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mixed methods findings from the Generation Healthy Kids feasibility study**

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Published in:
BMC Public Health

DOI:
[10.1186/s12889-024-20605-7](https://doi.org/10.1186/s12889-024-20605-7)

Publication date:
2024

Document version:
Final published version

Document license:
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Citation for pulished version (APA):

Lund, L., Brautsch, L. A. S., Hoeeg, D., Pedersen, N. H., Thomsen, L. T., Larsen, M. N., Krustrup, P., Damsgaard, C. T., Toft, U., & Krølner, R. F. (2024). Feasibility and acceptability of school-based intervention components to promote healthy weight and well-being among 6–11-year-olds in Denmark: mixed methods findings from the Generation Healthy Kids feasibility study. *BMC Public Health*, 24, Article 3208. <https://doi.org/10.1186/s12889-024-20605-7>

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Feasibility and acceptability of school-based intervention components to promote healthy weight and well-being among 6–11-year-olds in Denmark: mixed methods findings from the Generation Healthy Kids feasibility study

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Abstract

Background Overweight and obesity among children is a serious public health challenge worldwide which may lead to a range of negative physical, mental, and social consequences in childhood and later in life. There is a strong need for developing new innovative, integrated approaches and programs which can prevent overweight in children effectively and can be embedded into everyday practices. The Generation Healthy Kids intervention is a multi-component, multi-setting intervention aiming to promote healthy weight and well-being in children aged 6–11 years in Denmark. The present study investigates the feasibility and acceptability of 10 selected school-based intervention components and barriers and facilitators for implementation.

Methods A seven-week feasibility study was conducted in January to March 2023 among children in 1st and 2nd grade at a Danish public school, testing the multi-component intervention targeting children's meal-, physical activity-, sleep- and screen habits. Process evaluation data were collected using multiple methods (surveys, log-books, evaluation sheets, registrations, counts, interviews, and observations) and data sources (parents, school staff, and school leader).

Results Most intervention components were feasible to deliver at the school, but only four components were fully delivered as intended, while the remaining components to some or low degree were delivered as intended. Some components were found acceptable by all/nearly all children (e.g., 40 min of high intensity training three times a week), and others by some or few children (e.g., reusable water bottles and midmorning snack). Intervention activities for the parents and families were found acceptable by all/nearly all participating parents. Parents' acceptability of the intervention activities delivered to their children at school could not be assessed, as only few parents

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participated in surveys and none in interviews. School staff's acceptability of the intervention tasks they were asked to deliver varied but was overall relatively high. Facilitators and barriers for implementation of intervention components were identified at both individual-, school class-, and school level.

Conclusions The study underlines the importance of conducting feasibility studies as preparation for large trials. The findings will be used to refine intervention components, implementation strategies and data collection procedures before the Generation Healthy Kids main trial.

Keywords Feasibility study, Multi-component intervention, School-based intervention components, Physical activity, Diet, Screen media use, Sleep, Prevention of overweight

Background

Childhood overweight and obesity is one of the most serious public health challenges worldwide [1]. It is estimated that almost 18% (i.e., more than 340 million) children and adolescents have overweight or obesity, and the prevalence is increasing almost everywhere [2]. In Denmark, 12–13% of children have overweight or obesity at age 6–7 years when they enter primary school [3], and this increases to 18–19% at age 14–15 years [3] and 53% in adulthood [4, 5]. Children with overweight and obesity are in increased risk of experiencing reduced self-esteem, bullying or stigmatization, and low quality of life in childhood [6–8], and of having overweight and obesity as adults [9] with increased risk of severe health conditions such as cardiovascular disease, diabetes, some cancer types, and premature mortality [10]. Most intervention studies aiming to prevent childhood overweight and obesity have found only small or no effects on children's body mass index (BMI), and the evidence of long-term effects is limited [11–18]. Thus, there is a strong need for developing effective, universal, innovative, and integrated approaches and programs to prevent overweight among children which can start early in life and be embedded into everyday practices.

Based on this rationale, we developed the Generation Healthy Kids (GHK) intervention to promote healthy weight development and well-being in Danish children aged 6–11 years. The intervention development was guided by the Medical Research Council (MRC) framework [19] and combined promising characteristics and elements for effective prevention of childhood overweight and obesity identified in the literature, such as being a multi-component and multi-setting intervention [14, 15, 20–23]; focusing on several health behaviours/risk factors for unhealthy weight simultaneously [11, 14, 18]; combining educational and environmental intervention components [11, 20, 24] and actively involving parents [14, 15]. The innovative aspect of the study is the combination of a randomized controlled trial with community capacity building and a systems approach [25], i.e., the integrated intervention program combines already tested effective intervention strategies with

intervention components developed using co-creation and systems approaches. The intervention targets all children in the targeted age groups, and has a specific focus on reaching children and families with low socio-economic status as they have a markedly higher prevalence of overweight and obesity [3]. Overall, the intervention aims to make healthy choices easier by creating healthy environments around the children, both at school and during leisure time. The effectiveness of the GHK intervention will be tested in a two-school-year cluster-randomized controlled main trial, initiated fall/winter 2023, with more than 1300 children attending 1st and 2nd grade at inclusion (i.e., aged 6–9 years) in 23 school districts in selected municipalities [26].

Although a thorough intervention development is an essential first step, it is not sufficient for ensuring feasibility and quality of the intervention program and study design. The MRC framework recommends a feasibility and piloting phase in which process evaluation has a vital role in understanding main uncertainties related to the feasibility and acceptability of the intervention components. This knowledge can be used to optimize intervention design and evaluation procedures before the main trial [27]. Feasibility studies thereby have the potential to avoid waste in research by reducing the risk of testing and committing resources to a trial that is likely to 'fail' [28].

Thus, to test our main uncertainties regarding recruitment of participants, data collection procedures, local community capacity building and implementation of intervention components, we conducted a thorough feasibility study prior to the main trial. The present study aims to explore the feasibility and acceptability of the preliminary version of a selected number of the school-based intervention components of the GHK intervention delivered to children and parents. We investigated the following overall themes and research questions:

- 1) *Feasibility and fidelity*: Is it feasible to deliver the planned intervention components in the school context? Are the intervention components delivered as intended? Which adaptations are made?

- 2) *Participant responsiveness and reach*: Do children, parents and school staff find the intervention components acceptable and/or satisfactory? I.e., are all children and parents reached by the intervention activities, and how do children, parents, and school staff interact with the intervention components?
- 3) *Barriers and facilitators*: Which contextual factors facilitate or limit the implementation of the intervention components?

This paper evaluates selected GHK intervention components delivered at school focusing on food and nutrition, physical activity, and sleep and screen media habits. Evaluation of other central parts of the feasibility study (including the process for participant recruitment, the children's acceptability of data collection procedures, and the local community intervention focusing on co-creating and implementing intervention activities in collaboration with local stakeholders) is reported elsewhere [29].

Methods

Study design, setting, and population

The GHK feasibility study was conducted from December 2022 to May 2023 [29]. This process evaluation focuses on selected school-based intervention components implemented during a seven-week period from January 23 to March 19, 2023 (i.e., eight weeks excluding one week winter holiday), among 1st and 2nd grade children at one public school in the eastern part of Denmark.

In the included classes, i.e., two 1st and three 2nd grade classes (including a remedial class, i.e., a 2nd/3rd grade class for children with special needs), approx. 44–55% of the children had parents with vocational education as the highest completed educational level, and approx. 23–24% had parents with another ethnicity than Danish (data obtained from Ministry of Children and Education, 2023).

According to the school management, usual practice in the 1st and 2nd grade classes at the school, i.e., prior to the initiation of the present study, was that 1) the children brought their own (often poor nutritional quality) midmorning snack and packed lunch from home, 2) there were no health pedagogical principles for the school staff to follow during the lunch meal, 3) the children brought their own drinks from home or could get water from the water taps in the classroom or toilets, 4) the children had two scheduled sports lessons per week (plus ad hoc physical activity during school hours) with no requirements to the intensity, 5) the children did not use iPad or PC in class yet, but all children would get a PC in 3rd grade, and 6) teachers collected all mobile phones from the children in the morning and returned them after school hours; smartwatches were not collected and often caused

disruptions during school hours from e.g., parents calling their children.

