
| CHAT: Wen 2017 (2017), Australia [1, 63, 69] | Process evaluation in protocol | Documentation of contact with families by intervention nurses; recruitment data barriers and enablers; study retention and intervention acceptability; interviews with participants to assess program satisfaction; identify emerging issues | Satisfaction questions administered at the 6-month and 12-month surveys | Interviews with participants to assess program satisfaction; identify emerging issues (during intervention) | • Consent to participate due to convenience of receiving interventions via telephone calls or text messages. • Behaviour modification likely if information is from a credible source such as from health professionals. • Delivery of interventions via text messages facilitated sharing of messages with family and friends. • Level of engagement |
intervention phase [63]. Five studies evaluated participants’ perceptions upon completion of the intervention or post-intervention period through semi-structured interviews [68], semi-structured telephone interviews with purposive sampling [67], qualitative interviews [66], a questionnaire with open-ended process evaluation questions [32] and an in-person exit interview [33]. Additional process evaluation components included examination of researchers’ diaries, field records, project meeting minutes [64], and interviews with participants and recruiters during the recruitment phase to assess facilitators and challenges in recruiting pregnant women to trials [69] (Table 6).

Process evaluation of the recruitment phase of the studies indicated that participants consented to participate due to the convenience of the delivery mode via telephone or text messages [69]. Evaluation of participants’ experience indicated that participants were likely to modify behaviour if they received information from a credible source such as from health professionals [63–65, 67]. Delivery of interventions via text messages facilitated sharing of messages with family and friends [63, 64]. Participants were more likely to adhere to recommendations and change behaviours if the content delivered aligned with their pre-existing beliefs [33, 67]. Participants’ levels of engagement with programs fluctuated based on their needs at a particular point in time and based on their child’s stage of development.

Preference for a combination of delivery modes (e.g., text messages, telephone calls, emails, push notifications, web, group sessions) was frequently mentioned. Participation via telephone calls and by text messages was convenient. Appeal to first-time mothers was well supported through participation in programs. Participants’ lack of time to participate due to return to work was a common challenge. Lack of personalisation of contents in text messages placed on them as mothers.

Table 6 Process evaluation of interventions (Continued)

| Trial name: First author | Evaluation components | Quantitative evaluation (including during or post-intervention) | Qualitative evaluation (including during or post-intervention) | Participant perceptions where evaluated |
|-------------------------|-----------------------|---------------------------------------------------------------|---------------------------------------------------------------|----------------------------------------|
| Ekambareshwar et al. International Journal of Behavioral Nutrition and Physical Activity (2021) 18:10 Page 20 of 25 | Process evaluation of telephone contact with mothers (stated in study protocol, no evidence since study was ongoing) | Thematic analysis of participants’ responses (de-identified) will be evaluated retrospectively | Ongoing | Ongoing | Ongoing |

Linked trial for HB: Wen 2019 (2019), Australia [19]
through a combination of non-face-to-face delivery modes including but not limited to text messages, telephone, emails, Web and push notifications [63, 67]. The programs were more appealing to first-time caregivers in comparison to those who cared for previous children [63, 66, 67] and participants considered themselves well supported through participation [32, 63]. Some barriers to participation included: lack of personalisation of text messages [63, 64]; participants’ lack of time due to return to work [63, 66]; and where participants perceived that high expectations were placed on them as mothers [63]. The process evaluation findings are represented in Table 6.

Discussion

Key findings

The objective of this systematic review was to explore the acceptability of the interventions to stakeholders through process evaluation of early childhood obesity prevention studies. Of the 24 eligible studies that delivered interventions via telephone or text messages, only one-third of studies (n = 8) examined stakeholder perceptions, with all of these studies focussing on the satisfaction / acceptability of the interventions that were delivered to participants. We found no evidence of evaluation of perceptions of other key stakeholders including those who delivered the interventions or health managers or policymakers, and no evidence of other process evaluation measures such as reach or fidelity.

