



HAL
open science

A web-based and mobile randomised controlled trial providing complementary feeding guidelines to first-time parents in France to promote responsive parental feeding practices, healthy children's eating behaviour and optimal body mass index: the NutrienT trial study protocol

Camille Riera-Navarro, Camille Schwartz, Pauline Ducrot, Laurence Noirot, Corinne Delamaire, Edith Sales-Wuillemin, Denis Semama, Sandrine Lioret, Sophie Nicklaus

► **To cite this version:**

Camille Riera-Navarro, Camille Schwartz, Pauline Ducrot, Laurence Noirot, Corinne Delamaire, et al.. A web-based and mobile randomised controlled trial providing complementary feeding guidelines to first-time parents in France to promote responsive parental feeding practices, healthy children's eating behaviour and optimal body mass index: the NutrienT trial study protocol. *BMC Public Health*, 2024, 24 (1), pp.2649. 10.1186/s12889-024-20057-z . hal-04737265

HAL Id: hal-04737265

<https://hal.inrae.fr/hal-04737265v1>

Submitted on 15 Oct 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

STUDY PROTOCOL

Open Access



A web-based and mobile randomised controlled trial providing complementary feeding guidelines to first-time parents in France to promote responsive parental feeding practices, healthy children's eating behaviour and optimal body mass index: the Nutrient trial study protocol

Camille Riera-Navarro¹, Camille Schwartz¹, Pauline Ducrot², Laurence Noirot², Corinne Delamaire², Edith Sales-Wuillemin³, Denis S. Semama⁴, Sandrine Lioret⁵ and Sophie Nicklaus^{1*}

Abstract

Background Childhood obesity is a crucial public health issue. Early childhood is a critical time to foster the establishment of healthy eating behaviours and growth, which are partly shaped by parental feeding practices. To inform French parents of the recently updated national complementary feeding guidelines for 0–3 years (in terms of nutrition and responsive feeding as a mean to encourage infant appetite control skills and promote healthy growth), an official printed brochure was developed and nationally disseminated in 2021 by the French public health agency, Santé publique France. This randomised controlled trial aims to investigate whether the provision of guidelines through digital (smartphone application) and printed (brochure) tools (vs. the printed brochure alone, usual service) results in healthier parental feeding practices, infant eating behaviours and weight status.

Methods This double-blinded monocentric 2-arm trial is currently conducted among first-time parents living in the area of Dijon (France) and recruited in a maternity ward. From child age 3 to 36 months (mo), an app provides a range of 106 age-adapted messages, including dietary recommendations, educational advice, recipes, and tips (intervention group only). Additionally, parents of both groups are provided with 48 messages related to child general development and the printed brochure at child age 2.7 mo. The primary outcome is the body mass index (BMI) z-score at child age 36 mo. Secondary outcome measures include a combination of online parents' reports and behavioural assessments (experimental meals) of parental feeding practices and infant eating behaviours from inclusion to 36 months of age. Analyses of covariance on these outcomes will assess the effect of the intervention, adjusted for relevant confounders. Complementary mediation and moderation analyses will be conducted. Sample size was determined to be $n = 118$ in each arm of the trial, plus 20% to compensate for potential attrition.

*Correspondence:

Sophie Nicklaus
sophie.nicklaus@inrae.fr

Full list of author information is available at the end of the article



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

Discussion This is the first public eHealth randomised control trial in France to assess the effect of a web-based and mobile intervention targeted to first-time parents to improve child feeding practices and child growth.

Trial registration This trial was registered at clinicaltrials.gov as NCT05285761 (March 18, 2022).

Keywords eHealth, Childhood obesity, Parental feeding practices, Infant eating behaviour, Weight status, Complementary feeding, Appetite control, Responsive feeding

Introduction

Obesity and early childhood feeding

In France, obesity is a concern for both adults and children: indeed, in 2014–2015, 13.2% of children aged 1–3 years were overweight and 5.4% of children aged 4–6 years were living with obesity [1, 2]. Moreover, in France obesity at 7 years is rather associated with complementary feeding (CoF) practices (that is, the introduction of foods other than milk into the child's diet) than with breastfeeding practices [3]. Rapid weight gain in early life has been shown to have detrimental effects on long-term health (e.g., increased risk of obesity) [4].

The growth velocity of an infant is greatly influenced by his or her ability, or inability, to adjust food and energy intake (e.g., appetite control). A lack of caloric compensation (which measures the ability to adjust one's intake based on the energy density of a food preload) and a greater propensity to eat in the absence of hunger (EAH) have been associated with a higher BMI in preschool children [5–8] and even below 3 years of age [9, 10]. In addition, growth can also be influenced by an inadequate provision of food (insufficient intake of micronutrient rich foods such as vegetables and fruits, along with excessive intake of energy-dense foods) [11]. Meanwhile, children's food preferences and eating habits are also established during early childhood, when the child begins to discover the foods that will comprise his or her later diet [12, 13]. Thus, the foods introduced at complementary feeding (CoF) and the manner in which these foods are introduced are of particular importance in the development of healthy eating behaviours as a pathway towards a healthy weight.

Role of parents in early childhood feeding

Parents are the main decision-makers and role models regarding infant and child feeding, through the foods offered, the frequency and initiation of meals, and the feeding practices and styles, which may be more or less centred on the child's needs. For instance, children's appetite control is largely under parental influence as early as during the first year [14]. It is thus now acknowledged that responsive feeding (e.g., the bidirectional relationships between maternal feeding practices and child food responsiveness and satiety responsiveness) [15] as a child-centred approach to feeding, promotes the infant's

ability to adjust food intake appropriately and thus healthy growth [16–18]. In addition, the acceptance of vegetables (a core component of a healthy diet) is largely influenced by parental practices, during pregnancy, breastfeeding and also from the onset of CoF [19]. Children's ability to eat such foods also depends on their ability to manipulate their textures and process them orally, which strongly evolves as a result of the child's experiences [20–22]. Therefore, it is important to expose the child to non-smooth textures timely during the course of CoF [23].

Parental awareness of their influence on their children's eating behaviour can be modulated by their attitudes, subjective norms and beliefs, linked more broadly to their social representations [24–26]. If there is a primacy of action in the genesis of social representations, the way in which information promoting a social object (e.g. child feeding) is formulated (e.g. via an informative message) can also influence attitudes and cognitions relating to this social object [27]. The connections parents make between feeding on the one hand and health, growth, and pleasure on the other hand may influence how they feed their child. Therefore, food intake is strongly linked to the interaction between the parent (or feeder) and the infant [28].

Role of information dissemination to parents on feeding behaviour adoption

Parental guidance on more appropriate CoF practices is a way to achieve more sensitive, responsive feeding and to encourage the development of healthy eating habits in children.

Research on the role on information provision to parents on feeding behaviour adoption is carried out in Anglo-Saxon countries, but has not yet led to any published work in France [29]. Furthermore, cultural differences are likely to generate differences in parental dietary practices, pointing to the need of conducting an intervention on information dissemination to parents in France [30]. Currently in this country, only the ongoing ECAIL trial (an intervention study providing a multi-component home visitation nutrition programme compared to usual care) will provide new insights into promotion of healthy early feeding practices in socially vulnerable population groups and their effect on growth [28]. Recent reviews of

early feeding interventions (before 2 yo) show the importance of incorporating a responsive feeding component into guidance and to explore parental feeding knowledge, beliefs and perceptions of child's feeding and weight, as they can influence feeding practices and self-efficacy [31, 32] and ultimately may contribute to "normal" weight gain [33, 34], in particular in disadvantaged families [35]. In this context in France, CoF guidelines have been recently updated, containing both nutritional recommendations and educational advices for parents of 0–3 years [36]. An official printed brochure has been nationally disseminated to the French general public and healthcare professionals since September 2021 [37].

Growing interest of smartphone applications in public health interventions

The communication strategy is certainly as important as the content of feeding guidelines. Considering the widespread use of new information and communication technologies [38, 39], parents largely rely on digital information to inform themselves [40, 41]. In France, in 2022 more than 91% of 15–44 yo owned a smartphone [39]. When looking for information on CoF, French parents foster information in digital format (smartphone app: 43%) as much as in printed format (multi-page printed booklet: 41%) [41]. Smartphone apps are a valuable tool for the implementation of interventions for child obesity prevention [42] as they offer a variety of interesting features, including the ability to provide health information "on the go" through push notifications and a variety of multimedia formats [42, 43]. Apps may also provide more convenient and flexible interventions (e.g., without the need to travel for face-to-face sessions), lowering participants' and staff burden [42]. Although there has been much interest in implementing interventions through smartphone applications, academic research on the development and evaluation of these apps is still nascent. To date, only one study has documented the effects of CoF guidelines from a free app with age-appropriate push notifications on maternal feeding practices and infant's eating behaviour: the mHealth Programme in Australia [44]. Differences between groups at follow-up were almost null, which calls for more research to understand how to build an efficient intervention with a mobile app.

First-time parents express that the progression of CoF is a cause of concern, they generally do not feel much informed [40]. However, when participating in digital interventions, first-time parents are maximally engaged [45–48]. Finally, it is typically more difficult to change existing behaviours than to establish new ones [49]. For these reasons, the present study focuses on first-time parents.

Objective and hypotheses

In this context, we developed an intervention consisting of disseminating the recently updated French feeding guidelines for children aged 0–3 years via a smartphone application (as an added value to the existing and nationally disseminated official printed brochure), with the aim of promoting the establishment of healthy eating habits and preventing childhood obesity. Using a randomised controlled trial (RCT) design, we aim to evaluate the effect of this intervention on parental feeding behaviour, and children's eating behaviour and weight status among first-time parents, compared to the control group receiving the printed brochure alone.