All children ($n=81$) in the five classes received the intervention components during school hours and were invited with their families for intervention activities conducted outside school hours. Forty-four of the children (54%) were formally enrolled in the study by parental consent and therefore also participated in the testing of the acceptability of the biomedical measurement schedule, reported elsewhere [29]. Thirteen school staff members (i.e., teachers and pedagogues) were involved in delivering the intervention components, and one school leader was responsible for coordinating the conduct of the study with the research group.

Intervention components

A total of 10 main intervention components of the GHK study were selected for the school-based process evaluation. These 10 components were selected based on the criteria of being 1) pre-defined by the research group based on previous evidence (e.g., [30–36]) and experiences, and 2) mandatory for the research group and school staff to deliver during the study period. The components are shown in Table 1 and described in detail elsewhere [29]. School staff and the research group delivered four and six of the intervention components, respectively, to the children and/or their families. All content and materials for the school staff-delivered components were provided to the school by the research group. All intervention components were provided free of charge to all children and parents in the included classes (i.e., irrespective of whether the child was enrolled in the study's biomedical measurement schedule) to create equal access to the components.

Implementation strategies

To facilitate implementation, the following implementation strategies [37] were applied:

Education of school staff in delivery of intervention components. Prior to the study, school staff involved in teaching of 1st and 2nd grades were invited to participate in one or more of the following three preparatory courses, depending on their role in the class during the study: 1) a 4-h course on food and nutrition focusing on nutrition and the pedagogical aspects of food and eating, and preparing staff for eating midmorning snack and lunch with the children; 2) a 6-h course on FIT FIRST 10 including peer supervision on the FIT FIRST 10 concept, preparing staff for undertaking FIT FIRST sessions with the children; and 3) a 3-h course for the teachers in charge of the classes on children's screen media and

Table 1 The 10 selected Generation Healthy Kids school-based intervention components: aims and content**Intervention kick-off***Delivered by the research group:***Family evening**

A three-hour family evening for the children, parents, and siblings with information, tips, exercises, and games related to both food and nutrition (30 min), physical activity (30 min), and screen media habits (30 min). The goal of the event was to 'kick start' the intervention at school. The family evening included free dinner to motivate participation

Food and nutrition*Delivered by school staff:***Midmorning snack & cold, pre-prepared do-it-yourself lunch at school four days a week**

The meals were based on the national Danish food-based dietary guidelines [30] and the Nordic Nutrition Recommendations [31] and sought to promote a balanced energy intake and increase the intake of wholegrains, fruits, vegetables and legumes, and fish, and reduce the intake of sugar. The lunch was accompanied by health pedagogical principles for school staff to promote 'the good school meal situation': 1) *school staff as role models*, e.g., focusing on the meal, eating with the children, guiding the language around the food (positive conversations), and encouraging the children to taste; 2) *involvement of the children*, e.g., the children take turns being 'table heroes' setting the table, presenting the food to the class, etc., and all children eat in small table groups sharing the food; 3) *sufficient time* for the children to e.g., eat enough, put everything on the plate and investigate new food with all senses, and experience class community during the meal; and 4) *Parental support*, e.g., parents should not provide additional lunch from home [32, 33]

*Delivered by the research group:***A cold-water dispenser at school & a reusable water bottle for each child**

To encourage water consumption

Physical activity*Delivered by school staff:***3 x 40 min per week of organized vigorous physical activity during school hours (FIT FIRST 10)**

The sessions encompassed modified and varied sporting activities and games promoting motivation, active involvement of all children, and high intensity. These 40-min sessions were developed to achieve at least 30 min of varied, vigorous activity in relation to cardiopulmonary and musculoskeletal loading for all children, irrespectively of sex, fitness levels, skills, and prior experience with sporting activities, and to promote joy through play-based activities and to challenge the children's motor competences and physical capacity adequately [34]

*Delivered by the research group:***Packages of loose play and sports equipment for school recess for participating school classes**

To increase the children's daily amount of physical activity [35, 36], the participating school classes received skipping ropes, frisbees, street chalk, cones, handballs, footballs, and tennis balls for use during recess

Sleep and screen media habits*Delivered by school staff:***Screen media habits assignment in class**

To make the children reflect on their screen media habits, school staff were asked to conduct the assignment 'The Digital Barometer' from The Danish Media Council [In Danish: 'Medierådet'] with the children during school hours

*Delivered by the research group:***Three inspiration sheets for parents on screen media habits and sleep**

Parents received three inspiration sheets introducing knowledge about and recommendations for screen media habits and sleep, potential tools to address knowledge and comply with recommendations, as well as suggestions for child and parent activities to support dialogues about sleep and screen media habits

Parent workshop on screen media habits

A three-hour workshop with information and dialogue focusing on children's screen media practices. The workshop presented the results of the assignment 'The Digital Barometer' which the children completed during school hours. The goal of the workshops was to increase parent knowledge on their own and their children's screen media practices, strengthen the dialogue with other parents, their own child, and between children within the provided subject (e.g., evening screen media use). The workshop included free dinner and childcare to motivate participation

sleep habits, presenting evidence and recommendations and preparing teachers to conduct assignments on screen media habits in the class.

Provision of intervention manuals to school staff. School staff were provided with the official FIT FIRST 10 manual (specifying the required content, duration, intensity, etc. of the FIT FIRST 10 sessions) as well as manuals developed for the present study with optional competence-building exercises and

assignments within food and screen media habits to be used in class with the children.

Financial support to school (study funding). The school was compensated for the time school staff spent attending the preparatory courses, and an external kitchen assistant was paid to arrange the delivered pre-made lunch for the children at the school.

Dialogue between research group, school management, and school staff. The research group was in

continuous dialogue with both school management and staff to answer questions and solve potential problems related to the intervention components.

Overall theoretical approach of the evaluation

The evaluation was guided by the MRC framework for conducting process evaluation studies [27]. The MRC framework focuses on three main themes: 1) implementation (what is implemented, and how?), 2) mechanisms of impact (how does the delivered intervention produce change?), and 3) context (how does context affect implementation and outcomes?). Our study focused on two of these themes, i.e., implementation and context. Furthermore, the key recommendations of the MRC framework facilitated the planning and conduct of the evaluation [19, 27].

The evaluation of feasibility and acceptability of the school-based intervention components was planned and conducted on basis of the following two Key Performance Indicators (KPIs) agreed upon by the study management and funding body:

- Minimum 85% of activities should be fully delivered as intended, and
- Minimum 85% of participants and stakeholders should find the program acceptable and/or satisfactory.

The KPIs were used to report feedback to the funding body and served as pre-defined ambitions guiding the need for adjustments to the intervention design prior to the main trial.

Overall, the data collection was guided by key process evaluation concepts [38–42] (Table 2) deemed to be relevant on basis of the KPIs and inspired by existing

guidance for applying mixed methods to feasibility studies [43].

Measures

Delivery

We operationalized delivery of each intervention component to the children and/or families by selecting and defining one or more criteria for successful delivery (Table 3, second column). For intervention components with more than one criterium necessary for the assessment of delivery, an overall judgement across all criteria determined the level of delivery. We divided degree of delivery into three categories: “Fully delivered as intended”, i.e., according to the KPI, “To some degree delivered as intended”, and “To a low degree delivered as intended”.

Acceptability

For children and parents, level of acceptability of each intervention component was determined by assessing the proportion of children/parents participating in each intervention activity, and/or the proportion of children/parents liking/being satisfied with each intervention activity. For school staff, levels of acceptability were assessed only for the two most comprehensive intervention components, i.e., the lunch scheme and the FIT FIRST 10 sessions, and were determined by assessing the proportion of school staff members feeling capable of delivering each of the intervention components. The level of acceptability was assessed and reported according to the KPI.