Process evaluation findings highlight participants’ appreciation of the convenience of receiving interventions via telephone or text messages [63, 69], and the importance of delivering interventions from credible sources for participants’ compliance with interventions and behaviour changes [63–65, 67]. Level of engagement in a program was not dependent on the mode of delivery but was dictated by participants’ needs and on their children’s developmental stage [33, 63, 67]. Although participants perceived telephone or text messages as convenient, they expressed preference to be able to receive interventions through a combination of one or more delivery methods, namely, telephone, text messages, Web, apps with optional face-to-face [63, 66, 67]. Participants highlighted the co-benefits they received, such as early identification of any issues (clinical, social or similar needs) and referral to appropriate services. Participants considered themselves well supported [32, 63], with first-time caregivers considering the programs more valuable than those who had previous children [63, 66, 67]. Participants expressed some barriers to participation such as lack of personalisation of content in text messages [63, 64], lack of time due to return to work (irrespective of the mode of delivery) [63, 66] and a perception that high expectations were placed on them as mothers [63].

The growth in childhood obesity prevention interventions delivered by telephone/text messages is shown by the large proportion of studies conducted in the last decade. Similar to previous systematic reviews of childhood obesity prevention interventions [25, 70], several outcomes were measured including BMIz or weight gain, breastfeeding, solid feeding/food habits, tummy time, play time/physical activity, sleep duration/sleep quality, screen time/TV viewing, goal-setting and mother’s well-being. Less than one-quarter (23%; 3 of 13) of the studies that measured outcomes for weight and BMIz reported a statistically significant decrease in weight gain or a lower BMIz score in comparison to the control [25, 70, 71], while over three-fifths (63%; 15 of 24) of all studies in this review showed improvement in one or more behaviours related to childhood obesity prevention. Previous reviews have reported inconsistent outcomes for behaviour changes [25, 70]. Studies that were included in this review provided interventions for “tummy time” and sleep duration that were not included in previous reviews. These outcomes suggest that while it is more difficult to change weight outcomes such as BMIz, interventions delivered by telephone can be effective in supporting behaviours important for the prevention of obesity.

Delivery of interventions remotely via telephone has been proven to be more cost-effective [72]. Although text only studies would be the most cost-effective method of delivery, there was limited evidence in this review, with just three studies delivering interventions solely via text messages for breastfeeding of which two demonstrated an increase in exclusive breastfeeding. The average retention rates for studies delivered with and without a face-to-face component were both 85%. This may suggest that interventions delivered remotely via telephone or text messages have the potential to reach, attract and retain equal or a greater number of participants than those delivered via face-to-face modes. This implies that childhood obesity prevention interventions delivered via telephone or text messages have the potential to be more cost-effective and have equal or greater reach than interventions that include a face-to-face component.

Comparison with prior reviews

Previous systematic reviews of early childhood obesity (0–5 years of age) prevention trials have not examined process evaluation or participant involvement but have recommended inclusion of these components for improved quality and relevance [25]. Although the focus of previous reviews was not on delivery of interventions via telephone or text messages, multiple modes of traditional delivery methods were employed [73] and the reviews recommended exploring intervention delivery via
low cost methods such as telephone and the internet [71]. Three of the previous reviews examined delivery of interventions exclusively by healthcare professionals e.g., research nurses, lactation consultants, psychologists and social workers [25, 70, 74]. Similarly, in almost four-fifths of the studies in this review, interventions were delivered by health professionals such as nurses, midwives, health educators, or dietitians; and in one-fifth, interventions were delivered via automated text messages, apps or online.

Systematic reviews of obesity prevention interventions delivered to older children and adolescents (12–24 years of age) using mobile technologies have noted heterogeneity in research design and in the interventions delivered [75–77]. These reviews observed a small number of studies that delivered interventions to adolescents and young adults via telephone, text messages or mobile apps. Very limited or post hoc process evaluation studies were noted [76] and research in this area was considered to be in its infancy with further research required to elucidate effectiveness [75, 76].

Previous reviews have not reported on process evaluation literature but noted its potential value [26, 71, 76]. Process evaluation findings in this review demonstrate that participants valued and trusted interventions delivered from credible sources, hence intervention deliverers are crucial to the acceptability of interventions. Thorough reporting of recruitment and training of intervention deliverers is important in replicating intervention effects during scale up [26, 71]. This review demonstrates limited evidence of evaluation of participants’ perceptions and a lack of evidence that existing studies have examined the perceptions of intervention deliverers, health professionals and policymakers.