The primary objective is to determine whether this intervention (which provides parents with age-appropriate information about health-promoting child feeding practices) results in a difference in the BMI z-score at age 36 mo of children from parents in the intervention group compared with those in the control group. Specifically, we hypothesise that the intervention will result in a decrease in BMI z-score at age 36 mo.

The secondary objectives are to determine whether the intervention results in the adoption of healthier feeding practices by parents (e.g., offering more vegetables and less unhealthy foods, using more responsive feeding and less intrusive/coercive practices), and in turn in healthier children's eating behaviour (e.g., higher liking and consumption of vegetables, more appropriate appetite control), compared with the control group. Secondary objectives also include assessing parents' understanding and application of the new recommendations in the intervention group at the end of the intervention. Exploratory objectives will determine whether any effect observed on the BMI z-score at 36 mo will remain apparent at 48 mo.

Methods and design

The SPIRIT checklist was applied to the description of methods (Additional file S1, Table S1).

Study design

The NutrienT trial ("feediNg gUidelines infanT RandomIsEd coNtrolled Trial") is a double-blinded RCT of digital provision of new French CoF guidelines to first-time parents from children age 3 to 36 mo. It is conducted as a superiority trial with two parallel groups (allocation ratio 1:1), and a primary end point at child age 3 years [50, 51]. This RCT was developed following the CONSORT guidelines (Additional file S2) [52].

Setting

This is a monocentric study conducted in Burgundy, France. This region was chosen because of geographic proximity to the laboratory of the principal authors.

Ethics

The protocol was approved by the Comité de Protection des Personnes SUD-EST VI Clermont-Ferrand (research ethics committee) on January 11, 2021 (protocol number “ID RCB: 2020-A01941-38”). This paper reports the second version research protocol for the RCT (July 2023). The protocol was registered in March 2022 (clinicaltrials.gov, NCT05285761).

A signed consent form (paper) is obtained from both parents before any further survey administration. The consent form describes the purpose of the study, the procedures to be followed, the eligibility criteria and the risks of participation. Participants are free to contact the research team to ask any question.

Personal data of participants are stored online in the smartphone application (no paper data) under personal non-identifiable codes. The personal data protection has been approved by the French National Data Protection Commission (Commission Nationale de l’Informatique et des Libertés) committee (registration number: 921054). Personal data of the approached but not included families are not saved.

Participants

Participants to the study are parent–child dyads, where the parent is either the mother (or parent 1) or the father (or other parent). Inclusion criteria are:

- Adult parents (at least 18 years old);
- First-time parents;
- Parents living in Dijon and its surroundings (< ~70 km around Dijon);
- Parents mastering enough the French language to understand and answer self-administered questionnaires.

Since the intervention is delivered through a web-based tool, internet literacy and internet access are implicit eligibility criteria, not checked at inclusion.

Exclusion criteria are:

- Parents who are not affiliated to a health insurance scheme;
- Parents of a child born before 31 weeks gestational age;
- Parents of a child having diseases likely to have a strong impact on his/her diet or feeding habits (allergy to cow’s milk proteins, feeding through a

nasogastric tube or gastrostomy, congenital defect of the digestive tract, oral feeding disorders);

- Parents of a child with a multiple pregnancy (≥ 3 foetuses);
- Additional exclusion criteria for participation in filmed meals from the age of 11 mo (behavioural assessment): children with food allergies or intolerances or suffering from coeliac disease.

Children born prematurely or with diseases were excluded because the feeding recommendations applicable to them may be different from those aimed at children with typical development.

Smartphone application

The NutrienT RCT is based on a progressive web app (PWA) named NutrienT, which is accessible online from any device (smartphone, tablet, laptop) regardless of its operating system, while offering users a very similar experience to a native app. Therefore, the PWA will hereinafter be named as “smartphone application”.

The smartphone application is used for 1/ recruitment, 2/ intervention delivery to participants, 3/ data collection through self-administered questionnaires, and 4/ study management purposes. The application was developed by ClinSearch (a clinical research organisation) according to specifications provided by the researchers and is owned and sponsored by the French National Research Institute for Agriculture, Food and the Environment (INRAE, contact: corresponding author); with the aim of providing an ergonomic and pleasant interface to users. Source code is not public but can be made available upon request. The application is accessible at the following URL [53].

Only participants included in the study can login to access their personal account on the app: the URL and their password are automatically emailed to them at child age 70 days. Login to the personal profile requires a two-factor authentication. Participants’ profiles are personalised with child and parent names and child age. Participants are free to visit their personal profile whenever they want to.

Recruitment

Participating parents are recruited after birth and before hospital discharge by two midwives working at the maternity ward of the university hospital (Centre Hospitalier Universitaire) located in Dijon, France¹ (Fig. 1). First-time mothers are face-to-face approached

¹ Another maternity unit was solicited (Hôpital Privé Dijon Bourgogne (HPDB, private clinic) but did not wish to get involved in the recruitment.

TIMEPOINT (relative to child age)	STUDY PERIOD													
	Enrolment	Allocation	Post-allocation										Post intervention	
	0-66 days	70-87 days	2,7 mo	3 mo	6 mo	11 mo	12 mo	18 mo	24 mo	30 mo	32 mo	36 mo	48mo (follow-up)	
ENROLMENT:														
Eligibility screen (0-3 days)	X													
Informed consent	X													
Baseline data assessment		X												
Randomisation		X												
INTERVENTIONS:														
Intervention arm			Brochure	provision of control (n=48) + intervention (n=106) messages via the app										
Control arm			Brochure	provision of control (n=48) messages via the app										
ASSESSMENTS*:														
Primary outcome Measured z-BMI												X		
Secondary outcomes Online parent-reports of anthropometric data <small>N.B. collected at child ages 3, 4, 5, 6, 9, 11, 12, 13, 18, 24, 36, 48 mo</small>				X	X		X	X	X			X	X	
Secondary outcomes Online parent-reports of parental feeding practices							X		X			X		
Secondary outcomes Online parent-reports of child eating behaviour							X					X		
Secondary outcomes Behavioural assessments of parental feeding practices and child eating behaviour <small>(experimental meals on a subgroup of 130 participants)</small>						X				X	X	X		
Face-to face-interviews <small>on a subgroup of 20-50 participants</small>												X		

Fig. 1 SPIRIT flow diagram (study schedule of enrolment, interventions, and assessments)

as systematically as possible during their stay in the maternity ward. Midwives briefly introduce the activity of the research centre and the study to mothers (who are told that the research objective relies on child-care). Then, midwives check parents' willingness to

participate and eligibility using an online questionnaire (Additional file S3) on the smartphone application, addressing all inclusion and exclusion criteria. Contact data of volunteer parents are registered in the application, as well as their newborn's birthdate and first name.

To be included in the study, volunteer parents are asked to sign the paper consent form within 54/66 days² (before randomisation). The number of participants who are approached, willing to participate, eligible (and reason for non-eligibility) and included are recorded.

Randomisation

Allocation assignment is made by the smartphone application following a computer-generated random allocation sequence. Participants are randomly assigned to either control or intervention arm with a 1:1 allocation following a randomisation schedule stratified by feeding mode at child age 1 month (50% breastfed, 50% bottle-fed) and socio-economic position (50% low: employees, workers, non-workers, 50% high: intermediate occupations, self-employed entrepreneurs, executives and higher intellectual professions). In light of the very low rate of breastfeeding in France [54, 55], the randomisation on the mode of feeding ensures equal representation of children being exposed to different modes of feeding.

Randomisation automatically occurs between child age 70 and 87 days as soon as the first baseline questionnaire is completed. If randomisation has not occurred at child age 87 days, participation in the study is stopped.

Before enrolment, parents are explicitly informed that they will be randomly allocated to a “control” or an “intervention” group, each group receiving a different set of information (more or less detailed). Since parents of both groups are provided with regular messages throughout the intervention period (although at a different frequency), they cannot assume in which group they are allocated.

Investigators have access to data blinded to the study group until completion of the study. Study group will only be disclosed at the end of the follow-up of the study. A trusted third-party, (working in a different research team and site of the researcher centre compared to investigators) is the only person able to access group allocation during the completion of the study.

Control condition

Development and wording of updated national CoF guidelines in the form of a printed brochure. Following the evidence-based update of French dietary recommendations for children from birth to 3 yo [56, 57], Santé publique France simplified the recommendations in order to make them accessible (comprehensible and acceptable) to all parents through simple tips [36] to replace previous guidelines issued in 2005 [58]. Pre-tests

established that parents from all socio-economic statuses could understand the messages [36, 59]. This led to the development by Santé publique France of a 36-page official printed brochure [37]—a reference base for all the subsequent communication supports. The updated recommendations on CoF developed by Santé publique France were released in September 2021, in particular by means of the printed brochure [37]. Parents in the control and the intervention groups receive this brochure at child age 2.7 mo.

Control messages about child general development. During the follow-up, parents of intervention and control groups answer various self-administered questionnaires on the app and receive 48 online age-appropriate “control” messages. Control messages provide general information about child motor and social development, information about child care or safety, and motivational messages. All participants receive messages from the app; the control condition only differs in the content and frequency of messages provided to parents. Parents of both groups are not specifically allowed or prohibited to consult other sources of information and upon study completion, are asked to report such sources, if any.

Intervention condition

Printed brochure

Parents in the intervention groups are sent the same brochure at child age 2.7 mo as parents in the control condition.