Context

We explored contextual facilitators and barriers for implementation of the intervention components through field work, i.e., a specific focus was on noticing any factors and mechanisms within the specific school context promoting or limiting the implementation process. We

Table 2 Key process evaluation concepts

Feasibility	The extent to which an intervention can be delivered or carried out within a given setting
Delivery	
Fidelity	The extent to which the intervention activities are delivered by the intervention providers as planned and are true to the ‘spirit of the intervention’
Dose delivered	The amount of each intervention activity delivered by the intervention providers
Adaption	Changes made by intervention providers to the original intervention activity during implementation
Acceptability	
Reach	The proportion of intended intervention recipients participating in each intervention activity
Participant responsiveness	How the intervention providers and recipients interact and are satisfied with the intervention activities
Context	Aspects of the physical, social, and economic environment that may influence delivery and acceptance of the intervention
Implementation	A composite score indicating the extent to which the intervention has been implemented and received by the intervention providers and recipients

Table 3 Delivery and acceptability of the 10 selected school-based Generation Heathy Kids intervention components, according to the Key Performance Indicators

Intervention component	Delivery	Acceptability
	Pre-specified criteria for successful delivery	Did a minimum of 85% find the intervention component acceptable and/or satisfactory? (Data)
Family evening across the themes of food & nutrition, physical activity, and screen media habits	<ul style="list-style-type: none"> • One family evening to be conducted • The workshop should contain sessions focusing on each of the three themes food & nutrition, physical activity, and screen media habits. Approx. 30 min should be allocated for each theme 	<p>Fully delivered as intended</p> <ul style="list-style-type: none"> • One family evening was conducted • The family evening included 30 min sessions on each of the three intended themes (Counts and registration by the research group) <p>Parents</p> <p>Yes (Counts, evaluation sheets for parents, and observations)</p>
Midmorning snack at school	<ul style="list-style-type: none"> • A midmorning snack should be delivered to the children four days a week throughout the study period 	<p>To a low degree delivered as intended</p> <ul style="list-style-type: none"> • Not delivered throughout the study period • Adaptations made by school staff compromised the healthiness of the mid-morning snack (Registration by the research group and observations) <p>Children</p> <p>No (School staff questionnaire, counts, and observations)</p>
Cold, pre-prepared do-it-yourself lunch at school	<ul style="list-style-type: none"> • A lunch meal should be delivered to the children four days a week throughout the study period • The school staff should adhere to the study's health pedagogical principles during the lunch break 	<p>To some degree delivered as intended</p> <ul style="list-style-type: none"> • Delivered as frequently and long as intended • Most school staff members adhered to the health pedagogical principles (Registration by the research group, observations, and focus group interviews with school staff) <p>Children</p> <p>Conflicting findings (School staff questionnaire, school staff logbooks, counts, focus group interviews with school staff, and observations)</p> <p>No (School staff questionnaire and focus group interviews with school staff)</p> <p>Yes (School staff questionnaire)</p>
Cold-water dispenser at school	<ul style="list-style-type: none"> • A cold-water dispenser should be installed and be available at the school throughout the study period • The cold-water dispenser should be maintained to ensure functionality 	<p>To a low degree delivered as intended</p> <ul style="list-style-type: none"> • Installed at school and available throughout the study period • Lack of maintenance caused periods where the dispenser did not work (Registration by the research group and focus group interviews school staff) <p>Children</p> <p>No (School staff questionnaire, counts, focus group interviews with school staff, and observations)</p>
Reusable water bottle for each child	<ul style="list-style-type: none"> • A reusable water bottle should be handed out to all children in 1st and 2nd grade 	<p>Fully delivered as intended</p> <ul style="list-style-type: none"> • A reusable water bottle was handed out to all children in 1st and 2nd grade (Registration by the research group) <p>Children</p> <p>No (School staff questionnaire, counts, and observations)</p>

Table 3 (continued)

Intervention component	Delivery		Acceptability	
	Pre-specified criteria for successful delivery	Fidelity: To which degree was the intervention component delivered as intended? (Data)	Did a minimum of 85% find the intervention component acceptable and/or satisfactory? (Data)	
Organized vigorous physical activity during school time (FIT FIRST 10)	<ul style="list-style-type: none"> The scheduled 3 × 40 min FIT FIRST 10 sessions should be carried out each week throughout the study period The school staff should follow the intervention manual for the FIT FIRST 10 sessions The FIT FIRST 10 sessions should contain the planned level of high intensity physical activity 	<i>To some degree delivered as intended</i> <ul style="list-style-type: none"> Delivered as frequently as intended in some classes Delivered almost as long as intended Sessions often had a shorter duration than intended The degree to which the school staff followed the FIT FIRST 10 manual varied The intensity of the sessions varied <i>(Registration by the research group, school staff questionnaire, observations, and focus group interviews with school staff)</i>	Children	Yes (Counts, focus group interviews with school staff, and observations) ^a
			School staff	N/A ^b
Packages of loose play and sports equipment for school recess	<ul style="list-style-type: none"> The equipment should be accessible for the children during recess 	<i>To a low degree delivered as intended</i> <ul style="list-style-type: none"> Limited access to the equipment during recess <i>(Registration by the research group, observations, and focus group interviews with school staff)</i>	Children	No (School staff questionnaire and observations)
Screen media habits assignment at school	<ul style="list-style-type: none"> The class responsible teachers should conduct the assignment 'The Digital Barometer' [in Danish: 'Det Digitale Barometer'] with the children in their class 	<i>To some degree delivered as intended</i> <ul style="list-style-type: none"> 'The Digital Barometer' was conducted in some classes <i>(Registration by the research group and focus group interviews with school staff)</i>	Children	N/A ^c
Inspiration sheets for parents on screen media habits and sleep	<ul style="list-style-type: none"> Three inspiration sheets about sleep and screen media habits should be sent to the parents 	<i>Fully delivered as intended</i> <ul style="list-style-type: none"> Three inspiration sheets were sent to the parents <i>(Registration by the research group)</i>	Parents	N/A ^d
Parent workshop on screen media habits	<ul style="list-style-type: none"> One workshop to be conducted The workshop should be centred around information and dialogue focusing on children's screen media practices 	<i>Fully delivered as intended</i> <ul style="list-style-type: none"> One workshop was conducted The workshop was centred around children's screen media practices <i>(Counts and registration by the research group)</i>	Parents	Yes (Counts, evaluation sheet for parents, focus group interviews with school staff, and observations)

^a Children's acceptability of this intervention component was also assessed in the school staff questionnaire, but due to few and thus not representative responses to these items, these data are excluded from the analysis^b No quantitative data available. Acceptability of this intervention component was assessed in the school staff questionnaire, but due to few and thus not representative responses to these items, these data are excluded from the analysis^c No quantitative data available. The children's acceptability of this component was only evaluated^d Data only collected with parent questionnaires (excluded from the analysis)

explored factors and mechanisms within both the individual- (e.g., child characteristics), class- (e.g., pupil composition), and school- (e.g., resources, management) contextual level.

The theory of action of the program theory for the 10 selected school-based intervention components, specifying how the theory of change is resourced and implemented to achieve the expected intermediary outcomes of the intervention [44] is shown in Fig. 1. For simplicity, we have shown only the program theory for the school-based intervention components, but the assumption of the GHK is that an effect is achieved through synergy from intervention components in multiple settings.

Data sources and data collection

Quantitative data

Parent and school staff questionnaires At the end of the seven-week implementation period, on March 17, 2023, one parent of each enrolled child and all school staff involved in the delivery of the intervention activities received a web-based questionnaire by e-mail about their own experiences of being involved in the study and their perception of their child/the children's acceptance of the intervention components. School staff members were asked to assess all children's acceptance of the intervention, irrespective of whether children were enrolled in the study by their parents. The questionnaires were developed for the present study with inspiration from existing process evaluation questionnaires [45–47] but tailored to the specific intervention components and procedures of GHK. Before use, the questionnaires were tested among and adjusted on basis of feedback from 1) experts, to ensure that items covered the relevant process evaluation concepts, 2) researchers responsible for each of the intervention components, to ensure that items covered all interventions activities and 3) representatives of the target groups, to ensure comprehension (for English language versions of the parent and school staff questionnaires, see Additional files 1 and 2, respectively). Two reminders were sent out, and the data collection ended on March 27, 2023. A total of 13 parents (30%) and six school staff members (46%) answered the questionnaires. As each parent response concerned only one child/parent, and the item response rate was around 25% or less for most items, we did not consider the parent data to be representative and thus excluded them from the analyses of acceptability. As each school staff response concerned their view on all children's experiences in a school class, and as the responding school staff members represented four of the five included classes, we have used these data in our analyses despite the low response rate.