Public health implications

Evidence gathered through process evaluation of trials contribute crucial knowledge to refinement of interventions and programs prior to their replication and scale up [78, 79]. Additionally, process evaluation of trials facilitates integration of qualitative and quantitative methods that yields rich detail about study outcomes that neither method could achieve alone [78, 80]. Although process evaluation has been in existence for over two decades, only one-third of the studies in this review had evidence of process evaluation or satisfaction measurement, demonstrating the limited number of studies that conducted process evaluation to measure stakeholder perception. The findings from this review provide important insights for researchers about the importance of conducting process evaluation alongside trials to explore the perceptions of stakeholders in addition to evaluating effectiveness of interventions. While outcome measures of childhood obesity prevention interventions are indicative of the success of programs delivered to caregivers with young children, a key component of the success is attributed to the acceptability of, and compliance with the program by its participants.

Although process evaluation often takes a back seat to impact evaluation, information about stakeholders’ perceptions and how a program is implemented, makes it easier to understand why participants did or did not gain some benefit from participating in the program [81]. Stakeholder feedback obtained as a result of process evaluation is important for modifying and improving interventions to enhance engagement, retention and effectiveness of programs prior to scale up [78, 81]. In circumstances where comprehensive process evaluation is not feasible due to limited resources or time pressures in trial environments, at a minimum, evaluating the perceptions of participants, intervention deliverers, health managers and policymakers during or immediately after intervention delivery is warranted [78].

Review strengths and limitations

This systematic review has a number of strengths. The scope and search for this systematic review was comprehensive and conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) standardised reporting guidelines and checklist [27]. A protocol was developed prior to the review process and registered with PROSPERO. Eligible studies were identified using the Population, Intervention, Comparison, Outcomes (PICO) framework [28]. Titles and abstracts of references were independently screened by two reviewers in Covidence. Data were gathered and analysed similar to that described in the template for intervention description and replication (TIDieR) [49]. Risk of bias for all eligible studies was independently assessed by two reviewers using the Cochrane Collaboration tool for assessing risk of bias [53]. Qualitative studies were assessed using the COREQ and SRQR tools [55, 56], our assessment demonstrated lack of evidence of elements described in the tools. One recommendation is for qualitative studies to include self-assessment against a standard tool.

However, this review only included peer-reviewed papers published in English. Therefore, we may have missed peer-reviewed literature published in other languages. Despite our best efforts to obtain further information from study investigators of ongoing trials, this review was not able to include information on those ongoing or unpublished studies, and two studies did not conduct process evaluation as planned. The main limitation of this review stems from the small number of studies that conducted and reported process evaluation data, limiting our ability to describe effective engagement and retention approaches for scale up of programs.
Conclusion
Of the 24 studies included in this review, only one-third reported process evaluation to measure perceptions of participants. Evaluation of participants’ experiences during recruitment and intervention phases demonstrated the potential for childhood obesity prevention interventions to be delivered conveniently via telephone or inexpensively via text messages. Interventions delivered remotely via telephone or text messages have the potential to reach, attract and retain equal or a greater number of participants than those delivered via face-to-face methods. While outcomes for weight varied, many of the studies in this review showed improvements in behaviours related to childhood obesity. This review shows that the conduct of process evaluation alongside trials is uncommon, future studies should build in process evaluation alongside effectiveness measurements to provide important insight into intervention reach, acceptability and to inform scale up.

Supplementary Information
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Additional file 1. Supplementary file 1 Assessment of evidence for process evaluation or satisfaction within studies. Supplementary file 2 Assessment of qualitative studies against the COREQ tool. Supplementary file 3 Assessment of qualitative studies against the SRQR tool. Supplementary file 4 PRISMA checklist.

Abbreviations
RCT: Randomised controlled trial; BMI: Body mass index; BMIz: Age and sex standardized body mass index z-score; PICO: Population, Intervention, Comparison, Outcomes; SRQR: Standards for Reporting Qualitative Research; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analysis; PROSPERO: Prospective Register for Systematic Reviews; TIDieR: Template for intervention description and replication

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Authors’ contributions
ME conducted all searches, interpreted results, wrote the first draft of the protocol and manuscript. ME and SE independently screened titles and abstracts, SM was the third reviewer. LAB, CR, RL, SM, LMW, ST and SE contributed to the protocol development and interpretation of the results. All authors provided comments, read and approved the final manuscript.

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