Development of the app as a complementary tool for the timely diffusion of the information from the updated CoF guidelines. In addition to the printed brochure, to complete the global communication system and provide parents with more elements to encourage behaviour change, the app was developed to provide age-appropriate information illustrating various aspects of responsive feeding during CoF, using a variety of formats. Information provided to parents is fully in line with the evidence-based recommendations formulated in the printed brochure. As the app matches the evidence-based recommendations formulated in the official printed brochure, no revision is expected, as long as the printed brochure does not change. The printed brochure was published in September 2021 and was revised in May 2022, regarding baby-led weaning. The May 2022 version was used for final content development. In case of further potential modifications of the brochure content, authors will evaluate by consensus whether these modifications should be included in the app.

Content of the intervention

One hundred six age-adapted messages about CoF are provided regularly throughout the 33-month intervention

² Initial intention: reception of signed consent before the 54th day of the child; adjusted to 66 days after inclusion of the first 20 participants.

to parents of the intervention group. In order to reinforce app consultation and create habits, steadier information is provided during the first year, which is also when complementary feeding should be initiated. Behaviour change techniques (BCTs) according to Michie et al.'s taxonomy [60] included in the intervention are described in Table 1.

The number and frequency of messages delivered to participants according to their allocation group are summarised in Table 2.

The messages are delivered to parents at a specific child age in the form of a push notification and/or an email (asynchronous communication, acting as reminders

to use the smartphone application and encourage participants to visit the section on intervention material) including a catchphrase and referring to the complete version of the message which is available on the app. The messages are then available for consultation as many times as wanted on the participant's personal profile. The messages are conveyed through either brief short videos or short and easy-to-understand sentences. They are of six different types, described in Table 3, and fully displayed in Additional file S4.

An online version of the printed brochure is available for consultation within the app for both allocation

Table 1 Behaviour Change Techniques (BCTs) included in the intervention [60]

BCT Taxonomy	BCT	Description of the BCT in the intervention
1. Goal and planning	1.2 Problem solving	Messages identifying future challenges that parents may encounter in terms of their child's diet and health and detailing the behaviour to adopt accordingly (e.g., food refusals/food neophobia)
4. Shaping knowledge	4.1 Instruction on how to perform the behaviour	Messages providing parents with instructions explaining how to achieve targeted behaviour (e.g., explaining how to add fat in baby foods if they don't contain any, explaining how to trust child's appetite etc.)
5. Natural consequences	5.1 Information about health consequences	Messages informing parents about the impact of certain behaviours on the infant's health (e.g., whole starches are richer in fibre, which contributes to the proper functioning of intestinal tract)
5. Natural consequences	5.3 Information about social and environmental consequences	Messages informing parents about the consequences of certain behaviours/actions or inactions on the infant (e.g., making the textures more complex enables baby to develop his/her masticatory abilities.)
6. Comparison of behaviour	6.1 Demonstration of the behaviour	Messages showing how to perform the behaviour through videos or images (e.g., video of recipes, video illustrating infant's signs of hunger and fullness, etc.)
7. Associations	7.1 Prompts/cues	Messages including challenges (parents are encouraged to do the recipe, to cook with their child or to present one ingredient of the recipe to their child, etc.) and offers the possibility of bookmarking the messages (e.g., recipes.)
9. Comparison of outcomes	9.1 Credible source	Messages from credible sources (i.e., Santé publique France), which are explicitly cited in the smartphone application
13. Identity	13.1 Identification of self as role model	Messages informing parents that their behaviour may be an example to their infant

Table 2 Intervention and control messages delivered to parents through the smartphone application

Type of messages	Target group	Intervention time frame	Total number of messages	Number of messages per month
Intervention messages (CoF guidelines)	Intervention group	Whole time frame [3–36 mo]	106	/
		1st year [3–12 mo]	45	5
		2nd year [12–24 mo]	36	3
		3rd year [24–36 mo]	25	2
Control messages (child general development)	Intervention and Control groups	Whole time frame [3–36 mo]	48	/
		1st year [3–12 mo]	18	2
		2nd year [12–24 mo]	15	1.25
		3rd year [24–36 mo]	15	1.25

Table 3 Message themes and content

Type of messages	Message theme	Message content	Timeframe	Number of messages delivered to participants (n=)	
Intervention messages: CoF guidelines (target group: intervention)	FOODS SUITABLE FOR BABY	Informative messages related to the printed brochure, addressing dietary recommendation. Explain parents which foods they can offer to their child (e.g. fat, pulses, nut powder, whole-grain cereals) and which foods are not adapted (e.g. sweet foods and beverages, deli meats). Briefly explains why	Intervention [3–36 mo] 1st year [3-12mo] 2nd year [12-24mo] 3rd year [24-36mo]	12 10 1 1	
	DID YOU KNOW?	Informative messages related to the printed brochure, providing educational advices, especially guiding parents towards the adoption of responsive feeding practices (e.g., not forcing the child to eat, explaining how to recognise signals of hunger and fullness, benefits of repeated exposure, etc.)	Intervention [3–36 mo] 1st year [3-12mo] 2nd year [12-24mo] 3rd year [24-36mo]	33 17 8 8	
	RECIPES & MENUS	Age-appropriate recipes in the form of videos or pictures; or example of menus (after 1 year). Always associated with a challenge: parents are invited to make the recipe or to cook with their child or to present him/her one ingredient. Ingredients of recipes are basic foods, to favour accessibility (no avocado or mango for example)	Intervention [3–36 mo] 1st year [3-12mo] 2nd year [12-24mo] 3rd year [24-36mo]	33 9 15 9	
	TIPS & TRICKS	Information and tips to make parents' daily life easier, or alternatives to certain foods (e.g. use the ice cube tray to freeze small portions of food, add fruit puree to naturally sweeten plain yogurt, etc.)	Intervention [3–36 mo] 1st year [3-12mo] 2nd year [12-24mo] 3rd year [24-36mo]	16 9 4 3	
	QUIZ	Questions and Answers to introduce or recall information of the printed brochure <i>In the first year of intervention, quizzes are proposed within messages of other themes</i>	Intervention [3–36 mo] 1st year [3-12mo] 2nd year [12-24mo] 3rd year [24-36mo]	10 0 7 3	
	CHALLENGE	Suggests a challenge (unrelated to a recipe) to parents (e.g. to identify like/dislike cues of their infant, etc.) <i>In the first year of intervention, challenges are proposed within messages of other themes</i>	Intervention [3–36 mo] 1st year [3-12mo] 2nd year [12-24mo] 3rd year [24-36mo]	2 0 1 1	
	Control messages: Child general development (target groups: intervention AND control)	BABY GROWS	General information about child motor and social development (based on the website "naitreetgrandir.com")	Intervention [3–36 mo] 1st year [3-12mo] 2nd year [12-24mo] 3rd year [24-36mo]	27 11 7 9
		TAKING CARE OF BABY	Information about child care or safety (based on the child health record booklet)	Intervention [3–36 mo] 1st year [3-12mo] 2nd year [12-24mo] 3rd year [24-36mo]	13 5 5 3
		THANKS TO YOU	Motivational messages to thank participants and keep them engaged in the study	Intervention [3–36 mo] 1st year [3-12mo] 2nd year [12-24mo] 3rd year [24-36mo]	8 2 3 3

groups, but for the control group the link to these pages is not put forward. For the intervention group, more than half intervention messages ($n=55$) encourage parents to refer to the brochure for more information and provide a link opening the corresponding online page of the brochure.

Level of human involvement

With a view to generalising the present web-based and mobile intervention based on the timely distribution of feeding advice to parents as part of a routine application, it was designed to be delivered in a completely automated way. The printed brochure is mailed to parents as co-intervention at 2.7 months (82 days) of age. For research purposes specifically, human involvement is necessary to approach participants at recruitment and to carry out behavioural assessments at the laboratory. Researchers regularly check that participants complete the questionnaires for data collection, and send reminders when necessary.

Assessments and outcomes

Outcomes were selected following the recommendations from Matvienko-Sikar and colleagues [31]. The primary outcome is the BMI z-score at child age 36 mo measured at the laboratory. Secondary outcomes are collected using 1/self-administered online questionnaires completed by all participants (parent reports) at various child ages and 2/ behavioural measurements of children's appetite control and parental feeding practices conducted on a subsample of participants.

Measures for the whole sample

Outcomes collected for the whole sample are described in Table 4. Table 5 illustrates the data collection schedule.

Self-administered questionnaires are validated or were used in previous research projects. Questionnaires become available on the participants' personal profile at specific child ages. Participants are initially asked to fill in the questionnaire through a push notification and/or an email. If the questionnaire is not completed within 7–10 days, participants get first an email reminder, then a phone call reminder from investigators if required. Even if they do not answer some questionnaires, participants receive the following questionnaires. Questionnaires consist of a varying range of items, organised in screen pages (1–6 pages per questionnaire). Participants cannot modify their answers after submission.

Behavioural assessments for a subsample

Behavioural measurements of children's appetite control and parental feeding practices are carried out through laboratory and home test meals at child ages 11, 30, 32

and 36 mo. The subsample consists of the first 130 study participants (65 in each arm) who were eligible for this part of the study (i.e. consented for the video recording, lived in the city area of Dijon and whose children had not developed any food allergy). These measurements were not mandatory for all participants, because they impose strong constraint and they are not essential to evaluate the principal outcome of the study.

Infant Caloric Compensation at 11 months of age. Experimental task. To measure short-term energy compensation abilities, we adapted the preload paradigm [9, 72] to calculate caloric compensation scores. The measure is performed in the laboratory at child age 11 mo. The experimental protocol is described in Additional file S5.

Eating in the Absence of Hunger (EAH) at 30 months of age. Experimental task. Self-regulation of energy intake is assessed by an eating-in-the-absence-of-hunger (EAH) experiment at child age 30 months. The procedure for measuring EAH is based on the free-access procedure for children aged 3–5 y in a laboratory setting as described by Fisher and Birch [73] and adapted for 30-mo-old children. The experimental protocol is described in Additional file S5.