School staff logbooks During the last two weeks of the implementation period, school staff were asked to roughly estimate and register the proportions of children tasting and/or eating each lunch meal and participating in each FIT FIRST 10 session via a few questions developed for the present study (for English language versions of the lunch meal and FIT FIRST 10 logbooks, see Additional files 3 and 4, respectively). School staff filled in a) 20 of 50 possible (40%) logbooks regarding consumption of the served lunch: two regarding the 1st grades; 10 regarding the 2nd grades; and eight regarding the remedial class, and b) seven of 30 possible (23%) logbooks regarding the children's participation in the FIT FIRST 10 sessions: two regarding the 1st grades; three regarding the 2nd grades; and two regarding the remedial class. We considered the seven FIT FIRST 10 logbooks to be too few to be representative and thus excluded them from the analyses of acceptability.

Evaluation sheets for parents At the end of the family evening and parent workshop, the participating parents were invited to fill in a brief, anonymous evaluation sheet developed for the present study regarding their experiences of the event (for English language versions of the family evening and parent workshop evaluation sheets, see Additional files 5 and 6, respectively). Twenty-three (77%) and 16 (76%) of the parents that attended completed an evaluation sheet at the family evening and parent workshop, respectively.

Counts Throughout the implementation period, all research group members contributed to counting intervention activities and attendees when relevant, e.g., during delivery or observation of intervention activities.

Qualitative data

Observations of intervention components We conducted five observations of the midmorning snack; 14 observations of the lunch, including children's use of the reusable water bottles; 14 observations of the FIT FIRST 10 sessions; approx. 8.5 h observation of the cold-water dispenser (mainly during recess); three observations of children's use of the loose play and sports equipment in recesses; and observation of the family evening (3 h) and the parent workshop on screen time (3 h). We did not observe teachers' delivery of the assignment on screen media habits as we were not informed by the school staff about when this assignment was conducted in the classes.

For each intervention component, we developed a semi-structured observation guide [48, 49] based on the specific component and relevant process evaluation

concepts. During all observations, we took detailed field notes.

Interviews with parents, school staff and school leader At the end of the implementation period, we invited parents of participating children and school staff involved in delivering the intervention to participate in a semi-structured focus group interview [50] about their own experiences of participating in the study and their views on children's acceptance of the intervention components. Also, we invited the school leader to participate in a semi-structured interview about the school's experiences of being involved in the study.

We conducted two focus group interviews with school staff of 1.5 h duration each: one with 1st grade staff ($n=4$) (February 27, 2023), and one with 2nd grade staff ($n=9$) (March 2, 2023), as well as one individual online 45-min interview with the school leader (February 28, 2023). Despite several reminders, none of the parents of the 44 enrolled children signed up for interviews. We developed semi-structured interview guides for all interviews in relation to the intervention components and relevant process evaluation concepts and supplemented with questions inspired by our observations during the study. We audio recorded the interviews and transcribed them verbatim.

Registration by the research group During the implementation period, we consecutively registered whether the provision of study materials to the school, structural changes at the school, etc. was done as planned.

Ethics and data management

The study was approved by the Regional Committee on Health Research Ethics for Southern Denmark (reference number S-20220059). All children, parents and school staff received written and/or verbal information prior to the study, and all custody holders of participating children provided written informed consent before enrolment of their child into the study's biomedical measurement schedule. To prevent differential treatment in the classrooms, all intervention components were offered to all children, irrespective of whether the child was enrolled in the study's measurement schedule. To avoid stigmatizing groups with certain health behaviours and body types, the research group was continuously aware of how the intervention was framed and how the target group was approached in both the qualitative and quantitative data collection.

All data were processed and stored in accordance with the EU General Data Protection Regulation (GDPR) and

national Danish data protection legislation. Data management was registered at Research and Innovation Organization at University of Southern Denmark (no. 11.815).

Data analyses

Overall, data were analysed using mixed methods, with a main approach of *merging integration*, i.e., co-analysing, comparing, and relating quantitative and qualitative data and results with each other when feasible and relevant [43].

Quantitative data were analysed using descriptive statistics, i.e., frequencies were calculated and reported on child-, parent-, school staff-, and/or school class level. Regarding the assessment of acceptability from questionnaire and logbook data, the response categories were not completely aligned with the 85% KPI. We therefore judged/defined that if 85% of respondents answered positively, i.e., 'All/nearly all'; 'Strongly agree' or 'Agree'; 'To a high degree' or 'To some degree'; 'Very satisfied' or 'satisfied'; 85% of children/parents/staff found the given intervention component acceptable.

Qualitative interview transcripts and field notes were analysed by 1) reading and familiarization with the data to form an overview, and 2) extracting, summarizing, and coding data according to the concepts of delivery, acceptability, and facilitators and barriers for implementation, and 3) selecting quotations and fieldnotes illustrating main points [51].

The level of delivery was determined on basis of a review of all relevant data and discussion and consensus among the involved research group members (LL, LASB, and RFK).

Results

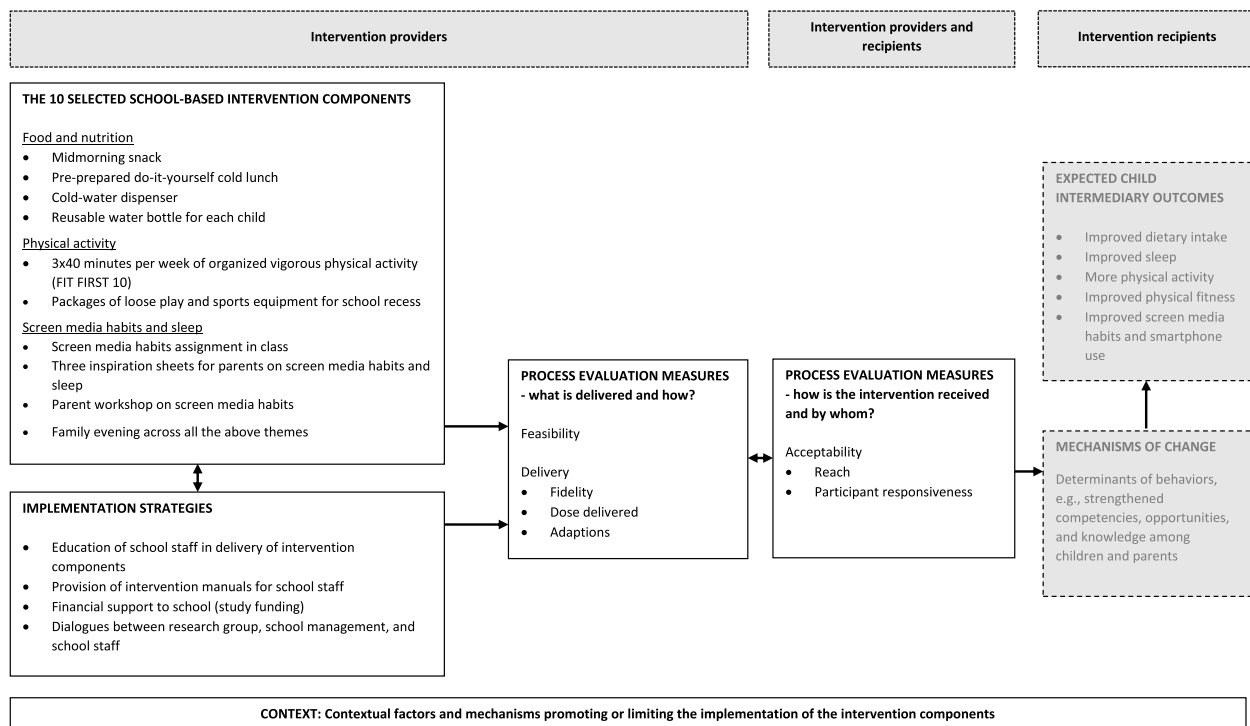
Delivery of intervention components

In the following, the results are divided into components delivered by the research group and the school staff, respectively, as the prerequisites for and thus the degree of implementation by these providers are incomparable.