Caregiver-infant mealtime interaction at 32 and 36 months. Participants are invited to video-record a meal of their choice at home, when their child is 32 months old, in order to assess the quality of interactions in a more natural context. The meal takes place as usual. Using an a posteriori analysis of the video records, we will estimate to what extent parents use responsive feeding practices, according to a validated methodology that will be adapted to the French cultural feeding context [74, 75].

To observe parental strategies to cope with food refusal at a laboratory meal at 36 months, parents will be asked to offer a vegetable that their child does not like (or an unknown vegetable if the parents declare that the child likes all vegetables). The strategies that parents use to get the food tasted will be recorded (*e.g.*, is the parent distracting by "flying the plane with the spoon", or using a tablet or phone). The child will therefore be encouraged to taste the food that he does not like but will not be forced to consume it. In case the child does not eat the food, to ensure well being of participants, a meal (with two components) composed of recipes selected by the caregiver (among a preselection of food offered by investigators) may be then offered to the child.

Qualitative evaluation for a subsample

At the end of the intervention (at child age 36 months), a second subsample of participants ($n=20-50$ among the first ones included in the study) from the intervention group will be interviewed until the saturation

Table 4 Primary and secondary outcomes for the whole sample

Item	Description
Primary outcome	
Body mass index (BMI) z-score	Weight and height data measured (Seca Leicester) in duplicate by experimenters at the laboratory. Calculated according to WHO references [61]
Secondary outcomes	
Anthropometrics	
Anthropometric data	Weight, height and head circumference data, self-reported online by parents according to measures made by paediatricians at compulsory medical visits and noted in the health record booklet of the child (a follow up document of child health given to parents at maternity) <i>At 3 months, parents retrospectively report data from 8 days, 1 month and 2 months old. Then once a month until 6 mo. Then at 9 mo, 11 mo, 12 mo, 18 mo, 24 mo, 36 mo and at follow-up (48 mo)</i>
Parental Feeding Practices	
Feeding strategies	17 items rated on a 5-point response scale "never, rarely, sometimes, mostly, always." from the validated Feeding Strategy Questionnaire [62] designed to evaluate strategies used by parents to make their child taste rejected foods, and resulting in four factors: Coercion, Explanation, Contingency and Preference. Higher scores mean more frequently used strategy
Feeding practices	39 items from the validated French version of the Comprehensive Feeding Practices Questionnaire [30, 63]. Items numbered 1–13 are rated on a 5-point response scale "never, rarely, sometimes, mostly, always." Items numbered 14–49 utilise a 5-point scale with different anchors, "disagree, slightly disagree, neutral, slightly agree, agree." Ten aspects of parental feeding behaviour are measured: monitoring child food intake, using food to regulate the child's emotions, using food as a reward, child control over feeding, teaching about nutrition, encouraging balance and variety, restricting child's food intake for weight reasons, restricting child's intake for health reasons, modelling healthful eating habits and responsibility for feeding. Higher scores mean higher behaviours
Meal context	7 items translated from the validated Feeding Practices and Structure Questionnaire (FPSQ-28, [64]) rated on a 5-point response scale "never, rarely, sometimes, mostly, always" to assess 3 dimensions: Structured Meal Setting; Structured Meal Timing; Family Meal Setting + 12 items translated from the validated Family Food Behaviour Survey [65] rated on a 5-point response scale "never true, rarely true, sometimes true, mostly true, always true" to assess maternal control and organisation of eating environment + 4 items from a previous research project measuring 4 aspects of meal context: duration of meals, use of screens, family members sharing the main meals and whether the child is seated at the table) [66]. Higher scores mean higher behaviours
Maternal distractions during feeding	14 items from an adapted and translated version of the validated Maternal Distraction Questionnaire [66]. The items are grouped to define 2 dimensions: 'Use of technologic distractors' and 'Perceived Distraction'. Higher scores mean higher behaviour/perception
Serving Size Decisions	Single item: "How do you most often decide the size of the portion you feed your child?" (response modalities: "I give a quantity equivalent to the size of the baby jars or to the recommendations (e.g. from my doctor, paediatrician)"; "I give the quantity my child usually eats"; "I adjust the portion served according to my child's appetite.")
Number of trials	Single item rated on a 9-point scale from '1' to '9 or more trials' assessing number of trials before deciding that the food is not liked (question from a previous research project [66])
Children's eating behaviours (CEB)	
Children's eating behaviour	31 items from the French version of the Child Eating Behaviour Questionnaire adapted for toddlers (CEBQ-T [14]) rated on a 6-point response scale ('never', 'rarely', 'sometimes', 'often', 'always', 'I don't know') to assess 7 dimensions: 'responsiveness', 'enjoyment of food', 'satiety responsiveness', 'food fussiness', 'slowness in eating', 'emotional overeating', and 'external food cue responsiveness'. Higher scores mean higher behaviours

Table 4 (continued)

Item	Description
Milk- and complementary-feeding	93 items regarding BF (age at BF cessation and reasons for stopping), type of milks offered to the child, age and reasons for starting CoF and items representing different drinks and complementary foods (among which major allergens): parent answers to each complementary food item using a 5-point scale ('not yet introduced', 'only once', '2 or 3 times', 'more often', 'every day or almost every day') and indicates the age of introduction as soon as the consumption frequency is higher than 'only once'. Questions from a previous research project [66]
Exposure to sensory variety and food acceptance	257 food items rated using a 5-point scale ('almost every day', '1 to 3 times a week', '1 to 3 times a month', 'less than once a month', 'never') to assess food frequency and using a 4-point scale ('+ +', '+', '-', '-') to assess liking. Questionnaire from a previous research [67]. Higher scores mean higher exposure to sensory variety and higher food acceptance
Infant appetite control abilities (self-reported by parents)	9-items from a validated questionnaire [68] rated on a 6-point response scale ('never', 'rarely', 'sometimes', 'often', 'always', 'I don't know') to assess 2 aspects of CEB: 'Caloric compensation' and 'Eating in the absence of hunger' (EAH). Higher scores mean higher behaviours
Texture exposure and acceptance	39 food items (common foods consumed in France in different texture combinations: puree, pieces, raw, cooked, etc.) from a questionnaire developed to characterise the pattern of food texture exposure in French children aged 4–36 months [21]. Items are rated on a 4-point scale ('not offered', 'spit out', 'eaten with difficulty', 'eaten without difficulty'). Higher score means higher exposure to texture and higher acceptance
Self-feeding	8-items rated on a 5-point scale ('often', 'sometimes', 'rarely', 'never', 'I don't know') to report children general feeding skills (holding a spoon in the mouth alone, eating with fingers, self-feeding with a fork, etc.) [21]
Parental knowledge and attitudes	
Parental attitudes in relation to child growth and feeding	9 items translated from Laksham et al. [69] rated on a 5-point scale (from strongly agree to strongly disagree) assessing 5 dimensions: attitudes related to growth, attitudes related to food, growth self-efficacy, food self-efficacy and weight perception
Beliefs about the usefulness of dietary recommendations and feelings of self-efficacy in feeding ("self-confidence")	9 items adapted and translated from Laksham et al. [69] rated on a 5-point scale (from strongly agree to strongly disagree) to assess 5 dimensions: positive and negative expected efficacy, positive and negative self-efficacy and intentions
Beliefs/knowledge around child nutrition	10 items related to nutritional recommendations for 0–3 years [66]
Knowledge about child nutrition	30 items related to various child feeding recommendations [59]. Parent answers to items on a dichotomous true/false scale and indicates how sure he/she is of his/her answer on a 4-point scale ('I am not at all sure', 'I am rather unsure', 'I am rather sure', 'I am completely sure'). Two dimensions are assessed: Knowledge accuracy (number of correct answers) and certainty (number of correct answers given with the maximal degree of certainty)
Sources of information	Questions assessing sources of information consulted, their influence and the extent to which parents have confidence in them, feeling of information about the food of children from 0 to 3 years old, satisfaction with sources of information, expectations regarding the type and format of information, evaluation of satisfaction with the informational content disseminated through the information brochure (and the smartphone application in the intervention group) [40]
Descriptive data, covariates and potential mediators/moderators	
Descriptive data	Marital status, parents' socio-economic position, parents' body size, parents' lifestyle, information related to pregnancy and birth, perception of the financial situation, return to work date. Assessed at baseline and then at each change of situation regarding marital status and professional situation of the parents. Questions from previous research projects [40, 59, 66]
Child care	Questions from a previous research project [66]. 10 child care modalities are suggested. Parents answer yes/no + enter the number of days and half-days half days spent there (if yes)

Table 4 (continued)

Item	Description
Temperament in Infancy	Excerpt from French version of Rothbart et al. (1981) IBQ-Revised [70]. 55 items rated on a 8-point scale ('never', 'very rarely', 'less than half the time', 'about half the time', 'more than half the time', 'almost always', 'always', 'not applicable') to assess 4 dimensions: perceptual sensitivity, soothability, low intensity pleasure, duration of orienting. Higher scores mean higher behaviours
Parents' perception of and satisfaction with their toddler's body size	Silhouette scale translated from Hager et al. [71] (2 dimensions: perception, satisfaction) + questions from a previous research project [66]

WHO World Health Organisation, CEB child eating behaviour, CoF complementary feeding, BF breastfeeding

Table 5 Data collection schedule for the whole sample

Item	Baseline	Intervention						Follow-up
	2-3-mo	3- mo	6- mo	12- mo	18- mo	24- mo	36- mo	48- mo
Primary outcome								
Body mass index (BMI) z-score							✓	
Secondary outcomes								
Anthropometric data*		✓	✓	✓	✓	✓	✓	✓
Parental Feeding Practices								
Feeding strategies				✓		✓	✓	
Feeding practices				✓		✓	✓	
Meal context				✓		✓	✓	
Maternal distractions during feeding				✓		✓	✓	
Serving Size Decisions			✓	✓		✓	✓	
Number of trials			✓	✓		✓	✓	
Children's eating behaviours (CEB)								
Children's eating behaviour				✓			✓	
Milk- and complementary-feeding		✓	✓	✓	✓	✓	✓	✓
Exposure to sensory variety and food acceptance							✓	
Infant appetite control abilities (self-reported by parents)				✓			✓	
Texture exposure and acceptance				✓				
Self-feeding				✓			✓	
Parental knowledge and attitudes								
Parental attitudes in relation to child growth and feeding			✓					
Beliefs about the usefulness of dietary recommendations and feelings of self-efficacy in feeding ("self-confidence")			✓					
Beliefs/knowledge around child nutrition	✓							
Knowledge about child nutrition							✓	
Sources of information							✓	
Descriptive data, covariates and potential mediators/moderators								
Descriptive data	✓							
Child care	✓		✓	✓	✓	✓	✓	✓
Temperament			✓					
Parents' perception of and satisfaction with their toddler's body size				✓				

* At 3 months, parents retrospectively report data from previous medical visits (at 8 days, 1 month and 2 months of age); then once a month until 6 mo; then at 9 mo, 11mo, 12mo, 18mo, 24mo, 36 mo and at follow-up (48 mo)

threshold will be reached through semi-structured interviews (~60 min). The aim of the interview is to provide insights into their use, understanding and application of the child feeding recommendations provided during

the intervention. The semi-structured interviews will be conducted following a guide, which will make it possible to scan the three dimensions of the social representation of food (knowledge, practices, psychosocial values)

(Additional file S6). After data transcription, the corpus will be prepared to perform a lexicometric analysis using the Iramuteq[®] and NVivo[®] softwares in order to access the social representations of the participants. In addition, a manual qualitative content analysis will be performed.

Adherence to intervention

Compliance with the intervention is assessed on the basis of browsing data related to the use of the application: count of logins and calculation of their mean duration (time at the last action – time at the first action) and opening of messages. A global score of adherence will be calculated as the frequency of all logins and total duration of material consultation.

Data management

The data collected on the app is securely hosted on an OVH server until the end of the data collection. Thereafter, it will be stored on hard drives with AES 256 hardware encryption and keyboard lock for 25 years, or for 2 years after the last publication depending on the participant's consent. Data from behavioural assessments and audio recordings will also be stored on hard drives after a computerisation step. A range check is applied to anthropometric data collected on the application to ensure quality. The ranges were defined at each age using the minimum and maximum values of the growth curves from the French child health record booklet. The primary outcome is measured in duplicate and the metrology of the weighing scale is checked regularly. Data consistency will be checked at the time of analysis.

Sample size calculation

We aim at enrolling 330 participants. The first 30 participants are enrolled with the objective of stabilising potential bugs in the app. The study is powered to detect a 0.28 difference in BMI z-score (WHO reference) at 36 mo (which has a clinical significance since the French BMI z-score at 36 mo in France is 0.28 ± 0.86 (EDEN cohort, personal communication)) between intervention and control arms (80% power, 5% type I error rate, one tail, 20% attrition). We hypothesise that children in the intervention group will have a lower BMI z-score than those in the control group. The power calculation involves recruiting 118 parents in each group. We considered a potential attrition during the trial of approximately 20%, which corresponds to the attrition observed in previous cohorts [76, 77]. We expect to enrol 330 participants within 3 years. With a primary endpoint at 36 months of age and a follow-up one-year later, the study may last 7 years.

Among the whole study population, 130 participants (65 participants in each arm) are included in behavioural

assessments. This number was calculated to detect a difference of 56% in caloric compensation score (%) at the age of 11 months between the intervention and control arms, with a power of 80%, and an error rate of 5% type I (unilateral test) based on available data [9, 14]. The power calculation involves recruiting 57 parents in each group, topping it to 65 allows to mitigate risk if some data are not usable (i.e., if the child does not want to eat anything).

Regarding the qualitative evaluation, we plan to select the first participants in the intervention group using the so-called “maximum variation” technique, which makes it possible to count common response patterns (called “invariants”). Conducting interviews will be stopped when the saturation threshold will be reached. This technique is traditionally used in qualitative analysis.

Statistical analysis

Statistical analyses will be conducted on the quantitative data, using SAS software, with a significance level α equal to 5%.

The equivalence of the two groups is ensured by the randomisation of the subjects. Baseline differences between groups will be checked to evaluate the risk of bias. The sociodemographic characteristics of each of the two groups, at the time of inclusion will be described in detail [78]. The analyses will then be conducted in three main stages: 1/ the search for an intervention effect on the primary and secondary outcomes, 2/ the study of the mechanisms of action of the intervention, 3/ the search for participants who respond best to the intervention.

Analysis of the effect of the intervention

First, the effect of the intervention on the BMI z-score at 36 months will be assessed by means of an analysis of covariance including the intervention factor (2 levels; control, intervention) and a covariate, the BMI z-score at 3 months (i.e. before the intervention). Second, this analysis of covariance will be adjusted for the BMI of each parent, and then for a composite score of socioeconomic position and mode of breastfeeding at birth. These additional analyses, performed in separate models, will allow adjustment for prognostic variables of BMI in the event of a slight imbalance between the two groups, resulting for example from selection bias or differential attrition between the groups. In addition, the effect of the intervention on variables measuring parents' knowledge, feeding practices, and children's eating behaviours will be assessed using an analysis of covariance as described above for each of these variables (see details of the ages at which these data will be available in Table 5). Regarding beliefs/knowledge about child feeding, an initial measure after inclusion will be conducted to allow for an analysis of covariance. Analyses including all subjects

as initially distributed in each group (intention-to-treat) are planned, as well as per-protocol analyses. In this case, data on the consultation of the material transmitted to parents via the smartphone application (see § Adherence to intervention) will be used as post-hoc criteria for the selection of the subject population.

What are the mechanisms of action of the intervention?

Mediation analyses will be implemented to evaluate the mechanisms of action of the intervention. For this purpose, structural equation models are considered [79–81]. These models will be based on a priori assumptions derived from the literature. For each mediating variable, a model will be considered with a direct path and an indirect path on the 36-month BMI z-score (variable Y also known as the endogenous variable). The indirect path could result from the succession of a variable related to parents' knowledge (variable set X1), a variable related to parents' feeding behaviours and practices (variable set X2; including the degree of responsive feeding, strategies used in the case of refusal, mealtime context, portion size decisions, degree of parental distractions during feeding related to screen use, exposure to sensory variety, etc.), then a variable related to children's eating behaviours (variable set X3; preferences for different food groups including vegetables, as well as energy adjustment abilities). These variables could be a measure at a given age or the evolution in the case of beliefs/knowledge about child feeding. Separate models (with variables sets X1 to X3) will be considered in priority in order to take into account possible difficulties related to collinearity (variance inflation factor criteria < 5). In addition, models with several mediating variables in the same model (corresponding to different causal paths) could be considered, if these variables are independent and not causally related to each other. For each of the models, the direct effect will be interpreted as an effect potentially linked to the other mediating variables not taken into account in the model.

Who are the participants who respond best to the intervention?

Moderation analyses are envisaged to explore the potential moderating effect of the following factors measured at baseline or 6 months: socioeconomic position, parental attitudes related to infant growth and feeding, beliefs about the usefulness of feeding recommendations and feelings of self-efficacy in feeding, prematurity, and general infant temperament.

Treatment of missing data

Because the trial is a prospective longitudinal follow-up, both monotonic (due to attrition before the end of

follow-up) and non-monotonic (due to a missing measurement point) missing variables are likely. The proportion of missing data by variable, the number of missing data per subject, and the patterns of missing data will be analysed. For subjects with missing data, (multiple) imputation methods may be implemented, according to recommended practices at the time of analyses [82].

Discussion

This is the first public health RCT in France to assess the effect of a web-based and mobile intervention targeted to first-time parents to improve child feeding practices and child growth.

Development of the intervention

The content of this eHealth mobile intervention was developed in collaboration with public health stakeholders and provides parents with the official French CoF guidelines updated in 2022. Several studies conducted among French parents and health care professionals have reported the circulation of contradictory messages over the last decades, especially due to continual evolutions of recommendations [83–85]. Providing parents with harmonised and standardised recommendations is crucial in order to reduce confusion and increase the appropriation of and adherence to the new CoF recommendations.

Public health campaigns usually struggle to reach populations experiencing social disadvantage [85, 86], even though they are those for whom campaigns would be the most beneficial [87, 88]. In the printed brochure, Santé publique France aimed to give recommendations and messages that are acceptable to the highest number of parents, taking into consideration in particular the populations facing economic difficulties. Several studies with parents [40, 41, 59]—including parents of lowest socioeconomic position- and with professionals who relay these recommendations [41, 83], have informed and validated the formulation choices throughout the design process. A study ensured that reading the messages was associated with an increase in knowledge about child feeding for all parents, not just for parents from higher socio-professional categories [59]. Next, following the communication campaign of the new official printed brochure [36], Santé publique France proposed a variety of tools (videos, tutorials, dedicated pages on the official public health nutrition website [89, 90] and short videos. Then, Santé publique France verified that the campaign reached parents of lowest socioeconomic status [36]. In the moderation analysis, particular attention will be paid to results according to parental socioeconomic position to provide evidence on how to better address social inequalities in health and health literacy in public health campaigns related to feeding very young children. Of note, in

France, the ongoing ECAIL trial specifically targets families experiencing social vulnerabilities and will provide complementary insights into early feeding practices in families of lower socioeconomic position [66]. Whenever possible, the measuring tools used in the NutrienT trial were similar to those used in ECAIL to ensure comparability. However, the ECAIL trial differs from the present study in as much as the intervention comprises financial support to the families in addition to delivery of public health messages.