Intervention components delivered by the research group

Of the six intervention components planned to be delivered by the research group, four components (67%) were delivered fully as intended:

A family evening (4–7 pm) was conducted across the themes of food & nutrition, physical activity, and screen media habits inviting both the children and their parents and siblings. In the food & nutrition session, the researchers delivered 1) information on the Whole Grain logo and the Keyhole label (Danish labels informing about wholegrain and sugar content in foods) combined



Intervention providers: School staff and research group
Intervention recipients: Children and families

Fig. 1 Theory of action of the program theory for the 10 selected school-based intervention components

with a tasting session with whole grain and plain pasta, and 2) tips and demonstration of healthy alternatives to ‘Friday candy’ (in Denmark, many families have a tradition of serving candy on Fridays). In the physical activity session, a researcher presented and demonstrated a range of active games suitable to play at home/inside the house (e.g., balloon tennis) to promote movement in the family, followed by an opportunity for parents and children to try out the different games. In the session on screen media habits, the researchers showed a video with good advises on behaviour on social media and facilitated a group exercise demonstrating, e.g., people’s different interpretations of emojis.

A reusable water bottle was handed out to all children in 1st and 2nd grade in the beginning of the study.

Three inspiration sheets for parents on screen media habits and sleep were sent out to the parents of enrolled children in week 5, 8, and 10, respectively.

A parent workshop on screen media habits (4–7 pm) was conducted, touching upon three topics 1) digital everyday life, 2) digital communities, and 3) image and video sharing. The format was a mix of presentation, discussion in plenary and smaller groups, and video display.

The two remaining components (33%) were to a low degree delivered by the research group as intended:

A cold-water dispenser was installed at the school and present throughout the study period. However, its location was not appealing; due to the placement of the water outlet, the dispenser was placed in the hallway, right next to the toilets. Also, school staff explained that there had been periods in which the dispenser did not work at all and in which the water had not been cold or had been yellow/brown due to unplugging and the school’s old plumbing system.

Packages of loose play and sports equipment for school recess were provided by the research group to the participating school classes for outdoor use, but for more than half of the study period, no school staff knew the purpose of the equipment. The research group subsequently divided the equipment into bags and placed one in each class, but at the end of the study, many school staff members still had no knowledge about the equipment bags. The school staff members who knew about its presence expressed an uncertainty about how and when to use the bag, and if they were obliged to use it.

Intervention components delivered by school staff

Of the four intervention components planned to be delivered by school staff, three components (75%) were to some degree delivered as intended:

A cold, pre-prepared do-it-yourself lunch was served to the children four days a week throughout the study period. During the focus group interviews, the school staff expressed that they had used a lot of time on implementing the lunch, e.g., on the practical tasks, and even used their own breaks to clean up after the meal.

During observations, most school staff members adhered to the study's principles of health pedagogy during the lunch meal:

'The teacher talks positively about the food; encourages the children to taste the food; eats the food herself; asks the children to wait before they eat their own packed lunch; etc.' (field note, 1st grade)

However, a few school staff members did not follow (all) the principles:

'There is no study related interaction from the teacher. And he does not notice the printouts on the rolling table (menu, allergens, etc. from the lunch supplier)' (field note, 2nd grade)

Organized vigorous physical activity during school hours (FIT FIRST 10). The FIT FIRST 10 sessions in the 2nd grades were carried out for five-to-six of the seven-week implementation period, with usually three sessions per week, but only once a week in the remedial class (no data available for the 1st grades). In all classes, most of the observed sessions had a duration of less than 30 min. The degree to which the school staff followed the FIT FIRST manual varied. Most often, they did not use all exercises listed for the chosen sport – sometimes because of limited time, other times because they chose to use other exercises than described. Most school staff members were good at keeping all children active throughout the sessions, while some sessions resulted in build-up of queues with children standing still.

The intensity of the FIT FIRST sessions varied between sessions and school staff: in some sessions, the vigorous physical activity was sparse or not present at all, while in others it was more prominent:

'In general, a high level of intensity...(...)... Especially during the chain-tag game, the children are laughing a lot and lose their breath; it is easy to hear that they are working hard and most of them also take off some of their clothes' (field note, 1st grade)

Yet, many children slowed down and transformed the intended high intensity training to low intensity training, unless the school staff encouraged an up-beat tempo persistently throughout the activity.

Screen media habits assignment in class ('The Digital Barometer'). Two teachers did not conduct the assignment in their classes before deadline, i.e., before the

parent workshop on screen media habits in which the children's replies should be used. The teachers that did conduct the assignment experienced that the time allocated for discussing the many questions in the assignment with the children was too sparse (the research group had suggested one school lesson for the assignment).

Finally, one intervention component (25%), i.e., a mid-morning snack at school, was to a low degree delivered by school staff as intended. The snack consisted of a wholegrain bun (often with baked in vegetables, e.g., carrots, to avoid dryness and meet the dietary guidelines), and twice a week also a piece of fruit. From day one of the study, many children had difficulties in biting into the large buns and whole pieces of fruit as they were about to change teeth. Thus, after only a few days, some school staff members started to cut the buns and spread them with butter or jam purchased by the school, and to cut the fruit into pieces. This adaption made it easier for the children to eat the midmorning snack and made them eat more:

'Several children went up [to the teacher] and got half a bun extra with butter' (field note, 1st grade)

But the use of butter and jam did not comply with the national dietary guidelines, and it cost extra time and resources from the school. A dialogue between the research group and the school staff was initiated to make the adaption comply with the nutritional guidelines, but any solution would require extra time and resources from the school, and the midmorning snack was therefore ended. Instead, the research group provided the parents with an inspiration sheet with tips, tricks, and suggestions for healthy midmorning snacks.

The results concerning the delivery of intervention components are summarized in Table 3 (third column).

Acceptability of intervention components

Family evening across the themes of food & nutrition, physical activity, and screen media habits

Parents Approx. 30 parents (and 30–35 children) participated in the family evening, including a group of mothers with another ethnic background than Danish; a pedagogue from school with another ethnic background than Danish had reached out to these mothers and encouraged them to attend, and she voluntarily attended the event and translated the presentations to them.

The evaluation sheet was completed by 23 parents (77%), and 96% were 'Very satisfied' or 'Satisfied' with the event. In general, our experience from observations was that the participating parents found the sessions relevant and fun. The emoji group exercise in the session on screen media habits was facilitated by parents, which

overall created a good dialogue between parents and children, but occasionally also led to an uncertainty about how to proceed with the exercise. The participating parents with another ethnic background than Danish were particularly fond of this game, and asked if they could bring the printed exercise home. A few parents made fun of the healthy foods agenda to each other, but most parents seemed to like the myth-busting related to (un) healthy food, tasting sessions, and ideas to reduce Friday candy. Also, most parent participated (with their children) in the physical activity games with great enthusiasm, smiles, and laughs.

Midmorning snack

Children None of the school staff members answered 'All/nearly all' when asked 1) how many children in the class usually had been eating the midmorning snack, and 2) how many children in the class usually had liked the midmorning snack.

During observations, the majority of children only took a few or no bites of the buns. Most children expressed that they did not like the buns (e.g., some buns tasted too much of vegetables) and that they were or looked dry:

'Why are the buns always so dry?' (quote, girl 1st grade)

'The children say 'Oh no!' [when they see the buns]' (field note, 1st grade)

The fruit was more popular than the buns, but still, usually the children only took a few or some bites of them. As previously mentioned, the children's change of teeth was also challenging for the consumption of the midmorning snack, and all in all, only very little was eaten, and the children expressed that they were still hungry.

Cold, pre-prepared do-it-yourself lunch

Children In the survey, half of the school staff respondents answered 'All/nearly all' when asked how many children in the class usually had eaten the lunch, while the school staff answering the logbooks reported that in 40% of the meals, all or nearly all children tasted/ate the lunch. None of the school staff answered 'All/nearly all' when asked how many of the children usually had liked the lunch in the survey.

Based on observations, all or nearly all children tasted some or all food served at lunch, and usually the children liked at least some of the food, but never all of it. In general, the children seemed to have a positive attitude towards the lunch; they were curious about the menu of

the day, and they talked positively about the things they liked.

'I am just sitting here eating cabbage! It tastes good!' (quote, girl 1st grade)

However, the children also talked about the things they did not like – in some cases very loudly which encouraged other children to say the same, e.g.:

'DAMN, that tastes disgusting!' (quote, girl 1st grade)

A few children were very picky and ate only or mainly their own packed lunch from home throughout the study. However, among the children eating the served lunch, an increasing number also started bringing a packed lunch from home and supplemented the served meal with this, i.e., from a few in the beginning of the study up to as much as approx. half of a class at the end of the study.

Of the served food, we observed some clear favourites among the children of which they could have eaten more if available, e.g., mackerel in tomato sauce. Likewise, there were some things which was hardly ever touched, e.g., pea puree and most dressings and dips.