Throughout the development of the web-based mobile intervention, in order to reinforce the added value of the app (compared to the printed brochure alone), particular attention was drawn on covering the recommendations which were the most difficult to understand (i.e., which generated less improvement in knowledge accuracy or in knowledge certainty) [59]. This was done by repeating advice, simplifying content, and providing tips to parents. In addition, we incorporated components shown to be appreciated and improve user engagement in a previous mHealth obesity prevention intervention (the Growing Healthy programme), including push notifications, personalised messages (to suit each infant's age) and videos [47]. We included a range of BCTs—which are anticipated to generate beneficial results [46, 47, 91, 92]—to guide parents in establishing healthier feeding habits.

Methodological considerations

The study design includes several methodological strengths. The multidisciplinary approach brings together data from behavioural nutrition, public health and social psychology. Evaluation is based on mixed method approaches, including qualitative and quantitative methods with a combination of behavioural evaluations and self-assessments. A follow-up until child age 48 mo will assess sustainability of the effect of the intervention (if any) one year after the end of the intervention. One other strength of this study is the RCT design, and that both participants and researchers are blinded to participants' allocation group. Active recruitment through health professionals is a further strength of this study as it ensures a first face-to-face contact before starting the 33-month digital intervention and is one way to achieve higher enrolment rate in people with lower socioeconomic position [93]. However, the study is fully digitised for the majority of participants (those who are not involved in the laboratory meals for evaluation). This lack of contact could lead to poorer engagement and increased attrition.

This study has some limitations. First, due to the exclusion criteria, the findings may not generalise to second-time parents, non-French speaking parents or parents

whose child suffers from a clinical condition affecting eating. Because of the web-based and mobile intervention design, the study necessarily faces an inclusion bias related to the inaccessibility to the internet (digital divide), which primarily affects people from the lowest socio-economic categories [39, 94, 95]. It is therefore likely that the most disadvantaged populations will be more difficult to reach in this study.

In other respects, the timing of participants' inclusion may not be optimal. The maternity ward is the place that allows approaching the highest number of (first-time) parents. Nevertheless, the period right after the child's birth is a time of major upheaval for parents. This may discourage parents to commit to a 4-year trial and induce an inclusion bias. Finally, midwives are asked to contact all potentially eligible families, but it cannot be excluded that they experience a selection bias. As shown in a nationally representative French birth cohort, selection bias at inclusion is hard to avoid [96].

This is the first randomised controlled trial in France to assess the effect of a web-based and mobile intervention targeted at first-time parents to improve feeding practices and child growth. This study will provide insights into the potential of using digital interventions in public health campaigns related to feeding very young children.

Abbreviations

ANSES	Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (the French Agency for Food, Environmental and Occupational Health & Safety)
BCTs	Behaviour change techniques
BMI	Body mass index
CEB	Children's eating behaviours
CoF	Complementary feeding
EAH	Eating in the absence of hunger
H CSP	Haut conseil de la santé publique (the French High Council for Public Health)
Mo	Months
PWA	Progressive web app
RCT	Randomised controlled trial
yo	Years old

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-024-20057-z>.

Supplementary Material 1.
Supplementary Material 2.
Supplementary Material 3.
Supplementary Material 4.
Supplementary Material 5.
Supplementary Material 6.

Acknowledgements

The authors thank all the participating families, the maternity ward and the two midwives from the university hospital of Dijon for their active involvement in recruiting participants as well as the members of the research team (Pauline Brugaillères, Valérie Feyen, Emilie Szeleper, Betty Hoffarth).

Plans for communicating important protocol modifications

Any substantial changes will be communicated through a statement to the Comité de Protection des Personnes SUD-EST VI Clermont-Ferrand (research ethics committee) with amendments to the initial protocol. The investigators will be responsible for the decision to modify the protocol. Authorship eligibility guidelines will follow INRAE (Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement, National institute for agriculture, food and environment research) guidelines. It is not planned to involve professional writers.

Dissemination policy

The summary of the results of the study will be communicated to participants at completion of the study. Results will be presented to the investigators study group, to healthcare and childcare professionals, and to the public via scientific publications and conferences targeted to scientists and professionals alike.

Author's contributions

CS and SN designed the study concept. SL, DS, ESW provided protocol specifications. CRN designed the intervention content under the supervision of SN, PD, LN, CD. The manuscript draft was written by CRN, SN, SL, PD, LN, CD, ESW and DS provided valuable revisions and comments on later versions of the manuscript and ultimately approved the final version.

Funding

This study is financed exclusively by public funds allocated to Sophie Nicklaus, PhD and Camille Schwartz, PhD (EU ITN-EDULIA project and Amorçage project, Conseil Régional Bourgogne-Franche-Comté, RECO-ALIM-BB (both external resources); and internal resources) and allows the realisation of the study in adequate conditions. These funding sources had no role in the design of this study and will not have any role during its execution, analyses, interpretation of the data, or decision to submit results.

Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

The protocol has been approved by the Comité de Protection des Personnes SUD-EST VI Clermont-Ferrand (research ethics committee) on January 11, 2021 (protocol number ID RCB: 2020-A01941-38). All methods will be conducted in accordance with the ethical standards of the declaration of Helsinki. Informed consent will be taken from the participants in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Centre Des Sciences du Goût Et de L'Alimentation, CNRS, INRAE, Institut Agro, Université de Bourgogne, F-21000 Dijon, France. ²Santé Publique France, French National Public Health Agency, F-94415 Saint-Maurice, France. ³Psy-DREPI (Psychologie: Dynamiques Relationnelles Et Processus Identitaires), Université de Bourgogne, EA 7458, F-21000 Dijon, France. ⁴Department of Neonatal Pediatrics, CHRU Dijon, Dijon University Hospital, Dijon, France. ⁵Université Paris Cité and Université Sorbonne Paris Nord, Inserm, INRAE, Centre for Research in Epidemiology and Statistics (CRESS, F-75004 Paris, France.

Received: 28 July 2023 Accepted: 12 September 2024

Published online: 27 September 2024

References

- ANSES. Étude individuelle nationale des consommations alimentaires 3 (INCA 3) - Rapport d'expertise collective. 2017. <https://www.anses.fr/fr/system/files/NUT2014SA0234Ra.pdf>. Accessed 1 June 2023.

- Chardon OD, Guignon ND, de Saint PT, Guthmann JP, Ragot M, Delmas MC, et al. La santé des élèves de grande section de maternelle en 2013: des inégalités sociales dès le plus jeune âge. *Études et Résultats*. 2015;16(920):1–6.
- Camier A, Hallimat Cissé A, Heude B, Nicklaus S, Chabanet C, Bernard J, et al. Infant feeding practices and BMI up to 7 years in the French nationwide ELFE study. *Pediatr Obes*. 2024;19(7):e13121.
- Singhal A. Long-Term Adverse Effects of Early Growth Acceleration or Catch-Up Growth. *Ann Nutr Metab*. 2017;70(3):236–40.
- Kral TV, Allison DB, Birch LL, Stallings VA, Moore RH, Faith MS. Caloric compensation and eating in the absence of hunger in 5- to 12-y-old weight-discordant siblings. *Am J Clin Nutr*. 2012;96(3):574–83.
- Johnson SL, Birch LL. Parents' and children's adiposity and eating style. *Pediatrics*. 1994;94(5):653–61.
- Carnell S, Benson L, Gibson E, Mais L, Warkentin S. Caloric compensation in preschool children: relationships with body mass and differences by food category. *Appetite*. 2017;116:82–98.
- Fisher JO, Cai G, Jaramillo SJ, Cole SA, Comuzzie AG, Butte NF. Heritability of Hyperphagic Eating Behavior and Appetite-Related Hormones among Hispanic Children. *Obesity*. 2007;15(6):1484–95.
- Brugailères P, Issanchou S, Nicklaus S, Chabanet C, Schwartz C. Caloric compensation in infants: developmental changes around the age of 1 year and associations with anthropometric measurements up to 2 years. *Am J Clin Nutr*. 2019;109(5):1344–52.
- Asta K, Miller AL, Retzlaff L, Rosenblum K, Kaciroti NA, Lumeng JC. Eating in the Absence of Hunger and Weight Gain in Low-income Toddlers. *Pediatrics*. 2016;137(5):e20153786.
- Huang JY, Qi SJ. Childhood obesity and food intake. *World J Pediatr*. 2015;11(2):101–7.
- Nicklaus S. The role of food experiences during early childhood in food pleasure learning. *Appetite*. 2016;104:3–9.
- Schwartz C, Scholtens PAMJ, Lalanne A, Weenen H, Nicklaus S. Development of healthy eating habits early in life Review of recent evidence and selected guidelines. *Appetite*. 2011;57(3):796–807.
- Brugailères P, Chabanet C, Issanchou S, Schwartz C. Caloric compensation ability around the age of 1 year: Interplay with the caregiver-infant mealtime interaction and infant appetitive traits. *Appetite*. 2019;142:104382.
- Jansen E, Williams KE, Mallan KM, Nicholson JM, Daniels LA. Bidirectional associations between mothers' feeding practices and child eating behaviours. *Int J Behav Nutr Phys Act*. 2018;15(1):3.
- Black MM, Aboud FE. Responsive Feeding Is Embedded in a Theoretical Framework of Responsive Parenting. *J Nutr*. 2011;141(3):490–4.
- Pérez-Escamilla R, Segura-Pérez S, Hall Moran V. Dietary guidelines for children under 2 years of age in the context of nurturing care. *Matern Child Nutr*. 2019;15(3):e12855.
- DiSantis KI, Hodges EA, Johnson SL, Fisher JO. The role of responsive feeding in overweight during infancy and toddlerhood: a systematic review. *Int J Obes*. 2011;35(4):480–92.
- Bell LK, Gardner C, Tian EJ, Cochet-Broch MO, Poelman AAM, Cox DN, et al. Supporting strategies for enhancing vegetable liking in the early years of life: an umbrella review of systematic reviews. *Am J Clin Nutr*. 2021;113(5):1282–300.
- Demonteil L, Tournier C, Marduel A, Dusoulier M, Weenen H, Nicklaus S. Longitudinal study on acceptance of food textures between 6 and 18 months. *Food Qual Prefer*. 2019;71:54–65.
- Tournier C, Demonteil L, Ksiazek E, Marduel A, Weenen H, Nicklaus S. Factors Associated With Food Texture Acceptance in 4- to 36-Month-Old French Children: Findings From a Survey Study. *Front Nutr*. 2021;1(7):616484.
- Tournier C, Bernad C, Madrelle J, Delarue J, Cuvelier G, Schwartz C, et al. Fostering infant food texture acceptance: A pilot intervention promoting food texture introduction between 8 and 15 months. *Appetite*. 2021;158:104989.
- Fewtrell M, Bronsky J, Campoy C, Domellöf M, Embleton N, Fidler Mis N, et al. Complementary Feeding: A Position Paper by the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) Committee on Nutrition. *J Pediatr Gastroenterol Nutr*. 2017;64(1):119–32.

24. Lahlou S. Les représentations du bien manger. In: Nicolas F, Valceschini E, editors. *Agro-alimentaire: une économie de la qualité*. Institut National de la Recherche Agronomique, Paris: France; 1995. p. 51–64.
25. Lavallée M, Garnier C, Quesnel M, Marchildon A, Bouchard L. Les représentations sociales de l'alimentation : convergences et divergences entre enfants, parents et enseignants. *Rev Univ Monct*. 2005;35(2):101–29.
26. Sammut G, Andreouli E, Gaskell G, Valsiner J. *The Cambridge Handbook of Social Representations*. 1st Ed. Cambridge University Press; 2015.
27. Sibley CG, Liu JH, Kirkwood S. Toward a Social Representations Theory of Attitude Change: The Effect of Message Framing on General and Specific Attitudes toward Equality and Entitlement. *N Z J Psychol*. 2006;35:3–13.
28. McNally J, Hugh-Jones S, Caton S, Vereijken C, Weenen H, Hetherington M. Communicating hunger and satiation in the first 2 years of life: a systematic review: Hunger and satiation in the first 2 years of life. *Matern Child Nutr*. 2016;12(2):205–28.
29. Boundy EO, Fisher Boyd A, Hamner HC, Belay B, Liebhart JL, Lindros J, et al. US Pediatrician Practices on Early Nutrition, Feeding, and Growth. *J Nutr Educ Behav*. 2020;52(1):31–8.
30. de Lauzon-Guillain B, Musher-Eizenman D, Leporc E, Holub S, Charles MA. Parental Feeding Practices in the United States and in France: Relationships with Child's Characteristics and Parent's Eating Behavior. *J Am Diet Assoc*. 2009;109(6):1064–9.
31. Matvienko-Sikar K, Griffin C, Kelly C, Heary C, Lillholm Pico Pedersen M, McGrath N, et al. A core outcome set for trials of infant-feeding interventions to prevent childhood obesity. *Int J Obes*. 2020 Oct;44(10):2035–43.
32. Matvienko-Sikar K, Toomey E, Delaney L, Harrington J, Byrne M, Kearney PM. Effects of healthcare professional delivered early feeding interventions on feeding practices and dietary intake: A systematic review. *Appetite*. 2018;123:56–71.
33. Spill MK, Callahan EH, Shapiro MJ, Spahn JM, Wong YP, Benjamin-Neelon SE, et al. Caregiver feeding practices and child weight outcomes: a systematic review. *Am J Clin Nutr*. 2019;1(109):990S–1002S.
34. Savage JS, Birch LL, Marini M, Anzman-Frasca S, Paul IM. Effect of the INSIGHT Responsive Parenting Intervention on Rapid Infant Weight Gain and Overweight Status at Age 1 Year: A Randomized Clinical Trial. *JAMA Pediatr*. 2016;170(8):742.
35. Lioret S, Harrar F, Boccia D, Hesketh KD, Kuswara K, Van Baaren C, et al. The effectiveness of interventions during the first 1,000 days to improve energy balance-related behaviors or prevent overweight/obesity in children from socio-economically disadvantaged families of high-income countries: a systematic review. *Obes Rev*. 2023;24(1):e13524.
36. Delamaire C, Noirot L. Designing the new recommendations on complementary feeding for children up to 3 years of age. *Saint-Maurice : Santé publique France*. 2022. <https://www.santepubliquefrance.fr/determinants-de-sante/nutrition-et-activite-physique/documents/rapport-synthese/designing-the-new-recommendations-on-complementary-feeding-for-children-up-to-3-years-of-age>. Accessed 28 Nov 2022.
37. Santé publique France. Pas à pas votre enfant mange comme un grand - Le petit guide de la diversification alimentaire. 2022. <https://www.santepubliquefrance.fr/determinants-de-sante/nutrition-et-activite-physique/documents/brochure/pas-a-pas-votre-enfant-mange-comme-un-grand>. Accessed 28 Nov 2022.
38. Combes G. Santé et nouvelles technologies de l'information. *Health and new information technologies*. 2002;31:773.
39. Legleye S, Nougaret A, Viard-Guillot L. 94 % des 15–29 ans ont un smartphone en 2021. 2022. <https://www.insee.fr/fr/statistiques/6036909>. Accessed 28 Nov 2022.
40. De Rosso S, Nicklaus S, Ducrot P, Schwartz C. Information seeking of French parents regarding infant and young child feeding: practices, needs and determinants. *Public Health Nutr*. 2021;25(4):879–92.
41. De Rosso S, Schwartz C, Ducrot P, Nicklaus S. The Perceptions and Needs of French Parents and Pediatricians Concerning Information on Complementary Feeding. *Nutrients*. 2021;13(7):2142.
42. Tate EB, Spruijt-Metz D, O'Reilly G, Jordan-Marsh M, Gotsis M, Pentz MA, et al. mHealth approaches to child obesity prevention: successes, unique challenges, and next directions. *Transl Behav Med*. 2013;3(4):406–15.
43. Dennison L, Morrison L, Conway G, Yardley L. Opportunities and challenges for smartphone applications in supporting health behavior change: qualitative study. *J Med Internet Res*. 2013;15(4):e86.
44. Russell CG, Denney-Wilson E, Laws RA, Abbott G, Zheng M, Lymer SJ, et al. Impact of the Growing Healthy mHealth Program on Maternal Feeding Practices, Infant Food Preferences, and Satiation Responsiveness: Quasi-Experimental Study. *JMIR MHealth UHealth*. 2018;6(4):e77.
45. Taki S, Lymer S, Russell CG, Campbell K, Ong KL, Elliott R, et al. Assessing User Engagement of an mHealth Intervention: Development and Implementation of the Growing Healthy App Engagement Index. *JMIR MHealth UHealth*. 2017;5(6):e89.
46. Laws RA, Denney-Wilson EA, Taki S, Russell CG, Zheng M, Litterbach EK, et al. Key Lessons and Impact of the Growing Healthy mHealth Program on Milk Feeding, Timing of Introduction of Solids, and Infant Growth: Quasi-Experimental Study. *JMIR MHealth UHealth*. 2018;6(4):e78.
47. Taki S, Russell CG, Lymer S, Laws R, Campbell K, Appleton J, et al. A Mixed Methods Study to Explore the Effects of Program Design Elements and Participant Characteristics on Parents' Engagement With an mHealth Program to Promote Healthy Infant Feeding: The Growing Healthy Program. *Front Endocrinol*. 2019;25(10):397.
48. Ekambareshwar M, Taki S, Mihrshahi S, Baur LA, Rissel C, Wen LM. Participant Experiences of an Infant Obesity Prevention Program Delivered via Telephone Calls or Text Messages. 2020;8(1):60.
49. Helle C, Hillesund ER, Wills AK, Øverby NC. Evaluation of an eHealth intervention aiming to promote healthy food habits from infancy -the Norwegian randomized controlled trial Early Food for Future Health. *Int J Behav Nutr Phys Act*. 2019;16(1):1.
50. Dunn DT, Copas AJ, Brocklehurst P. Superiority and non-inferiority: two sides of the same coin? *Trials*. 2018;19(1):499.
51. Lesaffre E. Superiority, equivalence, and non-inferiority trials. *Bull NYU Hosp Jt Dis*. 2008;66(2):150–4.
52. Moher D, Hopewell S, Schulz KF, Montori V, Gotzsche PC, Devereaux PJ, et al. CONSORT 2010 Explanation and Elaboration: updated guidelines for reporting parallel group randomised trials. *BMJ*. 2010;23(340):c869–c869.
53. Nutrient Progressive Web Application. <https://www.etude-nutrient.fr/>. Accessed 1 June 2023.
54. Ibanez G, Martin N, Denantes M, Saurel-Cubizolles MJ, Ringa V, Magnier AM. Prevalence of breastfeeding in industrialized countries. *Rev Epidemiol Santé Publique*. 2012;60(4):305–20.
55. Blondel B, Coulm B, Bonnet C, Goffinet F, Le Ray C. Trends in perinatal health in metropolitan France from 1995 to 2016: Results from the French National Perinatal Surveys. *J Gynecol Obstet Hum Reprod*. 2017;46(10):701–13.
56. ANSES, Saisine n°2017-SA-0145. Avis de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail relatif à l'actualisation des repères alimentaires du PNNS pour les enfants de 0 à 3 ans. 2019. <https://www.anses.fr/fr/content/avis-de-lanses-relatif-%C3%A0-lactualisation-des-rep%C3%A8res-alimentaires-du-pnns-jeunes-enfants-0-3>. Accessed 28 Nov 2022.
57. HCSP, Avis relatif à la révision des repères alimentaires pour les enfants âgés de 0–36 mois et de 3–17 ans, 2020. <https://www.hcsp.fr/explore.cgi/avisrapportsdomaine?clefr=924>. Accessed 28 Nov 2022.
58. INPES, PNNS. La santé vient en mangeant - Le guide parents 0–3 ans. 2005. https://sante.gouv.fr/IMG/pdf/guide0_3ans.pdf. Accessed 1 June 2023.
59. De Rosso S, Ducrot P, Chabanet C, Nicklaus S, Schwartz C. Increasing Parental Knowledge About Child Feeding: Evaluation of the Effect of Public Health Policy Communication Media in France. *Front Public Health*. 2022;24(10):782620.
60. Michie S, van Stralen MM, West R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implement Sci*. 2011;6(1):42.
61. WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards based on length/height, weight and age. *Acta Paediatr Suppl*. 2006;450:76–85.
62. Rigal N, Chabanet C, Issanchou S, Monnery-Patris S. Links between maternal feeding practices and children's eating difficulties. Validation of French tools Appetite. 2012;58(2):629–37.
63. Musher-Eizenman D, Holub S. Comprehensive Feeding Practices Questionnaire: Validation of a New Measure of Parental Feeding Practices. *J Pediatr Psychol*. 2007;32(8):960–72.
64. Jansen E, Williams KE, Mallan KM, Nicholson JM, Daniels LA. The Feeding Practices and Structure Questionnaire (FPSQ-28): A parsimonious