When the children tasted something new, we often observed that they were positively surprised. For instance, a boy in 1st grade, who thought he did not like mackerel in tomato sauce on wholegrain rye bread, which is a traditional Danish lunch component among children, tasted it and ended up eating three pieces.

When observed, most children were good at staying seated during lunch, talk to each other in the small table groups, and focusing on the meal/eating, yet some children also struggled with these rules. At tables without an adult seated, the children were more likely to forget existing rules and instead play, walk around, and speak loudly/get into conflicts, even though the school staff usually got up from time to time and walked around to help.

During the focus group interviews, school staff expressed a range of challenges with the lunch, e.g., there was a too little selection of the served food the children liked and were familiar with; most children did not like the food that was unfamiliar to them; some children were still hungry after the lunch; some of the food was too difficult to chew; and as the study evolved and as also observed, more and more children brought packed lunch from home.

School staff Among school staff, 80% felt 'to a high degree' (20%) or 'to some degree' (60%) able to carry out the health pedagogical tasks around the lunch meal, and all school staff felt 'to a high degree' (20%) or 'to some degree' (80%) able to undertake the practical tasks around the lunch meal (school staff questionnaire; 5 respondents).

During the focus group interviews, most school staff members expressed feeling capable of adhering to the health pedagogical principles. However, some circumstances around the lunch meal challenged adherence, i.e., some school classes were burdened with a lot of noise and conflicts between children, and in some classes, there was only one adult to handle the lunch situation. Two teachers explained in relation to the lunch meal:

'It is very different from class to class (...) Such a set-up can easily work in class X [a 1st grade class] – here it is cozy, nice and it is comfortable. In class Y [another 1st grade class], I can feel that I actually sometimes think to myself: "Ugh, now it is just... it is getting a bit chaotic" (quote, school staff focus group interview, 1st grade staff)

'When there are two of us, it is much easier to handle those groups [disruptive children] than when you are alone. (...) Because there can be two boys jumping around the whole classroom because they are playing with peas or with white cabbage and so on' (quote, school staff focus group interview, 2nd grade staff)

Furthermore, the school staff felt that they needed time beyond the seven-week study period to get more familiar with the lunch meal situation to be able to adhere to the many principles.

Cold-water dispenser

Children None of the school staff members answered 'All/nearly all' when asked how many children in the class who had been drinking water from the cold-water dispenser on a daily basis.

During our 8.5 h of observations of the cold-water dispenser, two children drank (a little bit) from the dispenser, and three children just played with it. Our general observation was that the children instead brought water from home or used the water taps in the classroom or toilets. During the focus group interviews, school staff members explained that in the beginning of the study, some children had used the dispenser.

Reusable water bottle

Children Only one school staff member answered 'All/nearly all' when asked how many children in the class had used the water bottle on a daily basis.

In the first part of the study period, we observed that the children talked positively about their new bottles, and most children brought them to school. Later, children's use of the water bottles during lunch differed a lot: in classes in which school staff did not encourage the children to drink something during lunch, relatively few children (approx. 25–50%) took out their drinking bottles during lunch, and it varied whether these were the water bottles provided from the study. In classes in which the school staff encouraged the children to drink water, e.g., by asking all children to take out their drinking bottle and say 'cheers', all children had something to drink, and approx. 50% of the bottles were water bottles from the study.

Organized vigorous physical activity during school hours (FIT FIRST 10)

Children Our observation was that usually all or nearly all children participated in all or most of the FIT FIRST 10 sessions. Occasionally, a few children did not want to participate, but they usually changed their mind during the session or were persuaded by the school staff to participate. It was rarely seen that a child did not participate at all in the sessions.

Overall, the vast majority of children had fun during the sessions: they laughed, were engaged in the activities, cheered each other on, and made loud squeals/screams of joy. However, we observed a few children struggling with maintaining the attention throughout the sessions, and some of them disrupted the sessions:

'The three children (...) do not listen, they disturb the others and do other things than they should – and this becomes clearly worse when the supporting teacher leaves the session' (field note, 2nd grade)

Also, some girls observed in one of the sessions expressed they did not like their classmates to jump over them as part of a FIT FIRST 10 exercise as they were afraid, they would stumble and hurt them.

During the focus group interviews, a teacher explained that from the first time the children tried FIT FIRST 10, everyone thought it was fun, and none of the children

had grown tired of it during the study period. He also explained how the exercises were great at challenging the “body scare” between boys and girls: now, all were doing the exercises with each other irrespective of gender, and the sessions had strengthened the sense of cohesion in the school classes.

School staff During the focus group interviews, most school staff members expressed that the FIT FIRST 10 manual was a good tool and inspiration, and for the most part easy to understand. However, some of the described exercises were too technical and therefore not used. Some school staff explained how some (but few) of the exercises in the manual could be difficult to conduct for some children with a high body weight (e.g., an exercise called ‘the record player’ in which one child should lay down on the back of another child and spin around) and thus expressed a wish for alternative exercises to enable inclusion of all children. Some school staff also expressed that it was difficult to conduct the FIT FIRST 10 sessions with the entire class of more than 20 children, being only one school staff member present. Thus, in one of the classes, school staff chose to conduct the FIT FIRST 10 sessions with only half of the class at a time while sending the other half to do schoolwork together with another class. As no more time was allocated for this, each half of the class received sessions considerably shorter than the intended 40 min.

Packages of loose play and sports equipment for school recess

Children No school staff members answered ‘Strongly agree’ or ‘Agree’ to the statements that most children in 1st grade and in 2nd grade had used the equipment.

From observations, our overall impression was that the use of this equipment was very limited. For instance, during one recess, we observed some of the skipping ropes being used for tying each other up, one girl was drawing with chalk, and one frisbee was lying in the grass. We observed that in most of the recess, some children played different kinds of ball games, usually with balls from the selection already present in the classes before the study was initiated.

Screen media habits assignment in class

Children During the focus group interviews, the teachers expressed that it took some time and required a lot of

effort from the children to complete the assignment ‘The Digital Barometer’. A teacher explained:

‘There was a lot of ‘What does that mean?’ and ‘What does that mean?’ and ‘Is it correct now?’ And they [the children] were more focused on answering, than reflecting over the questions. But you know, in 1st grade it just requires a lot of them.’ (quote, school staff focus group interview, 1st grade staff)

They also stated that many of the questions concerned social media which to their knowledge was not relevant for or used by 1st graders.

Parent workshop on screen media habits

Parents Twenty-one parents (five men and 16 women, from a total of 14 families) participated in the workshop. Among these was also a group of mothers with another ethnic background than Danish; again, the pedagogue from school had reached out to them, and she voluntarily attended the event and translated the content to them.

Of the 16 parents filling in the evaluation sheet, all (100%) were ‘Very satisfied’ or ‘Satisfied’ with the workshop.

During observations, we experienced that the parents listened to the presentation, asked a lot of questions, and participated actively in the integrated small group exercises. Based on the parents’ reactions, they seemed to find the topics of the workshop very relevant. There was also lots of smiles and laughs, e.g., related to their recognition of themselves as parents (in the presentation and videos). Some parents were clearly surprised with some of the results presented from the small survey ‘the Digital Barometer’ completed by the school classes prior to the workshop, e.g., the number of children stating that their parents do not know who the children follow on the social media.

During the focus group interview, the pedagogue participating in the workshop explained that the mothers with another ethnic background than Danish liked the workshop and learned a lot, e.g., there was a good discussion between the mothers about being a role model for their children.

The results concerning the acceptability of intervention components are summarized in Table 3 (right column).

Table 4 Contextual influences on implementation of the 10 selected Generation Healthy Kids school-based intervention components

Individual level		<i>Barriers and facilitators related to the intervention recipients</i>
Child characteristics	Age	As the children were about to change their teeth, it was difficult for them to bite into the large buns and fruit served as midmorning snack and to chew some of the food served for lunch 'The Digital Barometer' was difficult to understand and complete for children in 1st grade, and some questions were not relevant for 1st graders. Also, the recommended time allocated for the assignment was too sparse for children this age
	Body weight	Some FIT FIRST 10 exercises were not suitable/optimal for children with a high body weight
	Taste preferences	Most children did not like the buns served as midmorning snack A few children were very picky Too little variety and too much unfamiliar food served for lunch There was not enough of the food that the children liked (best) to make them full, so some children (over time more and more) brought packed lunches from home as a supplement
	Behavioral issues	Some children disrupted the FIT FIRST 10 sessions by e.g., disturbing the other children and doing other things than they were told (also see 'Social dynamics')
Class level		<i>Barriers and facilitators related to the school class</i>
Social dynamics		It was easier for school staff to follow the health pedagogical principles during the lunch meal in school classes with a low level of noise and conflicts compared to classes with higher levels of noise and conflicts (also see 'Behavioral issues')
Class size		(see 'Number of school staff members in the class')
School level		<i>Barriers and facilitators related to the intervention provider context</i>
School resources	Physical facilities	The old plumbing system at school caused yellow/brown water in the cold-water dispenser As the only water outlet was next to the toilets, the cold-water dispenser was placed at a non-appealing location
	Time	Overall, scarcity of school staff's time was the main challenge for implementation of the intervention components
	Number of school staff members in the class	Being only one school staff member present made it difficult to conduct the FIT FIRST 10 sessions with an entire school class at a time Being only one school staff member present during the lunch meal challenged the adherence to the health pedagogical principles
School staff characteristics	Commitment	Committed school staff adhered to a large extent to the health pedagogical principles during lunch and the FIT FIRST manual; they encouraged the children to drink water; and they facilitated that the intervention also reached parents with another ethnic background than Danish (through school staffs' voluntary participation in after school events, taking on the role as interpreter, and actively encouraging this group of parents to participate) On the contrary, lack of commitment from school staff clearly caused e.g., low level of adherence to health pedagogical principles during lunch
	Capability	The intervention period was too short for the school staff to get familiar with all the health pedagogical principles; too little time to make them a routine Some FIT FIRST 10 exercises were too technical for the school staff to understand and to conduct with the children Some school staff members adapted intervention components to facilitate delivery and acceptability
Interaction between school staff and research group		Insufficient communication between school staff and research team limited maintenance of the cold-water dispenser and use of the loose play and sports equipment for school recess

Barriers and facilitators for implementation of intervention components

From the above analysis we have identified a range of barriers and facilitators for delivery and acceptance of intervention components at different contextual levels: individual (child age, body weight, taste preferences, behavioural issues), school class (social dynamics, class size), and school (school resources, school staff characteristics, and interaction between school staff and research group). The identified barriers and facilitators are summarized in Table 4.

Furthermore, from the school leader's perspective, the greatest barrier for implementation was finding the time in the school staff's schedules for all the different intervention activities:

'So that has probably been the biggest challenge in all this - quite simply, it is finding the time for it' (quote, school leader interview)

Discussion

Main findings

In the present study, we found that it was feasible to deliver most of the selected school-based GHK

intervention components in the school context. Concerning fidelity, however, only four of ten (40%) intervention components were fully delivered as intended, while the remaining components to some or to a low degree were delivered as intended. Both school staff and the research group adapted challenging intervention components during the study period to facilitate delivery and acceptability of the intervention components. Data showed a mixed picture of the children's acceptability of the intervention components, with some intervention components found acceptable by all/nearly all children and others only by some or a few children. We were not able to evaluate parents' acceptability of the intervention activities delivered to their children due to limited data. Only approx. 30 (19%) and 21 (13%) of approx. 162 potential parents participated in the family evening and the parent workshop, respectively. These intervention activities were found acceptable by all/nearly all participating parents. School staff's acceptability of their intervention related tasks varied, but was overall relatively high, yet, due to limited data, we could not evaluate their acceptability of all tasks. Contextual factors at child-, school class-, and school level acted as barriers or facilitators for optimal implementation.

Interpretation of the 85% cut-off

The pre-defined ambition of the present study was that minimum 85% of activities were delivered as intended, and that minimum 85% of participants and intervention providers found the program acceptable and/or satisfactory. As our results show, we did not adhere to the 85% KPI for the delivery, and in summary, only for four of the intervention components, a minimum of 85% of children, parents or school staff found (aspects of) the component acceptable. It is debatable whether the cut-off was set too high. To our knowledge, there are no recommended cut-offs for successful implementation in general. According to Durlak & Dupre [39], an implementation level around 60% is common, and levels above 80% are rare, which makes our 85% cut-off seem unrealistically high. Also, for acceptability, other feasibility studies have evaluated intervention components as 'well-received by the participants' when proportions lower than 85% of participants express satisfaction with the components [52, 53]. We had to decide on a cut-off on a relatively short notice based on a request from the funding body. At that time, we had not planned the intervention design and evaluation in detail, and the cut-off of 85% was thus decided based on many uncertain assumptions. In hindsight, we consider that it was not realistic to strive for 85% for all intervention components, not least due to the relatively short intervention period of the feasibility study. Furthermore, some intervention components were delivered by the research group and should therefore be expected

to be delivered almost as intended (85% realistic) and to a larger extent compared to intervention components delivered by school staff in a busy school day with competing tasks. It is thus not surprising that most of the research group delivered components, but none of the school staff delivered components, were fully delivered as intended. In other words, it does not seem meaningful nor fair to compare the levels of implementation between researchers and school staff. That said, as seen for the cold-water dispenser and the play and sports equipment for recess, there was no guarantee for delivery success for simple, research group delivered components; this was mainly due to limitations of the implementation strategy, i.e., dialogue between the research group and the school. It was not clear to the school staff that they should contact the research group in case of problems with the cold-water dispenser, or what the purpose of the recess equipment was. Also, the complexity of the intervention components to be delivered ranged from being very simple, e.g., a reusable water bottle, to being highly complex, e.g., the lunch scheme with a range of practical tasks and health pedagogical principles to adhere to. The simple initiative 'just' needed to be handed over, e.g., a water bottle from the study to the child, while the school staff expressed a need for a longer intervention period than allocated for the feasibility study to get used to the lunch meal situation and to be able to adhere to the many principles.

The value of combining data

Our study reflects the value of combining data in feasibility studies, not least when we missed quantitative indicators due to low response rates on surveys from parents. In general, the different data collected in the study largely confirmed each other which made conclusions regarding the acceptability quite straightforward. However, for the lunch meal, data were conflicting: the school staff reported a lower level of acceptability (quantitative and qualitative studies) than observed by the research group in class. This discrepancy might be due to the school staff observing only a few children (at the table where they were eating themselves) or because their focus during lunch was on encouraging the pickiest children to eat the lunch. This may have overshadowed the overall level of acceptability and have led to an underestimation of the level of acceptability. On the other hand, it is also possible that the children made a greater effort to e.g., taste the food when observed by us, leading to an overestimate of the 'every-day level' of acceptability. However, our impression was that our frequent visits in the classes made the children 'forget' our presence and acted unaffected.

Unfortunately, no quantitative data were available from school staff on their acceptability of the FIT FIRST 10 or the children's acceptability of the screen media habits assignment. However, qualitative data indicated a rather high level of acceptability of the FIT FIRST 10 among school staff, and a low level of children's acceptability of the assignment which may also be considered in the adjustment of the intervention components for the main trial.

Barriers and facilitators of implementation

Similar to previous school-based interventions [54, 55], time constraints and staffing were identified as main barriers for school staff members' implementation of the intervention components. We will try to accommodate these barriers in the main trial by making agreements with school leaders to allocate more time for the meal situation, and by study staff supporting the school staff, especially in the beginning of the study where, e.g., the implementation of the new lunch structure is expected to be more time consuming than when the children bring their lunches from home.

Another barrier for implementation was low level of commitment to intervention-related tasks among some school staff members. We expected the level of commitment (their interest in and priority of the focus areas) among the school staff to vary as they had not volunteered for the tasks but were assigned to them by the school leader based on their usual role in the classes. In line with this, a survey by van Kleef et al. [56] among 204 primary school staff in the Netherlands found that approx. 30% of the school staff would be willing to invest time and energy to initiate a school lunch program or thought that a school lunch fits their school tasks [56]. Other studies have shown quite high levels of acceptability of interventions among the school staff, e.g., in a qualitative process evaluation of universal free school meal provision in two London secondary schools, Jessiman et al. [57] found that school staff were very positive about the intervention due to the perceived benefits for the children and reduced financial burden on families [57]. Importantly, the intervention evaluated in the latter study contained no practical nor health pedagogical tasks for the school staff in relation to the lunch scheme, only preparatory communication with parents, e.g., information, encouragement, and application [57]. Thus, for our main trial, we are aware of the potential barrier of low level of commitment among school staff due to the considerable range of study tasks, and we will therefore pay even greater attention to emphasizing the intervention benefits for the children during the training of school staff (e.g., provide the children with energy to concentrate during school lessons, to play and to enter into social

relations with peers) and consider means to support the staff even more in the commitment to and delivery of the intervention-related tasks.