- version validated for longitudinal use from 2 to 5 years. *Appetite*. 2016;100:172–80.
65. McCurdy K, Gorman KS. Measuring family food environments in diverse families with young children. *Appetite*. 2010;54(3):615–8.
 66. Lioret S. The prEgnanCy and eArly Childhood nutrItion trial (ECAIL). 2016. <https://clinicaltrials.gov/ct2/show/NCT03003117>. Accessed 28 Nov 2022.
 67. Nicklaus S, Schwartz C, Monnery-Patris S, Issanchou S. Early Development of Taste and Flavor Preferences and Consequences on Eating Behavior. In: Henry CJ, Nicklas TA, Nicklaus S, editors. *Nurturing a Healthy Generation of Children: Research Gaps and Opportunities*. Nestlé Nutrition Institute Workshop Series vol.91. Karger AG; 2019. p. 1–10.
 68. Monnery-Patris S, Rigal N, Peteuil A, Chabanet C, Issanchou S. Development of a new questionnaire to assess the links between children's self-regulation of eating and related parental feeding practices. *Appetite*. 2019;138:174–83.
 69. Lakshman RR, Landsbaugh JR, Schiff A, Hardeman W, Ong KK, Griffin SJ. Development of a questionnaire to assess maternal attitudes towards infant growth and milk feeding practices. *Int J Behav Nutr Phys Act*. 2011;8(1):35.
 70. Cascales T. A French version of the IBQ-R, translated by Thomas Cascales (Gartstein, M. A., Rothbart, M. K. Studying infant temperament via the Revised Infant Behavior Questionnaire. *Infant Behavior and Development*. 2003;26(1):64–86.
 71. Hager ER, McGill AE, Black MM. Development and Validation of a Toddler Silhouette Scale. *Obesity*. 2010;18(2):397–401.
 72. Birch L, Deysher M. Calorie compensation and sensory specific satiety: Evidence for self regulation of food intake by young children. *Appetite*. 1986;7(4):323–31.
 73. Fisher JO, Birch LL. Restricting Access to Foods and Children's Eating. *Appetite*. 1999;32(3):405–19.
 74. Sall NS, Bégin F, Dupuis JB, Bourque J, Menasria L, Main B, et al. A measurement scale to assess responsive feeding among Cambodian young children. *Matern Child Nutr*. 2020;16(3):e12956.
 75. Pérez-Escamilla R, Segura-Pérez S. Can a pragmatic responsive feeding scale be developed and applied globally? *Matern Child Nutr*. 2020;16(3):e13004.
 76. Müller C, Chabanet C, Zeinstra GG, Jager G, Schwartz C, Nicklaus S. The sweet tooth of infancy: Is sweetness exposure related to sweetness liking in infants up to 12 months of age? *Br J Nutr*. 2022;111:1–11.
 77. Yuan WL, Nicklaus S, Lioret S, Lange C, Forhan A, Heude B, et al. Early factors related to carbohydrate and fat intake at 8 and 12 months: results from the EDEN mother–child cohort. *Eur J Clin Nutr*. 2017;71(2):219–26.
 78. de Boer MR, Waterlander WE, Kuijper LD, Steenhuis IH, Twisk JW. Testing for baseline differences in randomized controlled trials: an unhealthy research behavior that is hard to eradicate. *Int J Behav Nutr Phys Act*. 2015;12(1):4.
 79. Gunzler D, Chen T, Wu P, Zhang H. Introduction to mediation analysis with structural equation modeling. 2013;25(6):5.
 80. Hanisch C, Hautmann C, Plücker J, Eichelberger I, Döpfner M. The prevention program for externalizing problem behavior (PEP) improves child behavior by reducing negative parenting: analysis of mediating processes in a randomized controlled trial. *J Child Psychol Psychiatry*. 2014;55(5):473–84.
 81. Rijnhart JJM, Twisk JWR, Chinapaw MJM, de Boer MR, Heymans MW. Comparison of methods for the analysis of relatively simple mediation models. *Contemp Clin Trials Commun*. 2017;7:130–5.
 82. Dong Y, Peng CYJ. *Principled missing data methods for researchers*. Springerplus. 2013;2(1):222.
 83. De Rosso S, Riera-Navarro C, Ducrot P, Schwartz C, Nicklaus S. Counseling parents about child feeding: a qualitative evaluation of French doctors and health/childcare professionals' experiences and perception of a brochure containing new recommendations. *BMC Public Health*. 2022;22(1):2303.
 84. Chouraqui JP, Delmas B, Le Bris M, Bellaïche M, Jung C, Hanh T. Physicians advice, parental practice and adherence to doctor's advice: an original survey on infant feeding. *BMC Pediatr*. 2019;19(1):313.
 85. Dhuot R. La genèse précoce des différences sociales dans les habitudes alimentaires. 2018. <https://theses.hal.science/tel-02069319>. Accessed 1 June 2023.
 86. Régnier F, Masullo A. Une affaire de goût? Réception et mise en pratique des recommandations nutritionnelles. 2008. <https://hal.inrae.fr/hal-02823372>. Accessed 1 June 2023.
 87. Buoncristiano M, Williams J, Simmonds P, Nurk E, Ahrens W, Nardone P, et al. Socioeconomic inequalities in overweight and obesity among 6- to 9-year-old children in 24 countries from the World Health Organization European region. *Obes Rev*. 2021;22(Suppl 6):e13213.
 88. Lioret S, Campbell KJ, McNaughton SA, Cameron AJ, Salmon J, Abbott G, et al. Lifestyle Patterns Begin in Early Childhood, Persist and Are Socioeconomically Patterned, Confirming the Importance of Early Life Interventions. *Nutrients*. 2020;12(3):724.
 89. Manger Bouger website. <https://www.mangerbouger.fr/>. Accessed 1 June 2023.
 90. 1000 premiers jours - Là où tout commence. <https://www.1000-premiers-jours.fr>. Accessed 1 June 2023.
 91. Taki S, Russell CG, Wen LM, Laws RA, Campbell K, Xu H, et al. Consumer Engagement in Mobile Application (App) Interventions Focused on Supporting Infant Feeding Practices for Early Prevention of Childhood Obesity. *Front Public Health*. 2019;22(7):60.
 92. Jiang H, Li M, Wen LM, Baur LA, He G, Ma X, et al. A Short Message Service Intervention for Improving Infant Feeding Practices in Shanghai, China: Planning, Implementation, and Process Evaluation. *JMIR MHealth UHealth*. 2018;6(10):e11039.
 93. Al-Dhahir I, Reijnders T, Faber JS, Janssen V, Kraaijenhagen R, Visch VT, et al. The Barriers and Facilitators of eHealth-Based Lifestyle Intervention Programs for People With a Low Socioeconomic Status: Scoping Review. *J Med Internet Res*. 2022;24(8):e34229.
 94. Régnier F, Adamiec C. Les outils numériques pour réduire la fracture alimentaire ? Étude sociologique de deux dispositifs à destination des catégories modestes. *Cah Nutr Diététique*. 2019;54(6):326–35.
 95. CREDOC. Baromètre du numérique - Enquête sur la diffusion des technologies de l'information et de la communication dans la société française. 2021. <https://www.credoc.fr/publications/barometre-du-numerique-edition-2021>. Accessed 28 Nov 2022.
 96. Charles MA, Thierry X, Lanoe JL, Bois C, Dufourg MN, Popa R, et al. Cohort Profile: The French national cohort of children (ELFE): birth to 5 years. *Int J Epidemiol*. 2020;49(2):368–369j.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.