Our aim was to identify contextual facilitators and barriers for implementation. However, some of the identified barriers obviously also relate to both the intervention itself and implementation strategies, e.g., age- and weight inappropriate components, too complex intervention components, and insufficient communication between school staff and research team, underlining the need for refining these intervention components and implementation strategies in the main trial.

Emerging mechanisms and outcomes

The qualitative studies of implementation also uncovered some emerging mechanisms and outcomes to consider in the main trial. For instance, our observations and school staff interviews provided us with preliminary indications that the assumed working mechanisms of the intervention activities worked as intended, e.g., the school lunch meal and FIT FIRST 10 seem to strengthen school class cohesion. However, the interviews also indicated that some FIT FIRST 10 exercises may work against this aim if children with a high body weight cannot take part (cf. the example with the 'record player'), calling for more exercises for the teacher to choose between to avoid exclusion or stigmatization of certain groups of children. We also found preliminary support for the intended working mechanisms on food literacy (e.g., the children became more food courageous during the study and were often surprised that they liked certain food items they thought they did not like) as pathways to more healthy habits. The proportion of children eating a packed lunch from home in addition to the school lunch meal increased throughout the study period which might have increased the risk of children ending up eating more than they needed. We will make sure to serve familiar, delicious looking food in enough quantities in the main trial to prevent children from bringing their own lunch bag. Furthermore, we will encourage parents to support the school meal scheme and encourage children to use it.

Strengths and limitations

The findings of the present study should be interpreted in the context of the methodological strengths and limitations.

As a main limitation should be mentioned the study duration of only seven weeks. Often, the duration of a feasibility study is considerably longer, e.g., Morgan et al. [28] reports that the average duration of feasibility studies funded by the National Institute for Health Research's Research for Patient Benefit program and closed by May

2016 was 31 months (range: 18 to 48) [28]. Our limited study time frame obviously challenged the study of feasibility of structural changes, e.g., in relation to the lunch scheme, as such changes probably will take time to implement and become a routine. However, based on our experiences and previous studies [11, 15, 58–61], we are optimistic about the two-school-year time frame in the main trial.

Another limitation includes the low response rates on the parent process evaluation survey, school staff surveys and logbooks, and the unsuccessful recruitment of parents for interviews, making it impossible to assess, e.g., the acceptability of some intervention activities. However, the many positive views and experiences from school staff expressed in the focus group interviews combined with their input on where refinement of intervention components is needed, and the positive parent evaluation of the two-family events make us optimistic about the acceptability of the main trial. Low response rates among school staff and parents are a common challenge across school-based intervention projects [62–66], and we are considering different initiatives to promote participation in surveys and interviews and in this way ensuring a thorough and nuanced process evaluation of the main trial. Also, it is possible that the numerous invitations, reminders, and information during the short intervention period has caused a general ‘project fatigue’ [29] or that the short intervention period may have challenged whether parents found it meaningful to spend time on surveys and focus groups. We hope that the enrolment in the larger main trial of two years duration instead of a brief feasibility test will motivate parents and school staff to participate.

It is also a limitation that we did not include interviews with children and child surveys in the process evaluation of the intervention components [67] – we only had informal chats with children during our observations. Due to the low response rate on parent surveys, the child perspective on intervention activities was mainly represented through our observations. We plan to include children’s perspective in surveys and interviews in the process evaluation of the main trial.

A considerable strength of this study includes the opportunity for testing all intervention activities and measurements in the target group (1st and 2nd grade children) at a school with a rather high proportion of children from households with low SES and children with another ethnicity than Danish before initiating the main trial on 23 schools and more than 1300 children [28].

Another, major strength includes the combination of quantitative methods (surveys, logbooks, evaluation sheets, and counts) and qualitative methods (observations, interviews, and registrations) as well as multiple

data sources and perspectives on the study (parents, school staff, school leader, and field work among children and school staff) [68]. E.g., the disagreement between school staff reports on proportions of children eating the lunch meal provided and our observations of children’s participation in the lunch scheme underlines the importance of including many perspectives on the implementation process.

Implications for research and practice

This study has provided valuable insights into which of the selected school-based intervention components and implementation strategies that need to be refined, excluded, or replaced by other activities in the GHK main trial. Identified main concerns include 1) the content and delivery of the midmorning snack and lunch scheme, including some school staff’s low adherence to the study’s health pedagogical principles, and children’s rejection of some of the food offered; 2) that some school staff delivering the FIT FIRST 10 sessions did not adhere to a) the recommended duration of 40 min, b) the list of exercises recommended in the manual, and c) the aim of high intensity training; 3) that the provided loose play and sports equipment for active breaks were not made accessible to the children during recess; and 4) that the assignment on screen media habits was not age-appropriate. Based on the identified concerns, we have developed action points for the main trial (Additional file 7). Examples of action points are: the provision of midmorning snacks will be replaced by parental inspiration sheets with tips and tricks for midmorning snacks; use of a new food delivery company; focus on the age appropriateness of the lunch; focus on supporting school staff in the implementation of the lunch scheme; highlighting the study expectations to school staff’s delivery of the FIT FIRST 10 sessions in terms of frequency, duration and content, and encourage the use of the loose play and sports equipment for recess during the school staff preparatory course; and further development of use of an adapted, age appropriate version of ‘the Digital Barometer’. By implementing the suggested action points and refinement of the intervention components, we expect to develop a feasible and acceptable intervention, ready for efficacy testing in the main trial.

Future feasibility studies may build on our experiences and methodological approaches. Especially, and as other scholars [43, 48, 69], we highly recommend the combination of multiple methods and perspectives to get a nuanced picture of the implementation processes. Furthermore, we recommend funding of longer feasibility studies to mimic the length of the intervention period in the main trial and account for the time needed

to implement changes and make them a part of routine practice in the school context.

Conclusions

This study has provided valuable insights into the feasibility and acceptability of the selected main school-based Generation Healthy Kids intervention components, and the study underlines the importance of conducting feasibility studies as preparation for large trials. The findings will be used to refine intervention components, implementation strategies and data collection procedures before the main trial, and future feasibility studies may benefit from our experiences and methodological approaches.

Abbreviations

GHK Generation Healthy Kids
MRC Medical Research Council

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-024-20605-7>.

Additional file 1. Parent questionnaire (English language version).
Additional file 2. School staff questionnaire (English language version).
Additional file 3. Lunch meal logbook for school staff (English language version).
Additional file 4. FIT FIRST 10 logbook for school staff (English language version).
Additional file 5. Family evening evaluation sheet (English language version).
Additional file 6. Parent workshop evaluation sheet (English language version).
Additional file 7. Action points for the Generation Healthy Kids main trial.

Acknowledgements

The authors gratefully acknowledge all research group staff participating in the present feasibility study, as well as the 1st and 2nd grade children, parents, school staff and school management at the participating school.

Authors' contributions

LL, LASB, DH, NHP, LTT, MNL, PK, CTD, UT, and RFK made substantial contributions to the design of the work. LL and LASB were major contributors in collecting data. LL, LASB, and RFK analysed and interpreted the data. LL was major contributor in writing the manuscript, and LASB and RFK made substantial contributions in the writing process. LL, LASB, DH, NHP, LTT, MNL, PK, CTD, UT, and RFK have read and approved the final manuscript.

Funding

The study is funded by the Novo Nordisk Foundation (grant no. NNF22SA0077224). The study management and the funding body agreed on the study KPIs. The funding body played no further role in conceptualization, design, data collection, analysis, decision to publish, or preparation of the manuscript.

Data availability

The data used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was performed in accordance with the Declaration of Helsinki and was approved by The Regional Committee on Health Research Ethics for Southern Denmark (reference number S-20220059). Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 7 June 2024 Accepted: 4 November 2024

Published online: 19 November 2024

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